Monetary Policy Shocks in the new EU members: A VAR approach

by Alessio Anzuini* and Aviram Levy*

Abstract

The paper provides empirical evidence on the effects of monetary policy shocks in the three largest new EU members: Czech Republic, Hungary and Poland. VAR system estimates suggest that, despite the lower financial development of these countries, the co-movement of macroeconomic variables, conditional on a monetary policy shock, is similar across countries and not dissimilar to what is found for more advanced European economies. While qualitatively similar to the responses observed in the old members, the responses of the new members are, on average, weaker. Poland has the most stable responses both over time and across different identification schemes.

JEL classification: C30, E44, E52, F41.

Keywords: Financial structure, identified VAR, monetary policy shock, price puzzle.

Contents

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1. Introduction[1]

In May 2004 ten countries joined the European Union (EU): Cyprus, Czech Republic, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia. In the short to medium term, it is to be expected that these countries will strive for closer integration with EU member States also in the monetary field, by applying for ERM2 membership and, later on, for the adoption of the euro. In this respect, it is desirable that the effects of monetary policy do not differ significantly between old and new members of the euro area. This issue had been analysed by a large body of literature in the late 1990s, in the context of the debate on whether countries with a diverse economic cycle and financial structure would be able to adopt successfully a common monetary policy.[2] Against this background, the main purpose of this paper is to provide econometric evidence on the effects of a monetary policy shock: the VAR estimates are aimed at comparing the effects of monetary policy in these three countries and, subsequently, assessing whether the effects differ from the conditional responses which can be observed in other western European countries[3].

The econometric results suggest that, despite the lower level of financial development, the macroeconomic variables of the three countries react to a monetary policy shock in the standard way. Following a 1 percentage point increase in interest rates, in all countries industrial production declines significantly and persistently. If we exclude the first part of the 1990s, in all countries consumer prices tend to decline significantly after roughly 1 year. As for the exchange rate, in all countries a contractionary domestic monetary shock leads to an appreciation. Using previous studies on monetary transmission in the EU as benchmarks, an important result of this exercise is that in the three new members considered the contribution of a domestic monetary shock to output fluctuation is in line with previous estimates for the four

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[2] Recent studies on this issue are Guiso et al. (1999), Angeloni et al. (2002).

[3] Our results are compared with Kim (1999), Kim and Roubini (2000).

largest EU economies. We conclude that no evidence of asymmetric effects is found either between new and old EU members or among new members. Three additional results are worth mentioning. The first is that, on average, the responses of macroeconomic variables are weaker compared to the old members. The second result is that Poland has the most stable impulse response functions. For this country, the estimated responses are stable over time and across different identification schemes. Third, within the three new members Hungary's responses are the strongest, Poland's responses are the weakest[4]. However, it is important to note that, even if the identification scheme is the same and the shock is normalised across countries so that comparisons are possible to some degree, the confidence bands are generally large enough to suggest that differences in averages may not be significant.

The paper is organised as follows. Section 2 presents the empirical model. Section 3 describes the estimates of the VAR systems, which are carried out separately on each acceding country. Section 4 concludes.

2. The empirical model

This exercise aims at analysing the effects of a contractionary monetary shock in the new members of the EU. We estimate a five variable VAR system, one for each new member considered, i.e. Czech Republic, Hungary and Poland. All estimated VARs are just identified systems. All identifying restrictions are short run restrictions, i.e. zeros in the impact matrix. All variables are expressed in log levels (except interest rates); we implicitly assume that there is enough cointegration so that the variables are jointly covariance stationary (Sims (1990)). In all regressions, a complete set of dummy variables is included in order to capture any seasonality effect. The lag length of each system is chosen with a view to strike a balance between two needs: eliminate the autocorrelation of residuals and preserve as many degrees of freedom as possible. We chose to perform a Ljiung-Box test and increase the number of lags up to the point where the autocorrelation was not significant at a 5 per cent level. Since the Ljiung-Box test has a strong small sample bias we always evaluate the lag structure obtained from this test against a set of alternatives using AIC (Akaike Information Criterion) and SBC (Schwartz Bayesian Criterion). In the VAR literature no general consensus has emerged on the ordering to

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[4] Notice, however, that the estimates for Hungary are sorrounded by great uncertainty.

assume for the variables included in the system[5]. Neither a consensus has emerged on the use of the recursive structure in the identification process. However, it is possible to distinguish between two groups of identification schemes based on short run restriction: the recursive structure as in Christiano, Eichenbaum and Evans (1998) and the non-recursive structure as in Kim (1999). Both identification schemes are designed to recover only the effects of a monetary policy shock. In both schemes a contractionary monetary policy shock is a positive innovation in the nominal interest rate and the row in which the nominal interest rate appears as endogenous variable is interpreted as a reaction function of the monetary authorities. While in the recursive structure the Wold order of the variables implicitly assumes that monetary authorities choose the interest rate by looking at the current level of prices and output and assumes that output and the price level do not change in the impact period but react only with a one-period delay, in the non-recursive identification approach (hereafter, Structural VAR) each row has its own interpretation (see Kim, 1999) and it is assumed that monetary authorities, due to an information delay, do not see the current value of prices and output when choosing the interest rate[6].

More precisely, the variables are placed in the vector y_t. The structural form is:

$$C\left(L\right)y_t = \eta_t$$

where $C(L)$ is a polynomial matrix in the lag operator and $VCV\left(\eta_t\right) = \Lambda$ is a diagonal matrix with the variances of the structural shocks as elements. We estimate (ignoring predeterminates) the reduced form:

$$y_t = A\left(L\right)y_{t-1} + \varepsilon_t$$

where $A\left(L\right)$ is a polynomial matrix in the lag operator and $VCV\left(\varepsilon_t\right) = \Sigma$ and $\eta_t = C_0\varepsilon_t$ therefore $\Sigma = C_0^{-1}\Lambda C_0^{-1\prime}$. In order to obtain a just identified system we need $\frac{n\times(n-1)}{2}$

[5] An illuminating survey on the topic is provided in Christiano, Eichenbaum and Evans (1998).

[6] Sims and Zha (1995) made similar assumptions.

restrictions. The recursive identification scheme is:

$$\begin{bmatrix} \eta_t^1 \\ \eta_t^2 \\ \eta_t^3 \\ \eta_t^{monetary} \\ \eta_t^5 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ g_{21} & 1 & 0 & 0 & 0 \\ g_{31} & g_{32} & 1 & 0 & 0 \\ g_{41} & g_{42} & g_{43} & 1 & 0 \\ g_{51} & g_{52} & g_{53} & g_{54} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{cpi} \\ \varepsilon_t^{ip} \\ \varepsilon_t^{m} \\ \varepsilon_t^{i} \\ \varepsilon_t^{cp} \end{bmatrix}$$

where the variables in the vector $y_t = (cpi, ip, m, i, cp)$ are: prices, industrial production, money, interest rate and commodity prices. The C_0 matrix identifies the relation between the structural disturbances η_t and the reduced form residuals ε_t. We also estimate a version of the system excluding money from the VAR. While results, in this specific exercise, did not change significantly, it is worth noting that in case of estimation of a VAR system without money a confusion is likely to arise between a money demand shock and a money supply shock.

In the non-recursive scheme the C_0 matrix takes the form:

$$\begin{bmatrix} \eta_t^{monetary} \\ \eta_t^2 \\ \eta_t^3 \\ \eta_t^4 \\ \eta_t^5 \end{bmatrix} = \begin{bmatrix} 1 & g_{12} & 0 & 0 & g_{15} \\ g_{21} & 1 & g_{23} & g_{24} & 0 \\ 0 & 0 & 1 & g_{34} & 0 \\ 0 & 0 & 0 & 1 & 0 \\ g_{51} & g_{52} & g_{53} & g_{54} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{i} \\ \varepsilon_t^{m} \\ \varepsilon_t^{cpi} \\ \varepsilon_t^{ip} \\ \varepsilon_t^{cp} \end{bmatrix}$$

where a g_{ij} means that the coefficient is not constrained. The first line is a money supply equation modeled as a reaction function of the monetary authority, the second line is a standard money demand equation, the third and fourth lines encapsulate the hypothesis of price stickiness or adjustment cost. The fifth line is an arbitrage equation.

In the first scheme we normalize the shock to a 1 per cent increase in interest rates whereas when we use the second scheme the size of the shock is the commonly used one standard deviation.

In both schemes the last variable is the world export price in domestic currency, i.e. the nominal exchange rate multiplied by the world export price in U.S. dollars. The inclusion of the latter variable is motivated, in the VAR literature, by the need for some control for imported inflation or, more generally, to control for an endogenous increase in the interest rate. Since we are dealing with a very small open economy we will interpret the movements of this latter variable, conditional on a monetary shock, as the movement of the nominal exchange rate. Both identification schemes allow nominal exchange rates to react immediately to the monetary shock, but only the second scheme assumes that monetary authorities look at the contemporaneous value of the exchange rate while choosing nominal interest rate. In order to avoid changes in the transmission mechanism of a monetary policy shock we would like to deal with economies for which the exchange rate arrangements do not change in the estimation period. Unfortunately, all the small open economies considered have modified the exchange rate regime in the sample period used for the estimates (see the Table 1).

This last consideration may cast some doubts on the plausibility of a stable linear model for new members. However, even if a model with stochastic regime switches might be more appropriate for transition economies, the estimates in this paper may be of some interest as they summarize relations in the data averaged over different states. Moreover, it is not completely clear how the exchange rate regime affects the transmission of a monetary shock in less industrialized economies (see for example Canova, 2003).

In all the systems we identify only a monetary shock while impulse response functions with a 48 month horizon after the shock are considered. Following a standard Montecarlo experiment, confidence bands at 68 per cent and 95 per cent significance level are plotted in all impulse response functions recovered with the first identification scheme. Confidence bands at 68 per cent significance level, calculated by means of a Bayesian Montecarlo experiment (Sims and Zha, 1999), are plotted for all estimates obtained using the second identification scheme. We use monthly data covering the period 1993-2002. Results are encouraging: despite the lack of financial development, for all the new members, conditional on a monetary shock, macroeconomic variables display standard behaviour. In all the impulse responses recovered, following an increase in interest rates, industrial production declines and the exchange rate tends to appreciate. The price level declines when the second part of the 1990s is used as a sample period for estimation, while we find a significant price puzzle when we use the entire sample. This last result applies to the Czech Republic and Hungary, but not to Poland. Results for Poland are robust across sample periods as well as across identification schemes.

2.1 *The expected effects of monetary shocks*

Before presenting the empirical results, we discuss the expected movements of the macro variables conditional on a monetary policy shock. The effectiveness of monetary policy is closely related to the transmission of a monetary impulse from the central bank's key rates to money market and then other fixed income interest rates. The transmission from the money market to the lending rates applied by banks to non-banks is the other part of the story. The degree of development of the financial markets and their proper functioning are therefore crucial for the propagation of monetary impulses. The effect of the interest rates on the exchange rate is obviously another important channel. In the theoretical literature there are two major classes of models used to study the effects of a monetary shock: "limited participation models" and "money in utility function models" are standard examples[7]. In both classes of models, following a contractionary monetary shock the interest rate increases, prices decrease and output does not increase; it is worth noting, however, that similar effects are reached through very different transmission mechanisms.

In a "limited participation" model, following an injection of liquidity by the authority the available funds that banks can lend to firms increase, firms can raise investment and the increased investment boosts economic activity. In the real world this mechanism is represented by the credit channel. Since we expect the credit channel to play a central role in firms' response to changes in monetary policy, we use the share of bank loans to total liabilities of the corparate sector as an indicator of firms' expected reaction to interest rate changes, i.e. the higher this share is, the more firms should be affected by monetary impulses. Hungary has the highest share at 34 per cent. It is worth noting that this figure is high not only compared with the other two new members considered (27.2 per cent for the Czech Republic and 19.2 per cent for Poland) but also compared with the EU average (24.8 per cent)[8].

In a "money in utility function" model, some nominal rigidity is usually introduced in order to obtain real effects from a nominal shock; price stickiness, for example, is a standard assumption when a positive co-movement of nominal and real interest rates is desired. In this class of models, as in most microfounded models, the interest rate plays a role because it enters the Euler equation which gives the optimal consumption path for the representative household. An increase in the interest rate increases the cost of today's consumption in terms of future consumption and therefore the optimal household's response is a decrease in today's consumption. Since those models are usually demand driven, a contraction in one component of the demand reduces real activity. In the real world this mechanism is difficult to isolate. An

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[7] See Walsh (2001) for an extensive treatment of monetary models.

[8] Data on balance sheets of banks, firms and households which are quoted throughout the paper are taken from Anzuini and Levy (2004).

increase in the interest rate may impact directly on the expected future income and through it on consumption if the share of mortgage payments to total payments is a non-negligible part of households' balance sheets. For this reason we use this share as an indicator of the expected reaction of households, i.e. the higher this share the greater the impact of monetary policy. In the new members household debt is very low compared with the EU average (60 per cent of GDP). For the Czech Republic and Poland loans to households account for 8 per cent of GDP and for Hungary 6 per cent[9].

At an aggregate level the financial development of the new members is still well behind those of the old EU members. The ratios of financial assets to GDP are well below the EU average, with the Czech Republic displaying a higher ratio than the other two countries. The so called "Financial Intermediation Ratio" is lower than the EU average in all new members, again with the Czech Republic being closest to the EU average. On a more disaggregated level the picture is slightly different. The structure of firms' financial liabilities suggests that Hungarian firms raise risk capital to an extent similar to EU members: the fraction of stocks in total liabilities in Hungary is 56.1 per cent, very close to the EU average of 60.6 per cent. The share is lowest in the Czech Republic (39.5 per cent) whereas Poland's share is 42.9 per cent. Even if deposits are the favourite asset for carrying wealth over time among the new members, the percentage of "shares and mutual funds" of Hungarian households (34.9 per cent) is very close to the EU average (33.5 per cent)[10].

If we take those numbers as a proxy of financial development we can say that the three largest new members have relatively low levels of financial depth and financial intermediation. Moreover, an important role is played by non-residents. At an aggregate level, the financial development of those countries is still behind that of EU. At a sectoral level the behaviour of firms and households in Hungary is less distant from the EU average. However, despite the lack of financial development, we argue that in the three new members the effects of a contractionary monetary policy shock are qualitatively not dissimilar to what is found in the more advanced economies and not dissimilar from the predictions of a large class of theoretical models.

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[9] See Anzuini and Levy (2004).

[10] See Anzuini and Levy (2004).

3. Estimation results

3.1 *Czech Republic*

For the Czech Republic three lags seem enough to capture the dynamics of the system. Using the entire sample (1993:01-2002:01) it is difficult to get a clear-cut dynamic response with a recursive or a non-recursive identification scheme. In particular, while industrial production and the exchange rate move in the expected direction (at a 68 per cent significance level) money's reaction is not statistically significant and we observe a counter-intuitive change in prices (see Figure 1). The increase in the price level following a contractionary monetary policy shock is called "price puzzle" in the literature. In this case, however, there might be an explanation. In the first part of the 1990s the price system in the Czech Republic was mostly based on administrative controls; those controls were removed only gradually and the price formation mechanism started to work as in a market economy. By the second part of the 1990s and the beginning of 2000, the Czech Republic had covered most of the distance from a fully fledged market economy. Indeed, if we use the second part of the 1990s as a sample period (July 1997 - January 2002, floating exchange rate regime), in case of a recursive identification scheme we find a picture which is very different from the one obtained using the entire sample. All variables move in the expected direction and almost all of them are significant at a 95 per cent significance level (Figure 2). After roughly a year industrial production reaches its negative peak (0.9 per cent), the nominal exchange rate appreciates at impact (maximum appreciation is 1.9 per cent) and the price puzzle disappears. The price level follows closely the movement of the monetary aggregate and both variables decrease significantly reaching a negative peak only a few months later than industrial production. The Czech Republic is the only country for which we were not able to recover clear-cut dynamic responses using the non-recursive identification scheme and therefore the impulse responses are not shown. In this experiment the exclusion of money from the variables in the VAR does not change the results significantly (see Figure 3). However caution is needed when estimating a system without a monetary aggregate since if we do not control for money we may find it difficult to disentangle the effects of a money supply shock from the effects of a money demand shock. Only the former should be interpreted as a monetary policy shock[11]. The quick and

[11] We also tried to change the position of the last two variables in order to allow interest rates to be set by monetary authorities taking exchange rate movements into account (this identification may be motivated by the so called "fear of floating", see Calvo and Reinhart 2002) and results did not change significantly.

sizeable response of the exchange rate (an appreciation close to 2 per cent during the first two quarters after the shock) may be due to the high elasticity of portfolio investment. Since we are dealing with a small open economy we assume that the shock has no impact on world export quantities. Therefore, two channels are operating at the same time: the interest rate channel (and through it the credit channel) and the exchange rate channel. An increase in the interest rate should depress economic activity through tighter credit conditions (limited participation model), while the increased interest rate attracts foreign funds and appreciates the currency. The nominal appreciation of the currency may depress the economy even more if, due to some stickiness, it affects the relative price of domestic and foreign goods. Overall, the shape of the dynamic responses of the Czech Republic, since the end of the 1990s, are strikingly similar to what we observed in more advanced economies such as the G-7.

3.2 *Hungary*

In the case of Hungary four lags seem sufficient to capture the dynamics of the system. Point estimates are surrounded by considerable uncertainty, which enlarges confidence bands. When we use the entire sample, the 95 per cent confidence bands easily include the zero line. If we look at the 68 per cent significance level we are confronted with more reasonable dynamics. At impact, money and the exchange rate decrease, with both effects very short-lived; industrial production decreases (at 95 per cent significance level) and prices do not move (see Figure 4). Using the non-recursive identification scheme the results do not change appreciably: all variables move (not significantly) in the expected direction (see Figure 5). In this case too, when using a subperiod (1995:04-2002:01, a crawling peg exchange rate regime with few months with different regimes) that excludes the very first years of transition we get much more clear-cut dynamic responses (see Figure 6). All variables move in the expected direction and except for money all movements are significant at every considered significance level. The effects on industrial production and the exchange rate are particularly strong: the former variable displays a negative peak of roughly 2.2 per cent, the latter appreciates by around 4 per cent[12]. Prices and money decline significantly. Our results are independent of the identification scheme adopted (see Figure 7) and excluding money from the system do not

[12] Notice that for Hungary the IMF's *International financial statistics* does not provide the money market rate; as a consequence we used the policy rate. This can partly explain the strong effects observed for this country. We performed the same experiment using the interbank rate (3 months) and the effect on industrial production and the nominal exchange rate were smaller, 1.2 and 3.1 respectively. Still, responses found for Hungary are the strongest among the three new members.

affect on the signs of the responses (see Figure 8). However, when we exclude money we save some degrees of freedom and, with such a short time series, even this small increase in the degrees of freedom improves the precision of the estimates; in this case excluding money from the system reduces uncertainty. Also in the case of Hungary we can conclude that when we exclude the first half of the 1990s it is possible to recover standard responses.

3.3 *Poland*

For Poland we were not able to estimate an equation without serial correlation until we included the fifth lag. The impulse responses for Poland are surprisingly stable. Using the entire sample we get clear-cut dynamics, conditional on a monetary shock, for all variables (see Figure 9). Results are robust across identification schemes (see fig.10). The exclusion of money does not affect results (see fig.11). We estimate the system using different years as starting points (1993, 1994, 1995,1996) and results do not change significantly. While the responses are strikingly stable, the real effect of a monetary shock is small, i.e. industrial production declines significantly but the negative peak is around 0.4 percentage points. An explanation for this result is suggested by Bednarski and Osinski (2002). They argue that the weak transmission is due to two peculiarities of Poland's banking system: excess liquidity and unwillingness to cut credit when monetary policy is tightened. Excess liquidity is defined as high level of banks' holdings of central bank debt. The strong capital inflow made the commercial banks less dependent on the central bank. The unwillingness to cut credit is mainly reflected in the utilization of securities as buffer stock: due to the large holdings of securities, banks can reduce their accumulation instead of cutting credit following a contractionary monetary shock. Also the maximum appreciation of the exchange rate is relatively small, 0.9 per centage points.

3.4 *Overview of results*

The impulse responses of the new members are consistent with a large class of theoretical models and qualitatively similar to those found for western European countries, but one feature stands out: on average, the responses of new members to a monetary policy shock are smaller than those found for old members[13], see Table 2. Our finding of weaker responses is not surprising, when the degree of financial development is taken into account. Total financial

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[13] Jarocinski (2004), using a Bayesian VAR approach, reaches a similar conclusion.

assets are in the range of 2.5 to 4.5 times GDP, which is far behind the EU average of 8 times GDP[14]. The new members have a low level of financial intermediation (measured as the ratio of financial assets held by banks to financial assets held by all other sectors). Moreover, at the sector level, a significant role is played by foreigners in bank ownership (close to 70 per cent of bank assets) and a large share of total bank credit is granted to domestic firms directly by banks located abroad. The low degree of financial depth and intermediation may explain the weakness of the standard *interest rate channel*. The *equity price channel* may be weak due to the low level stock market capitalization (between 13 and 19 per cent compared to the 46 and 165 per cent of the EU). Since bond markets are little developed as equity markets the overall effect on firms balance sheet is likely to be weak. Financial assets held by the household sector ranges from 55 to 83 per cent of GDP, which is remarkably lower than the EU average of 232 per cent. Therefore wealth effects operating through the impact of interest rates on equity prices are likely to be weak too.

Table 3 shows the variance decomposition for the four main European economies, as estimated by Kim (1999), together with our estimates for the three new members. The table suggests that among the new members considered the contribution of the domestic monetary shock to output fluctuation is, on average, smaller than in the case of the four largest EU economies but the difference is probably not statistically significant. The fact that the responses in the new members display a similarity with EU's old members is important because this makes the case of a particularly strong asymmetry in the effects of monetary policy very unlikely. Once those countries adopt the euro they will give up their monetary sovereignty and the exchange rate channel will weaken significantly. The optimum currency area literature suggests that the cost of giving up those instruments should be lower the higher the symmetry in response to a common shock. Since no strong evidence of asymmetry emerges in our exercise this would suggest that the cost of entering may be relatively low. A similar conclusion is reached in Frenkel and Nickel (2002), who analyse the differences in the effects of demand and supply shocks on EMU and then candidate countries to EU accession.

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[14] See Anzuini and Levy (2004)

4. Conclusions

The financial accounts of the three countries considered provide a picture of a private non-financial sector that is, not surprisingly, financially less mature than the EU average. Despite the low degree of financial development, the econometric results suggest that the co-movement of macroeconomic variables in the new members, conditional on a domestic monetary shock, is not different from the standard behaviour we would expect, at least when we exclude from the sample the first years of the transition. Following a 1 per cent increase in interest rates, in all the three countries considered industrial production declines persistently and significantly. The impact of monetary policy on the exchange rate is always the expected one. Presumably this is due to a high elasticity of portfolio investment to the interest rate differential. We find no evidence of counter-intuitive effects of a monetary policy shock in the these economies. The contribution of monetary policy to business cycle fluctuations does not differ too much from that observed in current EU members. While qualitatively very similar to those of the old members, however, the responses of the new member economies are quantitatively weaker. The lower level of financial development may help explaining this gap.

The main caveat of our analysis is that the number of observations in our time series is very small. Even if some caution is required in interpreting our results, it is possible to argue that in the new members the monetary policy transmission mechanism works in a way fairly similar to the one operating in the old members. The absence of strong asymmetries between old and new members suggests that the cost of the adoption of a common monetary policy may be relatively low.

Appendix: Data description

Most data series used for the econometric estimates were obtained from the IMF's *International financial statistics*, as follows:

Industrial Production

Czech Republic: 935..66; Hungary: 944..66; Poland; POIPTOT.H (*Datastream*)

Consumer Prices

Czech Republic: 935..64; Hungary: 944..64; Poland: 964..64

Interest Rate

Czech Republic: 935..60b; Hungary: 944..60; Poland: 964..60b

Monetary aggregates

Czech Republic: 93535..; Hungary: HNM3....A; Poland: 96435..

Exchange Rate

Czech Republic: 935..rf; Hungary: 944..rf; Poland: 964..rf

World export commodity price

00176axd

World export commodity price in terms of domestic currency

This variable is constructed by multiplying the exchange rate (defined as the amount of domestic currency needed per U.S. dollar) and the world commodity price in U.S. dollars.

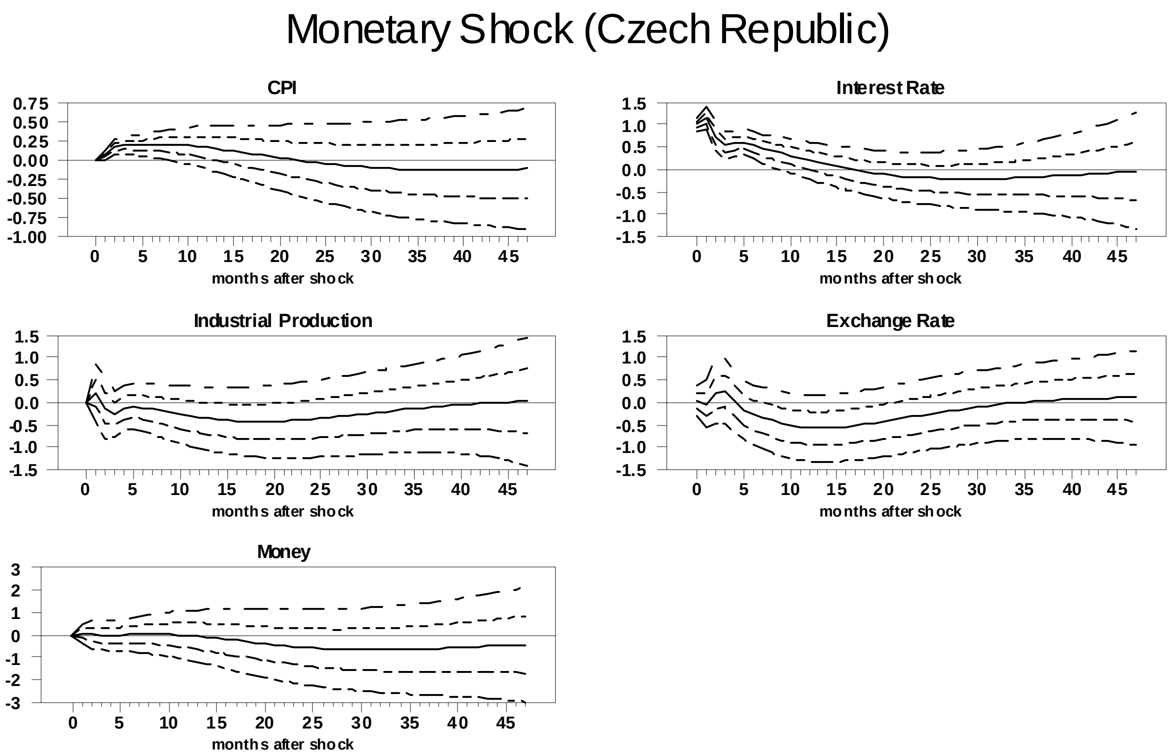

Figure 1: Recursive identification scheme, sample period 1993:01-2002:01.

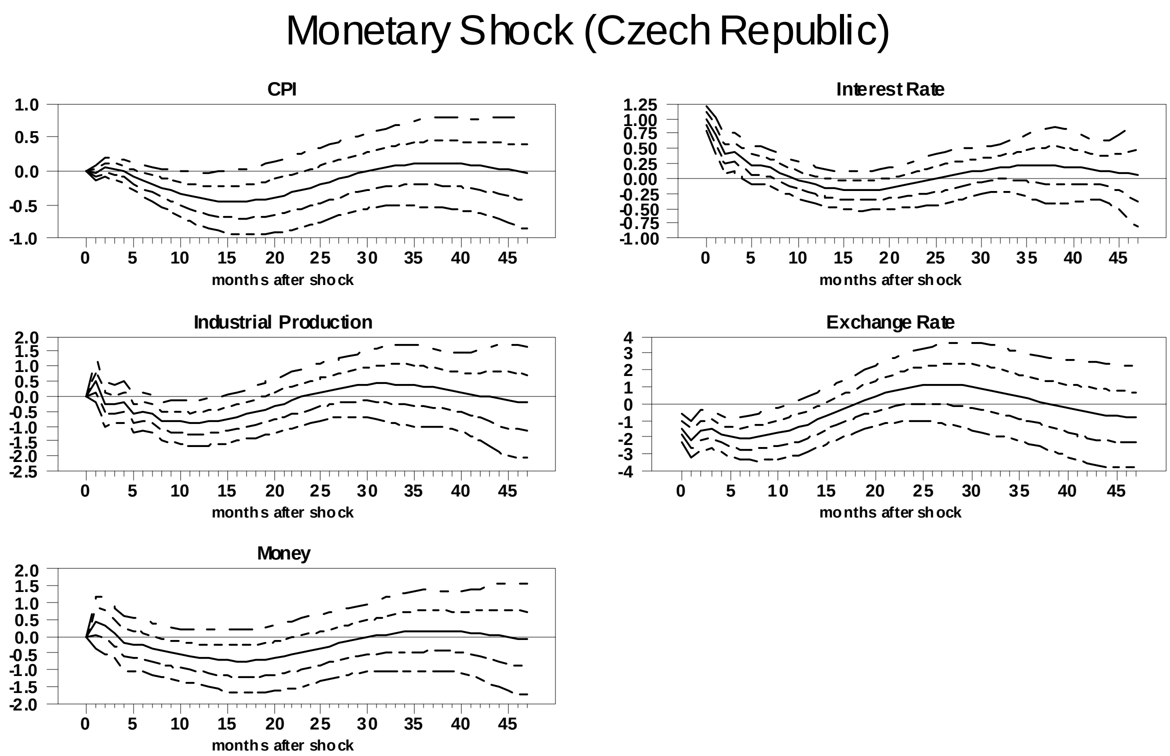

Figure 2: Recursive identification scheme, sample period 1997:07-2002:01.

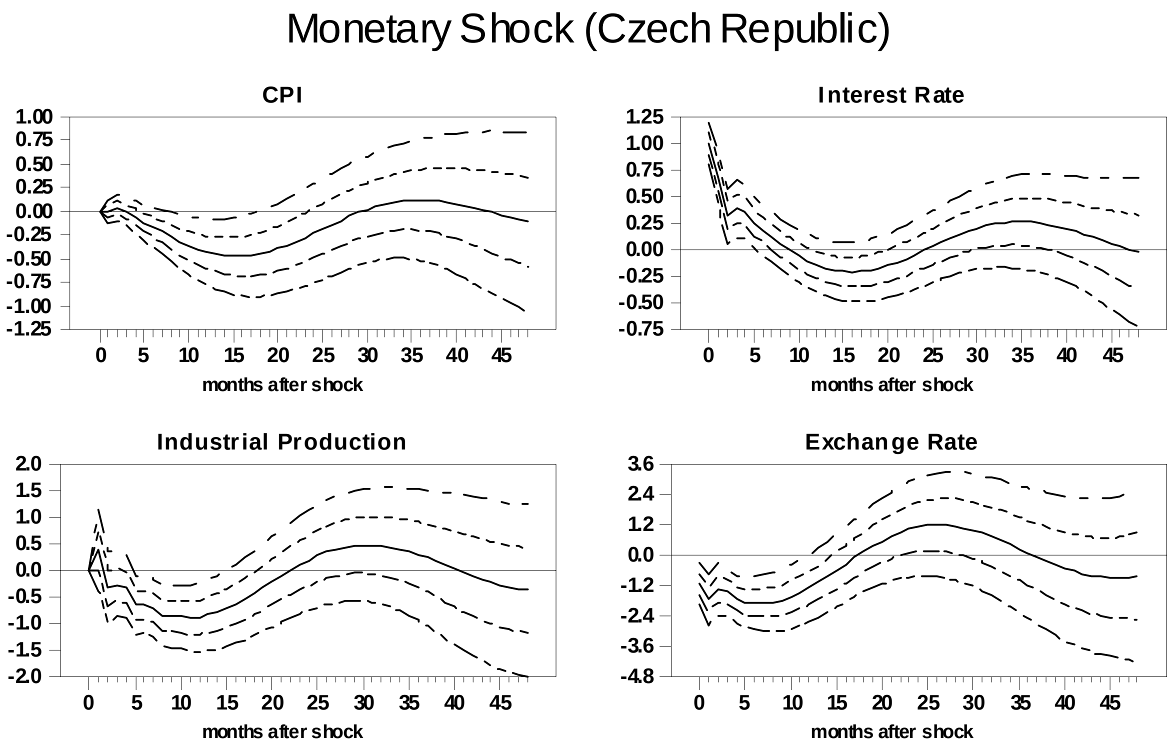

Figure 3: Recursive identification scheme, sample period 1997:07-2002:01, without money.

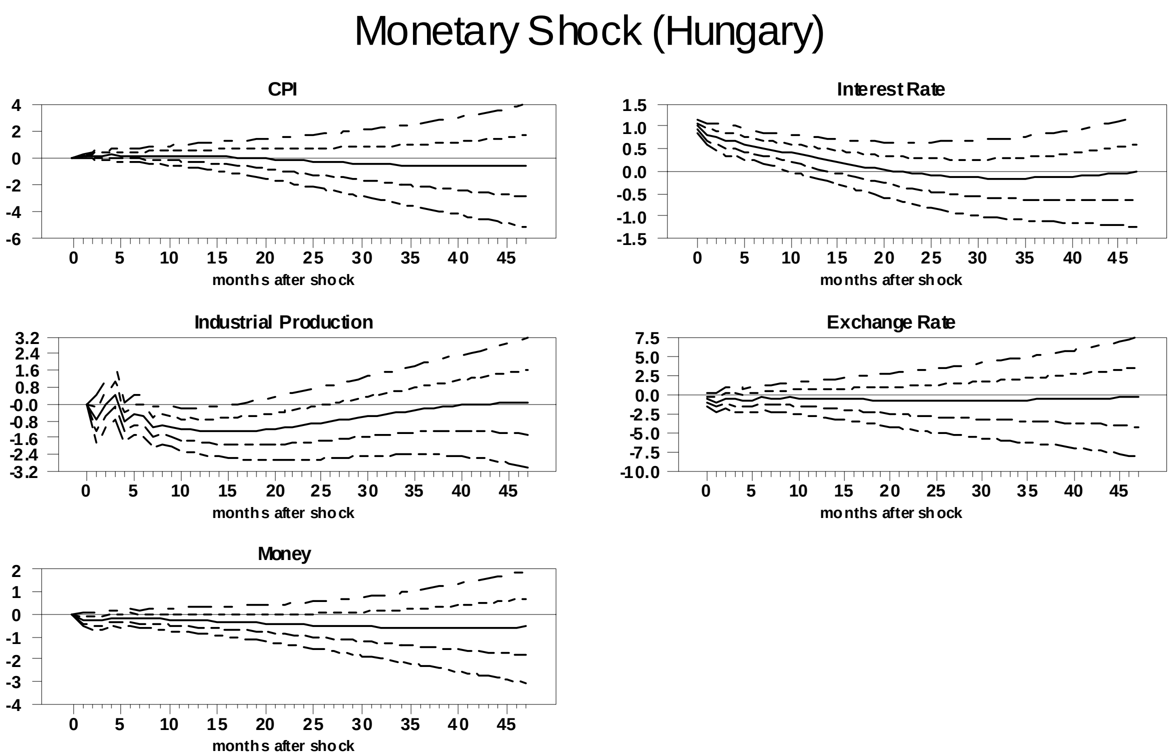

Figure 4: Recursive identification scheme, sample period 1993:01-2002:01.

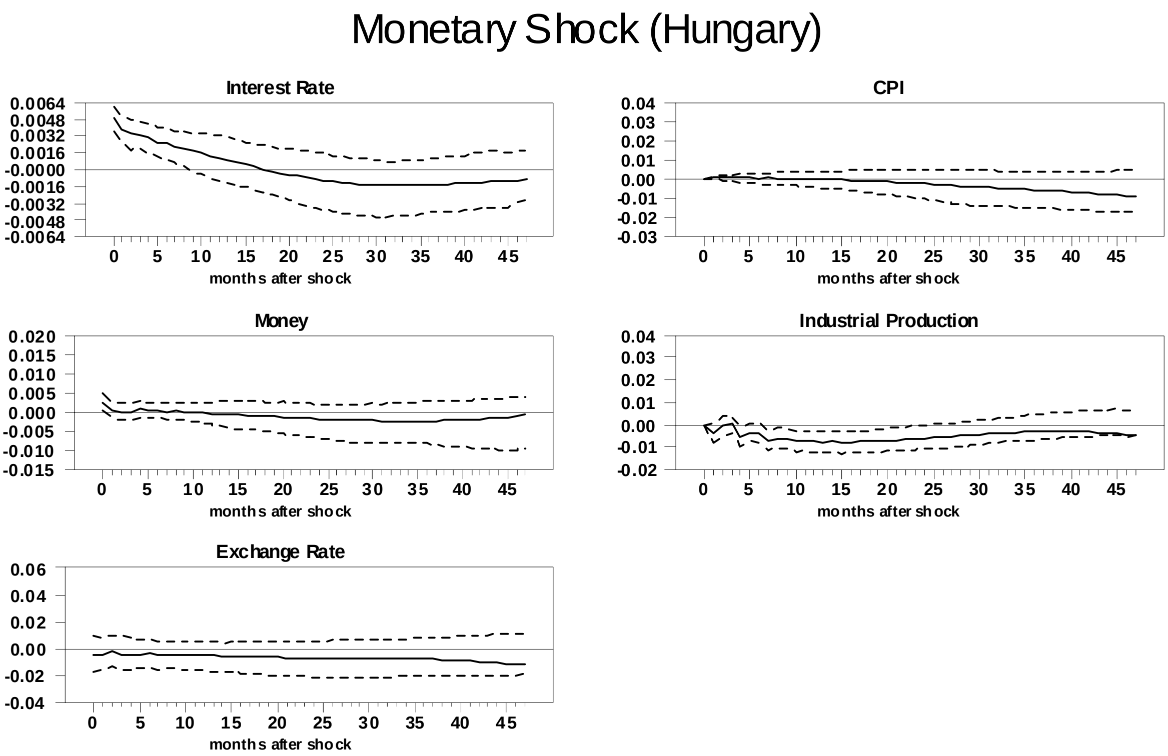

Figure 5: Non-recursive identification scheme, sample period 1993:01-2002:01.

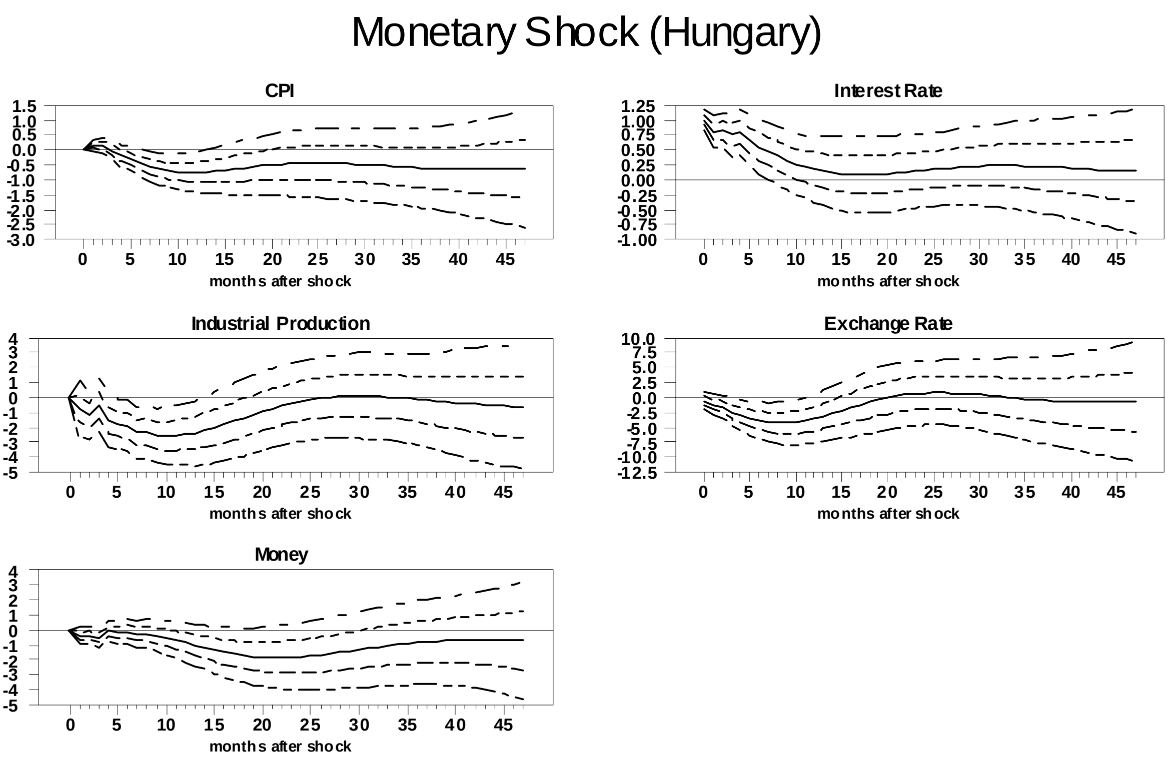

Figure 6: Recursive identification scheme, sample period 1995:04-2002:01.

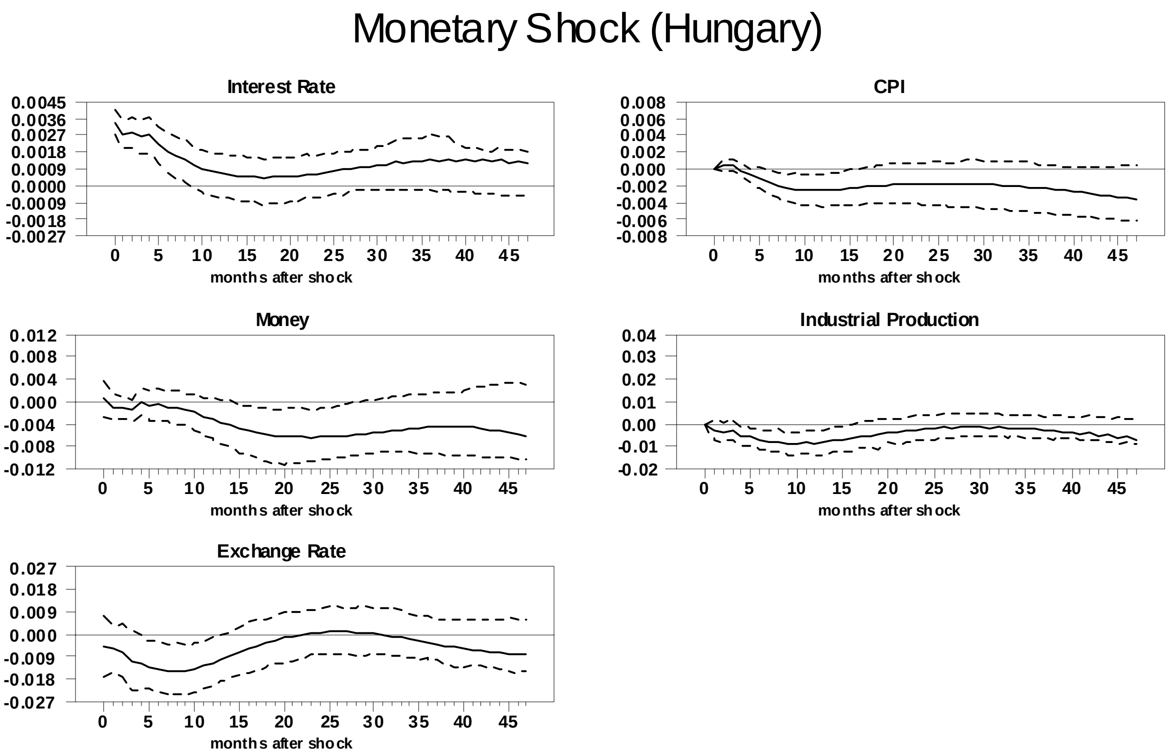

Figure 7: Non-recursive identification scheme, sample period 1995:04-2002:01.

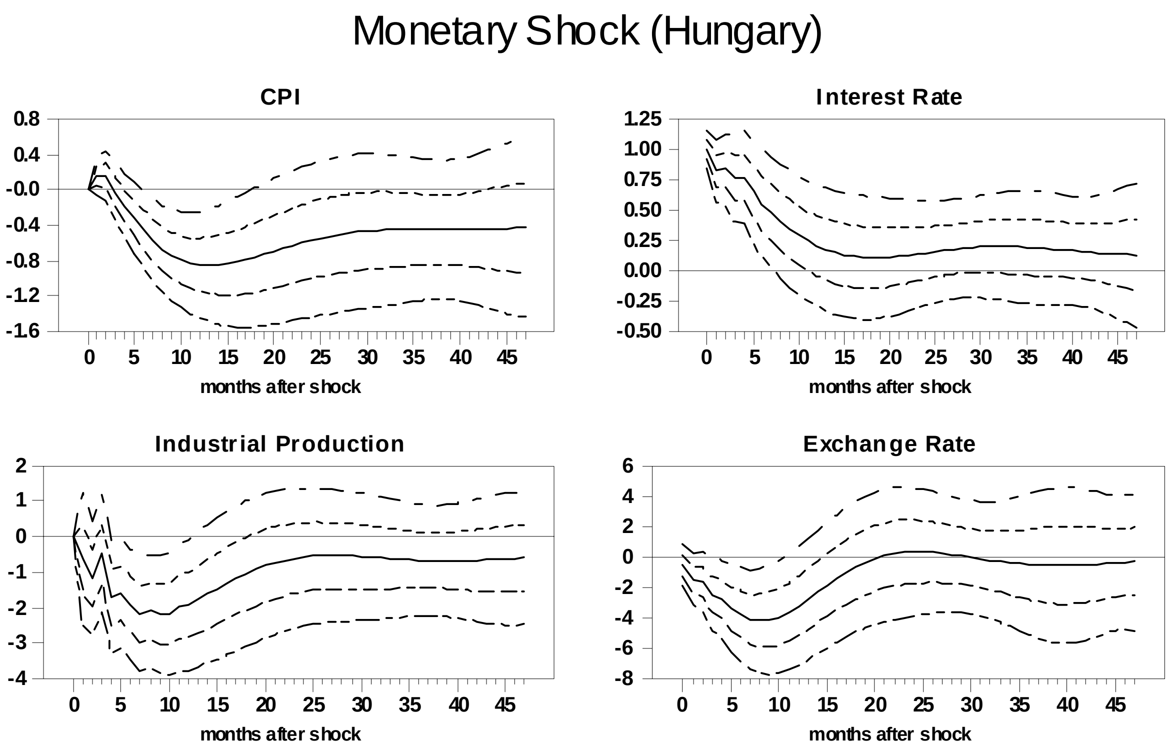

Figure8: Recursive identification scheme, sample period 1993:01-2002:01, without money.

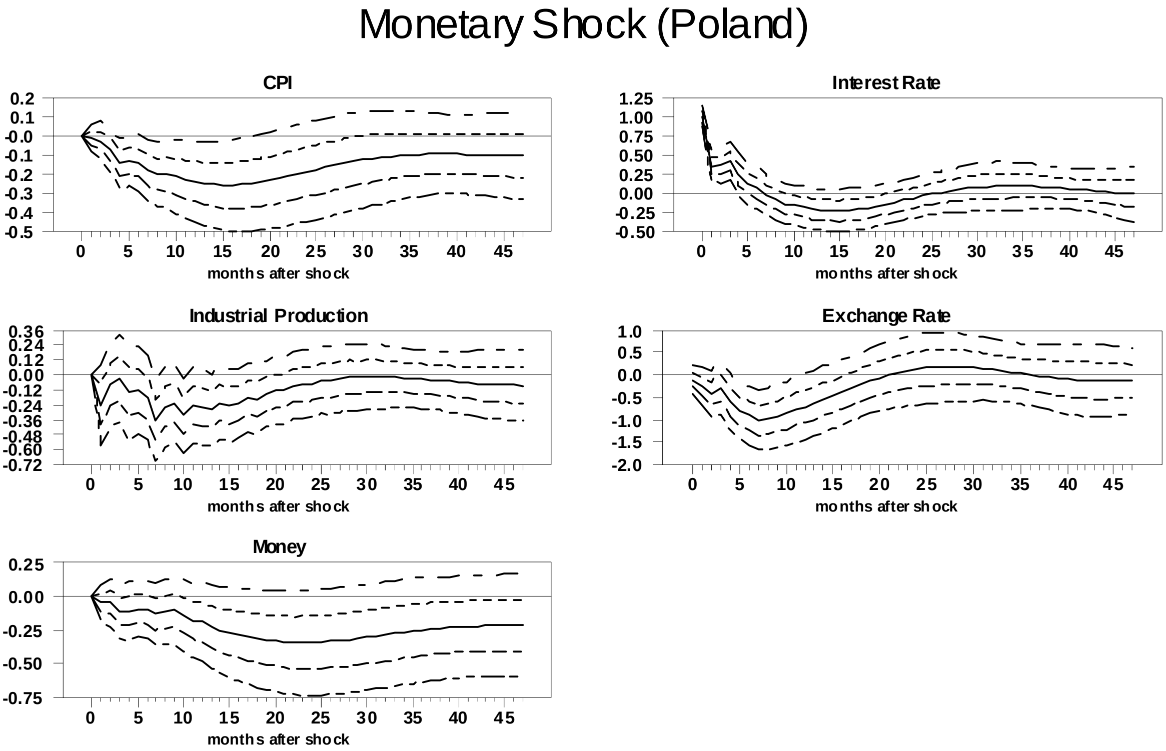

Figure 9: Recursive identification scheme, sample period 1993:01-2002:01.

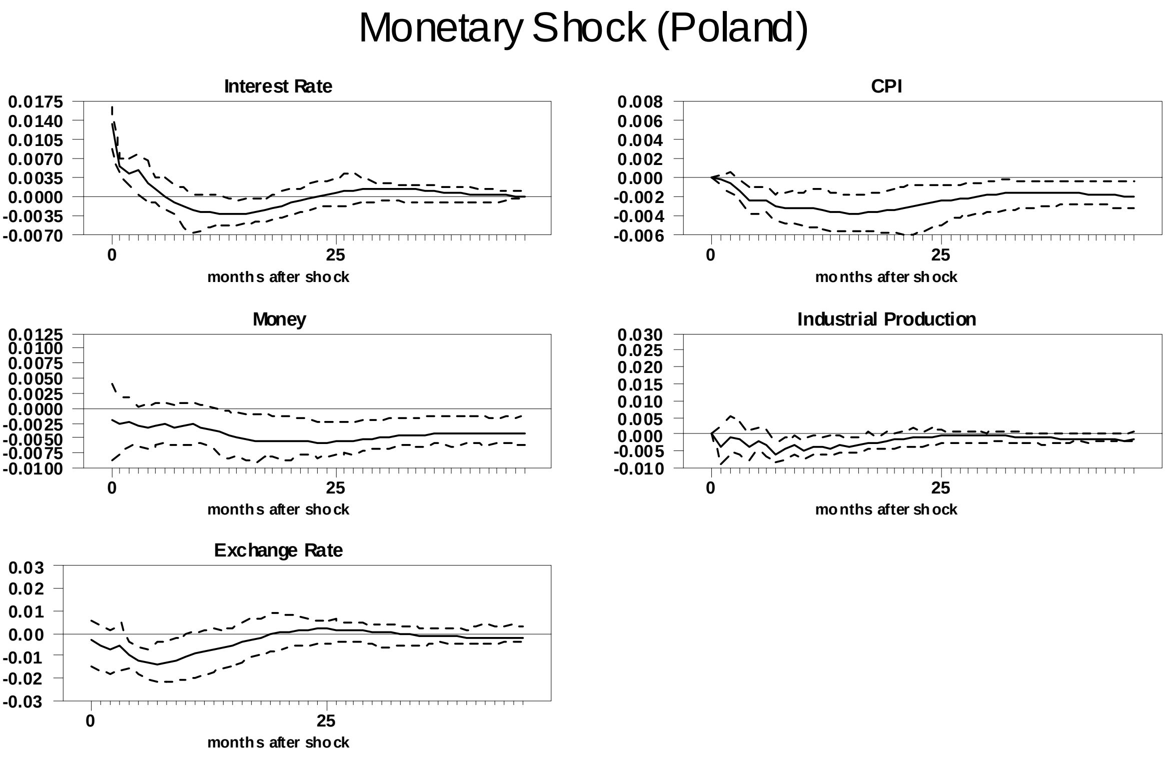

Figure 10: Non-recursive identification scheme, sample period 1993:01-2002:01.

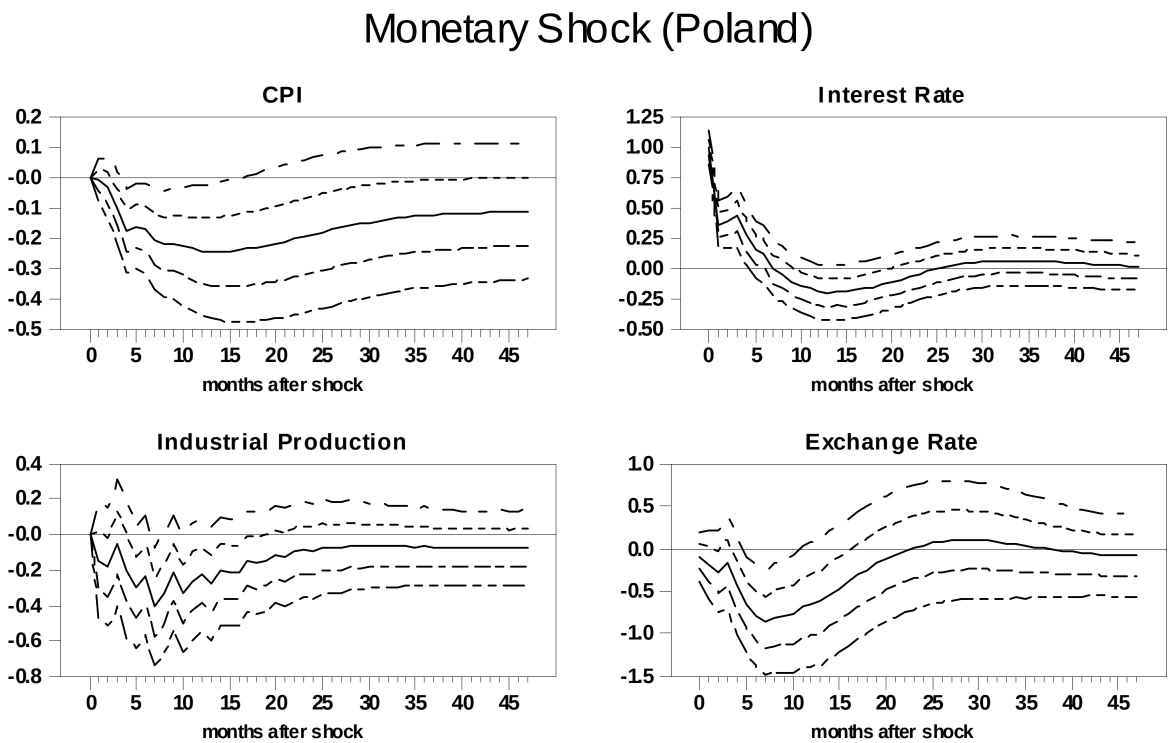

Figure 11: Recursive identification scheme, sample period 1993:01-2002:01, without money.

Table 1: Chronology of exchange rate regimes

Czech Rep.	1993:01-1997:05 Fixed
	1997:06-2002:01 Floating
Hungary	1993:01-1995:03 Adjustable peg
	1995:04-2001:04 Crawling peg (± 2.25)
	2001:05-2001:09 Crawling band
	2001:10-2002:01 Fixed (±15)
Poland	1995:05-2000:03 Crawling band
	2000:04-2002:01 Floating

Table 2: Average responses to a 100 bp shock [1]

	New Members	Kim (1999)	Kim and Roubini (2000)
output	-1.2 (-0.8)	-1.9	-1.8
prices	-0.5 (-0.4)	-2.3	-1.3
exchange rate	-0.6 (-0.6)	-7.6	-5.8

(1) The numbers for the new members are the average responses of Czech republic, Hungary and Poland, while the values reported for Kim (1999) and Kim and Roubini (2000) are the average responses for Germany, France and Italy. Number in brackets are obtained using a three months interbank interest rate for Hungary (instead of the policy rate). Output and prices responses are taken at the peak (maximum) level while exchange rate responses are taken at impact (first period). The maximum response of the exchange rate for the new members, -2.3 (-1.9), is closer to the euro level.

Table 3: Variance decomposition of industrial production due to monetary policy shocks[1]

Step	Ger.	U.K.	Fr.	It.	Cz.Rep.	Hun.	Pol.
6	9.3 (4.0)	10.1 (3.9)	6.2 (3.3)	4.3 (3.0)	10.9 (6.1)	3.4 (5.3)	5.7 (4.8)
12	17.9 (6.6)	15.3 (6.1)	13.9 (6.6)	7.1 (4.4)	12.6 (6.7)	10.1 (10.0)	6.2 (5.2)
24	23.1 (8.5)	11.6 (6.3)	17.7 (9.9)	8.9 (5.2)	12.4 (7.8)	18.7 (14.0)	5.8 (5.6)
36	22.5 (8.6)	9.8 (5.5)	5.6 (9.4)	8.6 (4.8)	11.9 (8.5)	21.7 (14.8)	5.7 (5.9)
48	20.4 (8.0)	10.1 (5.9)	14 (8.9)	8.6 (4.8)	10.8 (9.0)	22.3 (14.7)	5.7 (6.2)

(1) The numbers in brackets are standard errors. For the four largest European economies estimates are borrowed from Kim (1999), for the AC3 we use the period 1997:07-2002:01 for Czech Republic; the period 1995:04-2002:01 for Hungary; the period 1993:01-2002:01 for Poland. Significance levels are obtained by Montecarlo simulation.

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