MONETARY MODEL OF EXCHANGE RATE DETERMINATION: EVIDENCE FROM THE CZECH REPUBLIC, HUNGARY AND POLAND

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STRUCTURE

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- Theoretical framework
- Recent empirical studies
- Data and statistical methodology
- Estimation results
- Conclusions

THEORETICAL FRAMEWORK

The standard flexible-price (Frenkel—Bilson) monetary model assumes a conventional real money-demand function in domestic and foreign countries (in logs):

$$m_t - p_t = \alpha_1 y_t - \beta_1 i_t, \quad (1)$$

$$m_t^* - p_t^* = \alpha_1 y_t^* - \beta_1 i_t^*, \quad (2)$$

where m_t and m_t^*, p_t and p_t^*, y_t and y_t^*, i_t and i_t^* are the domestic and foreign money supply, price level, output and nominal interest rate, respectively.

Assuming $e_t = p_t - p_t^*,$ (3)

we obtain a flexible-price monetary model:

$$e_t = m_t - m_t^* - \alpha_1(y_t - y_t^*) + \beta_1(i_t - i_t^*) + \varepsilon_t, \quad (4)$$

where e_t is the nominal exchange rate (units of domestic currency per foreign currency).

Following Frenkel (1976, pp. 200—224), uncovered interest parity is hold:

$$i_t - i_t^* = E_t(e_{t+1} - e_t) = \Delta e_t, \qquad (5)$$

where Δe_t is the expected depreciation of domestic currency

As $p_t - p_t^* = m_t - m_t^* - \alpha_1(y_t - y_t^*) + \beta_1 \Delta e_t + \varepsilon_t$

and $e_t = p_t - p_t^*$, it follows that

$$\Delta e_t = \Delta p_t^e - \Delta p_t^{e*} = \pi_t^e - \pi_t^{e*} \qquad (6)$$

Respectively, it is obtained that

$$e_t = m_t - m_t^* - \alpha_1(y_t - y_t^*) + \gamma_1(\pi_t^e - \pi_t^{e*}) + \varepsilon_t \qquad (7)$$

- Assuming that prices are rigid and would only adjust gradually, Dornbusch (1976, pp. 1161—1176) developed a competing model of the monetary approach to exchange rates

Decrease in money supply $\Rightarrow$ no matching drop in prices $\Rightarrow$ rise in domestic interest rate $\Rightarrow$ inflow of foreign capital $\Rightarrow$ an excessive appreciation of a nominal exchange rate in the short-run ("overshooting")

Replacing $e_t = p_t - p_t^*$ with a long-run version

$$\bar{e}_t = \bar{p}_t - \bar{p}_t^*, \tag{8}$$

it turns out that

$$\bar{e}_t = \bar{m}_t - \bar{m}_t^* - \alpha_1(\bar{y}_t - \bar{y}_t^*) + \gamma_1(\bar{\pi}_t^e - \bar{\pi}_t^{e*}) + \varepsilon_t \tag{9}$$

and

$$\bar{e}_t = m_t - m_t^* - \alpha_1(y_t - y_t^*) + \gamma_1(\pi_t - \pi_t^*) + \varepsilon_t \tag{10}$$

In the long run, the exchange rate is expected to depreciate as follows:

$$\Delta e_t = -\theta(e_t - \bar{e}) + \pi_t - \pi_t^* \tag{11}$$

Assuming $i_t - i_t^* = \Delta e_t$, it is obtained that

$$e_t - \bar{e} = -\left(1/\theta\right)\left[(i_t - \pi_t) - (i_t^* - \pi_t^*)\right], \tag{12}$$

which leads to

$$e_t = m_t - m_t^* - \alpha_1(y_t - y_t^*) + \gamma_1(\pi_t - \pi_t^*)$$
$$-\left(1/\theta\right)\left[(i_t - \pi_t) - (i_t^* - \pi_t^*)\right] + \varepsilon_t \tag{13}$$

As $\pi_t - \pi_t^* = 0$, it follows that

$$e_t = m_t - m_t^* - \alpha_1(y_t - y_t^*) - \left(1/\theta\right)\left[(i_t - i_t^*\right] + \varepsilon_t \tag{14}$$

Frankel (1979, pp. 610— 622) developed an integrative approach that combines the sticky-price concept with the notion of secular rates of inflation

- All models share the assumption on income and price effects, but differ in respect to the effects of interest rate differential

$$e_t = m_t - m_t^* - \alpha_1(y_t - y_t^*) + \beta_1(i_t - i_t^*) + \gamma_1(\pi_t^e - \pi_t^{e*}) + \varepsilon_t$$

Frenkel	$\beta_1=0;\ \gamma_1>0$
Bilson	$\beta_1>0;\ \gamma_1=0$
Dornbusch	$\beta_1<0;\ \gamma_1=0$
Frankel	$\beta_1<0;\ \gamma_1>0$

2 RECENT EMPIRICAL STUDIES

- Early studies during the late 1970s and the early 1980s employed traditional regression analysis and found mixed evidence for the validity of monetary model in explaining the exchange rate movements
  - USA (Hartley 1983, pp. 153-188; DeJong and Husted (1993)
  - Canova (1993, pp. 233-261)
  - Lane (2001)
- Engle and Granger (1987) two-step cointegration methodology provided no evidence for the validity of monetary model either
- Since 1990s, VAR models bring about numerous results in favor of the monetary model

- Empirical support for the monetary model is found for
  - Canada (Frensis 2000)
  - Greece (Diamandis and Kouretas 1996)
  - India (Shylajan *et al*. 2011, pp. 89—105)
  - Mexico (Loria et al. 2010, pp. 540—554)
  - Turkey (Civcir 2003, pp. 113—129)
  - Several CEE countries (Crespo-Cuaresma 2003, pp. 138—151; Uz and Ketenci 2008)
  - Poland (Hsing 2008)

- However, mixed results are not lacking
  - **Poland** — long-term estimates show that the zloty/euro exchange rate depends on changes in industrial production and on short- and long-term interest rates, while the influence of M1 money supply proves to be statistically insignificant (Wdowinski 2011, pp. 67-86). In the short term, the zloty tended to appreciate as a result of increases in short-term interest rates
  - **Poland** — the exchange rate is under influence of interest rate (Demchuk *et al*. 2011)
  - **The Czech Republic, Hungary, Poland** — it is very difficult to outperform a simple random walk model in forecasting contest (Mućk and Skrzypczyński 2012)

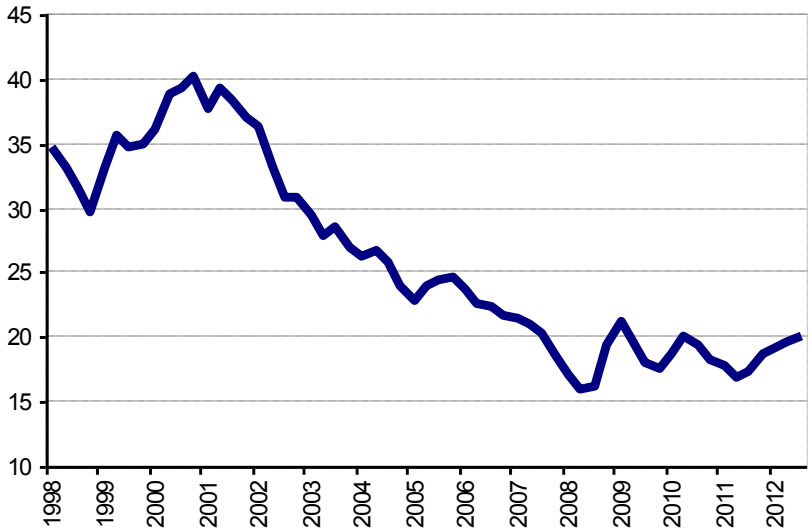
Explanations of a weak link between the money supply and exchange rate include:

- The PPP condition does not apply in the short run (Bilson 1979)
- Nominal interest rates are not exogenous
- Exchange rates are too volatile to be consistent with an efficient market (Huang (1981)
- Impact of expectations about the future exchange rate (Hartley 1983; Hoffman and Schlagenhauf 1983)

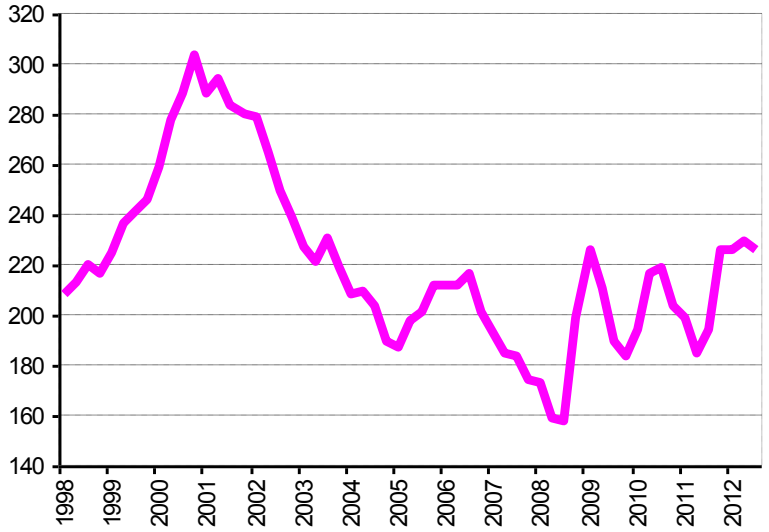
- Conditional results
  - Basher and Westerlund (2009, pp. 506—513): the monetary model emerges for industrial countries only when the presence of structural breaks and cross-country dependence has been taken into account

DATA AND STATISTICAL METHODOLOGY

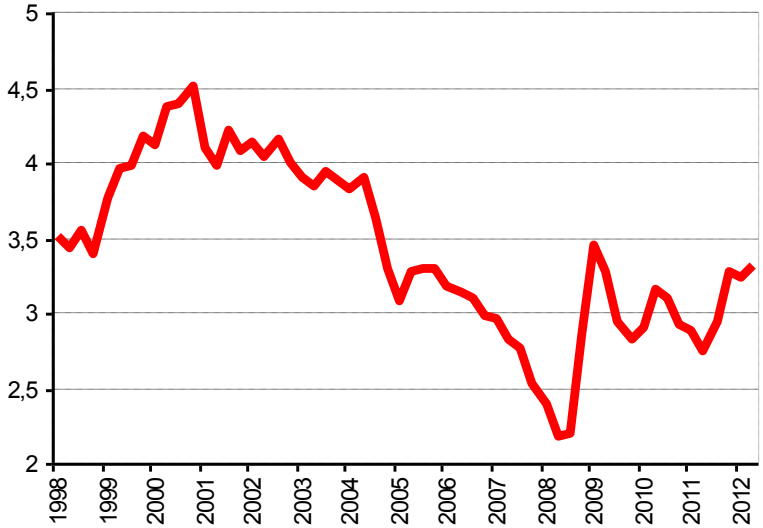
- Quarterly time series data for the Czech Republic, Hungary and Poland for the period 1998–2011 are used, as provided by the online IMF *International Financial Statistics*
- 2SLS
- VAR/VEC



a) the Czech Republic;



b) Hungary;



c) Poland

A nominal exchange rate for selected CEE countries

Table 1. Cointegration tests for the nominal exchange rate and its determinants

	Lags	LR(0)	LR(1)	LR(2)	LR(3)	LR(4)	LR(5)
The Czech Republic	2	243.1*	163.8*	107.5*	70.2*	34.3*	12.6**
Hungary	2	138.3*	91.4*	51.9*	26.1**	5.9	0.4
Poland	2	150.8*	97.5*	49.6*	23.6***	8.3	2.4

Note: LR(r) denotes the likelihood ratio statistic for H_0: r cointegrating vectors against H_1: stationary VAR; * denotes rejection of the hypothesis of H_0 at the 1% level (** at the 5% level, *** at the 10% level)

Following the Engle—Granger two-step methodology (1987, pp. 251—276), we estimate:

a) the long-run relationship (in levels)

$$E_t = \alpha + \beta \mathbf{X}_t + \varepsilon_t, \qquad (15)$$

b) the short-run relationship (in first difference)

$$\Delta E_t = \delta_0 + \delta \Delta \mathbf{X}_t - \gamma \varepsilon_{t-1} + \xi_t, \qquad (16)$$

where $\mathbf{X}_t$ is a vector of independent variables, ε_t and ξ_t are stochastic factors.

As the Engle—Granger procedure cannot deal with cases of more than one cointegrating vectors (Table 1), an alternative procedure of VAR/VEC can be used (Alogoskoufis and Smith 1991, pp. 97—128):

$$\Delta \mathbf{X}_t = \sum \delta_i \Delta \mathbf{X}_{t-i} - \gamma \varepsilon_{t-1} + \xi_t, \qquad (17)$$

where γ measures feedback coefficients.

ESTIMATION RESULTS

The long-run 2SLS estimates of the exchange rate vis-à-vis US dollar are summarized as follows:

	Money supply (M)	Domestic output (Y)	Foreign output (Y^*)	Domestic interest rate (I)	Foreign interest rate (I^*)
The Czech Republic	–0,355 (–1,78***)	–0,106 (–0,17)	0,842 (1,73***)	0,305 (1,77***)	–0,015 (–0,88)
Hungary	–0,053 (–0,97)	–0,249 (–1,17)	0,525 (2,66*)	–0,064 (–1,68***)	0,004 (0,76)
Poland	0,548 (3,02*)	–1,768 (–3,56*)	0,306 (1,83**)	0,033 (1,43)	–0,038 (–3,01*)

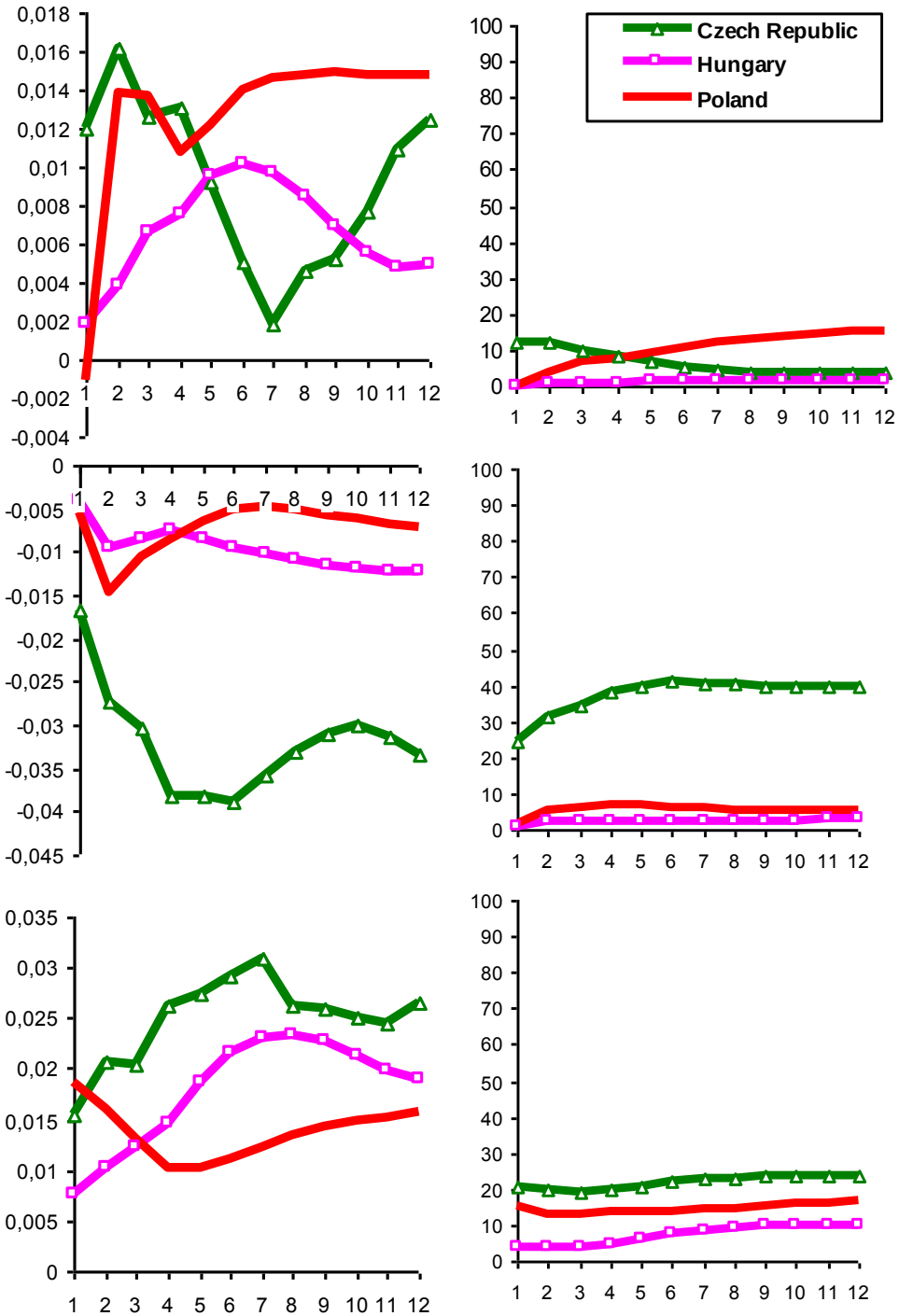
The short-run 2SLS estimates of the exchange rate vis-à-vis US dollar are summarized as follows:

	Money supply (M)	Domestic output (Y)	Foreign output (Y^*)	Domestic interest rate (I)	Foreign interest rate (I^*)
The Czech Republic	0,622 (1,75***)	–3,319 (–4,72*)	1,099 (1,22)	–0,597 (–1,62)	0,097 (3,20*)
Hungary	0,629 (2,37**)	–2,502 (–2,73*)	1,463 (1,47)	–0,104 (–1,73***)	0,057 (1,81***)
Poland	0,786 (2,90*)	–2,233 (–3,47*)	1,494 (1,95***)	0,094 (1,34)	–0,021 (–0,74)

Comparison of the long-run and short-run coefficients

	Money supply (M)		Domestic output (Y)		Foreign output (Y^*)		Domestic interest rate (I)		Foreign interest rate (I^*)	
	L	S	L	S	L	S	L	S	L	S
The Czech Republic	↓***	↑***	N	↓*	↑***	N	↑***	N	N	↑*
Hungary	N	↑**	N	↓*	↑*	N	↓***	↓***	N	↑***
Poland	↑*	↑*	↓*	↓***	↑**	↑***	N	N	N	N

Effects of VAR shocks on the exchange rate vis-à-vis US dollar according to VAR/VEC models



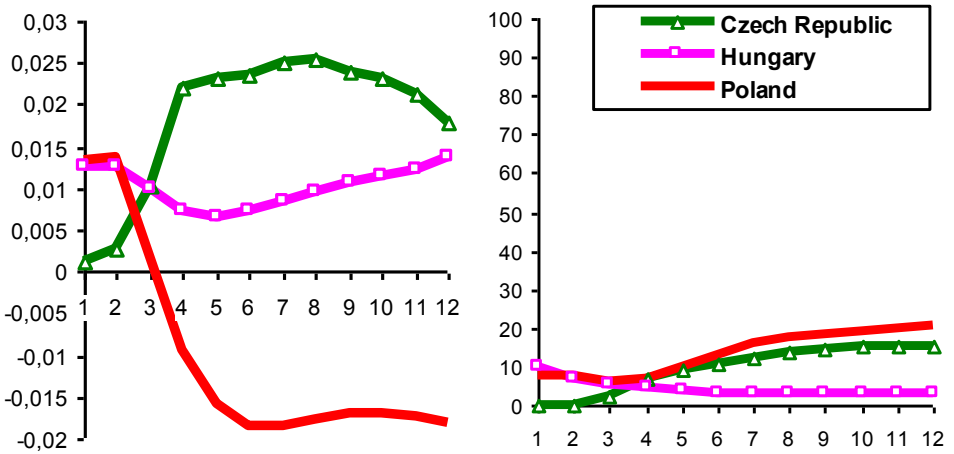
a) foreign output

b) domestic output

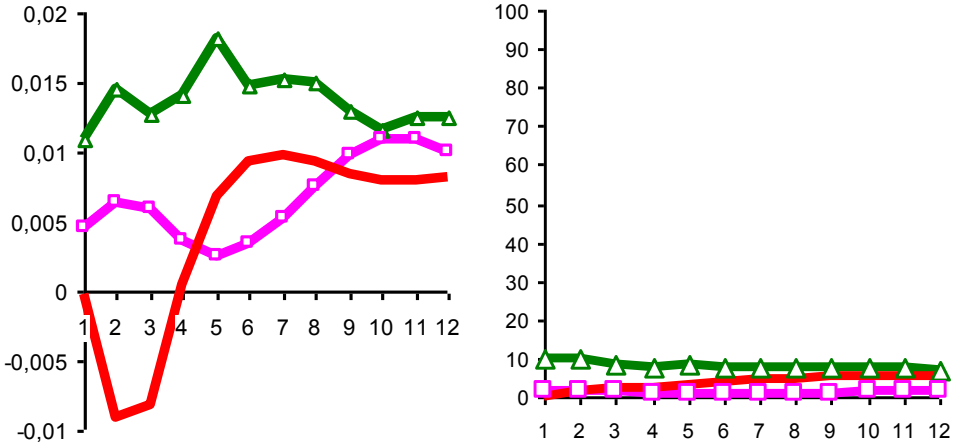
c) money supply

Effects of VAR shocks on the exchange rate vis-à-vis US dollar according to VAR/VEC models

d) foreign interest rate



e) domestic interest rate



CONCLUSIONS

- Our empirical results are in favour of long-run and short-run relationships between the nominal exchange rate, money supply and macro-economy, which are consistent with the monetary model of exchange rate determination
  - the increase in the money supply and negative growth differential are factors behind the nominal exchange rate depreciation
- A quite heterogeneous impact of the domestic and foreign interest rates could be explained by country-specific effects of capital flows

THANKS FOR ATTENTION !!!