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CZECH NATIONAL BANK

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The Monetary Transmission Mechanism in the Czech Republic (evidence from VAR analysis)

Kateřina Arnoštová and Jaromír Hurník [*]

Abstract

Due to significant lags between a monetary policy action and the subsequent responses in the economy, understanding the transmission mechanism is of primary importance for conducting monetary policy. This paper analyses the monetary policy transmission mechanism using VAR models – the most widely used empirical methodology for analyzing the transmission mechanism in the Czech economy. Using the VAR methodology, the paper tries to evaluate the effects of an exogenous shock to monetary policy. The results show that an unexpected monetary policy tightening leads to a fall in output, whereas prices remain persistent for a certain time. The exchange rate reaction then heavily depends on the data sample used. Although it is clear that due to the rather short time span of the data, the results should be taken with caution, they at least show that the basic framework of how monetary policy affects the economy does not differ significantly either from what would be predicted by the theory or from the results obtained for more developed economies.

JEL Codes: E37, E52.

Keywords: Impulse response, monetary policy, transmission mechanism, vector autoregressions.

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Nontechnical Summary

Our analysis of the transmission mechanism in the Czech economy is motivated by the fact that knowledge thereof is of primary importance for monetary policy conduct. In this paper, the transmission mechanism is analyzed using the VAR models methodology, which, of course, limits exploration of the transmission mechanism to only its basic properties. The precise role of the different channels should be taken as something that is beyond the scope of this paper. In particular, we address the question of what happens to output and prices after an exogenous shock to monetary policy.

We have estimated two identified VARs using the standard recursiveness assumption as the identification technique and a particular ordering covering the implicitly assumed structure of the economy. Consequently, we quantify the impulse responses of the main variables to an unexpected monetary policy tightening. The reason for estimating two models was a change in the monetary policy regime in the middle of the 1990s. Therefore, the first model covers the full data sample from the first quarter of 1994 to the fourth quarter of 2004, while the second one covers the period after the regime change only (1998 to 2004). Consequently, the results differ in several respects. However, both models are estimated using the same set of variables, namely, real GDP, the net inflation price index, the commodity price index, the short-term nominal interest rate, the bilateral euro exchange rate, the domestic money stock and foreign real GDP as an exogenous variable.

We conclude that an unexpected rise in nominal short-term interest rates tends to be followed by a fall in output, although the short data sample brings a faster and less persistent output response. The rest of the findings depend somewhat on the data sample chosen. The exchange rate response exhibits counterintuitive behavior in the full data sample case, i.e. a depreciation after the monetary policy tightening, which, with high probability, is a consequence of the exchange rate attack and policy regime switch. Hence, the response of prices is also highly persistent in the full data sample case. Excluding the regime change from the data sample, the response of the exchange rate becomes intuitive. The monetary policy tightening is followed by an immediate exchange rate appreciation. Consequently, prices start to fall after approximately two quarters of persistence, with the decline peaking in one and a half years. The relatively quick reaction of prices to the monetary policy contraction might be due to the strong role played within the economy by the direct exchange rate channel.

1. Introduction

One of the general claims that almost all economists agree on is that there exists a significant lag between a monetary policy action and the subsequent reaction of the economy. In addition, they would probably agree on the existence of enormous uncertainty surrounding this lag. This uncertainty not only arises from the transmission lag itself, but also covers the uncertainty connected with the precise understanding of the particular transmission channels whereby monetary policy influences the economy. Still, for monetary policy purposes, it is knowledge of the channels and lags, i.e. the transmission mechanism, that is of primary interest, as without knowledge of the transmission mechanism, monetary policy cannot be fully successful. Having these challenges in mind, this paper tries to describe the monetary policy transmission mechanism in the Czech economy using VAR models. In particular we grapple with the question: What happens after an exogenous shock to monetary policy?

The VAR methodology became widely used for estimating the effect of monetary policy on output and prices, i.e. the monetary policy transmission mechanism, during the 1990s. The use of VAR models began with the seminal work by Sims (1980). Recently, Leeper, Sims and Zha (1998) and Christiano, Eichenbaum and Evans (1999) (henceforth CEE) have reviewed the extensive literature on the monetary transmission mechanism in the United States. In Europe, the establishment of the EMU has led to quite frequent use of the VAR methodology to evaluate cross-country differences in transmission mechanisms. The results are summarized in Angeloni, Kashyap and Mojon (2003).

However, it is worth mentioning that despite the wide use of VAR in empirical analysis, its results are not generally accepted yet. In particular, the behavior of prices has shown the largest variability across models, whereas, as CEE claim, the impulse response of some other variables, such as output, have proven to be very robust to the specification. In addition, it is useful to recall that the use of the standard structural VAR approach serves for identifying monetary policy shocks and quantifying their consequences, and that these shocks are taken as unexpected deviations from the systematic behavior of monetary policy. As CEE state, this says nothing about the impact of the systematic component of monetary policy on aggregate output and the price level.

On the other hand, the effort to identify monetary policy shocks and their consequences through VAR analysis represents one of few ways to learn about the dynamics of the economy, as simple regression of changes in output and prices on changes in the monetary policy instrument is, thanks to the endogeneity problem, pretty useless.

Bearing in mind the characteristics of the VAR methodology, this paper is organized in the following way. After a brief introduction we devote the second part to a description of the identification procedure. The third part of the paper deals with the estimation and discussion of the results. The fourth part concludes.

2. Identification

In this section we describe the benchmark that was used in our VAR model for analyzing the effects of monetary policy. As a canonical identification scheme the CEE benchmark identification is used. However, to capture the high degree of openness of the Czech economy, two open economy extensions are added. For this, and also to enable potential comparison with the EMU results, the identification used by Peersman and Smets (2001) for the EMU as a whole, and by Mojon and Peersman (2001) for particular member countries, is also followed.

Mojon and Peersman (2001) distinguish basically three different types of countries by economic position and exchange rate position against the former German currency (i.e. the DEM). They also distinguish three different types of VAR identification.

Taking into account the position of the Czech economy among other European countries, we follow the identification type for the small open economy with relatively independent monetary policy, based on the CEE and Mojon and Peersman (2001) identifications. Then the estimated system has the following representation:

$$Y_t = aY_{t-1} + bX_t + \nu_t \tag{1}$$

where Y_t is the vector of endogenous variables, X_t is the vector of exogenous foreign variables and ν_t is the residuals vector. In addition, a is a matrix that includes all the coefficients describing the relationships among the endogenous variables, and b is a matrix that includes all the coefficients describing the relationships among the endogenous and exogenous variables. The use of the vector of exogenous variables in general helps to solve the so-called price puzzle[1] that is often observable in VAR results.

The vector of endogenous variables contains real GDP (y_t), the net inflation price index (p^{net}), the commodity price index (p^{com}), the domestic nominal short-term interest rate (s_t), the nominal bilateral euro exchange rate (x_t), and the domestic money stock (m):

$$Y_t = \left[y_t, p_t^{net}, p_t^{com}, s_t, x_t, m_t\right] \tag{2}$$

The net inflation price index is the headline inflation price index adjusted for any change in regulated prices, and the money stock is represented by the M2 monetary aggregate.

The inclusion of real GDP, the net inflation price index, the commodity price index, the domestic nominal short-term interest rate and the domestic money stock follows the CEE benchmark identification, except for the fact that CEE used the headline inflation price index instead of the

[1] The term price puzzle is connected with the empirical finding that an interest rate tightening is followed by a price increase. The price puzzle results from the monetary policy reaction to external shocks (see CEE or Mojon and Peersman, 2001, for a detailed discussion).

net inflation price index. Nevertheless, the adjustment of headline inflation for regulated price movements is necessary because of the transition period of the Czech economy during the 1990s.

Following the Mojon and Peersman (2001) identification, first, the nominal exchange rate is included in the vector of endogenous variables, and second, the vector of exogenous variables is added. In contrast to the Mojon and Peersman (2001) identification, which assumes that the foreign country GDP and world commodity index are exogenous variables, we consider a vector of exogenous variables containing only one variable – the level of GDP in Germany (y^F). This follows the fact that the commodity price index is already a part of the vector of endogenous variables.

$$X_t = \left[y_t^F \right] \tag{3}$$

The monetary policy shock is identified using the standard recursiveness assumption with the variables ordered as in (2) and (3). The VAR model described by equation (1) already represents the reduced form system. However, there is a high probability of simultaneity among the variables. The reduced form VAR is derived from the VAR model that allows for contemporaneous relationships among the variables. The initial model can be written using the following representation:

$$KY_t = AY_{t-1} + BX_t + \varepsilon_t \tag{4}$$

where matrix K includes all the coefficients describing the simultaneous relationships among the variables, matrix A includes all the coefficients describing the lagged relationships among the variables, matrix B includes all the coefficients describing the relationships among the endogenous and exogenous variables, and finally vector ε includes the residuals. Multiplying the VAR system by the inverse matrix $K^{(-1)}$ we get

$$Y_t = K^{(-1)}AY_{t-1} + K^{(-1)}BX_t + K^{(-1)}\varepsilon_t \tag{5}$$

which can be rewritten in a known reduced form as in equation (1)

$$Y_t = aY_{t-1} + bX_t + \nu_t \tag{1}$$

where

$$a = K^{(-1)}A$$
$$b = K^{(-1)}B$$
$$\nu = K^{(-1)}\varepsilon$$

The recursiveness assumption (based on Choleski factorization) is just an attempt to identify the original shocks ε_t using the vector of residuals ν_t. However, using the recursiveness assumption we will be able to identify the original shocks ε_t only if we assume that there exist exactly

$n^2 - \left[\left(n^2 - n\right)/2\right]$ simultaneous relationships among the variables, where *n* is the number of endogenous variables. This means that the recursiveness assumption requires $\left(n^2 - n\right)/2$ additional restrictions on our model. That is done in a very simple way by imposing matrix *K* as a lower triangular one (i.e. by setting all the coefficients above the diagonal equal to zero). Bearing in mind that matrix *K* is in lower triangular form we can choose an ordering of the endogenous variables reflecting the assumed structure of the economy. By doing so, we assume that there exists simultaneity only among particular variables[2].

The ordering of the variables expressed by (2) imposes implicit assumptions about (i) what is observed by the monetary policy authority at the time the policy decision is made, and (ii) which variables do not respond contemporaneously to the policy actions. In particular, the ordering used implies that while deciding, the monetary policy authority takes into account the current stage of output, inflation and commodity prices. At the same time, the monetary policy actions are assumed to have no contemporaneous impact on output and prices. As the exchange rate is ordered after the interest rate, the latter is supposed to have an immediate impact on the exchange rate. On the other hand, the interest rate does not respond in the same period to changes in the nominal exchange rate.

The latter assumption is without doubt a source of relatively serious disputes in the VAR literature. It is often claimed that such an assumption may be more appropriate for a large, relatively closed economy than for a small and open one. For example, Clarida and Gertler (1997) have found a significant contemporaneous response of interest rates to changes in the exchange rate in the case of Germany. However, the recursiveness assumption does not allow for both a contemporaneous reaction of the exchange rate to a change in the interest rate and a contemporaneous reaction of the interest rate to a change in the exchange rate, as a certain specific ordering must be chosen under the recursiveness assumption.

Although the Czech economy is undoubtedly a small open one, monetary policy as expressed by interest rate behavior should not respond to exchange rate movements *per se*. Instead, as monetary policy is conducted in an inflation-targeting regime, it should take into account the ultimate effects on the inflation forecast. That is why a limited simultaneous response of the interest rate to the exchange rate does not necessarily mean any substantial mistake. Smets and Wouters (1999) mention that the constraint imposed on simultaneity could be one of the reasons for the price puzzle. If we observe the price puzzle in our results, we will be able to evaluate the bias caused by the simultaneity constraint.

Before we close the question of interest versus exchange rate mutual simultaneity, we should mention the existence of two proposed solutions. Unfortunately, both of them are connected with other serious problems.

The first solution is a methodology proposed by Smets and Wouters (1999) based on the application of a reaction coefficient to the exchange rate. The reaction coefficient is estimated using the interest rate spread between the home country and another foreign country and the exchange rate behavior for the foreign currency versus yet another foreign currency. However, the application of this methodology to the Czech economy is problematic. The reason lies in the non-

[2] For a precise non-technical description of this algebra, see Enders (2004).

existence of countries satisfying two basic conditions, the first being a relatively strong relationship to the Czech economy and the second being movement against the EU (or Germany) that is relatively uncorrelated with respect to the Czech economy. For example, Mojon and Peersman (2001) used for the German case the spread between German and French long-term interest rates and the US dollar/yen exchange rate as instruments. The foreign economy, which in this case was described by the vector of exogenous variables, was the US economy.

The second and more fundamental solution of the simultaneity problem is an alternative identification scheme violating the recursiveness assumption. A similar identification scheme is found in Sims and Zha (1998) and Kim and Roubini (2000). When using the recursiveness assumption it is assumed that the residuals vector ν_t is related to the original vector of shocks ε_t thanks to the existence of a particular lower triangular matrix. This relationship can be represented by the following matrix equation:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ k_{21} & 1 & 0 & 0 & 0 & 0 \\ k_{31} & k_{32} & 1 & 0 & 0 & 0 \\ k_{41} & k_{42} & k_{43} & 1 & 0 & 0 \\ k_{51} & k_{52} & k_{53} & k_{54} & 1 & 0 \\ k_{61} & k_{62} & k_{63} & k_{64} & k_{65} & 1 \end{bmatrix} \begin{bmatrix} \nu_t^y \\ \nu_t^{p^{net}} \\ \nu_t^{p^{com}} \\ \nu_t^s \\ \nu_t^x \\ \nu_t^m \end{bmatrix} = \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^{p^{net}} \\ \varepsilon_t^{p^{com}} \\ \varepsilon_t^s \\ \varepsilon_t^x \\ \varepsilon_t^m \end{bmatrix} \tag{6}$$

Following the alternative scheme of Sims and Zha (1998) and Kim and Roubini (2000), we allow for contemporaneous interaction between the interest rate and the exchange rate, which can be written as:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ k_{21} & 1 & 0 & 0 & 0 & 0 \\ k_{31} & k_{32} & 1 & k_{34} & 0 & 0 \\ 0 & 0 & k_{43} & 1 & k_{45} & 0 \\ k_{51} & k_{52} & k_{53} & k_{54} & 1 & 0 \\ k_{61} & k_{62} & k_{63} & k_{64} & k_{65} & 1 \end{bmatrix} \begin{bmatrix} \nu_t^y \\ \nu_t^{p^{net}} \\ \nu_t^{p^{com}} \\ \nu_t^s \\ \nu_t^x \\ \nu_t^m \end{bmatrix} = \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^{p^{net}} \\ \varepsilon_t^{p^{com}} \\ \varepsilon_t^s \\ \varepsilon_t^x \\ \varepsilon_t^m \end{bmatrix} \tag{7}$$

The condition for $\left(n^2 - n\right)/2$ additional restrictions on the model is still fulfilled. The only difference is in identifying the coefficients k_{34} and k_{45}, which express simultaneity between the interest rate and the exchange rate, instead of coefficients k_{41} and k_{42}. However, this change means that the interest rate does not react to the contemporaneous change in output and inflation[3]. Bearing in mind the underlying structure of the economy, and using the Sims and Zha (1998) and Kim and Roubini (2000) identification, one thus claims that monetary policy does not take into account the actual performance of output and inflation. Sims and Zha (1998) and Kim and

[3] It is worth mentioning that violating the recursiveness assumption in fact means a completely different type of "true" policy shock identification procedure, explanation of which goes beyond the scope of this text. For a detailed discussion, see CEE.

Roubini (2000) argue that such a restriction is very plausible, as the latter information is in fact available to the monetary policy authority only with a lag. However, this argument is weakened for two reasons. First, using quarterly data the information on inflation is at least partially available already during the current period. The same also holds for the real sector of the economy, where data on aggregate employment, industrial production and other leading indicators are available. Second, as the VAR model is just a way of writing a solution of the Stochastic Dynamic General Equilibrium monetary model with a forward-looking Taylor-type rule[4], the reaction of monetary policy to contemporaneous changes in output is necessary. Because of the aforementioned arguments, the recursiveness assumption was chosen as the identification technique.

3. Results

3.1 Estimation

The VAR model is estimated using two different data samples. The first one covers the period from the first quarter of 1994 to the fourth quarter of 2004. The second one represents the period from the first quarter of 1998 to the fourth quarter of 2004. There are several reasons for using a shorter data sample next to the longer one. First, at the end of 1997 there was a change in monetary policy regime from an implicit fixed exchange rate regime (with the central bank officially targeting the money stock) to inflation targeting. Such a change may have caused a change in households' and firms' decision-making that would necessarily have been reflected in the values of the estimated coefficients. As a result, the use of the whole data sample is fully exposed to the Lucas critique. Second, the longer data sample covers the exchange rate crisis that took place in May 1997. The crisis resulted in the central bank abandoning the fixed exchange rate regime and floating the Czech currency. Moreover, quite a strong depreciation was observed during fall 1997 and summer 1998[5]. Mojon and Peersman (2001) conclude that the impulse response functions in the case of a monetary shock for countries that undergo an exchange rate regime shift, such as Italy and Spain in their country sample, express the so-called exchange rate puzzle. The exchange rate puzzle means that a tightening of the monetary policy stance leads to a depreciation of the exchange rate. The reason for such a pattern is straightforward. The monetary policy authority usually tries to defend the fixed exchange rate regime by increasing interest rates dramatically. Such behavior by the monetary policy authority in fact means a complete violation of the above-discussed assumption of monetary policy not reacting contemporaneously to a change in the exchange rate. If there is a similar monetary policy reaction, we will observe in the data a simultaneous interest rate increase and exchange rate depreciation. The exchange rate depreciation following the monetary policy tightening then also contributes to the existence of the price puzzle. At this stage we can conclude that similar performance could be present in the Czech data, so we might expect counterintuitive movements in the exchange rate and prices after the monetary policy shock.

The data used are in log levels and are seasonally adjusted, except for interest rates, which are just in levels and are not seasonally adjusted. As we do not provide an explicit long-run analysis of the

[4] For more details, see Leeper and Zha (2001).

[5] For a brief but comprehensive description of Czech monetary history, see Capek *et al.* (2003).

behavior of the economy, we allow only for an implicit cointegrating relationship in the data, following the methodology used by Christiano, Eichenbaum and Evans (1999)[6]. Readers interested in the debate about this methodology should refer to Sims and Uhlig (1991) and Uhlig (1994), among others.

For the monetary policy rate we use the three-month interest rate. Although the central bank conducts monetary policy via the two-week interest rate, the correlation between movements in the two-week and three-month interest rates is quite strong, so the use of the three-month rate does not represent any problem for the analysis.

Following CEE, we use the lag of order four for the whole data sample model (1994–2004). This is supported by standard likelihood tests, where both the Akaike and Schwarz test prefer the lag of order four to that of three or two. The residual test shows that there is no significant serial correlation in the v_t residuals[7]. For the short data sample (1998–2004), however, the results of the likelihood tests are ambiguous. Whereas the Akaike test prefers the lag of order two, the Schwarz test prefers the lag of order one. For both there is no significant serial correlation in the v_t residuals. Facing the relatively short data sample, we decided to use the lag of order one. However, the results for the lag of order two tell a similar story about the properties of the transmission mechanism.

3.2 Discussion of the Results

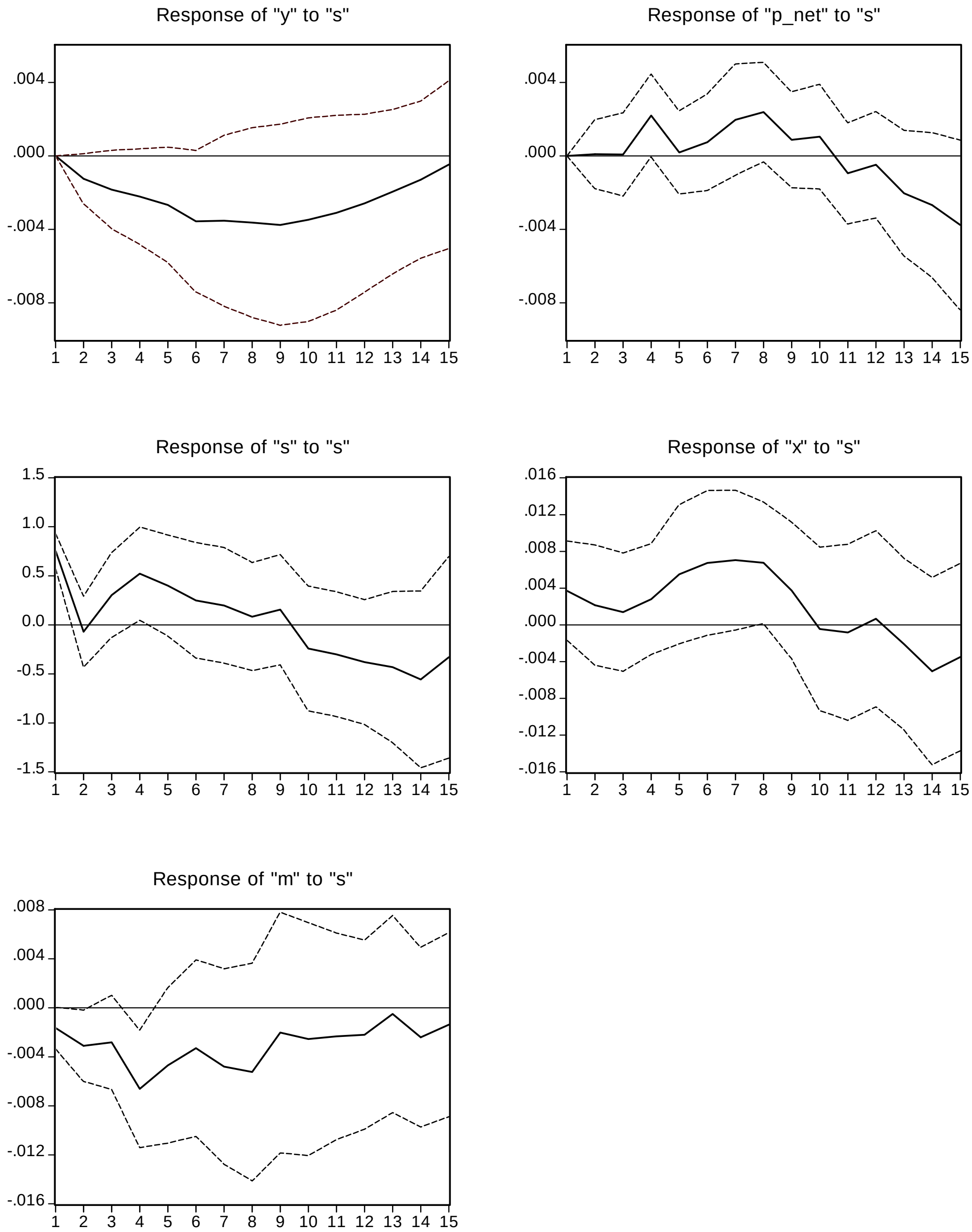
We start the discussion of the results with the full data sample from 1994 to 2004. Figure 1 shows the effect of a domestic, one-standard-deviation, monetary policy shock on domestic real GDP, prices, the exchange rate and the money stock. Remember that prices are measured using the net inflation price index, which excludes regulated prices.

The main consequences of a contractionary interest rate policy shock can be summarized as follows. First, there is a persistent rise in the interest rate accompanied by an immediate fall in the money stock. Second, it is obvious that an unexpected rise in the interest rate tends to be followed by a fall in output. The effect on output bottoms out in approximately 6 quarters, and output returns to the baseline thereafter. As we expected, the response of the exchange rate is rather counterintuitive. The increase in the interest rate is followed by a depreciation. It was mentioned above that such a rise in the exchange rate is called the “exchange rate puzzle” and has been observed for countries that underwent an exchange rate crisis during the relevant time period. The depreciation of the exchange rate could then be the reason why we observe persistent behavior of prices after a monetary policy tightening and a subsequent fall in output. Furthermore, we observe a rather sustained price increase, which is consistent with the existence of rather fast pass-through due to the direct exchange rate channel.

[6] See also Hamilton (1994)

[7] The detailed diagnostic of the residuals is presented in Appendix 1.

Figure 1: Responses of Output (y), the Net Inflation Price Index (p^{net}), the Interest Rate (s), the Exchange Rate (x) and the Money Stock (m) to a One-Standard-Deviation Shock to the Interest Rate (s) (1994–2004 Data Sample)



Although the result of a sluggish price response is not unusual (CEE find in the case of US economy, for example, that prices decline only after approximately 5 to 6 quarters), our results with a negative response only after 10 quarters raise doubts about the ordering used. The relevant question is whether these results really reflect the observed behavior of the economy, or, alternatively, are at least partially biased by the ordering used[8].

[8] There exists a technical way of evaluating the impact of ordering, namely, the generalized impulse response proposed by Pesaran and Shin (1998). The results of the generalized impulse response are presented in Appendix 2. They show that the change in ordering does not influence the results significantly. However, it should be mentioned that the use of the generalized response has no straightforward economic rationale and interpretation.

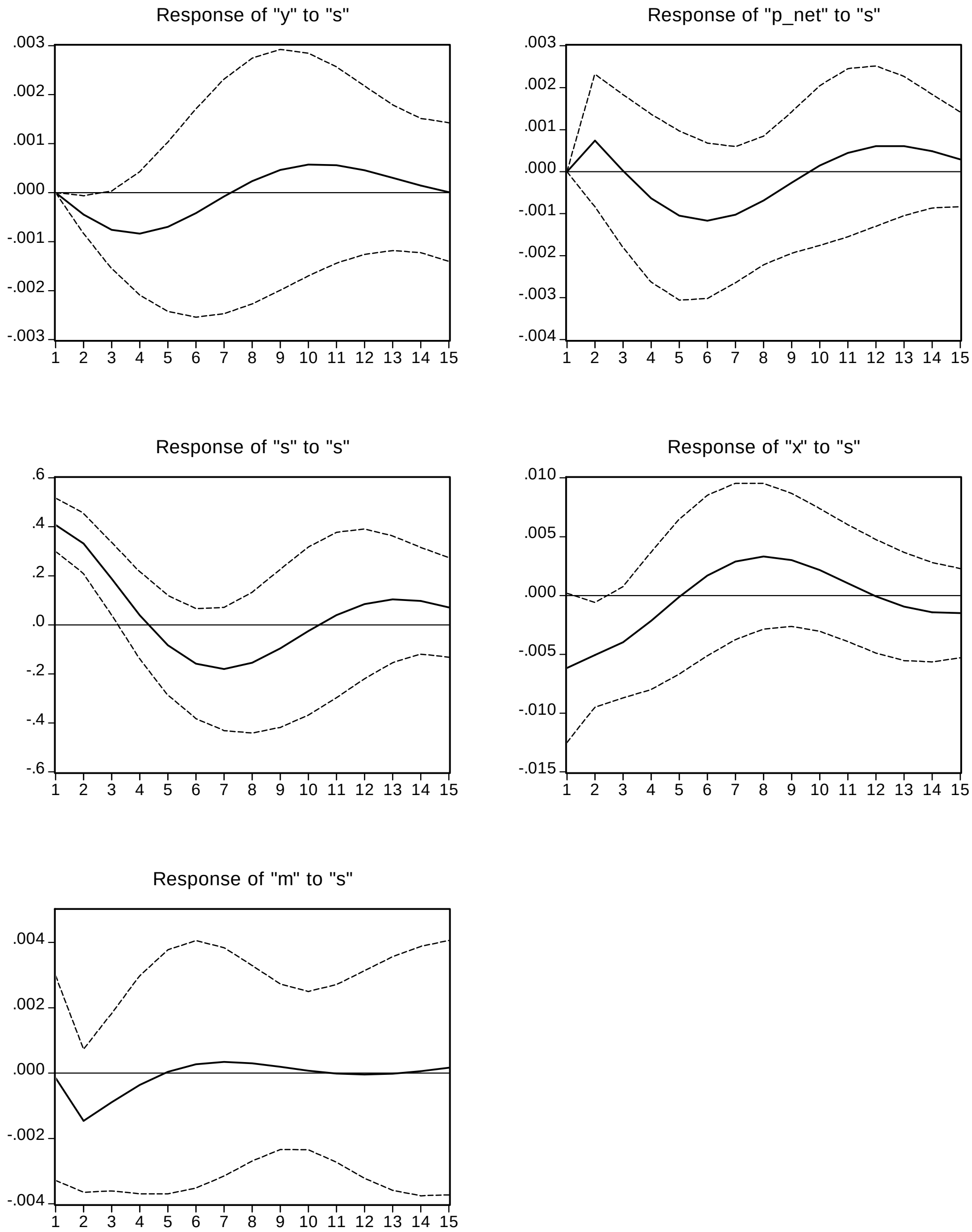
Mojon and Peersman (2001), however, argue that the "exchange rate puzzle" need not originate automatically from the monetary policy reaction to exchange rate movements, but may be caused by the influence of foreign monetary policy. Following this reasoning, Mojon and Peersman (2001) argue that the foreign interest rate should be a direct part of the vector of endogenous variables, reflecting the strong relationship between the home and foreign country. The domestic interest rate then responds to the foreign one without any impact on the exchange rate. Putting it differently, neglecting the foreign interest rate in the model can result in a price and exchange rate puzzle. The reason is that if one does not control for increases in the domestic interest rate that are just a response to an increase in the foreign rate, then the positive interest rate shock may be associated with an exchange rate depreciation. The exchange rate depreciation then puts upward pressure on prices.

However, the inclusion of the foreign interest rate in the vector of endogenous variables does not alter the results obtained. We can therefore conclude that the observed exchange rate puzzle is probably due to monetary policy behavior during the exchange rate crisis. This conclusion will be further supported by the results from the short data sample (see below).

We mention above that the results for the 1994–2004 data sample are only partially reliable. This limited reliability stems from the exchange rate regime shift and subsequent monetary policy regime shift which are both encompassed in the data sample used. This results in strong relevance of the Lucas critique to the estimated model and in a counterintuitive performance of the exchange rate in response to the monetary policy tightening. In order to avoid these problems at least partially, we estimated the model using the data sample from 1998 to 2004, which excluded the most problematic year 1997. Figure 2 depicts the effect of a domestic, one-standard-deviation, monetary policy shock on domestic real GDP, prices, the exchange rate and the money stock using the short data sample.

The main consequences of a contractionary interest rate policy shock for the short data sample can be summarized as follows. First, there is again a persistent rise in the interest rate, accompanied in this case by an only gradual and temporary fall in the money stock. This change in pattern probably reflects a relatively limited negative response of output by comparison with the full data sample, as the output decline arises more quickly and is less persistent. The negative effect on output reaches its peak in just 4 quarters. Second, by comparison with the full data sample case, the exchange rate follows an immediate appreciation trajectory. Third, regarding the reaction of prices, the results show that after approximately two quarters of persistence there is a gradual decline in prices. The price decline reaches its maximum in approximately 5 to 6 quarters. It seems that prices respond relatively quickly to the changes in output and that the observed price persistence should be taken as relatively limited. On the other hand, it should be mentioned that the high degree of simultaneity between output and prices may arise from the strong influence of the direct exchange rate channel.

Figure 2: Responses of Output (y), the Net Inflation Price Index (p^{net}), the Interest Rate (s), the Exchange Rate (x) and the Money Stock (m) to a One-Standard-Deviation Shock to the Interest Rate (s) (1998–2004 Data Sample)



The results should, without doubt, be taken with extreme caution. The data sample is not sufficient, which results in wave-shaped response functions and relatively wide confidence bands. However, excluding the 1994 to 1997 period we can at least observe a shift to more intuitive results, which could be interpreted as a gradual shift to an economy with standard behavior.

4. Conclusions

This paper deals only with the basic properties of the monetary policy transmission mechanism. The precise role of the different channels should be taken as something that is beyond the scope of this paper. The identified VAR model can then serve as an information tool for obtaining the basic transmission framework within a mutually interdependent environment. Consequently, in this paper we have estimated an identified VAR on Czech data. Using the standard recursiveness assumption as the identification technique and a particular ordering covering the implicitly assumed structure of the economy, we have quantified the impulse responses of the main variables to an unexpected monetary policy tightening.

The main focus of this paper is the reaction of the economy to a monetary policy shock. Therefore, we can hardly say anything about the effects of systematic monetary policy behavior. All the results should be taken with this reservation in mind.

In order to answer the above-mentioned question, two different VAR models were estimated. The reason for this was a change in the monetary policy regime in the middle of the 1990s, which is, of course, problematic from the Lucas critique perspective. Consequently, the first model covers the full data sample from the first quarter of 1994 to the fourth quarter of 2004, while the second one covers the period after the regime change only (1998 to 2004). The results differ in several respects.

We can conclude that in general, an unexpected rise in nominal short-term interest rates tends to be followed by a fall in output, although the short data sample brings a faster and less persistent output response. The rest of the findings depend heavily on the data sample chosen. The exchange rate response exhibits counterintuitive behavior in the full data sample case, i.e., depreciation after the monetary policy tightening, which, with high probability, is an artifact of the presence of an exchange rate attack and policy regime change in the data sample. Consequently, the price response is also highly persistent in the full data sample case. Excluding the regime change from the data sample the response of the exchange rate becomes intuitive. The monetary policy tightening is followed by an immediate exchange rate appreciation. Consequently, prices start to fall after approximately two quarters of persistence, with the decline peaking in one and a half years. The relatively quick reaction of prices to the monetary policy contraction might arise from the strong role played within the economy by the direct exchange rate channel.

Although the present results certainly cannot be taken mechanically, they at least show the basic framework of how monetary policy affects the economy. The findings encourage future research, as they show that applying standard techniques to the Czech data can bring meaningful results that can be useful as a benchmark for further analysis of the transmission mechanism in the Czech economy.

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Appendix

APPENDIX 1: Residual Test for Serial Correlation in v_t

Full Data Sample

VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Date: 07/27/05 Time: 15:42
Sample: 1994Q1–2004Q4
Included observations: 36

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	70.62228	NA*	72.64006	NA*	NA*
2	123.2655	NA*	128.3800	NA*	NA*
3	177.0217	NA*	187.0230	NA*	NA*
4	230.2464	NA*	246.9008	NA*	NA*
5	280.9600	0.0000	305.7941	0.0000	36
6	322.0749	0.0000	355.1319	0.0000	72
7	370.2539	0.0000	414.9403	0.0000	108
8	403.7392	0.0000	457.9928	0.0000	144

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

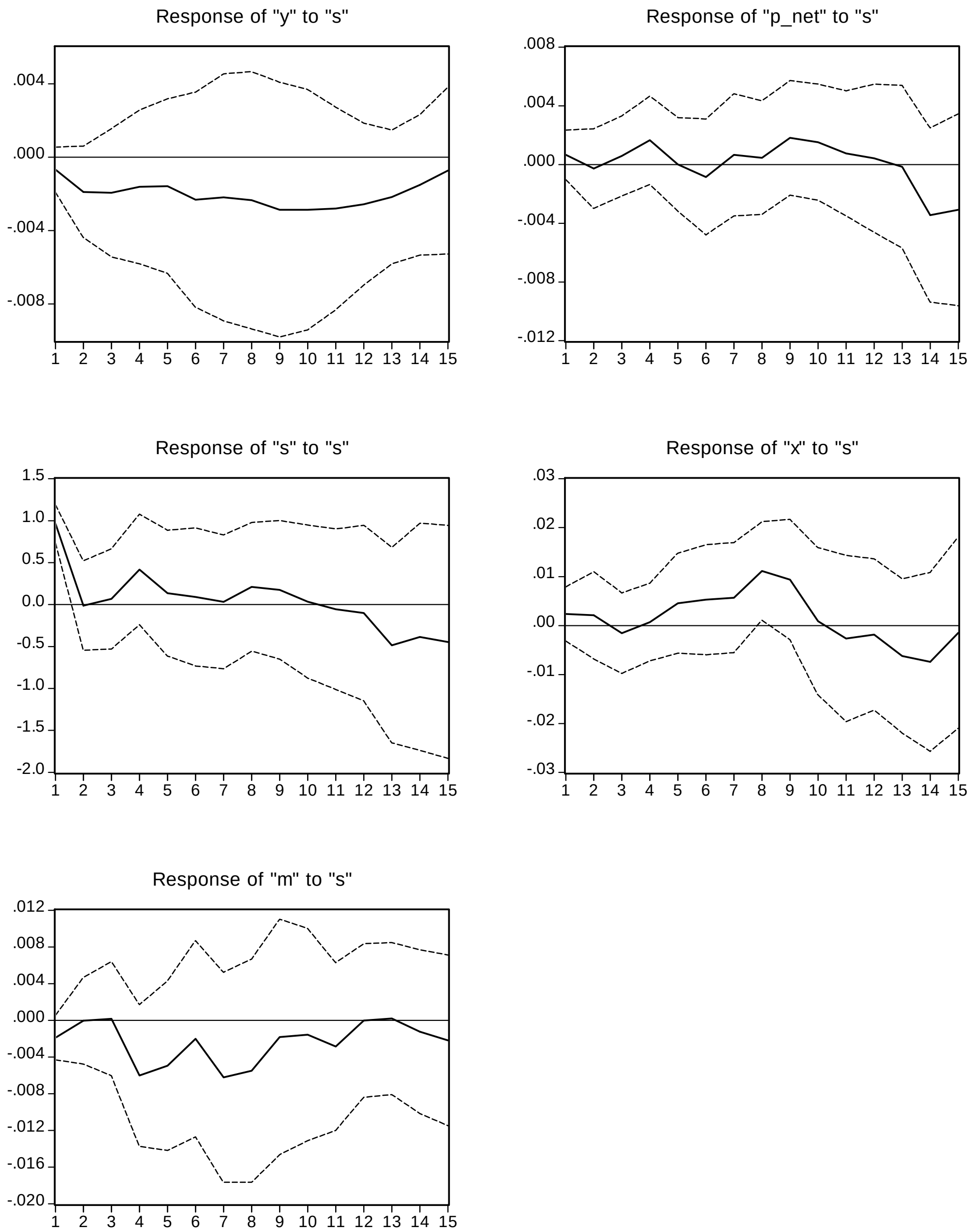
Short Data Sample

VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Date: 07/27/05 Time: 15:39
Sample: 1998Q1–2004Q4
Included observations: 28

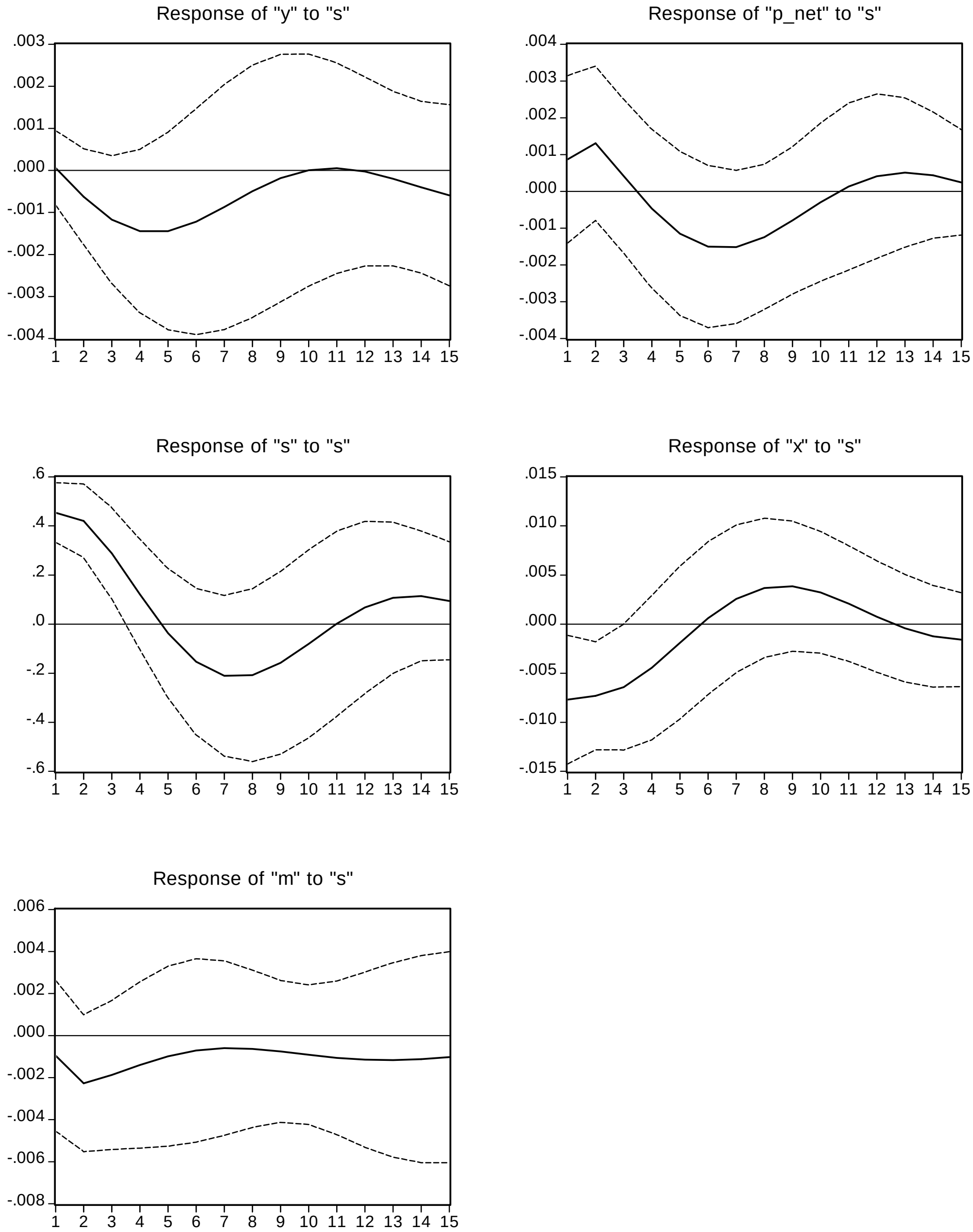
Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	48.86902	NA*	50.67898	NA*	NA*
2	82.67678	0.0000	87.08734	0.0000	36
3	119.4548	0.0004	128.2787	0.0001	72
4	157.2018	0.0014	172.3169	0.0001	108
5	190.1342	0.0060	212.4085	0.0002	144

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

APPENDIX 2: Generalized Responses of Output (y), the Net Inflation Price Index (p^{net}), the Interest Rate (s), the Exchange Rate (x) and the Money Stock (m) to a One-Standard-Deviation Shock to the Interest Rate (s) (1994–2004 Data Sample)



APPENDIX 2: Generalized Responses of Output (y), the Net Inflation Price Index (p^{net}), the Interest Rate (s), the Exchange Rate (x) and the Money Stock (m) to a One-Standard-Deviation Shock to the Interest Rate (s) (1998–2004 Data Sample)



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