The Hungarian monetary transmission mechanism: an assessment[1]

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1. Introduction

From the central bank's point of view, the transmission of monetary policy to the economy is of prominent interest among various macroeconomic topics. Without being aware of the monetary transmission mechanism (MTM), it is not possible to conduct good policy. In Hungary, our knowledge so far has been based mainly on intuitive understanding of the structural features of the economy instead of evidence from quantitative research.

At the beginning of 2004, a comprehensive research project was launched at the Magyar Nemzeti Bank (MNB). The objective of the project was to provide quantitative results about the Hungarian monetary transmission mechanism in order to form an overall picture. The focus of the project was on empirics. We first investigated those areas where the most up-to-date econometric methods could be applied.

The sample used for estimations typically covered the period between 1995 and 2004. In some cases when the higher frequency or the existence of panel data endowed us with enough observations, the sample was even shorter. The identification of the effect of monetary policy has been particularly challenging due to the fact that during this period the main driving force behind macroeconomic fluctuation came from the supply side, not from the demand side. Being aware of this difficulty, we tried to apply techniques capable of disentangling the monetary policy from other sources of shocks.

This paper attempts to create a synthetic view from particular results. During 2004 and 2006, nine papers were 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.

There are some aspects that make our synthesis challenging. The first difficulty to overcome is that the particular estimates were based on various sample periods. Despite this, we will treat the underlying studies as if they referred to the same sample, which is typically the decade between 1995 and 2004. The second problem is that the definition of monetary policy differs across estimations. Some papers consider the effect of an interest rate change, while other authors investigated only those changes that were not an endogenous reaction of monetary policy to some economic shocks. Taking into account their limited comparability, we try to create a qualitative synthesis which is consistent with all individual findings.

In the assessment of the overall picture, we focus on two particular issues that are of primary interest. The first is about the effectiveness of monetary policy. Having an open capital market with predominant presence of foreign investors, interest rates and the exchange rate are strongly influenced by the risk preferences and risk assessment of international players. It was sometimes not obvious whether there is an autonomous monetary policy in Hungary that conducts a policy according to its targets, or the interest and exchange rates are driven

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by international and other factors. Hence, we first posed the question whether it is possible to detect a 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 closely followed exchange rate movements influencing incomes, wages and other prices. Should this picture change 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 focuses on two stages of the 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 the 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 explicitly addressed 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) asked whether the 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 has so far provided mainly puzzling results regarding the effect of monetary policy. Although these puzzles were interesting from a scientific point of view, they were of less practical importance regarding large, closed economic entities like the United States or the euro area. Hungary is a small open economy, and the exchange rate has played a distinct role in formulating and communicating monetary policy. Hence, we allocated more resources to this issue than is usual in the literature on the 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 accumulating all the information about the stance of monetary policy through commercial bank interest rates and asset prices economic agents on the goods market make their purchase decisions. At this second stage, we analyse the behaviour of aggregate demand with special regard to private consumption, investment decisions and foreign trade.

Finally, we give a brief overview of how relative price changes disappear in the long run and what role the labour market plays in this procedure. We can consider this as the third stage of the transmission process. Despite its obvious importance, we cannot have a deep insight as we have no specific research focusing on this area.

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 the Hungarian MTM. Section 3 classifies particular results using Mishkin's (1996) approach. In Section 4, we investigate aggregate demand. In Section 5, we review our knowledge about medium-run effects, including the labour market and the non-tradable sector. Section 6 concludes and, based on Orbán and Szalai (2005), attemps to assess future trends.

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 of maintaining price stability. The volatility of output is also of prominent 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 the Hungarian MTM.

We investigate the behaviour of output and prices after an unexpected monetary tightening. According to Vonnák (2005), a typical monetary policy shock can be characterised as a 30-40 basis point interest rate hike coupled with a 0.6–0.8% exchange rate appreciation. Both changes are transitory, with the variables returning to the baseline after three to four years.

The response of Hungarian consumer prices to the shock 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 the 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 the price response is somewhat different from those found in closed, developed economies like the United States or the euro area. Most SVAR estimates[3] 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, the yearly inflation rate is higher at the beginning, but later falls below the baseline persistently. This stands in clear contrast with 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. We conclude therefore that Hungarian GDP drops somewhat after the contraction.

Estimates for the United States and the euro area show a more pronounced output response. Although there are some studies that could not find a significant effect of monetary policy,[4] 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, the GDP response leads the price response.

In the case of Hungary, the same new-Keynesian explanation alone is not able to explain fully what happens after a monetary policy shock. The response of output is moderate. The reaction of prices is instantaneous and does not lag behind that of the output gap. For

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

[4] Uhlig (2005) is such an example.

Hungary, some alternative description of the transmission mechanism is needed. In the following sections, we try to identify the special features of the 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, the credit supply of the banking sector and expectations through its policy rate and communication. Economic agents extract the signal transmitted by those markets and make decisions on their demand for goods and production. The second stage of the MTM consists of the reaction of demand as well as the adjustment process of the supply side and the labour market.

In this section, we classify the results that relate to the first stage of the MTM relying on Mishkin (1996), who distinguishes between interest rate, exchange rate, asset price and credit channels. This framework provides a convenient way to separate distinct mechanisms of monetary transmission. Another advantage is that Mishkin's categories are widely used when talking about the effect of monetary policy. However, the framework has some shortcomings as well. These channels cannot be regarded as a model-based, complete decomposition of the whole effect. For example, we augment Mishkin's classification scheme with the expectation channel. Another problem is that in some cases separating these channels is very difficult. Nonetheless, we found this framework to be a useful tool for arranging the results of our research on various aspects of the transmission mechanism.

3.1 Interest rate channel

The first stage of the interest rate channel is the mechanism through which the 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 the face of new interest rate conditions. We summarise 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 10 years, a short-term deposit rate has acted as policy instrument. Up until 1997, its maturity was one month, and since then the policy rate has been the two-week deposit rate.

According to the expectation hypothesis, longer maturities are linked to the policy rate through expectations of the 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 that short-term rates change. On the contrary, if the market expects that higher rates will remain for longer, long-term yields will increase more, whereby monetary policy may be more effective.

An important feature of most of our research is that typically three-month money market or T-bill rates are used as the 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 reflect the frequent change in the monetary policy stance. On the other hand, we can consider the three-month interest rate 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 reference to tightening bias, three-month market rates will rise and this reflects a genuine monetary tightening correctly, even in the absence of an immediate interest rate move. Nonetheless, at a monthly or quarterly frequency the policy rate co-moves with three-month market rates closely, as 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 increased by 10 basis points after a surprise 100 basis point policy rate hike on the same day. The one-year-ahead forward interest rate increased by half a percentage point, but beginning with the five-year horizon a significant decrease was detected. As long as forward rates reflect interest rate expectations, the reaction of forward rates can be interpreted as: 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 is 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 three-month interbank rate, rendering it essentially a short-term debt with frequent repricing.

HKN (2004) investigate the connection between the 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 80% 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, and that 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 mainly through 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 for 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 domestic 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.[5] The estimated relationship between interest rate and exchange rate was just the opposite, that is, appreciation was more frequently coupled with a positive 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

[5] For a survey, see MacDonald and Taylor (1992).

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 a higher domestic interest rate or 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 a 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 assessments 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.

The presence of shocks to the risk premium makes it difficult to measure the effect of monetary policy on the exchange rate. 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 the exchange rate to monetary policy. Rezessy (2005) estimated the immediate impact of monetary policy shocks on the exchange rate. He used daily data starting in the middle of 2001, when the intervention band of the forint was widened and the inflation targeting regime was introduced. His identification strategy exploited the fact that on the occasion of rate-setting meetings of the Monetary Council monetary policy shocks are typically larger than on other days. He detected a significant effect with the expected sign on the first day, and an even larger effect on the day after a 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, the short-term interest rate and the 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 assumed that, out of all the possible shocks that have only a delayed effect on output, the 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, being based instead on some historical evidence about Hungarian monetary policy. The response of the 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 five to 10 years monetary policy has been able to influence the exchange rate. An unexpected 25 basis point rate hike on average appreciates the exchange rate almost immediately by 0.5–1%.

Karádi (2005) introduced a more sophisticated model of monetary policy and the exchange rate. In his setup, there are two channels via which the central bank affects the exchange rate: one is the traditional interest rate policy, the second is by influencing exchange rate expectations. The relevance of his model is obvious from the characteristics of 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 range of exchange rates considered to be consistent with the inflation target was usually announced.

From equation (1) it is obvious that with full control over exchange rate expectations it is possible to manage the spot exchange rate without changing the policy rate. With constant foreign and domestic interest rates, a 1% change in the expected future exchange rate will move the spot rate by the same amount in 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 inflation. As a consequence, the forint appreciated by 10% within two months without any policy rate hike.

The second step in the exchange rate channel concerns 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 of the exchange rate. Hungary being a small open economy, the consensus view has been that exchange rate movements are tracked closely by tradable goods prices and affect the tradables sector strongly. Hence, the level of the exchange rate, not that of interest rate, was considered as a proper representation of the monetary policy stance. Although this MTM link belongs rather to the second stage, here we briefly review the most important findings for Hungary.

There is a branch of papers in the literature investigating how exchange rate changes pass 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 is stressed in Bouakez and Rebei (2005).

In order to highlight this issue, let us consider the case of the 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 has achieved this by quickly reversing exchange rate movements induced by sudden shifts in the risk assessment of foreign investors. As a result, these shocks have had virtually no effect on output and prices. In contrast to this, autonomous monetary policy had a persistent effect on the exchange rate, and therefore consumer prices also reacted in the medium term. Intuitively, after an exchange rate change economic agents 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 so far have attempted 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, the Czech Republic, Poland and Slovenia. He found that the long-run exchange rate pass-through was high in Hungary during the years of the crawling peg regime, compared to the other three countries.

Jakab and Kovács (2003) investigate the role of expectations, the goods market and the labour market in the exchange rate pass-through. Simulating with the Hungarian block of the NIGEM[6] model, they conclude that during the first one to two years after an exchange rate movement the pass-through mainly depends on the pricing elasticity to cost changes and the role which expectations play in price and wage setting. From the third year onwards, the markup elasticity becomes dominant. Labour market characteristics, namely the elasticity of wages to unemployment and productivity, are important only in the longer run, roughly five years after the shock.

[6] World model of National Institute of Economic and Social Research.

Our project has not included any research with the sole aim of obtaining fresh estimates for the pass-through. Nevertheless, for the understanding of consumption and investment decisions, JVV could not escape from dealing with the pass-through of monetary policy induced exchange rate movements. Using information from three empirical macromodels, they concluded that the pass-through to tradable goods 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 very informative insights into the effects 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 for investigating 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; and (3) the success of the package hinged primarily on fiscal policy, especially on the fact that 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.

It is in order here to mention the role of intermediate goods in transmitting exchange rate changes. 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.

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

Kovács (2005) demonstrates that firms’ profits did not significantly improve after the depreciation in 1995–96. 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 neutralising role of material costs was particularly important for firms producing for export. After the nominal appreciation in 2001–02, a similar story but with opposite sign can be read from firm-level data. Kovács (2005) concludes that, in Hungary, corporate sector profitability is mainly determined by foreign trade partners’ business cycle; the role of the real exchange rate is negligible.

3.3 Asset price channel

According to monetarist as well as Keynesian theories, asset prices decline after a monetary contraction. Higher interest rates result in higher yields expected from bonds whose prices fall. Stock prices also fall. The loss of property value can also be important as households’ consumption spending might be affected through house equity withdrawal.

Mishkin (1996) explains the asset price channel focusing on 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 investment declines. The second channel works through household consumption. Lower equity prices reduce household wealth and they consume less.

In Hungary, there are at least two reasons for considering the stock price channel as irrelevant. First, there is no empirical evidence that monetary policy affects stock prices. We have estimates only for the instantaneous impact of monetary policy decisions on the Hungarian stock market index (BUX). Rezessy (2005) found no effect, which is in contrast with Rigobon and Sack (2004), who detected significant decreases in major US 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 a delayed effect on equity prices.

Second, shares play a minor role in Hungarian households' financial wealth. They amounted typically to approximately 10% of all financial assets during the past 10 years. The same is true for other securities, like government bonds. Their amount has never exceeded 10% of total assets. Even households' financial wealth itself is not as large as in more developed countries. At the end of 2004, total financial assets excluding items that are not supposed to play a role in the asset price channel (cash, deposits, insurance technical reserves) amounted to 40% of annual GDP (see Figure 3).

Housing wealth may play a more important role in the asset price channel, as its market value is more than three times larger than household 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.[7] 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 a significant effect of the 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,[8] we can conclude that even the housing market is unable to explain the effect of monetary policy.

3.4 Credit channel

The role of credit supply in magnifying the effect of monetary policy is discussed in detail among others in Bernanke et al (1995). The basic idea is that monetary tightening leads to a higher external finance premium stemming from imperfections in the credit market, such as principal-agent problems. They argue that the conventional cost-of-capital effect fails to explain the size, timing and composition of the observed response of spending on durable goods. The additional mechanism, called the credit channel, should not be seen as a stand-alone mechanism but rather as an amplifier of the conventional way the 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 the bank lending channel and the balance sheet channel. The former concept rests on the assumption that a monetary contraction drains loanable funds from the banking sector. Commercial banks can raise new funds only at a higher price by issuing certificates of deposit or equity. The balance sheet channel is related to the financial accelerator phenomenon. Changes in the 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 a higher external finance premium.

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

[8] Kiss and Vadas (2005) assumed a permanent 1 percentage point increase in the interest rate and they obtained 0.3% and 1% 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% response of GDP components.

Stylised facts about the Hungarian economy suggest that even if a credit channel exists, its contribution to the transmission mechanism may not be highly significant. Many commercial banks as well as a large part of the non-financial corporate sector are owned by large foreign companies. Loans from the parent company are available for many domestic firms at a normal price even if 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 a credit channel is to use cross-section estimates. In this way, one can identify a 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 a 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 equations on a panel of 25 commercial banks during the period 1995–2004. They related banks' ability to raise new funds to their size, liquidity, capitalisation and foreign ownership. In the regression they also controlled for GDP growth, inflation, the exchange rate and the foreign interest rate. Using several specifications, they could not reject the null hypothesis that the effect of 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 a significant non-zero effect on investment spending. Although several channels may exist through which cash flow can influence investment, one plausible candidate is the external finance premium, that is, the balance sheet channel.

Taking into account the ownership structure of the 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 to 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, 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, monetary policy responds to it according to its rule and no one doubts that all the variables, including inflation, will return to the steady state value. As a consequence of forward-looking behaviour, the effect of the shock is mitigated by the public's expectations as well. Similarly, if the central bank changes its target and announces it, expectations may help interest rate policy 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 than with policy shocks.

In the real world, it is usually the case that the target is either not explicit or not believed by the public (credibility problem). The central bank may want to signal that its target is below or above the current or forecast level of inflation. It can do this by communication or, in the absence of credibility, by demonstrative, unexpected changes of its instrument. Monetary policy shocks can thus be useful for sending messages about monetary policy preferences to signal commitment and to gain credibility. In 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 roles in new-Keynesian theories of monetary transmission. The higher the credibility of 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 major changes in employment; therefore the short-run supply curve is more vertical than in the rigid-wage case.

An important example of 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 closely follow input prices as changes in the latter are expected to be short-lived due to the nominal stability established by monetary policy.

Expectations also play a role in some of the channels analysed earlier, 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 the exchange rate as well as of 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 changed 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 found in the United Kingdom 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. Nevertheless, whereas a typical Hungarian firm reviewed prices quarterly, in the United Kingdom respondents did so monthly. Another counterintuitive result was that in the 2001 Hungarian survey the pattern became more similar to the UK pricing practice despite the fact that Hungarian inflation had been decreasing between 1998 and 2001, even if not very dramatically (from 14–15% to 10%). The relatively rare practice in Hungary of reviewing prices can be justified by the costs of gathering information, as argued in Mankiw and Reis (2002). In any case, firms' responses regarding the reasons for price-changing suggest that costs are more important than expectations.

We know even less about the Hungarian labour market. Pula (2005) gives a comprehensive description of the flexibility of the Hungarian labour market. He claims that in Hungary the bargaining power of trade unions and employees is 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, a plausible reason for wage stickiness is the backward-looking nature of wage setting. An alternative explanation can be that the disinflationary monetary policy was not entirely credible, with economic agents expecting the past level of inflation to remain.

Some results related to other channels bear information about 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 preferences. His results show that communication was effective in coordinating market participants' exchange rate expectations and it helped exert influence on spot rates too. These two examples highlight the importance of the expectations of agents in financial markets.

Although this channel is the most difficult one from the econometrician's point of view and we do not have specific results, we have the overall impression that while financial markets were supportive and expectations made policy more effective, expectations of price and wage setters have 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 that gaining credibility for the new objectives takes time.

4. Demand

In basic models of the MTM, production is affected by monetary policy mainly through the demand channel, as 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 decreasing (increasing) their output, as repricing is costly and thus can be done only later. Lower demand without price adjustment results in output level and marginal costs lower (higher) than natural. As time passes, firms cut (lift) their prices according to the altered environment. Lower (higher) prices stimulate (calm down) demand and production returns to its natural level. This mechanism can be labelled as the output gap or demand channel.

There is some empirical evidence for Hungary of such a 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 repricing. Their finding is in accordance with the results of a similar survey in the United Kingdom 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 exports. For this section, JVV is our starting point. Using three different macromodels, they show that a significant effect of monetary policy can be detected first of all in the case of investment. 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 channels of the transmission.

4.1 Consumption

Investigating the transmission mechanism within an SVAR framework, Angeloni et al (2003) find that while in the United States. household consumption dominates the response of output to monetary policy shocks, in the euro area the contribution of investment is more important. Nevertheless, the signs of impulse responses are intuitive in both economies, namely: after an unexpected tightening, both consumption and investment drop.

In contrast with the euro area and the United States, JVV demonstrated that in Hungary there is no empirical evidence of lower consumption after monetary contraction; one model even shows rising consumption. This finding may appear to be counterintuitive especially when one takes into account the results of Kiss and Vadas (2005), who detected a significant effect of monetary policy on consumption through the housing market.

Nevertheless, there are some empirical studies as well as theoretical ones which suggest that this type of consumption response is plausible. Theoretically, one important reason can be that the appreciation of the currency increases the wealth of households. Households then may spend their excess revenue stemming from the higher purchasing power of their

wealth on either tradable or non-tradable goods depending on the income elasticities of both. Benczúr (2003) 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 the MTM in euro area members using country models. In four out of the 12 countries, consumption is above the baseline for a couple of years after a monetary tightening shock. In Belgium and Italy, the authors attribute rising consumption to the net creditor position 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 tradable prices respond to monetary policy quickly because they track exchange rate movements closely. Since the short-term reaction of non-tradable prices is virtually neutral, the overall price level declines already during the first year. Contrary to prices, nominal wages remain unchanged for at least one year, meaning that real wages rise. The income effect offsets other mechanisms such as asset price changes.

It is important to stress that the empirical evidence of this kind of consumption response is not strong enough. 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 10 years,[9] statistical methods that do not control for fiscal policy may fail to separate the two effects. Nevertheless, the way JVV explained why consumption does not fall after monetary contraction is in line with Jakab and Vadas (2001), who found that wages are by far the most important explanatory variable for consumption and who could not detect a significant role for interest rates.

To sum up, and putting these findings into Mishkin's framework, we can conclude that there are no signs that after a monetary tightening private consumption falls in Hungary. The reason is the relatively quick exchange rate pass-through and the slower nominal wage adjustment. Our interpretation is that the exchange rate channel offsets interest rate, asset price and other channels concerning the behaviour of Hungarian households.

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 of 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 estimate an investment function using a large number of observations of firm-level balance sheet data obtained from the APEH[10] database. The main advantage of their approach over aggregate time series techniques is the high degrees of freedom from the cross-section observations.

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

[10] Hungarian Tax Authority.

Most importantly, they found a significant and quick reaction of investment to changes in user cost, which reinforces the finding of JVV. Obviously, there are serious limitations in translating KW's result to the macro level. The first problem comes from the cross-section heterogeneity. The obtained impulse response is valid at the 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, the two-week deposit rate) and the user cost. The specification they used relates investment to the user cost, which consists of expected return on equity and bank lending rates among others. Obviously, monetary policy has no direct control over these factors. In order to assess the impact of monetary policy on investments, we need to know the relationship between the policy rate and user cost, but, unfortunately, we have no empirical evidence.

The third difficulty to overcome is that they estimate only one dynamic equation in which investment spending is explained by the user cost, sales and cash flow. Even if we treat user cost as exogenous, which is a questionable assumption in itself, cash flow and sales apparently depend 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 investment. The appropriate exercise would therefore be to simulate the effect of the policy instrument on user cost, cash flow and sales, and to 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 then needs a proper aggregation technique.

Using the same database as KW, Reiff (2006) estimates at the firm level an investment model for the 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 is then able to analyse at both aggregate and firm level how investment responds 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 and the limited comparability of the three models, the high degree of similarity between impulse responses from micro- and macro-estimates makes us believe that those results reinforce each other and – similarly to the euro area – investment is a key ingredient of the demand effect of monetary policy. As we will show in the next subsection, the demand for investment goods may help keep foreign trade balanced despite the strong exchange rate response.

It is worth noting that although the cost-of-capital channel is usually counted as part of the classical interest rate channel, the role of the exchange rate in investment decisions may be important, as JVV emphasise. Since investment goods are typically tradables, their prices move closely together with the exchange rate. The cost of capital includes the (expected) inflation of investment goods, and declining prices of the latter involves higher cost of capital as postponing investment spending pays off. Their conclusion is that although the existing evidence is insufficient to separate the exchange rate effect from the direct interest rate effect, the response of investment is likely to reflect 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 deterioration of the trade balance after an

unexpected monetary tightening, the other two suggesting rather a balanced path but with substantial uncertainty.

Looking at exports and imports separately, it becomes obvious that while the models indicate a similar response of exports, it is the reaction of imports that is responsible for diverging results. All three models predict a sizeable 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 strong competition in the international goods markets.

There is, however, much less agreement among models on how imports react 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 paper referred to predict declining imports, which can explain the fairly balanced net export response they obtained.

There are several plausible explanations for the insignificant net export response and the ambiguous import response. According to Kim (2001), after an appreciation expenditure-switching results in lower exports and more imports, due to the change in their relative price. The observed behaviour of Hungarian consumption itself would imply higher import demand, at least according to two models used in JVV. On the other hand, contractionary monetary policy may reduce imports by lowering domestic demand, that is, through income absorption. In Hungary, the significant drop in investment 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, exchange rate changes cause a quick response of exports in terms of both volumes and prices. Second, changes in investment and consumption as well as exports influence imports. It seems that the import demand from investments and exports dominates imports. Therefore the income absorption effect offsets expenditure-switching, implying that no significant net export reaction can be detected by econometric methods.

4.4 How do 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 exports. In other cases, even if the relationship exists, 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; sometimes it is not possible to identify through which channel a certain component of demand was affected. Nevertheless, using this scheme, we can rank the importance of particular mechanisms.

Taking into account the high sensitivity of private investment to monetary policy, the interest rate channel may play an important role in the transmission mechanism. Nonetheless, it is not possible to disentangle it from other channels. JVV explain how exchange rate appreciation can lead to the same reaction through the user cost of capital. Similarly, we cannot rule out that credit supply also contributes. On the other hand, the asset price channel seems not to influence the investment behaviour.

In the case of consumption, the exchange rate channel was identified as the main reason for the insignificant response. Through the income effect, it can offset the interest rate and credit channels. Asset prices are not found to explain consumption behaviour.

The role of the exchange rate is trivial in the case of net exports. Although we could not detect a significant effect of monetary policy on the trade balance, the quick reaction of export and import prices highlights the dominance of the exchange rate channel in short-run price development.

We can conclude that the exchange rate channel dominates the short-run output and price effect of monetary policy. Due to the openness of the Hungarian economy, consumer prices react more quickly than in the United States or the euro area, while the change in output is smaller due to the lack of households' consumption response. Nevertheless, the significant reaction of investment suggests that the interest rate channel may not be negligible in Hungary.

5. Nominal adjustment in the medium run

Changes in aggregate demand affect various sectors differently. In the medium run, relative prices adjust mainly because the labour market transmits monetary policy impulses between sectors. As for Hungary, we expect that tradable price changes spread over the entire economy, including non-tradable goods prices. In this section, we present what we know about the medium-run effects of monetary policy. Since we have not conducted specific research on this topic, we rely on some other studies outside the MTM project and present some fresh estimates.

The most important observation is that although exchange rate and tradable prices dominate the short-run effect of monetary policy, consumer prices remain at a lower level even when the exchange rate returns to its initial value. Since tradable prices follow exchange rate movements closely, this indicates some price adjustment of non-tradable goods.

Indeed, SVAR estimates[11] show (see Figure 4) that non-tradable prices, approximated by the price index of market services, respond slowly to monetary policy. The adjustment of goods prices not directly affected by the exchange rate seems to prolong the immediate reaction of tradable prices.

One possible explanation of relative price adjustment is based on the labour market. If wages equate between sectors, demand shocks to some sectors spill over to the rest of the economy. In our case, the fall in exports and investment after a monetary contraction may exert downward pressure on employment and wages in the entire economy. Lower wages allow producers in sectors not directly affected by lower demand to cut their prices. The relevance of the labour market in the medium run is demonstrated by Jakab and Kovács (2003), who found that, several years after an exchange rate shock, pass-through depends on labour market developments in Hungary.

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

Figure 5 presents impulse responses from an SVAR similar to the previous one used to estimate the tradable and non-tradable price response.[12] 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

[11] The estimation was based on Vonnák (2005). Similarly to the SVAR estimation strategy introduced in JVV, I augmented the four-variable benchmark monthly VAR (industrial production, CPI, three-month T-bill rate, exchange rate, sample 1995:m1–2004:m12) with industrial goods and market services subindices. For identification of monetary policy shocks, I used sign restriction as in Vonnák (2005). The results are comparable to those of the paper referred to.

[12] In this case, a VAR model of quarterly GDP, the CPI, the short-term interest rate, the nominal exchange rate, employment and nominal wages in the private sector was estimated. The identification was the same as in the previous SVAR.

to the baseline as early as in the second year. Probably it is the higher unemployment rate that promotes the nominal wage adjustment. According to the SVAR estimates, firms respond to higher wage costs first by cutting jobs. Lower employment then pushes wages down, allowing firms to keep prices low even three to four years after the monetary shock.

6. Conclusion and forward-looking remarks

In this paper, we reviewed the fresh results of nine studies conducted 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 summarised as follows. Consumer prices are affected immediately in the first year after monetary policy tightens through an increase in the policy rate. The response is persistent; the price level 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 more or less offset the demand effect of decreasing investment spending.

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

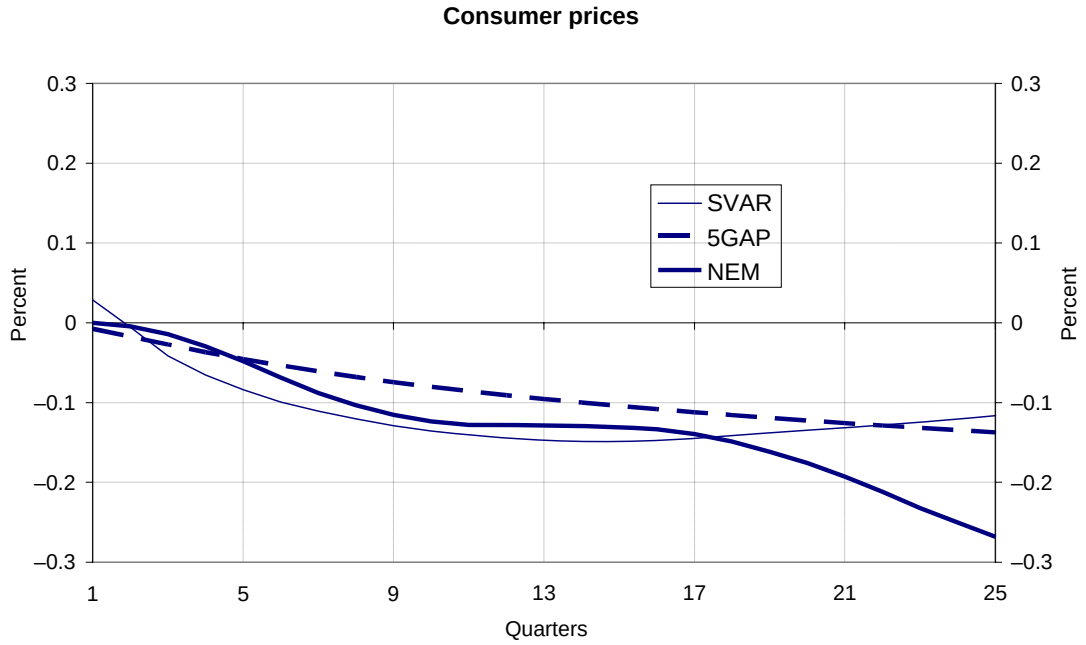
We attribute the difference first of all to the central role that the exchange rate plays in the Hungarian monetary transmission mechanism, mainly for two reasons. First, due to openness, exchange rate movements pass through to tradable goods prices quickly. Second, the output response is mitigated by the fact that, because of the short-run nominal wage rigidity and the quick exchange rate pass-through, the income effect offsets the interest rate effect on consumption, resulting in a fairly insensitive reaction.

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 of whether it is optimal for Hungary to join the euro area and run the risk that the economy will remain without an effective monetary policy that could smooth shocks.

Orbán and Szalai (2005) point out that, after euro adoption, the scope of the interest rate channel will broaden for at least two reasons. First, common monetary policy shocks in the euro area will influence the Hungarian economy through foreign demand, which is now an exogenous factor for monetary policy. Second, the ECB's interest rate policy affects the interest rate burden on euro-denominated loans directly. The authors conclude that the differences between the Hungarian MTM and those of present euro area member countries will not be so important that an asymmetric response to common monetary policy and real divergence in the euro area could be expected.

Figure 1

CPI responses to an unexpected rate hike[1]



[1] NEM and 5GAP model simulations from JVV; SVAR estimates from Vonnák, 2005.

Figure 2

Three-month money market, T-bill rates and the policy rate

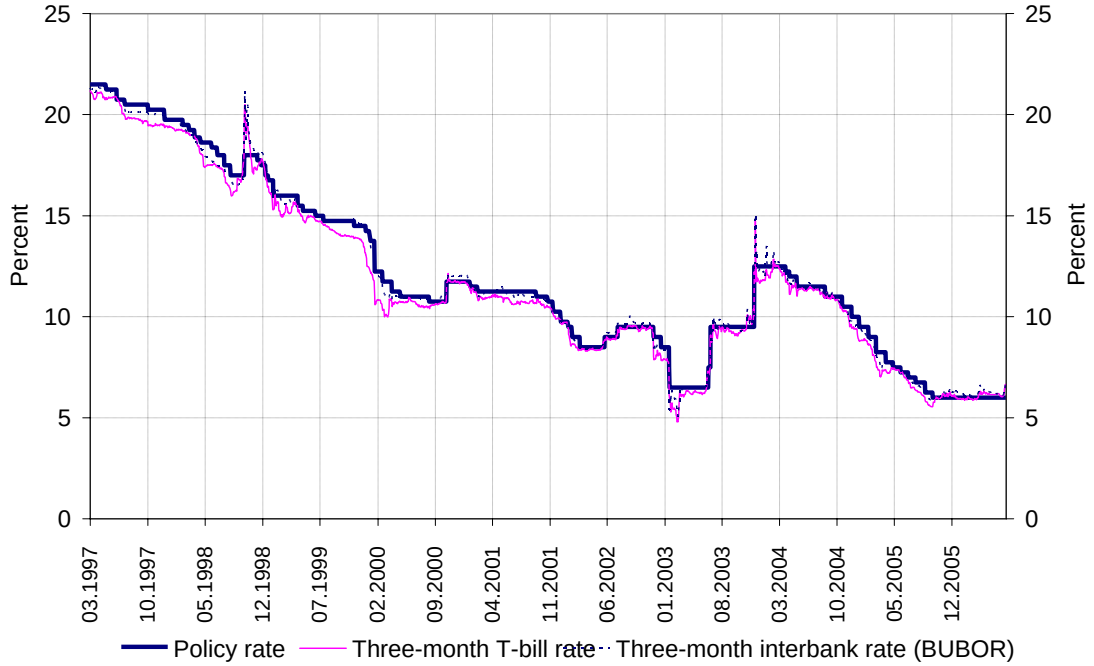


Figure 3

Households' wealth as a percentage of GDP

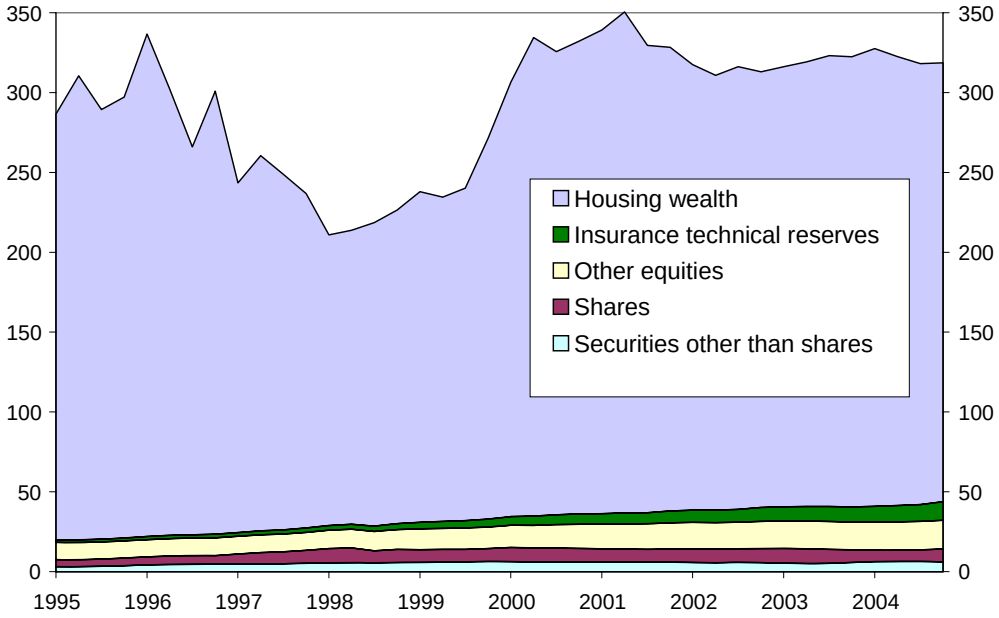
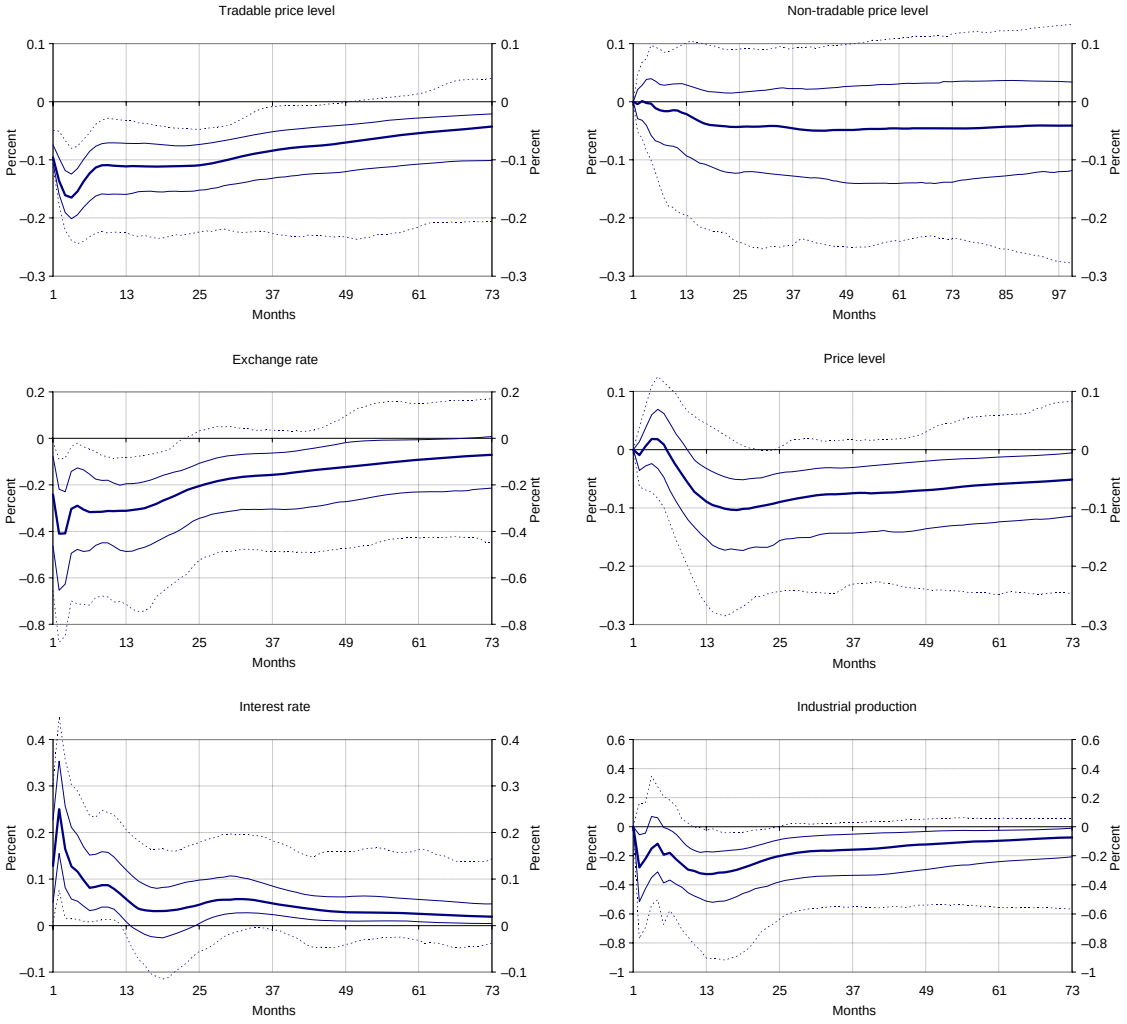


Figure 4

Response of tradable and non-tradable goods prices to an unexpected rate hike[1]

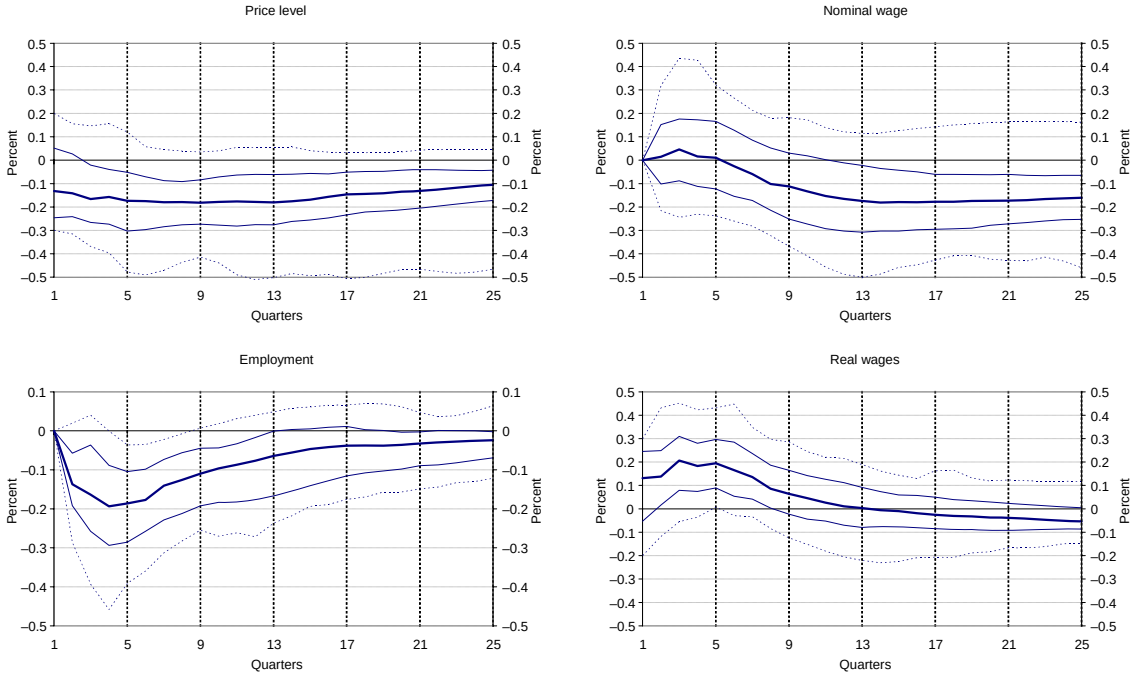


The median estimates and the middle 68% and 95% of the Bayesian posterior distributions.

[1] SVAR estimates.

Figure 5

Response of employment and private sector wages to an unexpected rate hike[1]



The median estimates and the middle 68% and 95% of the Bayesian posterior distributions.

[1] SVAR estimates.

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