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Exchange Rates in Central Europe: A Blessing or a Curse?

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Abstract

Central European accession countries (CECs) are currently considering when to adopt the euro. From the perspective of macroeconomic stabilization, the cost or benefit of giving up a flexible exchange rate depends on the types of asymmetric shocks hitting the economy and the ability of the exchange rate to act as a shock absorber. Economic theory suggests that flexible exchange rates are useful in absorbing asymmetric real shocks but unhelpful in the case of monetary and financial shocks. For five CECs—the Czech Republic, Hungary, Poland, the Slovak Republic, and Slovenia—empirical results on the basis of a structural VAR suggest that in the CECs the exchange rate appears to have served as much or more as an unhelpful propagator of monetary and financial shocks than as a useful absorber of real shocks.

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I. INTRODUCTION

Following confirmation of entry into the European Union (EU) for the first wave of transition countries, questions about post-accession monetary and exchange rate frameworks have moved center stage. For the five central European countries (CECs) that now operate independent monetary policies—the Czech Republic, Hungary, Poland, the Slovak Republic, and Slovenia—one of the key questions in determining the appropriate timing of euro adoption is on the costs (or benefits) of giving up monetary independence from the perspective of macroeconomic stabilization.[2] Under high capital mobility, with limited scope for independent interest rate policy, this question largely centers around the costs (or benefits) of giving up the flexible exchange rate as a stabilization tool (i.e., a shock absorber).

The usefulness of flexible exchange rates as shock absorbers depends largely on the types of shocks hitting the economy and the exchange rate. Flexible exchange rates can generate rapid adjustment in international relative prices even when domestic prices adjust slowly. This makes them potentially useful absorbers of real shocks, which require an adjustment in relative prices in order to "switch expenditure" and cause output losses or overheating in the absence of price adjustment. For instance, a sudden drop in demand would, under flexible exchange rates, cause a depreciation, which "crowds in" extra demand (Mundell, 1964). On the other hand, exchange rate adjustment in response to monetary and financial shocks leads to undesired changes in relative prices. For instance, in the case of a negative financial shock that puts upward pressure on interest rates, the exchange rate would appreciate, amplifying rather than dampening the negative impact on output. Under fixed exchange rates, in contrast, such a shock would be neutralized by an increase in liquidity stemming from a balance of payments surplus (assuming capital mobility). Moreover, such asymmetric financial market shocks would simply not occur in a currency union (Buiter, 1995). Thus, the usefulness of flexible exchange rates declines as the relative importance of asymmetric monetary/financial shocks increases.

The "New Open Economy Macroeconomics" theory stresses that if exchange rate changes do not generate adjustment in international relative prices because pass-through to import prices is very small, the exchange rate is of little use as a shock absorber even in the case of asymmetric real shocks.[3] Nevertheless,the empirical evidence to date remains supportive of the ability of the exchange rate to affect relative prices (Obstfeld (2001) and (2002)).

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[2] These considerations are of course only part of a full-fledged cost-benefit analysis, which would also consider benefits from reducing financial risk and related risk premia on interest rates, eliminating foreign exchange transaction costs, disciplining macroeconomic policies, and increasing trade and technology transfer.

[3] See Engel (2002), Obstfeld (2001), and Obstfeld (2002) for surveys.

Against this backdrop, most empirical studies on the costs (or benefits) of giving up exchange rate flexibility for industrialized countries analyze the incidence and impact of real and monetary/financial shocks. The less the exchange rate responds to the shocks that affect output, and the more the asymmetric shocks hitting the economy and the exchange rate are monetary/financial shocks rather than real shocks, the less useful is the exchange rate as shock absorber. These studies apply the structural vector auto-regression (SVAR) developed by Clarida and Gali (1994). Their system of three variables (often relative to trading partners)—output, prices, and the real exchange rate—yields the identification of supply (AS), demand (IS), and monetary/financial (LM) shocks (see Box 1). Impulse response functions (IRFs) can verify whether the freely estimated short-run dynamics are consistent with economic theory. Once the shocks are correctly identified, their contribution to the explanation of the variability in each variable can be assessed.[4]

Studies on large industrial countries tend to find that real shocks explain at least the majority of the variance in real exchange rates, suggesting that exchange rates in those countries served to a varying degree as shock absorbers. Clarida and Gali (1994) find this for Japan and Germany, the United Kingdom, and Canada. Enders and Lee (1997), employing a two-variable, two-shock model, find similar results for Japan and Germany, although for Canada they find that nominal shocks explain about half of the variation in the nominal exchange rate.

Other studies—mostly on smaller economies, and distinguishing between the role of the real and the nominal exchange rate—find the exchange rate to be less useful as a shock absorber. Canzoneri et al (1996) find for a group of EU countries that the ("non-neutral") shocks that explain the bulk of the variability in relative output (relative to Germany) explain little of the variability in the nominal exchange rate. Moreover, LM shocks explain the majority of the variability in the nominal exchange rate. Artis and Ehrmann (2000) find that the exchange rate is not very responsive to supply and demand shocks in the U.K., Sweden, Denmark, and Canada, and that in the first three it is largely driven by shocks in the exchange market. For the United Kingdom they also find, though, that monetary policy is (weakly) effective in influencing output.

Empirical studies on the CECs tend to use simpler econometric methods. Gros and Hobza (2003) find that in the CECs real exchange rate variability has been greater than that of the nominal exchange rate. They argue this suggests that the exchange rate has functioned as a source—rather than a dampener—of shocks, because the nominal exchange rate has not moved to offset inflation differentials. They do not analyze the sources of exchange rate

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[4] Other studies (i) compare experiences with fixed and flexible rates across countries (Hoffmaister, Roldós, and Végh (1995) for Uruguay); and (ii) construct a "counter factual" by comparing the responses to shocks between a standard model and a version with the monetary policy channel "blocked off." IMF (1997) does the latter for Finland with a vector error correction model and finds that the shock absorbing capacity of independent monetary policy was "minimal."

movements. Dibooglu and Kutan (2001) find that in Poland nominal shocks contribute significantly to movements in nominal and real exchange rates while in Hungary the impact of nominal shocks was more limited. They include periods with little exchange rate flexibility in their sample. Süppel (2003) finds for the Czech Republic, Poland, and the Slovak Republic that during the period with flexible exchange rates relative output Granger-caused the real exchange rate. He concludes that real exchange rates respond to shocks to relative output and help dampen divergences in the cycle. His study is based on an unrestricted VAR, and thus does not identify the structural shocks affecting output and the exchange rate. Kontolemis and Ross (forthcoming) apply a Clarida and Gali SVAR to a broad group of transition countries to investigate exchange rate dynamics in response to shocks. Their results on the incidence and impact of real and nominal shocks vary across countries.

Box 1. Classification and Identification of Shocks in the Mundell-Flemming (MF) model

Clarida and Gali (1994) derive a stochastic version of the Obstfeld (1985) open economy macro model with output, prices, and the real exchange rate as endogenous variables. The model exhibits the standard MF results: (i) sticky price and output adjustment; and (ii) national outputs that are imperfect substitutes in consumption in the short run while embodying mainstream long-run properties characterizing equilibrium after full price adjustment. Following Blanchard and Quah (1989), in the estimation of the structural VAR, the theoretical long-run properties are used as restrictions to identify three structural shocks that drive the system: relative supply (AS), demand (IS), and monetary/financial market (LM) shocks. Relative AS shocks have a permanent effect on relative output (productivity and labor market shocks). Relative IS shocks have a permanent effect on the real exchange rate but not on output. Relative nominal shocks have no permanent effect on relative output and the real exchange rate.[1/] Conceptually, monetary/financial shocks include changes in relative money supply and liquidity preferences, velocity shifts, varying risk premia, effects of financial liberalization, and speculative currency attacks.

Having identified the shocks by their long-run properties, the short- and medium-run structural dynamics are freely estimated. The contribution of each shock to the variability in each variable can be assessed (with variance decomposition), and impulse response functions can be generated. If correctly identified, these should show the following:

- A positive relative supply shock increases relative output. The short run impact on the real and nominal exchange rates is ambiguous, but eventually prices should fall. In the long run, relative output rises while the effect on the real exchange rate is ambiguous (Buiter, 1995).
- A positive relative demand shock increases relative demand. In the short run, the nominal and, due to sticky prices, real exchange rates appreciate, and relative output increases. Eventually, prices increase, and in the long run, relative output returns to its old level, while the real exchange rate appreciates if the shock is permanent.
- A positive relative monetary/financial shock lowers the countries' interest rate, relative to foreign rates. In the short run, both real and nominal exchange rates depreciate—amplifying the impact of the shock—and relative output increases. In the long run, relative output returns to its old level, and there is no effect on the real exchange rate.

1/ IS and LM shocks can be classified together as neutral shocks.

This paper applies the Clarida and Gali SVAR, as well as the simpler Enders and Lee one, to the CECs. In line with Canzoneri et al (1996) and Artis and Ehrmann (2000), but in contrast to other studies, we focus on the role of the nominal exchange rate, rather than just the real exchange rate. This requires us to modify the specification of the Clarida and Gali SVAR (without changing the underlying economic model). The reason for the focus on the nominal exchange rate is that the flexibility of the nominal rate will be given up after euro adoption, while the real exchange rate will still be able to adjust due to price changes. Unlike other studies, we estimate—to the extent possible—the SVAR only over the period with generally flexible exchange rates specified below. We think it is important to avoid distortions from systematic policy intervention (e.g., exchange market intervention), even if this means limiting the sample period to the current 6–10 years.

We argue, roughly in line with Canzoneri et al (1996), that an empirical assessment of the usefulness of flexible exchange rates as shock absorbers needs to shed light on the following two questions: (i) has the (nominal) exchange rate responded to the shocks that affect output?; and (ii) have real demand and supply shocks been more important than monetary/financial shocks in affecting the nominal exchange rate?[5]

The first question can be answered with a simple two-variable, two-shock model. If the exchange rate is found not to respond to the shocks that affect output, we have strong indications – although not yet conclusive evidence – that it is not useful as an output stabilizer. Our empirical results suggest that output is predominantly influenced by one type of shock—the non-neutral—while the nominal exchange rate is largely determined the other type—the neutral one—casting doubt on the usefulness of the exchange rate as shock absorber.[6] The evidence is not conclusive because in theory these results could also be consistent with the exchange rate being such an effective stabilizer of output in the face of a neutral shock that output is completely shielded from the shock—and thus exchange rate flexibility would be a helpful tool (Canzoneri et al).

Answering the second question then becomes crucial. Using the three-variable SVAR, shocks are classified into IS, AS, and LM shocks. We find that some of the exchange rate variability has been due to IS shocks, and thus useful. However, a larger share of the exchange rate variability has been due to LM shocks, and thus unhelpful, with the share of LM shocks particularly high in the smaller, more open CECs. In other words, judging from the observed exchange rate movements, the exchange rate appears on average to have served as much or more as an unhelpful propagator of LM shocks than as a useful absorber of IS shocks.

Together, our findings suggest that the cost of losing the flexible exchange rate as a stabilizing tool in the CECs is modest, if at all positive, particularly in the smaller countries.

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[5] Canzoneri et al (1996) ask a different second question.

[6] See Box 1 for the definition of a neutral shock.

The paper proceeds as follows. Section II discusses the estimation period, econometric methodology, and data. Section III discusses the empirical results, and Section IV contains concluding remarks.

II. Estimation Period, Methodology, and Data

A. Estimation period

To avoid distortions from systematic policy intervention the SVARs are estimated over a period with generally flexible exchange rates as described in Table 1. Flexibility has often been introduced in steps, and some subjective decisions have to be made on the estimation period, trading off regime shifts within the sample against the need to have a sufficiently large number of observations. Mitigating this trade off, (non-multiplicative) dummies are included to account for changes in monetary and exchange rate regimes, as well as exceptional periods, following Creel and Levasseur (2003) and Süppel (2003) (see Table 2).

Table 1: Observation period

Czech Republic	1996:II – 2003:II	Poland (2)	1998:II – 2003:II
Hungary	1995:III – 2003:II	Slovak Republic	1997:I – 2003:II
Poland (1)	1995:II – 2003:II	Slovenia	1993:I – 2003:II

- In the Czech Republic, exchange rate flexibility was introduced in February 1996 when a peg was replaced by a ± 7.5 percent band. Dummies are proposed for the adoption in early 1997 of a (managed) flexible exchange rate regime and the introduction in January 1998 of inflation targeting (IT).
- In Hungary, narrow bands of ± 2.25 percent were introduced in March 1995. Since full exchange rate flexibility was introduced only in mid-2001, with the widening of the exchange rate band to ±15 percent, the number of observations since that time would be too small and the estimation is carried out over the longer period from mid-1995 onwards, with a dummy proposed for the widening of the bands in mid-2001; results accordingly should be interpreted with particular care.
- Poland moved from a crawling peg to a crawling band regime in May 1995. Since this implied only moderate flexibility we also include an estimation for Poland from February 1998 onwards, when the intervention band was widened to ±10% (following Süppel (2003)). Dummies are proposed for the introduction of IT in September 1998 and the full float in April 2000.
- In the Slovak Republic, the band was gradually widened during 1996 to ± 7 percent by early 1997. A dummy is proposed for the float of the koruna in October 1998.
- For Slovenia, where official guidance of the exchange rate has been considerable, no significant change has occurred since 1993, and estimation begins in 1993.

B. Econometric Methodology

The methodology is based on the SVAR approach introduced by Blanchard and Quah (1989). Long-run properties stemming from econometric theory are used as restrictions to identify structural shocks—neutral vs. non-neutral in a two-variable model, or LM, IS, and supply (AS) shocks in a three-variable model—thereby leaving the short-run response of the variables to the shocks unrestricted (see Box 1).[7]

The models are estimated in first differences to be able to impose long-run restrictions on the level of the variables. Stationarity and cointegration test are performed to verify that the specification in first differences is appropriate. The VARs include a constant term and monthly dummies to capture seasonality.[8] On the basis of lag length tests reported in Tables A1 and A3, the lag length is uniformly chosen for all countries to be six periods in both models. We test for the inclusion of the period- and regime-specific dummies listed in Table 2; a dummy is maintained if it is significant in at least one of the three equations.

Table 2: Definition of dummies

D1	Asian and Russian Crises	1 from 1997:V – 1998:VIII
D2	Float in Czech Republic	1 from 1997:V onwards
D3	Widening of bands in Hungary	1 from 2001:VI onwards
D4	Float in Poland	1 from 2000:IV onwards
D5	Float in Slovak Republic	1 from 1998:X onwards
D6	Inflation targeting in Czech Republic	1 from 1998:I onwards
D7	Inflation targeting in Poland	1 from 1998:IX onwards

After estimating the models and imposing the relevant long-run restrictions, impulse response functions and forecast error variance decomposition tables are retrieved. Impulse response functions are used to compare the estimated response of the variables to the structural shocks with the response predicted by economic theory as described in Box 1. The variance decomposition tables report the contribution of each structural shock to the conditional variance of the variables at various forecast horizons (up to 48 months). As such, they give an indication of the relative importance of each of the shocks to changes in each of the variables.

[7] For a more detailed discussion of the methodology, see Clarida and Gali (1994)

[8] Monthly dummies are not included for Slovenia, since output data were only available on a seasonally adjusted basis.

C. Data

Monthly data from 1993 to 2003 are used for: (i) the bilateral nominal exchange rate against the euro [9] (from Eurostat); (ii) industrial production (from the IMF's International Financial Statistics (IFS) database); and (iii) the CPI index (also from the IMF's IFS database). The latter two variables are expressed relative to the euro area, to capture asymmetric shocks relative to the economic area against which the exchange rate is assessed. Industrial production covers only a part of economic output, and a series with wider coverage would have been preferable (e.g., GDP). Unfortunately, these are only available on a quarterly basis, which would reduce the number of observations too much. The real exchange rate is constructed using the bilateral euro exchange rate vis-à-vis the euro (see above) and the relative price level vis-à-vis the Euro area, measured by the CPI.[10] Figure 1 shows the evolution of the variables for each of the countries.

III. Results

A. Has the exchange rate responded to the shocks that impact on output?

The first SVAR model, introduced by Canzoneri et al asks whether the nominal exchange rate and output react to the same shocks:

$$\begin{bmatrix} \Delta e_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} \\ 0 & C_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{neutral,t} \\ \varepsilon_{non-neutral,t} \end{bmatrix},$$

where Δr_t is the first difference of the (log of the) nominal exchange rate and Δy_t is the first difference of (log of) relative industrial production. Two structural shocks are distinguished. The neutral shock has no long-run effect on relative output.[11] Non-neutral shocks have a long-run impact on output.

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[9] In units of domestic currency per euro so an increase is a depreciation of the exchange rate.

[10] An increase is a depreciation of the exchange rate.

[11] In terms of the Mundell-Fleming model, neutral shocks include monetary/financial market (LM) shocks and real demand (IS) shocks. Non-neutral shocks can be identified as supply shocks.

Figure 1. CECs: Evolution of the Nominal Exchange Rate, Real Exchange Rate and Relative Output

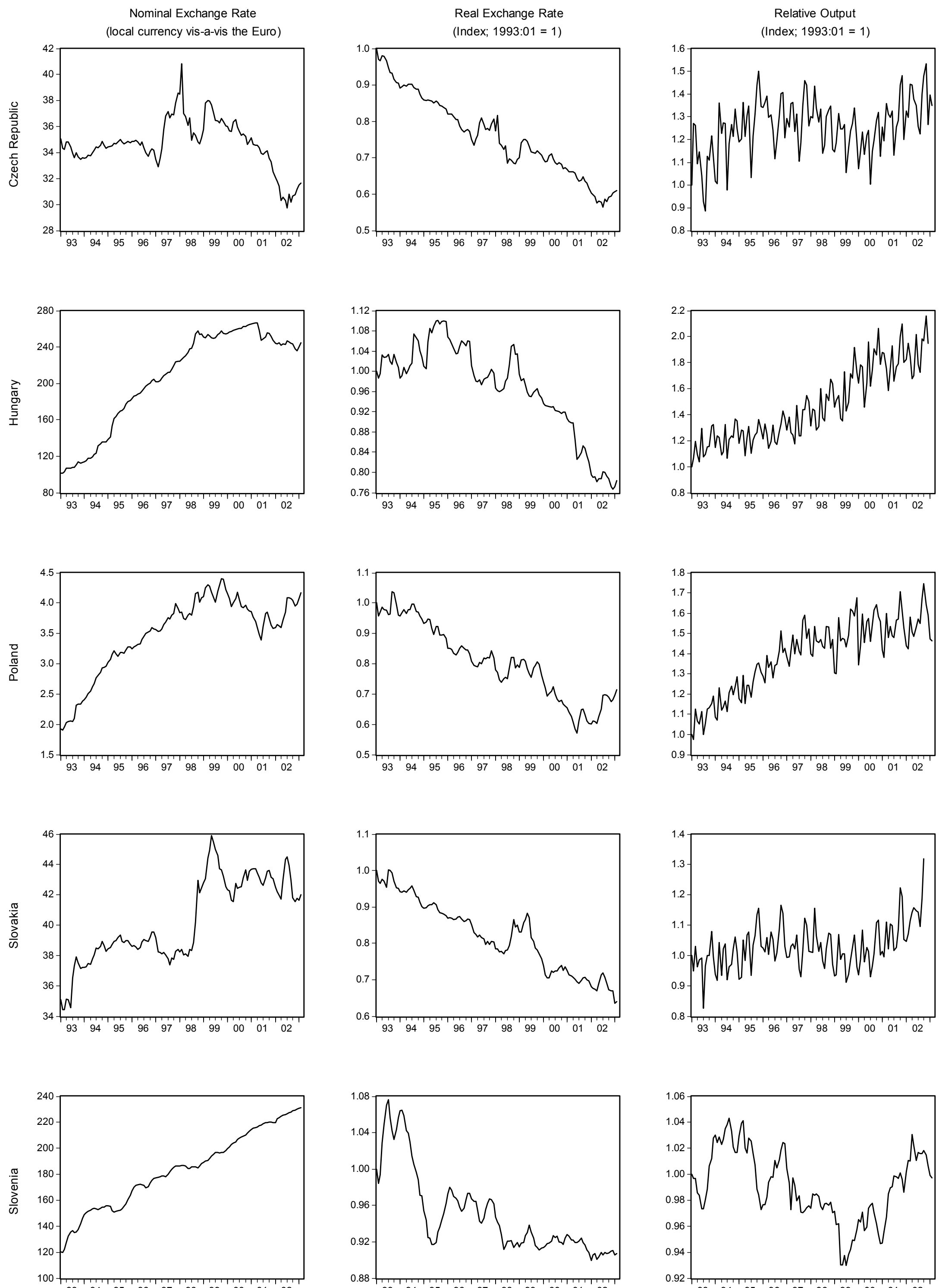

Table A1 reports the results of the stationarity and cointegration tests. For the nominal exchange rate, stationarity tests are run with and without a linear trend depending on the evolution of the exchange rate over the observation period. Both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics are reported. The ADF tests indicate that the null hypothesis of a unit root cannot be rejected for any of the series. This is confirmed by the PP test for all series except Hungary. For relative output, the ADF tests indicate that the null of a unit root cannot be rejected for any of the series except for Poland over the longer period, although the PP test also rejects a unit root in relative output in the Czech and Slovak Republics. Unit root test on the first difference of the variables indicate that the null of a unit root can be rejected in all cases. Hence it can be concluded that the variables are I(1) and not integrated of a higher order.

The tests for cointegration of the two variables in each of the countries consist of a two-step procedure. In the first step, the nominal exchange rate is regressed on relative output and a constant. Then, the residuals are tested for the presence of a unit root. If the variables are cointegrated, the residuals should be stationary and the null hypothesis of a unit root should be rejected. For all countries, the null hypothesis cannot be rejected, indicating that the variables are not cointegrated. A VAR model in first differences is therefore the correct specification.

Table 3 reports the variance decompositions for the estimated model. More extensive results – over a selected number of periods up to a horizon of 48 months – can be found in Table A2 at the end of the paper. The results are similar across all countries: at least three quarters of variability in the nominal exchange rate is explained by the neutral shock. The only exception is Poland over the estimation period 1998:II – 2003:II, in which the neutral shock explains only 53 percent of the exchange rate. Variability in relative output, on the other hand, is mostly determined by non-neutral shocks. The contribution of the non-neutral shock ranges from 60 percent in Slovenia to over 90 percent in the Slovak Republic. Again, Poland over the short period is an exception with a contribution of 52 percent. These results clearly suggest that the nominal exchange rate does not respond to the shocks that seem to cause the bulk of fluctuations in output—evidence that the exchange rate does not serve as an absorber.

Table 3. CEC5: Variance Decomposition for the Exchange Rate and Output
(Measuring the Contribution of Asymmetric Neutral and Non-neutral Shocks).[1/]

	Czech Republic 96/2-03/02		Hungary 95/3-03/02		Poland 95/5-03/02		Poland 98/2-03/3		Slovak Republic 97/1-03/2		Slovenia 93/1-03/2	
	Neut.	Non-neut.	Neut.	Non-neut.	Neut.	Non-neut.	Neut.	Non-neut.	Neut.	Non-neut.	Neut.	Non-neut.
Exchange rate	92	8	84	16	79	21	53	47	75	25	79	21
Output	18	82	9	91	27	73	48	52	6	94	40	60

Source: IMF International Financial Statistics, Eurostat, and national authorities.

1/ After 12 months.

The results from the variance decomposition do not help answer the second question that was posed—namely, whether the variability in nominal exchange rates has mainly been explained by IS or LM shocks. Ideally, the impulse response functions (IRFs) (Figure 2) would have helped answer this question. In particular, if all the IRFs to shocks to the nominal exchange rate and output were significant, the comparison of the effects from the two shocks on the two variables with the priors discussed in Box 1 would indicate whether the neutral shocks are predominantly LM or IS shocks. This is because a positive LM shock should depreciate the nominal exchange rate and increase relative output in the short run, while a positive IS shock would appreciate the nominal exchange rate and increase relative output in the short run. Unfortunately, the impulse response functions do not give unambiguous results: the aggregate effect of the neutral shock on output is very small in most countries. As a consequence, it cannot be determined whether the depreciation in response to the neutral shock in all countries is caused by a positive LM shock or a negative real demand shock—in part because both shocks have probably occurred.

B. Have IS shocks been more important than LM shocks in affecting the nominal exchange rate?

The following three variable VAR is used to distinguish LM, IS, and supply (AS) shocks.

$$\begin{bmatrix} \Delta r_t \\ \Delta e_t \\ \Delta y_t \end{bmatrix} = \begin{bmatrix} 0 & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ 0 & 0 & C_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_{mt} \\ \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix}$$

It builds on the above two-variable VAR model by adding the real exchange rate Δr_t.[12] The three different shocks can be distinguished by imposing the following restrictions:

- The LM shock ε_{mt} has no long-run impact on the real exchange rate.
- The LM shock ε_{mt} has no long-run impact on relative output.
- The IS shock ε_{dt} has no long-run impact on relative output.

Table A3 reports the results of the stationarity tests for the real exchange rate (the tests on the nominal exchange rate and output are reported in Table A1). With a trend and an intercept included, the null hypothesis of a unit root in the level of the real exchange rate cannot be rejected in all cases except Hungary, where in the case of both the ADF and the PP tests it is rejected. Stationarity tests on the difference of the real exchange rate clearly indicate that the null of a unit root can be rejected. Hence the (level) data are I(1).

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[12] The nominal exchange rate is used instead of relative prices (as in the standard Clarida and Gali SVAR). As the nominal rate will be given up after euro adoption, the explicit study of its response to shocks is key. The identification of the shocks remains the same, since the real exchange rate is *defined* as the product of the nominal exchange rate and relative prices.

The cointegration test follows the same procedure as outlined above. The ADF test performed on the residual of a regression of the real exchange rate on the nominal exchange rate, relative output, and a constant indicates that the null of a unit root cannot be rejected in all cases. This indicates that the variables are not cointegrated. Hence, the estimation of a VAR model in first differences is appropriate.

Lag length tests are reported in Table A3. The model is estimated using six lags and seasonal dummies. We also test for the significance of the above-described period- and regime-specific (non-multiplicative) dummies, and dummies are maintained if they are significant in any of the equations. This results in the acceptance of the monetary policy (D2) and inflation targeting (D6) dummies for the Czech Republic and Poland in the long period.

The analysis of the IRFs (Figure 3) reveals that the shocks generally are well identified, with the responses consistent with the theoretical priors discussed in Box 1 (except for Hungary), suggesting, inter alia, that exchange rate changes do generate relative price changes.

- In response to the (positive) IS shock, the nominal exchange rate appreciates. With prices rising, the real exchange rate appreciates even more. Output temporarily increases. The exchange rate movement thus dampens the impact of the shock on output. In Hungary, a positive IS shock leads to a depreciation. While different from the response in other countries, this appears consistent with the exchange rate regime conducted throughout most of the estimation period: as relative prices rise, the authorities would choose to depreciate the exchange rate to offset the impact on competitiveness.
- In response to the (positive) LM shock, the nominal exchange rate depreciates permanently and output increases temporarily. In this case, the exchange rate amplifies the impact of the LM shock on output. As prices rise only slowly, the real exchange rate depreciates in the short run; eventually, as prices catch up, it returns to its original level. In Hungary, the LM shock is difficult to quantify—not surprisingly, given the exchange rate regime. In Slovenia, output temporarily decreases, which also points to difficulties in identification potentially related to the monetary and exchange rate regime.
- The (positive) AS shock increases output and has an ambiguous effect on the exchange rates, consistent with theory.

The fact that the long-run relationships already start to dominate after 2-2½ years—here as well as in empirical studies on longer samples—appears to mitigate potential problems due to relatively short sample periods.

Table 4 and Table A4 report the variance decomposition of the real exchange rate, the nominal exchange rate, and relative output. Confirming the earlier finding, variability in relative output is mainly driven by AS shocks, with the contribution ranging from over 60 percent in the Czech Republic, Hungary, and Slovenia to more than 90 percent in the Slovak Republic. Again, Poland in the short period stands out with a relatively small contribution from the AS shock. The remainder of the variability in relative output is caused by LM and IS shocks. In Hungary, Poland (in the long period), and Slovenia, the contribution of the LM shock is larger than 15 percent. In the Czech Republic and Hungary, the contribution of the IS shock is larger than 15 percent.

Table 4. CEC5: Variance Decomposition for Selected Macroeconomic Variables
(Measuring the Contribution of Asymmetric LM, IS, and AS Shocks). 1/

	Czech Republic 96/2-03/02			Hungary 95/3-03/02			Poland 95/5-03/02			Poland 98/2-03/3			Slovak Republic 97/1-03/2			Slovenia 93/1-03/2		
	LM	IS	AS	LM	IS	AS	LM	IS	AS	LM	IS	AS	LM	IS	AS	LM	IS	AS
Real exchange rate 2/	59	32	9	60	29	12	35	57	8	21	47	31	37	49	14	45	43	12
Nominal exchange rate 3/	67	24	9	33	53	14	49	42	9	28	38	34	58	19	23	80	4	16
Output 4/	3	33	64	20	18	62	15	11	73	18	52	30	8	5	87	31	7	62

Source: IMF International Financial Statistics, Eurostat, and national authorities.

1/ After 12 months.

The variation in the nominal exchange rate is predominantly explained by a combination of LM and IS shocks. With the exception of Hungary, the contribution of LM shocks is 50 percent or higher in all countries and reaches 80 percent in Slovenia. The variance decomposition results for Hungary should be discounted, since the model is not able to identify the shocks very well, given the impact of policy intervention on the nominal exchange rate. That the variability in the Polish exchange rate is to a relatively large extent (around 40 percent) driven by IS shocks, with supply shocks also more important than in other countries, would suggest that the absorption role of the exchange rate has been the strongest in the largest, most closed CEC economy with perhaps the deepest financial markets. This would also appear to be roughly consistent with the results for industrialized countries.

As is the case for the nominal exchange rate, the real exchange rate is also predominantly driven by LM and IS shocks.[13] For all countries except Hungary, the relative contribution of LM shocks to the real exchange rate is smaller than its contribution to the nominal exchange rate. This finding is important in the comparison of results with the studies that look at the real, instead of the nominal, exchange rate to determine the shock-absorbing capability of the exchange rate. Our findings suggest that basing the results on the real exchange rate systematically over estimates the importance of the IS shock and under estimates the importance of the LM shock.

[13] Note that this analysis focuses on the volatility of exchange rates rather than trend movements. Supply-side phenomena that lead to trend movements in exchange rates, including Balassa-Samuelson effects, are captured by the constant terms in the equations (which are specified in first differences).

IV. Conclusions

The estimated short-run macroeconomic behavior in response to the shocks identified with a Clarida and Gali–type structural VAR for five central European countries (CECs) is generally in line with theoretical priors stemming from the Mundell-Fleming model, strengthening the confidence in the identification of the shocks despite relatively short data sets and significant structural changes. In particular, the impulse response functions indicate a response of the exchange rate generally in line with mainstream theory: it dampens demand (IS) shocks and amplifies monetary/financial (LM) shocks, in terms of the impact on output.

Analysis of the sources of unexplained movements in the nominal exchange rate, the real exchange rate, and output suggests that in the CECs, on average during the period with (relatively) flexible exchange rates, (i) the exchange rate has responded little to the shocks that affect output; and (ii) LM shocks have contributed significantly to nominal exchange rate variability, with their contribution particularly high (between 58 and 80 percent) in the smaller, more open CECs. Thus the results cast doubt on the usefulness of the exchange rate as shock absorber; the exchange rate appears on average to have served as much or more as an unhelpful propagator of LM shocks than as a useful absorber of IS shocks.

Although it is not possible to do a full-fledged cost-benefit analysis on the basis of these results, they suggest that the costs of losing exchange rate flexibility in the CECs are limited, if even positive.

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Figure 2. CECs: Impulse Response Functions of Nominal Exchange Rate and Relative Output
(Response of the level of the variables to a structural 1 standard deviation shock, in percent)

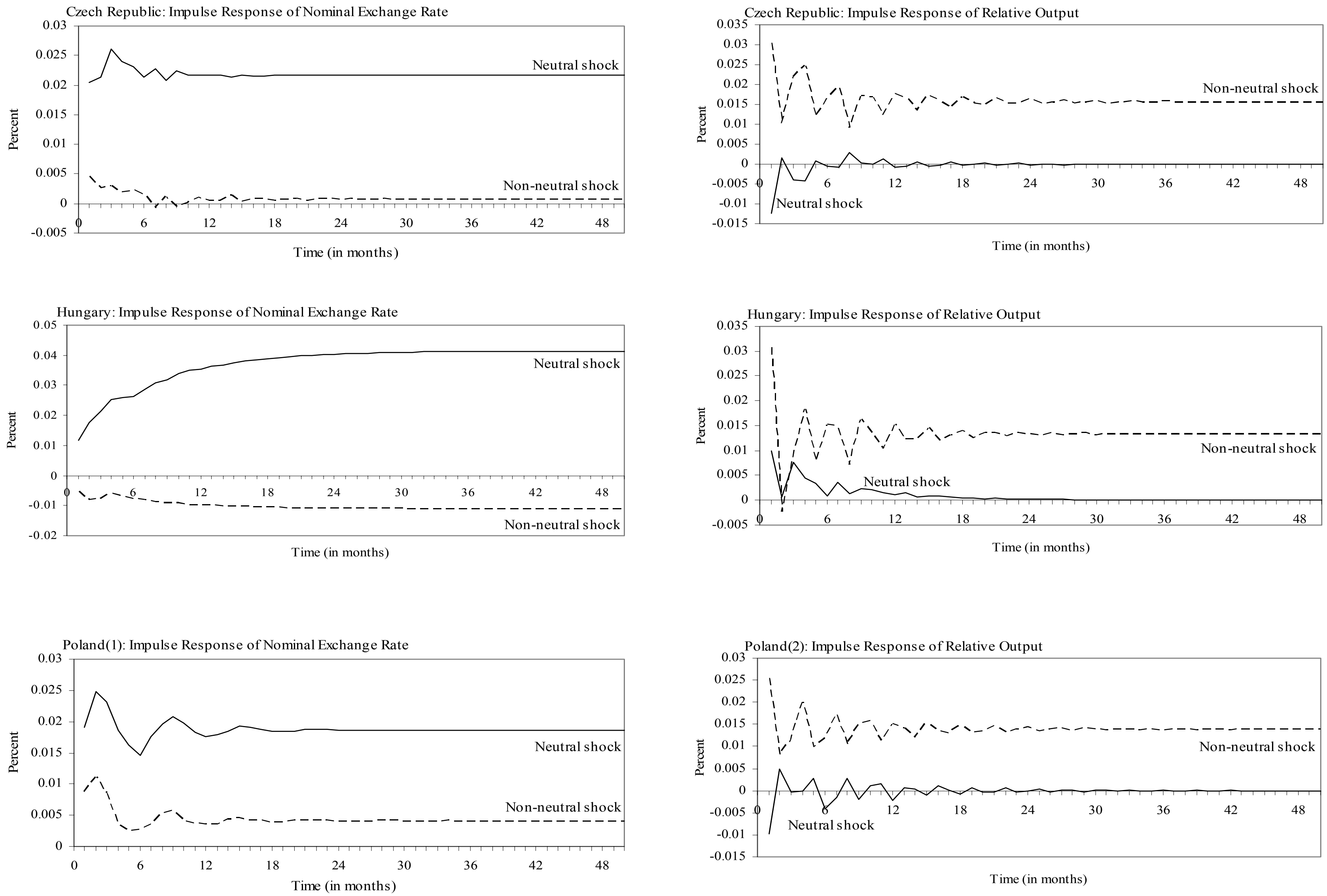

Figure 2 (continued). CECs: Impulse Response Functions of Nominal Exchange Rate and Relative Output
(Response of the level of the variables to a structural 1 standard deviation shock, in percent)

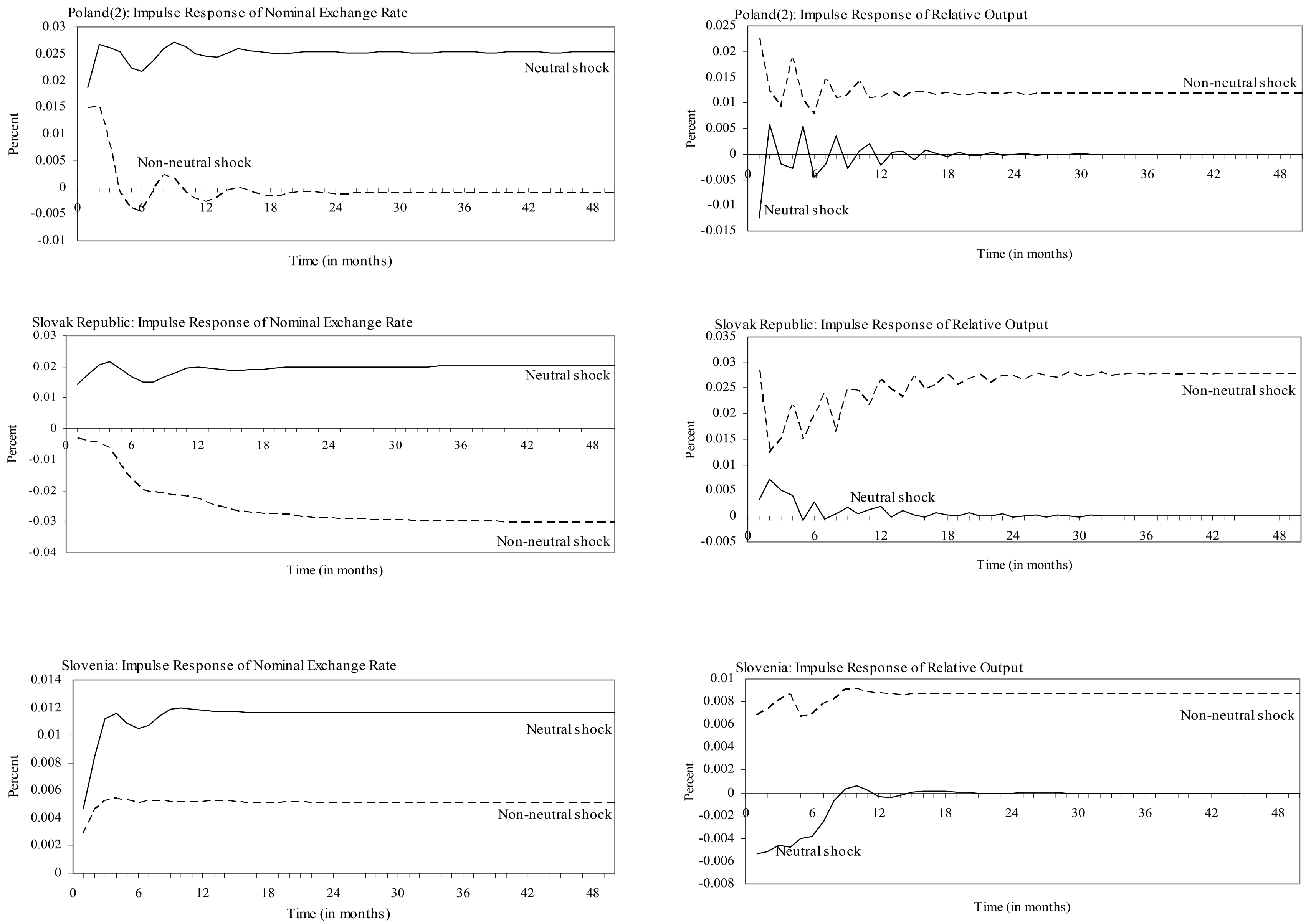

Figure 3. CECs: Impulse Response Functions (levels, 1 standard deviation shocks)

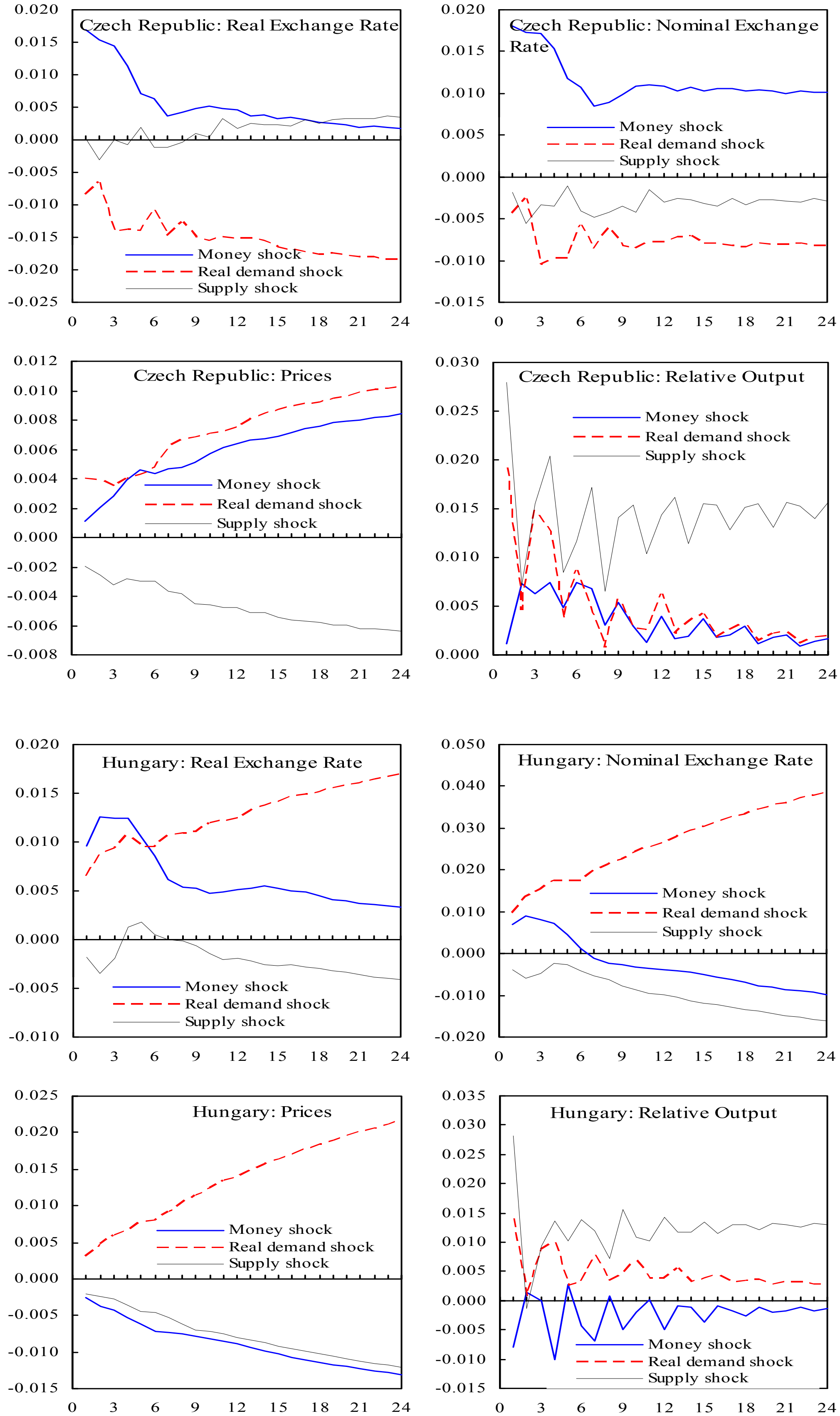

Figure 3 (continued). CECs: Impulse Response Functions (levels, 1 standard deviation shocks)

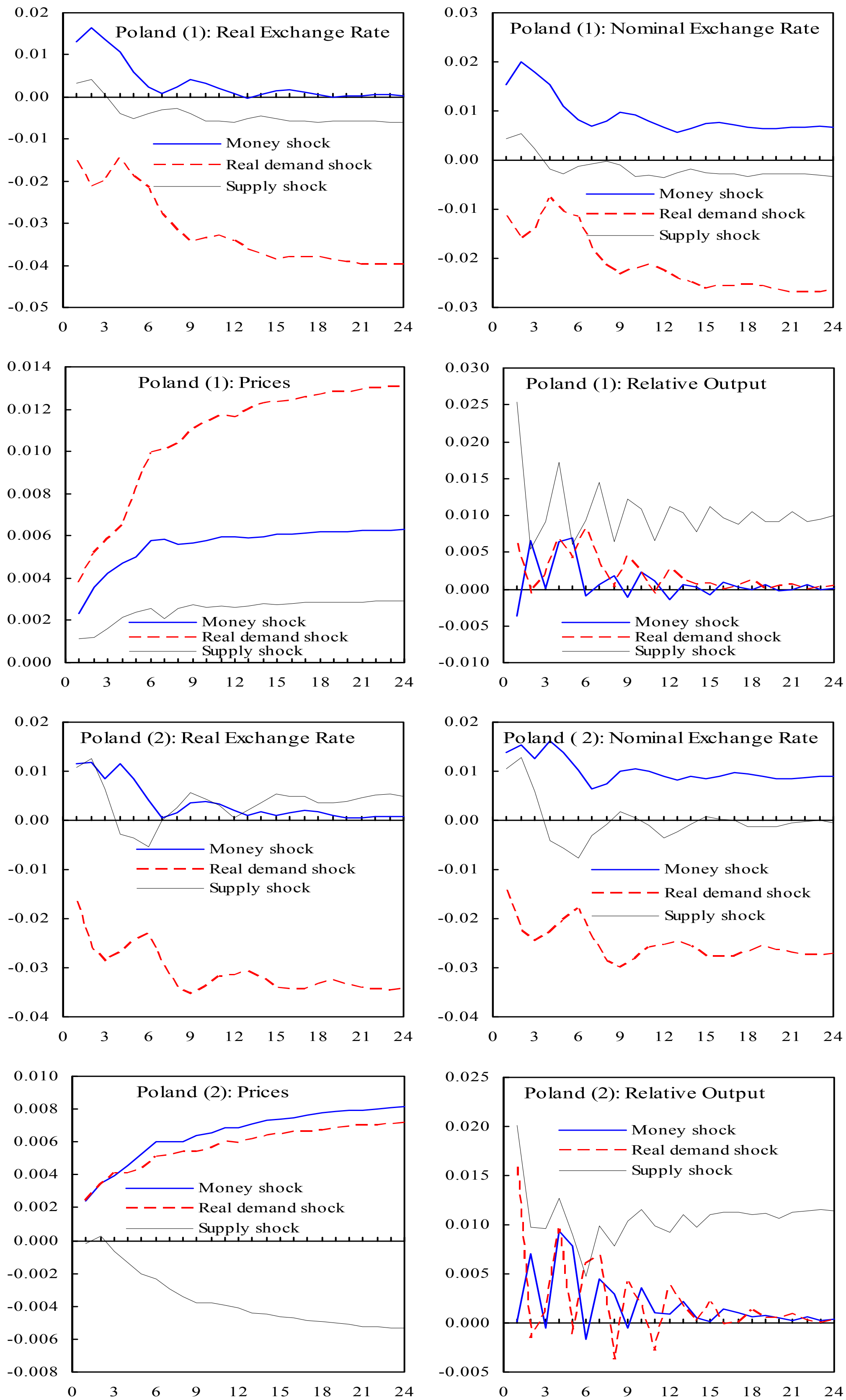

Figure 3 (concluded). CECs: Impulse Response Functions (levels, l standard deviation shock)

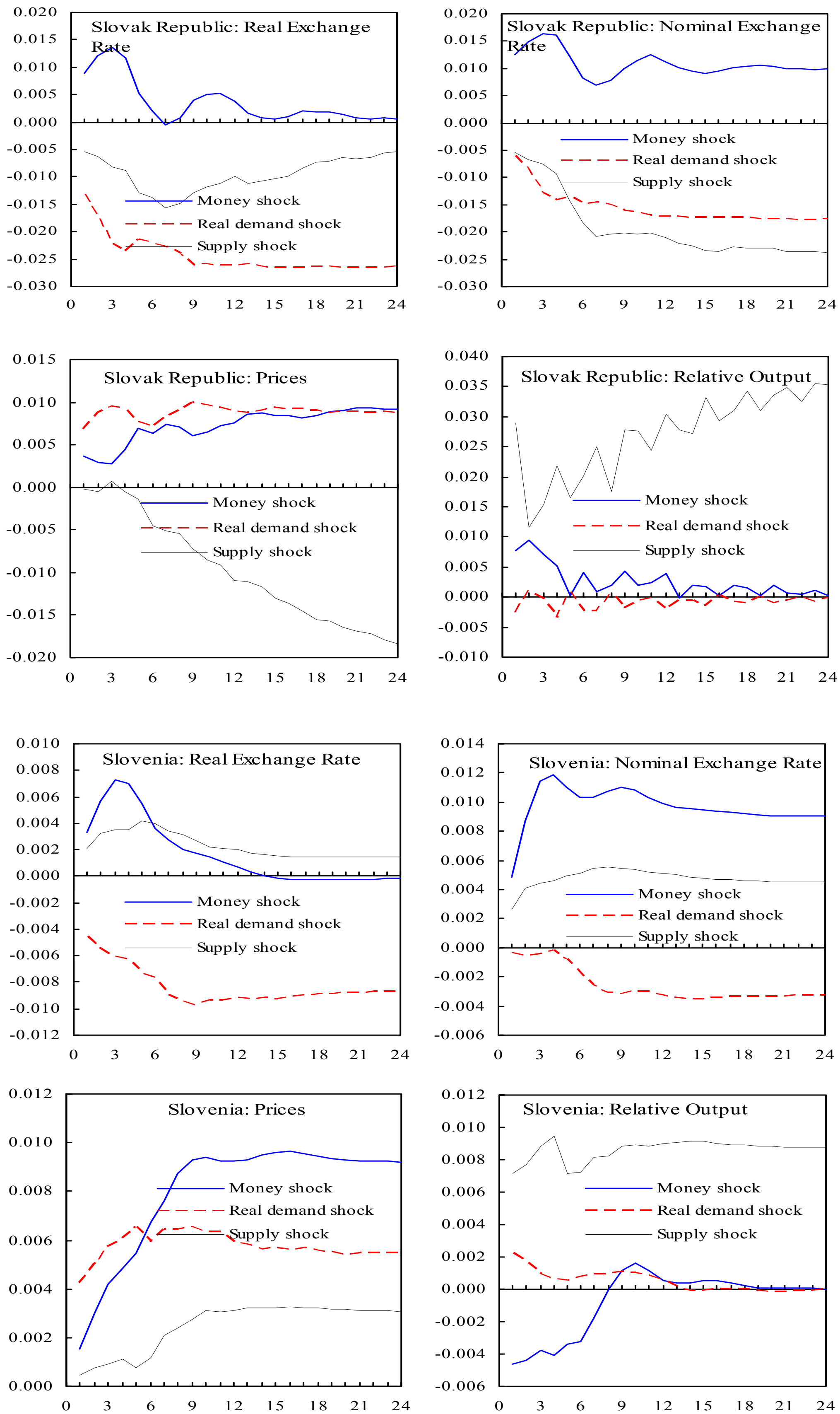

Table A1. Test statistics and model setup 2 VAR model

Country Period	CZ 1996:02 – 2003:02	HU 1995:03 – 2003:02	PO(1) 1995:05 – 2003:02	PO(2) 1998:02 – 2003:02	SR 1997:01 – 2003:02	SA 1993:01 – 2003:02	
Unit root test on level (ADF test statistic)							
NER	-1.06		-1.74	-2.50	-1.61		Intercept
NER		-3.15				-2.72	Trend and intercept
Relative output	0.14	0.87	-4.54***	-1.12	0.92	-1.85	Intercept
Unit root test on level (PP test statistic)							
NER	-1.14		-1.61	-1.67	-1.48		Intercept
NER		-3.34*				-2.49	Trend and intercept
Relative output	-6.36***	-2.36	-4.53***	-5.13***	-3.86***	-2.14	intercept
Unit root test on difference (ADF test statistic)							
NER	-9.74***		-7.02***	-5.80***	-6.43***		none
NER		-5.58***				-5.06***	intercept
Relative output	-3.95***	-3.13***	-3.45***	-7.48***	-4.63***	-9.62***	none
Unit root test on difference (PP test statistic)							
NER	-9.74***		-6.39***	-4.88***	-6.43***		none
NER		-5.34***				-4.89***	intercept
Relative output	-29.70***	-17.29***	-18.19***	-13.61***	-11.42***	-9.56***	none
Cointegration test[a]							
ADF	-2.10	-2.17	-1.55	-2.50	-1.81	-1.98	none
VAR Modeling							
Lag length	6	6	6	6	6	6	
Dummies included[b]	month	month	month	month	month	- (output is seasonally adjusted)	

[a] The critical values for the ADF test for 2 variables and the appropriate number of observations are computed using the tables in McKinnon (1991).
[b] Dummies are included if they are significant in at least one equation.
*: Null hypothesis can be rejected at the 10% level
**: Null hypothesis can be rejected at the 5% level
***: Null hypothesis can be rejected at the 1% level

Table A2. CECs: Forecast Error Variance Decomposition 2 VAR Model
(all variables in logarithmic first differences)

Czech Republic

Variable:	nominal exchange rate			relative output		
Shock:	S.E.	neutral	non-neutral	S.E.	neutral	non-neutral
1	0.021	95	5	0.033	14	86
2	0.021	95	5	0.041	20	80
3	0.022	95	5	0.043	20	80
6	0.022	95	5	0.046	19	81
9	0.022	92	8	0.048	19	81
12	0.022	92	8	0.048	18	82
18	0.022	92	8	0.049	18	82
24	0.022	92	8	0.049	18	82
36	0.022	92	8	0.049	18	82
48	0.022	92	8	0.049	18	82

Hungary

Variable:	nominal exchange rate			relative output		
Shock:	S.E.	neutral	non-neutral	S.E.	neutral	non-neutral
1	0.013	83	17	0.032	10	90
2	0.014	83	17	0.047	8	92
3	0.015	84	16	0.049	10	90
6	0.016	83	17	0.052	10	90
9	0.016	84	16	0.053	10	90
12	0.016	84	16	0.054	9	91
18	0.016	84	16	0.054	9	91
24	0.016	84	16	0.054	9	91
36	0.016	84	16	0.054	9	91
48	0.016	84	16	0.054	9	91

Poland(1)

Variable:	nominal exchange rate			relative output		
Shock:	S.E.	neutral	non-neutral	S.E.	neutral	non-neutral
1	0.021	83	17	0.027	13	87
2	0.022	83	17	0.036	25	75
3	0.022	82	18	0.036	26	74
6	0.023	79	21	0.039	26	74
9	0.024	79	21	0.041	26	74
12	0.024	79	21	0.042	27	73
18	0.024	79	21	0.042	27	73
24	0.024	78	22	0.042	27	73
36	0.024	78	22	0.042	27	73
48	0.024	78	22	0.042	27	73

Poland(2)

Variable:	nominal exchange rate			relative output		
Shock:	S.E.	neutral	non-neutral	S.E.	neutral	non-neutral
1	0.024	62	38	0.026	23	77
2	0.025	65	35	0.034	44	56
3	0.026	60	40	0.035	46	54
6	0.028	54	46	0.039	47	53
9	0.029	53	47	0.041	48	52
12	0.029	53	47	0.041	48	52
18	0.029	52	48	0.042	48	52
24	0.029	52	48	0.042	49	51
36	0.029	52	48	0.042	49	51
48	0.029	52	48	0.042	49	51

Table A2 (continued). CECs: Forecast Error Variance Decomposition 2 VAR Model
(all variables in logarithmic first differences)

Slovak Republic

Variable:	nominal exchange rate			relative output		
Shock:	S.E.	neutral	non-neutral	S.E.	neutral	non-neutral
1	0.015	96	4	0.029	1	99
2	0.015	95	5	0.033	2	98
3	0.015	95	5	0.033	3	97
6	0.017	78	22	0.036	5	95
9	0.018	75	25	0.038	6	94
12	0.018	75	25	0.038	6	94
18	0.018	74	26	0.039	6	94
24	0.018	74	26	0.039	6	94
36	0.018	74	26	0.039	6	94
48	0.018	74	26	0.039	6	94

Slovenia

Variable:	nominal exchange rate			relative output		
Shock:	S.E.	neutral	non-neutral	S.E.	neutral	non-neutral
1	0.006	73	27	0.009	38	62
2	0.007	76	24	0.009	38	62
3	0.007	79	21	0.009	38	62
6	0.008	79	21	0.009	36	64
9	0.008	79	21	0.009	40	60
12	0.008	79	21	0.009	40	60
18	0.008	79	21	0.009	40	60
24	0.008	79	21	0.009	40	60
36	0.008	79	21	0.009	40	60
48	0.008	79	21	0.009	40	60

Table A3. Test statistics and model setup 3 VAR model

Period	CZ 1996:02 – 2003:02	HU 1995:03 – 2003:02	PO(1) 1995:05 – 2003:02	PO(2) 1998:02 – 2003:02	SR 1997:01 – 2003:02	SA 1993:01 – 2003:02	
Unit root test on level (ADF test statistic)							
RER	-2.78	-3.81**	-2.62	-1.93	-2.47	-2.94	Trend and intercept
Unit root test on level (PP test statistic)							
RER	-2.89	-3.39*	-1.92	-1.14	-2.19	-2.40	Trend and intercept
Unit root test on difference (ADF test statistic)							
RER	-10.60***	-6.73***	-6.68***	-5.06***	-6.58***	-6.37***	intercept
Unit root test on difference (PP test statistic)							
RER	-10.58***	-6.71***	-5.97***	-4.76***	-6.57***	-6.63***	intercept
Cointegration test[a]							
ADF	-2.26	-2.65	-1.33	-2.40	-2.74	-4.28**	none
VAR Modeling							
Lag length	6.00	6.00	6.00	6.00	6.00	6.00	
Optimal lag length criteria							
LR	2	10	7	2	9	6	
FPE	2	2	7	2	9	2	
AIC	2	14	7	12	12	2	
SC	2	2	2	2	1	1	
HQ	2	2	2	2	2	1	
Dummies included[b]	D2, D6, month	month	D8, month	month	month	- (output is seasonally adjusted)	

[a] The critical values for the ADF test for 2 variables and the appropriate number of observations are computed using the tables in McKinnon (1991).
[b] Dummies are included if they are significant in at least one equation.
*: Null hypothesis can be rejected at the 10% level
**: Null hypothesis can be rejected at the 5% level
***: Null hypothesis can be rejected at the 1% level
LR: sequential modified LR test statistic
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A4. CECs: Forecast Error Variance Decomposition 3 VAR Model
(all variables in logarithmic first differences)

Czech Republic

Variable	real exchange rate				nominal exchange rate				relative output			
Shock	S.E.	money	demand	supply	S.E.	money	demand	supply	S.E.	money	demand	supply
1	0.019	80	20	0	0.019	93	6	1	0.034	0	32	68
2	0.019	77	20	3	0.019	89	6	5	0.043	2	32	66
3	0.021	65	30	4	0.021	75	20	5	0.045	2	34	64
6	0.022	63	29	7	0.022	71	22	8	0.048	2	34	63
9	0.023	60	33	7	0.023	68	24	8	0.051	3	33	64
12	0.023	59	32	9	0.023	67	24	9	0.052	3	33	64
18	0.023	59	32	9	0.023	66	24	10	0.053	4	32	64
24	0.024	59	32	9	0.023	66	24	10	0.053	4	32	64
36	0.024	58	32	10	0.023	66	24	10	0.053	4	32	64
48	0.024	58	32	10	0.023	66	24	10	0.053	4	32	64

Hungary

Variable	real exchange rate				nominal exchange rate				relative output			
Shock	S.E.	money	demand	supply	S.E.	money	demand	supply	S.E.	money	demand	supply
1	0.012	67	31	2	0.012	32	59	9	0.033	6	19	75
2	0.012	65	31	4	0.013	29	60	10	0.047	7	17	76
3	0.013	64	31	5	0.014	29	60	11	0.049	7	19	75
6	0.013	60	29	12	0.015	33	54	13	0.053	17	18	65
9	0.014	60	28	11	0.015	33	53	14	0.055	19	18	63
12	0.014	60	29	12	0.016	33	53	14	0.056	20	18	63
18	0.014	59	29	12	0.016	32	54	14	0.056	20	18	62
24	0.014	59	29	12	0.016	31	54	14	0.056	20	18	62
36	0.014	59	29	12	0.016	31	54	15	0.056	20	18	62
48	0.014	59	29	12	0.016	31	55	15	0.056	20	18	62

Poland (1)

Variable	real exchange rate				nominal exchange rate				relative output			
Shock	S.E.	money	demand	supply	S.E.	money	demand	supply	S.E.	money	demand	supply
1	0.020	41	56	3	0.020	62	34	5	0.026	2	6	92
2	0.021	39	58	2	0.021	60	35	5	0.035	10	7	84
3	0.022	39	56	5	0.021	58	35	7	0.036	12	7	81
6	0.025	38	54	8	0.023	54	38	9	0.041	16	8	76
9	0.026	35	58	7	0.025	49	43	8	0.043	15	10	75
12	0.026	35	57	8	0.025	49	43	9	0.044	15	11	73
18	0.027	35	57	8	0.025	48	43	9	0.044	16	11	73
24	0.027	35	57	8	0.025	48	43	9	0.045	16	11	73
36	0.027	35	57	8	0.025	48	43	9	0.045	16	12	73
48	0.027	35	57	8	0.025	48	43	9	0.045	16	12	73

Table A4 (continued). CECs: Forecast Error Variance Decomposition 3 VAR Model
(all variables in logarithmic first differences)

Poland (2)

Variable	real exchange rate				nominal exchange rate				relative output			
Shock	S.E.	money	demand	supply	S.E.	money	demand	supply	S.E.	money	demand	supply
1	0.023	25	52	22	0.022	38	39	22	0.026	0	38	62
2	0.025	21	59	20	0.024	34	46	20	0.034	4	50	46
3	0.026	21	55	23	0.025	32	43	26	0.034	9	48	43
6	0.028	22	47	30	0.028	30	36	34	0.041	18	49	34
9	0.030	21	48	31	0.030	28	38	33	0.044	18	51	31
12	0.031	21	47	31	0.031	28	38	34	0.045	18	52	30
18	0.031	21	47	32	0.031	28	38	34	0.045	18	52	29
24	0.031	21	47	32	0.031	28	38	34	0.045	18	52	29
36	0.031	21	47	32	0.031	28	38	34	0.045	18	52	29
48	0.031	21	47	32	0.031	28	38	34	0.045	18	52	29

Slovak Republic

Variable	real exchange rate				nominal exchange rate				relative output			
Shock	S.E.	money	demand	supply	S.E.	money	demand	supply	S.E.	money	demand	supply
1	0.017	28	61	10	0.015	70	17	13	0.030	7	1	93
2	0.017	29	61	10	0.015	69	18	13	0.035	5	2	93
3	0.018	27	63	10	0.016	64	24	12	0.035	6	2	93
6	0.020	35	53	12	0.018	58	20	22	0.037	8	4	88
9	0.021	37	50	13	0.019	57	19	23	0.040	8	5	87
12	0.021	37	49	14	0.019	58	19	23	0.041	8	5	87
18	0.022	37	48	14	0.019	58	19	24	0.042	9	5	86
24	0.022	37	48	15	0.019	58	19	24	0.043	9	5	86
36	0.022	37	48	15	0.019	57	19	24	0.043	9	5	86
48	0.022	37	48	15	0.019	57	19	24	0.043	9	5	86

Slovenia

Variable	real exchange rate				nominal exchange rate				relative output			
Shock	S.E.	money	demand	supply	S.E.	money	demand	supply	S.E.	money	demand	supply
1	0.006	31	57	13	0.006	78	0	22	0.009	27	7	66
2	0.007	38	49	13	0.007	81	0	19	0.009	27	7	66
3	0.007	41	47	13	0.007	83	0	16	0.009	27	7	66
6	0.007	46	42	12	0.008	82	3	16	0.009	26	7	67
9	0.008	45	43	12	0.008	80	4	16	0.010	31	7	63
12	0.008	45	43	12	0.008	80	4	16	0.010	31	7	62
18	0.008	45	43	12	0.008	80	4	16	0.010	31	7	62
24	0.008	45	43	12	0.008	80	4	16	0.010	31	7	62
36	0.008	45	43	12	0.008	80	4	16	0.010	31	7	62
48	0.008	45	43	12	0.008	80	4	16	0.010	31	7	62