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Determinants of the exchange market pressure in the euro-candidate countries

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Abstract

In the paper we choose the correct model specification for eight new EU Member States (NMS) to estimate the exchange market pressure (EMP) over the period 1995-2009. The results suggest that growth of domestic credit and money multiplier had a significantly positive impact on EMP. Furthermore, EMP in many NMS was determined by foreign disturbances, namely euro area's money supply, foreign capital inflow and interest rate differential. EMP in most of NMS with flexible exchange rate regime was primarily absorbed by changes in international reserves. This forms, along with fundamentally stable EMP development in recent years, a solid basis for potential fulfilment of the exchange rate stability convergence criterion.

JEL Classification numbers: C32; F31; F36

Keywords: exchange market pressure, Girton-Roper model, determinants, new EU Member States

1. Introduction

Although the role and significance of foreign exchange issues differs from country to country, according to adopted exchange rate regime, a monitoring of foreign exchange market is essential for successful monetary policy in any country. Exchange market pressure (EMP) is one of the appropriate tools to oversee the conditions in the foreign exchange market. Thanks to its universality it is conveniently applicable to any exchange rate arrangement.

Various concepts of EMP have been developed and empirically tested in literature. Girton and Roper (1977) used a monetary approach to balance of payments and exchange rate determination to derive EMP as simple sum of the rate of change in international reserves and the rate of change in exchange rates. Weymark (1995) revised the original model and introduced a more general approach. Eichengreen et al. (1994, 1995) developed a simpler and model-independent EMP measure.

The present study applies the original Girton-Roper (G-R) model and implements some modifications to choose the appropriate model specifications for eight new European Union Member States (NMS) over the period 1995-2009. The countries can be sorted into two groups according to the exchange rate regime applied. The group of NMS following some kind of exchange rate floating consists of the Czech Republic, Hungary, Poland, and Slovakia. The group of NMS with fixed exchange rate regime comprises Bulgaria, Estonia, Latvia, and Lithuania.

The paper has three complementary aims. First, we choose the correct model specification to estimate EMP and identify the EMP determinants. Second, we compare the magnitude and development of EMP across the nations. Third, we test whether the magnitude of EMP is independent of whether the pressure in NMS with floating exchange rate regime is absorbed by the changes in international reserves or exchange rate. By definition, EMP should not be sensitive to its composition in floating countries since this arrangement allows both channels of absorption.

The importance of such analysis stems from two crucial factors. All the NMS analyzed are supposed to join the euro area. Hence, they have to fulfil the official convergence criteria that include, beside others, a requirement of stability of exchange rate development. Fulfilment of the criterion requires the exchange rate to have been maintained within a fluctuation margin around the central parity "without severe tensions". We consider EMP as a good proxy for monitoring of tensions in the foreign exchange market. All NMS are rather small open economies with a thin foreign exchange market. If, in such a country, EMP is substantial, persisting, and predominantly absorbed by an exchange rate one could expect serious effects on exports and imports as well as capital flows with potentially inflationary consequences.

The remainder of the paper is organized as follows. Section 2 reviews the relevant empirical literature. Section 3 briefly introduces the concept of the G-R model and derives the equations and model modifications used in empirical testing. Section 4 deals with methodology and data selection. Section 5 reports the estimation results and Section 6 closes the paper with conclusions.

2. Literature review

The literature on EMP in NMS is not extensive. Almost all previous studies provide a cross-country analysis rather than a single-country estimation. Whereas some empirical papers are focused solely on estimation of EMP, other studies also put the EMP measures into context of monetary policy, financial crisis, exchange rate arrangements, monetary integration and other aspects.

Bielecki (2005) applies G-R model on Poland from 1994-2002 comparing two EMP measures calculated under alternative methodologies (using all foreign reserve changes and pure official foreign exchange intervention data). He comes to the conclusion that domestic credit reacted in a counter direction to innovations to EMP and the appreciation pressure prevailed over the sample period.

Stavárek (2006) estimates EMP in the Czech Republic, Hungary, Poland and Slovenia in 1993-2004 employing the EMP measure proposed in Eichengreen et al. (1995). The results obtained suggest that the Czech Republic and Slovenia went through considerably less volatile development of EMP than Hungary and Poland.

Very similar conclusions on altitude and behaviour of EMP are drawn in Van Poeck et al. (2007). Applying the Eichengreen et al. (1995) measure the authors address the question whether currency crises in NMS have been more frequent in fixed, intermediate or flexible exchange rate arrangements. The results support the bipolar view as EMP was higher in intermediate regimes than in extreme arrangements. The authors also estimate the determinants of EMP and find that regardless the exchange rate regime the current account deficit and domestic credit growth significantly contribute in EMP.

The relations between EMP and exchange rate arrangements are researched also in Stavárek (2010b). The paper concurrently applies model-dependent and model-independent measure of EMP on four NMS during 1995-2007 and reveals a substantial degree of inconsistency of the alternative measures. Stavárek (2010b) argues that de facto regime is better indicator of exchange rate arrangement than conventional de jure classification and, therefore, constructs a continuous measure of de facto regime. However, the paper provides no evidence of serious relationship between EMP and de facto regime in NMS.

Maret (2009) contributes to the literature by investigation of the relationship between EMP and quality of institutional framework in NMS and EU candidates. He applies a similar methodology to Van Poeck et al. (2007) and confirms the role of domestic credit and inflation differential in explaining EMP as well as the conclusion that extreme exchange rate regimes lead to lower EMP. The results suggest that also strong rule of law, effective control of corruption, efforts in financial market and enterprise sector reforms significantly reduce EMP in NMS.

Hegerty (2009) applies Vector Autoregressive approach to assess the contribution of capital inflows to EMP and growth of domestic credit in four NMS with fixed exchange rate regime. The study provides evidence that capital inflows, particularly inflows of portfolio and other investment, reduce EMP in three countries.

Kemme and Lyakir (2009) use G-R model and a small structural Vector Autoregressive model on Czech Republic's data over the period 1995-2006. They assess EMP as a monetary policy variable and examine relationships among the exchange rate, interest rate, and domestic credit during the two distinct monetary policy regimes. The estimations reveal rather strong connection between EMP and the monetary policy stance during the fixed peg regime as domestic credit creation and the interest rate differential were managed to maintain the exchange rate target. By contrast, the degree of the pass-through of exchange rate shocks decreased during the period of managed floating regime.

There are several ways in which the present paper can be distinguished from previous work on EMP in NMS. Although many researchers have used the G-R model on a variety of countries[1], the current paper is the first application of the original model along with some modifications on a large group of countries from Central and Eastern Europe.[2] Since the original model does not reflect ongoing integration of NMS with the EU and the euro area we implement some modifications to capture transmission of disturbances from the euro area and select the model specification that fits each NMS the best. A clear distinction from existing literature is also the modelling the EMP absorption through its components in NMS with flexible exchange rate regime. Finally, we use the most recent data available incorporating the period of global financial crisis into the analysis.

3. Measuring exchange market pressure and model specification

The main theoretical proposition of the G-R model is that the domestic money market equilibrium, if disturbed, is restored through some combination of the currency depreciation/appreciation and international reserves outflow/inflow. The excess domestic money supply will cause a combination of currency depreciation and reserves outflow while excess domestic money demand will cause some combination of currency appreciation and reserves inflow to restore the money market equilibrium.

This makes the model equivalently applicable in fixed, floating as well as intermediate exchange rate arrangement. In a completely fixed exchange rate regime, the change of the exchange rate is zero, while in absolutely flexible exchange rate regime the change of international reserves is zero. In the intermediate regime (e.g. managed float), the exchange market pressure is absorbed by either currency depreciation, or reserves losses, or a combination of the two.

[1] For example, Thornton (1995) on Costa Rica, Bahmani-Oskooee and Bernstein (1999) on G7 countries, Mathur (1999) on India, Pollard (1999) on a group of Caribbean countries, Pentecost et al. (2001) on selected EU countries, Younus (2005) on Bangladesh, Parlaktuna (2005) on Turkey, Khawaja (2007) on Pakistan, García and Malet (2007) on Argentina or Ziramba (2007) on South Africa.

[2] Stavárek (2010a) applied only the original G-R model on selected countries.

Since the original G-R model is well documented in literature we do not report here full derivation of the model. To conserve space we present only the final G-R formula.

$$e - r = d - y - p^{*} + m \tag{1}$$

where r and d denote ratios of changes in reserves and of domestic credit changes with respect to the monetary base. The remaining variables are growth rates of nominal exchange rate e, domestic income y, foreign prices p^{*} and money multiplier m. Exchange rate is measured in terms of domestic currency units per one unit of foreign currency. Hence, a positive e denotes depreciation of the domestic currency. As we prefer to keep the standard applied in literature that positive EMP refers to pressure towards depreciation of domestic currency we have to define EMP as $e - r$. Consequently, it makes a contradiction to some papers that define EMP as $r + e$.

Bertolli et al. (2010) point out that only part of central bank's operation is reflected in a variation of the level of international reserves. Central banks can defend the currencies through off-balance-sheet transactions or activation of credit lines from international authorities, particularly from the International Monetary Fund (IMF). If the central bank draws resources in foreign currencies from these credit lines a speculative pressure on the currency can be solved without having to reduce the gross foreign assets. Such an adjustment in the international reserves seems to be relevant for our analysis since only the Czech Republic did not use any IMF's funds during the period of estimation. Therefore, the amount of IMF credit and loans outstanding is subtracted from the gross international reserves yielding the net international reserves.

Bertolli et al. (2010) report that the components of EMP usually have different volatilities. Therefore, they suggest construction of EMP measure in such a way that prevents the most volatile component from dominating the whole indicator and report some of the possible procedures based on weighting of individual components. Since our EMP measure consists of only two components, none weighting scheme would reduce the obvious dominance of changes in reserves in the countries with fixed exchange rate regime. By contrast, implementation of some weighting scheme into the EMP index may be relevant for NMS with floating arrangement. Thus, we follow the calculation method proposed by Sachs et al. (1996):

$$emp_t = \left(\frac{1/\sigma_e}{(1/\sigma_e) + (1/\sigma_r)} \right) e_t - \left(\frac{1/\sigma_r}{(1/\sigma_e) + (1/\sigma_r)} \right) r_t \tag{2}$$

where emp_t is the weighted EMP, σ_e is the standard deviation of the rate of change in the exchange rate and σ_r is the standard deviation of the proportional change in the country's international reserves. The series of r and e in all NMS do not reveal symptoms of substantial volatility clustering and time varying. Therefore, we can use constant weights for the whole period.

After taking the most important caveats regarding the specification of the EMP measure into account we end up with four alternative EMP indicators (gross/net of the country's liabilities towards the IMF; and unweighted/weighted). Applying all the variants could make the results and their interpretation less convincing. Thus, we select the unweighted measure net of the liabilities towards the IMF as the only EMP indicator used in the empirical part of the paper. This selection is based on following arguments.

First, using of weighted measure is pointless in four NMS with currency fixing. Second, interpretation of an unweighted indicator is more straightforward as EMP is the exchange rate change that would have been required to remove the excess demand/supply of the currency in the absence of exchange market intervention. Third, all NMS except for the Czech Republic had some liabilities towards the IMF over the period of estimation. Fourth, all alternative measures of EMP are strongly correlated in every NMS (see Appendix 1) and, therefore, application of any of them should lead to principally similar estimation results. Fifth, we run all the regressions with all alternative EMP measures as a dependent variable, carried out a battery of stability and diagnostic tests and the selected EMP measure turned out to the most appropriate one.

The model's intuition is that, for given growth rates of foreign prices and domestic income, increase of domestic credit and/or money multiplier stimulates a proportionate loss in reserves with no change in the exchange rate (extremely fixed regime), or a proportionate depreciation of the domestic currency with no change in reserves (extremely floating regime), or some combination of these two (intermediate regime). On the contrary, an increase in domestic income and/or foreign prices results in a proportional appreciation of domestic currency and inflow of international reserves. For empirical purposes we use the following reduced-form equation:

$$emp_t = \alpha_0 + \alpha_1 d_t - \alpha_2 y_t - \alpha_3 p_t^* + \alpha_4 m + u_{1t} \qquad (3)$$

where α_0 is the constant, u_{1t} is the error term and other variables are denoted consistently with (1) and (2).

The original G-R model seems to be strict for NMS and, thus, this paper employs less restrictive versions of the G-R model inspired by Wohar and Lee (1992). The modifications relax some assumptions of the original approach. Specifically, purchasing power parity is not assumed to hold and foreign and domestic assets are imperfect substitutes with different interest rates. The recent empirical literature on purchasing power parity in NMS (e.g. Sideris (2006) or Bekö and Boršič (2007)) provides virtually no support for validity of purchasing power parity. Because EMP in NMS is estimated in relation to the euro area the assumption of constant interest rate differential is not legitimate. Therefore, the foreign interest rate is included among explanatory variables. Alternatively, we use a change in the short-term money market interest rate differential between NMS and the euro area.

Due to substantial level of integration and convergence of NMS with the euro area and prospective membership of NMS in the euro area we assume that the transmission of disturbances from the euro area is an important contributor to EMP in NMS. Hence, the modified formulations also incorporate foreign real income expecting a positive impact of rise in foreign real income on domestic currency demand. Further, we apply foreign money supply as the foreign monetary policy variable instead of foreign inflation in one version of the model. Finally, we expect foreign capital inflow to have a contribution to EMP in NMS as it is documented in Hegerty (2009) on a group of four NMS with fixed exchange rate regime. Since the types of capital are very different in nature we distinguish and experiment with three alternative definitions of the foreign capital inflow variable: (i) all capital registered on financial account, (ii) foreign direct investment, and (iii) portfolio and other investment.

Therefore, we estimate two alternatives to (3) defined as follows:

$$emp_t = \beta_0 + \beta_1 d_t - \beta_2 y_t - \beta_3 p_t^* + \beta_4 m + \beta_5 i_t^* + \beta_6 q_t + \beta_7 y_t^* + u_{2t} \qquad (4)$$

$$emp_t = \gamma_0 + \gamma_1 d_t - \gamma_2 y_t - \gamma_3 s_t^* + \gamma_4 m + \gamma_5 n_t + \gamma_6 q_t - \gamma_7 k_t + u_{3t} \quad (5)$$

where i^* is the change in foreign interest rate, q is the differential of the domestic inflation rate from the purchasing power parity condition, n is the difference between changes in domestic and foreign interest rates, s^* is the growth of the foreign money supply, k is the foreign capital inflow; and the other variables are denoted as above.

Equations (4) and (5) represent different approaches to the way in which foreign disturbances enter the model. While (4) is based on disturbances through the foreign inflation, interest rate and real income (5) accounts for disturbances driven by foreign money supply, interest rate differential and foreign capital inflow.

A growth of variable with a positive (negative) sign leads to proportional depreciation (appreciation) of domestic currency and outflow (inflow) of international reserves. Although the signs of most of the explanatory variables are obvious a positive sign of the difference between changes in domestic and foreign interest rates deserves a further clarification. A positive sign means that EMP is increasing if the domestic interest rate increases (decreases) more (less) than foreign interest rate. Because the model stems from monetarist theory the domestic money demand is negatively related to domestic interest rate. Thus, a relative increase of domestic interest rate results, ceteris paribus, in excess supply of money. This stimulates, for a given domestic component of money base, an outflow of international reserves or domestic currency depreciation, i.e. an increase of EMP.

4. Methodology and data

Estimation of all alternative models for all NMS would make the interpretation of the results more difficult. Thus, as the first step in empirical analysis, we have to identify the correct model specification for each NMS. Let us consider the models described by equations (3), (4) and (5) as Model 1, Model 2 and Model 3, respectively. Furthermore, according to the type of capital included in the estimation we denote the version of Model 3 as Model 3all (all capital), Model 3fdi (foreign direct investment) and Model 3poi (portfolio and other investment).

Model 1 is said to be nested with Model 2 since Model 1 is Model 2 with the restrictions $\beta_5 = 0, \beta_6 = 0, \beta_7 = 0$ imposed. Hence, we use an F-test to determine whether the full Model 2 contributes additional information about the association between EMP and the predictors. The full model will usually be able to fit the data better (lower residual sum of squares and more parameters) than the restricted model (higher residual sum of squares and less parameters). However, F-test is needed to determine whether the full model gives a significantly better fit to the data. In other words, a restricted Model 1 is preferable to Model 2 as long as both have similar predictive power.

Next, we proceed with selection of the appropriate version of Model 3. All three alternatives are estimated and the correct model chosen according to the Akaike Information Criterion. Next, a selection between Model1/Model2 and Model 3 is made. We cannot use an F-test because these sets of equations are not nested within each other. Neither equation is a special case of the other, i.e. we do not have a restricted and a full model. Two alternative procedures are applied to find the correct model: the testing techniques proposed by Davidson and MacKinnon (1981) and by Mizon and Richard (1986).

The first step of the Davidson and MacKinnon test is an inclusion of the fitted values of the dependent variable of each model as an additional explanatory variable in a re-estimation of the other model. Then, if Model 1(2) is true, the fitted values of the dependent variable of Model (3) should be insignificant in Model 1(2) and vice versa. In Mizon and

Richard approach, one tests whether a comprehensive model containing all explanatory variables from Model 1(2) and Model (3), even if false in an economic sense, can be still informative about the distribution of parameter estimates and other performance statistics of individual Model 1(2) or Model (3). This is the hypothesis that the comprehensive model encompasses the individual model. After estimation of the comprehensive model we apply an F-test as described above having Model 1(2) and Model (3) respectively as the restricted models.

Both tests have some drawbacks that one should bear in mind when interpreting the results. First, rejecting Model 1(2) does not necessarily mean that Model (3) is the absolutely correct alternative. Second, the results do not have to be straightforward as both models can be rejected or neither model can be rejected. If the case is that neither model is rejected we choose the one with higher R^2 as suggested by Asteriou and Hall (2007).

Once the best model is chosen for each NMS we extend it by inclusion of the variable $a = (e - 1)/(-r - 1)$ in the right-hand side of the equation as suggested by Pollard (1999) or Bahmani-Oskooee and Bernstein (1999). The main purpose of such an extension is to determine whether EMP is sensitive to its composition and how much of EMP is absorbed by change in the exchange rate and how much by the change in reserves. A significant and positive coefficient of *a* implies that more pressure is absorbed by reserves losses, while a significant and negative coefficient of *a* implies that the monetary authority absorb more pressure by the currency depreciation. An insignificant coefficient implies that the monetary authority is not sensitive to components of EMP.

The quarterly data from 1995:1 to 2009:4 are employed in the paper yielding 60 observations for each of the NMS.[3] Most of the variables were obtained from the IMF's International Financial Statistics and the Eurostat's Economy and Finance database. The missing observations in the time series were replenished from databases accessible on the NMS central banks' websites. The detailed description of all data series and their sources is presented in Appendix 2.

5. Estimation results

One of the paper's objectives is to estimate EMP and compare its magnitude and development of EMP across the group of NMS. For this purpose Figure 1 depicts evolution of actual EMP (dependent variable from correct model specification). Descriptive statistics of EMP and both components are reported in Appendix 3.

To evaluate EMP correctly it is necessary to remember some elementary facts. First, a positive value of EMP indicates the pressure either to depreciate domestic currency or to sell more international reserves to maintain equilibrium in the domestic money market. On the contrary, a negative EMP shows that the domestic currency is pressured to appreciate. Second, the value of EMP represents the magnitude of the foreign exchange market disequilibrium which should be removed by a respective change of the exchange rate and/or international reserves depending on the exchange rate regime.

One can observe only few features of the EMP development that NMS share in common. Probably the most striking one is a dominance of appreciation pressure. While this is particularly apparent in Bulgaria, Czech Republic, Latvia, Lithuania, Poland and Slovakia, the proportion of appreciation-pressure and depreciation-pressure observations is more balanced in Estonia and Hungary.

The most clear-cut example of analogous EMP evolution can be seen during the period of global financial crisis. EMP in all NMS except Slovakia[4] abandoned the

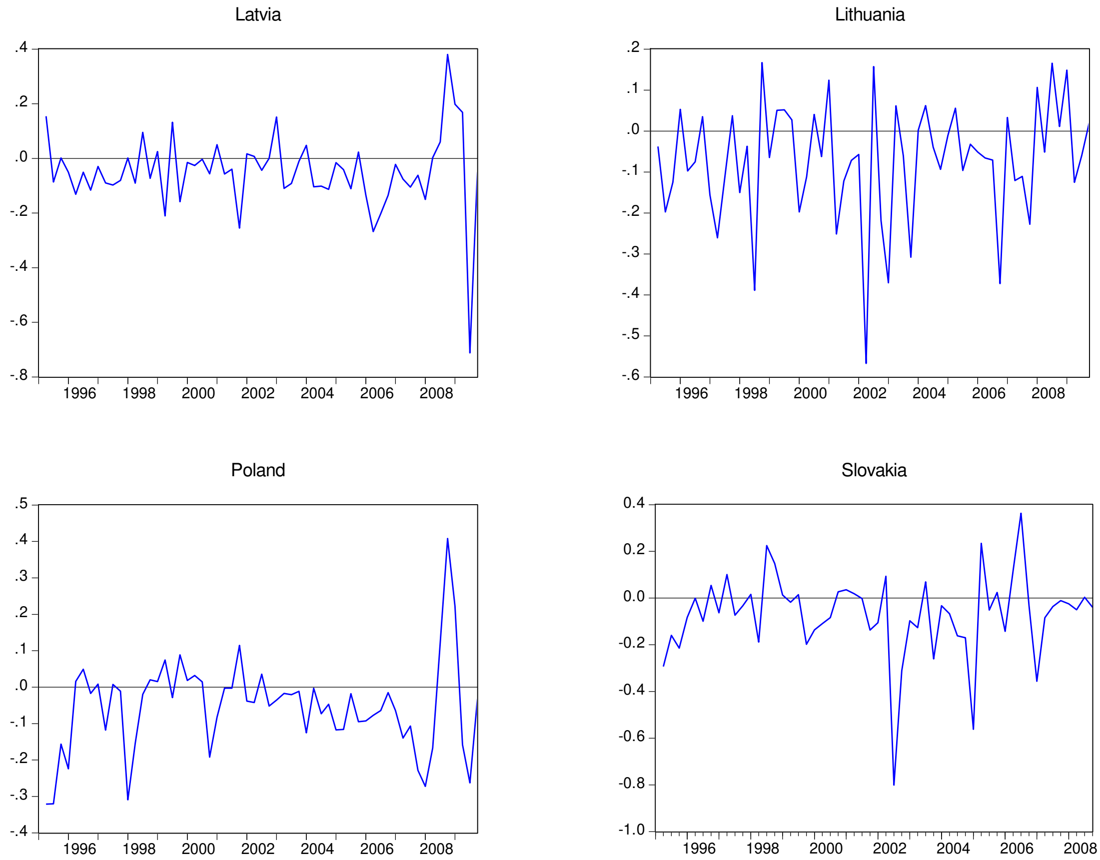
[3] The time span for Bulgaria was reduced to 1998:1 – 2009:4 and for Slovakia to 1995:1 – 2008:4.
[4] EMP in Slovakia was substantially softened by the coming integration to the euro area in January 2009.

appreciation-pressure zone and increased substantially in the second half of 2008 and beginning of 2009. A magnitude of depreciation EMP ranged from 9.60% in the Czech Republic to 40.77% in Poland. Considerably high EMP was also experienced by Latvia (38.03%) and Bulgaria (25.05%). Over the course of 2009, EMP in most NMS returned into appreciation-pressure zone partly because of gradual stabilization in the financial industry and partly thanks to financial aid provided to some NMS by the IMF and other multinational authorities.

We can also observe several episodes of common EMP development in some NMS. For instance, a sharp decrease of EMP in the Czech Republic, Hungary and Slovakia in 2002 reflected a rapid appreciation of national currencies against the euro accompanied by corresponding interventions in the foreign exchange market. Likewise, during the years 2004 and 2005 all NMS with fixed regime experienced a homogenous EMP development with low volatility and marginally increasing trend.

Moreover, the graphs illustrate many cases of disequilibrium in the foreign exchange market in individual NMS coming through excessive EMP. For instance, the financial crisis in the Czech Republic in 1997 that resulted in abandonment of a currency peg with fluctuation band and extensive depreciation of the Czech koruna is distinctly identified. In 2002-2003, the Hungarian forint was first under speculative attack on the strong size of the fluctuation band and appreciation pressure. Then, the central parity was unexpectedly devalued which caused a massive capital outflows from the country. One can also recognize the effect of parliamentary elections in Slovakia in 2006 whose results were accepted by market participants with scepticism about effort of the new government to continue in integration to the euro area.

Figure 1: Exchange market pressure in NMS



Source: Authors' calculations

EMP indices are often used for identification of speculative attacks and crisis episodes. Conventionally, some thresholds based on a certain number of standard deviations around the mean of the EMP measure. However, as Pontines and Siregar (2008) point out, such a procedure implicitly assumes that EMP indices are normally distributed. Since the national EMP indices used in this study do not follow the normal distribution we have to adopt an alternative approach first proposed by Moreno (1995) and recently used in Pontines and Siregar (2008) or Anastasatos and Manou (2008).

Moreno (1995) approach focuses on individual components of the EMP index and sequentially considers the crisis thresholds for each of them. Using data for each country, an arbitrary band was constructed around each component of EMP by taking the mean of the component plus or minus 1.5 standard deviations. To identify episodes of "excessive pressure", observations where changes in the exchange rate were outside the band were selected first. From the remaining (nonselected) observations, episodes were changes in international reserves breached the band's thresholds were selected next. In order to prevent the continuation of a crisis episode from being identified as a new episode, windows were created by dropping one observation (one quarter) around previously identified episodes.

All NMS analyzed in the paper are on the way to the euro area or have been officially accepted to join the euro area or even have already adopted the euro. Joining the euro area is, however, conditioned by fulfilment of several criteria including the exchange rate stability convergence criterion. It requires the compulsory participation in the Exchange Rate Mechanism II and, additionally, no downward realignment of central parity of the national currency vis-à-vis euro (devaluation) is possible, and the exchange rate should be maintained within a fluctuation margin around the central parity "without severe tensions". Therefore, we use the Moreno approach to identify only episodes of excessive depreciation pressure.[5] Table 1 reports the summary of all these episodes for each NMS.

Table 1: Episodes of excessive depreciation pressure

Country	Excessive pressure episodes	No. of quarters
Bulgaria		0
Czech Republic	1997Q2, 1999Q1, 2008Q4-2009Q1	4
Estonia	2001Q1	1
Hungary	1997Q1, 2001Q4, 2008Q4-2009Q2	5
Latvia	2008Q4-2009Q1	2
Lithuania		0
Poland	2001Q3, 2002Q3, 2008Q4-2009Q1	4
Slovakia	1998Q4-1999Q2, 2006Q3	4

Source: Author's calculations

The frequency of excessive depreciation EMP decreased after the EU enlargement in 2004 as there has been no episode except for global financial crisis and effect of Slovakia's parliamentary elections in fall 2006. From the perspective of the exchange rate stability criterion one can evaluate such a development as favourable. During the recent years, all NMS faced rather appreciation pressure that does not pose a serious threat to fulfilment of the convergence criterion. It is also worth noting that the episodes of excessive EMP were not likely to persist for a long time (more than one quarter) – again, with the exception of global financial crisis.

The second aim of the paper is to select the correct EMP model specification for each NMS. Before regression analysis, we applied Augmented Dickey-Fuller (ADF) tests to examine the stationarity of the time series used. According to the character of each series we tested the stationarity using one of the three test specifications: with intercept, with a linear trend and intercept, or with none of them. The results of ADF tests suggest that all time series are I(0) can be used in a regression analysis. The only two I(1) series are the differentials of the domestic inflation rate from the purchasing power parity q for the Czech Republic and Slovakia.

We estimated Model 1 and Model 2 for all NMS using Ordinary Least Squares and calculated F-test to determine the validity of Model 1. Results are reported in Table 2. They suggest that the restrictions concerning the change in foreign interest rate, differential of the domestic inflation rate from the purchasing power parity, and the change in foreign permanent income ($\beta_5 = 0, \beta_6 = 0, \beta_7 = 0$) can be rejected at the 5% level only for Estonia and Poland. Hence, unrestricted Model 2 is valid for these two NMS and restricted Model 1 is valid for all remaining NMS.

[5] Nevertheless, it is worth noting that number of excessive appreciation pressure episodes is considerably higher for all NMS, which corresponds with aforementioned general dominance of appreciation-side EMP.

Table 2: Results of F-tests

Bulgaria		Czech Republic		Estonia		Hungary	
0.7141 (0.5494)	Model 1	2.1473 (0.1057)	Model 1	3.5685 (0.0202)	Model 2	1.7320 (0.1721)	Model 1
Latvia		**Lithuania**		**Poland**		**Slovakia**	
2.4211 (0.0766)	Model 1	0.5972 (0.6197)	Model 1	4.6470 (0.0060)	Model 2	1.6297 (0.1951)	Model 1

Note: p-values in parentheses, identification of the non-rejected model
Source: Author's calculations

Next, all versions of Model 3 (Model 3all, Model 3fdi and Model 3poi) were estimated and the appropriate one selected for each NMS. According to Akaike Information Criterion we select Model 3all for the Czech Republic, Estonia, Hungary, Poland and Slovakia, and Model 3fdi for Bulgaria, Latvia and Lithuania. Further, the Davidson-MacKinnon and Mizon-Richard tests were calculated between Model 1 and Model 3 for Bulgaria, Czech Republic, Hungary, Latvia, Lithuania and Slovakia, and between Model 2 and Model 3 for Estonia and Poland. The test statistics are reported in Table 3.

Table 3: Results of Davidson-MacKinnon and Mizon-Richard tests

	Davidson-MacKinnon test		**Mizon-Richard test**	
	H_0: Model 1(2)	H_0: Model 3	H_0: Model 1(2)	H_0: Model 3
Bulgaria	23.468 (0.0000)	0.3125 (0.7565)	2.1710 (0.0903)	0.0979 (0.7560)
Czech Republic	3.0241 (0.0038)	0.4726 (0.6385)	2.1593 (0.0872)	0.2233 (0.6386)
Estonia	3.0773 (0.0034)	1.7737 (0.0822)	3.0593 (0.0370)	1.9070 (0.1410)
Hungary	3.8934 (0.0003)	-0.4203 (0.6761)	3.5828 (0.0121)	0.1766 (0.6762)
Latvia	5.1475 (0.0000)	0.8803 (0.3829)	6.2714 (0.0004)	0.7747 (0.3831)
Lithuania	3.5437 (0.0009)	0.6931 (0.4917)	3.2261 (0.0197)	0.5219 (0.4735)
Poland	0.5868 (0.5600)	4.5294 (0.0000)	3.1130 (0.0348)	6.9481 (0.0006)
Slovakia	5.8744 (0.0000)	0.8996 (0.3730)	8.1970 (0.0000)	0.8089 (0.3723)

Note: p-values in parentheses
Source: Author's calculations

According to results of Davidson-MacKinnon test Model 3 is rejected at the 5% level only for Poland and Model 1(2) is rejected in all NMS except for Poland. As far as Mizon-Richard test statistics are concerned, Model 3 is again rejected only for Poland and Model 1(2) is rejected for Estonia, Hungary, Latvia, Lithuania, Poland and Slovakia. If we apply the 10% level Model 1 is rejected also for Bulgaria and Czech Republic. Summarizing the results of both tests, one can conclude that Model 2 is the correct specification for Poland and Model

3 is the correct specification for all remaining NMS. The estimation results of the correct model as well as results of some diagnostic tests are provided in Table 4.

Table 4: Estimations of the correct model specifications

	Bulgaria (Model 3fdi)	**Czech Republic (Model 3all)**	**Estonia (Model 3all)**	**Hungary (Model 3all)**
constant	-0.0121 (0.0177)	0.0241 (0.0161)	-0.0308[b] (0.0132)	-0.0073 (0.0141)
d	1.0156[a] (0.0475)	0.8264[a] (0.0612)	0.8259[a] (0.0943)	0.8683[a] (0.0516)
y	-1.9157 (1.3179)	-3.2986[a] (1.2277)	0.6776 (0.9375)	-0.0933 (0.9094)
*s**	-1.0873[c] (0.6162)	-0.1715 (0.4165)	-0.9534[b] (0.4361)	-0.7455[b] (0.3647)
m	0.8939[a] (0.0954)	0.4371[a] (0.1294)	0.6310[a] (0.1128)	0.7384[a] (0.0948)
n	0.0365[b] (0.0172)	0.0469 (0.0385)	0.0485[a] (0.0177)	0.0932[b] (0.0356)
q	-0.0082 (0.0838)	-0.0689 (0.2180)	0.3093[b] (0.1194)	0.1120 (0.0791)
k	-0.0298 (0.1010)	-0.4805[b] (0.1935)	-0.2339[c] (0.1362)	-0.1533 (0.1241)
Adj. R^2	0.9337	0.8923	0.8636	0.9384
S.E.	0.0478	0.0556	0.0521	0.0432
D-W	2.0768	2.4062	1.7119	2.1704
J-B	4.2476 (0.1195)	3.2233 (0.1995)	0.1075 (0.9476)	2.2797 (0.3198)
LM	0.8300 (0.5149)	1.3404 (0.2690)	0.9720 (0.4318)	2.1861 (0.0720)
ARCH	2.8411 (0.1067)	1.0077 (0.3198)	0.1507 (0.6993)	1.8125 (0.1275)
WHITE	3.1819 (0.0179)	0.8720 (0.6500)	2.4943 (0.0121)	0.8310 (0.6958)
RESET	0.1483 (0.7022)	0.6340 (0.3987)	0.2026 (0.6546)	0.0005 (0.9810)
	Latvia (Model 3fdi)	**Lithuania (Model 3fdi)**	**Poland (Model 2)**	**Slovakia (Model 3all)**
constant	-0.153 (0.0139)	-0.0122 (0.0133)	-0.0156 (0.0216)	0.0316 (0.0263)
d	0.9089[a] (0.0600)	0.8666[a] (0.0532)	0.9927[a] (0.0564)	0.8071[a] (0.0695)
y	0.0519 (0.5839)	-1.8019[a] (0.5051)	-0.9392[b] (0.4531)	-2.6601[b] (1.1548)
*s**	-1.2568[a] (0.4027)	-0.6896[b] (0.3765)		-0.7049[c] (0.4197)
m	0.6992[a] (0.0954)	0.8175[a] (0.1113)	1.0596[a] (0.1098)	0.8192[a] (0.0790)
n	0.0507[a] (0.0166)	0.0433 (0.0309)		0.1309[a] (0.0433)
q	0.3631[a] (0.1161)	0.1672[b] (0.0713)	-0.0084 (0.1067)	-0.0669 (0.2364)
k	-0.6887[a] (0.2419)	-0.2977 (0.2331)		-0.3444[a] (0.1266)
*p**			0.0564 (0.9680)	
*i**			-0.1634[a] (0.0527)	
*y**			-1.4812 (2.2728)	
Adj. R^2	0.8755	0.8852	0.8732	0.9393
S.E.	0.0497	0.0492	0.0448	0.0441
D-W	1.7594	1.7176	1.8603	1.6853
J-B	0.1518 (0.9269)	0.8737 (0.6460)	0.0039 (0.9980)	3.0434 (0.2183)
LM	0.9533 (0.4418)	1.5412 (0.2057)	0.6814 (0.6083)	0.5837 (0.6761)
ARCH	0.6672 (0.4175)	0.0196 (0.8891)	0.8286 (0.3666)	0.0172 (0.8959)
WHITE	1.8558 (0.0613)	0.6478 (0.8788)	1.3665 (0.2180)	3.9327 (0.0012)
RESET	0.0363 (0.8495)	0.5500 (0.4618)	0.4929 (0.4859)	1.0369 (0.3139)

Note: standard errors in parentheses for regression coefficients and p-values in parentheses for diagnostic tests; [a, b] and [c] denote significance at 1%, 5% and 10% level respectively

Source: Author's calculations

Estimations lead to generally plausible results. All the models passed most of the diagnostic tests. However, we found evidence of potential heteroskedasticity of residuals in the models for Bulgaria, Estonia and Slovakia. Therefore, we corrected the standard errors of parameter estimates by the White procedure. There is no evidence of autocorrelation and non-normality of residuals in any estimation. The Ramsey RESET tests confirmed the appropriate functional form of the estimated models in all NMS.

With regards to coefficient estimates, growth of domestic credit (d) and change of the money multiplier (m) are significant and correctly signed in each individual model. This finding is in line with the monetarist logic that excessive growth of money supply, stimulated through growth of domestic credit and/or the money multiplier, results to depletion of reserves and/or depreciation of domestic currency. The coefficients of d and m are significantly different from unity in all NMS except Bulgaria and Poland.

Taking the Czech Republic's model estimation as an example, the coefficient of d (0.8264) implies that a 10% increase in the domestic credit causes the exchange rate to depreciate by 8.264%, or a loss of reserves by 8.264% or a combination of the two to the same extent.

The coefficient on domestic real GDP growth (y) has an expected negative sign in six NMS. However, it is significant only for the Czech Republic, Lithuania, Poland and Slovakia. The growth of real domestic income in these countries therefore influences EMP through accumulation of reserves or appreciation of domestic currency.

The coefficient on the interest rate differential (n) has a positive sign, as suggested by monetarist theory, in all national models, and is significantly different from zero for Bulgaria, Estonia, Hungary, Latvia and Slovakia. Moreover, the change in the foreign interest rate included in Model 2 is significant in the estimation for Poland. Hence, one can conclude that the changes in the interest rate differential between NMS and the euro area or changes in the euro area's interest rate influence EMP in most of the NMS analyzed.

The parameters of deviation from the purchasing power parity (q) are significantly different from zero and correctly signed in models for Estonia, Latvia and Lithuania. Such a result indicates that the original G-R model's assumption that purchasing power parity holds can be rejected only in NMS with fixed exchange rate. However, this finding does not tell anything about validity of the purchasing power parity in other NMS.

Foreign disturbances enter the model via foreign money supply (s^*) and foreign capital inflow (k). The growth of money supply in the euro area negatively influences EMP in all NMS. The coefficient is significant in four countries and coefficients for Bulgaria and Slovakia are significant at the 10% level. Such results provide clear evidence that the euro area money supply is a crucial source of international disturbances and important variable explaining EMP in the new part of the EU.

Although Hegerty (2009) examines contribution of foreign capital inflows to EMP and growth of domestic credit in some NMS applying a Vector Autoregressive approach, this is the first study that uses some measure of foreign capital inflow as one of the determinants of EMP in a broad group of NMS. The coefficients of k are negative in all national models indicating that foreign capital inflow helps to reduce EMP throughout the new part of the EU. However, significant coefficients can be found only in four countries. Capital inflow (all types of capital) turned out to be significant determinant also for Poland. However, as Model 3 is not the correct specification for Poland its estimation results are not reported in Table 3. If we consider solely portfolio and other investment as a capital inflow variable no significant impact on EMP was revealed in any of NMS. Nevertheless, it is worth noting that respective coefficients in Bulgaria's, Hungary's and Latvia's models carry a positive sign. All these countries had extensive liabilities towards the IMF over the estimation period including the most recent phase.

Differences between NMS with fixed exchange rate regime and NMS with floating arrangement are hard to find. The estimation results suggest that only the deviation of domestic inflation from the purchasing power parity is significant only in some of the “fixing” countries. The occurrence of signs opposite to theoretical is rare and equally distributed among all NMS regardless the exchange rate regime applied.

All models have good explanatory power and seem to be consistent over the whole estimation period. We performed the Quandt-Andrews test which tests for unknown structural breakpoints in an equation’s sample. The null of no structural changes cannot be rejected in any model. The tests tend to designate 2005Q1 for Bulgaria and Hungary, 2002Q2 for the Czech Republic and Lithuania, and 2006Q3 for Slovakia as major though insignificant breakpoints.

The next step in the empirical analysis is the extension of Model 2 for Poland and Model 3 for the remaining NMS by the variable *a* to realize whether EMP is sensitive to its distribution on foreign exchange and reserve components. This specification (Model 4) is defined in equation (6) for Poland and equation (7) for all remaining NMS.

$$emp_t = \beta_0 + \beta_1 d_t - \beta_2 y_t - \beta_3 p_t^* + \beta_4 m + \beta_5 i_t^* + \beta_6 q_t + \beta_7 y_t^* + \beta_8 a_t + u_{2t} \tag{6}$$

$$emp_t = \gamma_0 + \gamma_1 d_t - \gamma_2 y_t - \gamma_3 s_t^* + \gamma_4 m + \gamma_5 n_t + \gamma_6 q_t - \gamma_7 k_t + \gamma_8 a_t + u_{3t} \tag{7}$$

Although Model 4 was estimated for each NMS, the attention is primarily paid to countries with a flexible exchange rate regime. Since the Baltic States and Bulgaria apply a fixed exchange rate regime the imbalance in the foreign exchange market is fully captured by changes in a country’s international reserves. Hence, the variable *a* shall be highly significant and positive in these NMS. On the contrary, a flexible exchange rate regime applied in the remaining four NMS allows for absorption of EMP through changes of international reserves as well as exchange rate. Thus, we expect the variable *a* to be statistically insignificant. In other words, an insignificant *a* implies that monetary authority does not make choices between reserves and exchange rate changes in response to monetary shocks. The estimation results are reported in Table 5 including results of standard diagnostic tests.

The results confirm the expectations of the coefficient of *a* as positive and significant in all NMS with a fixed exchange rate regime. However, the inclusion of *a* into the model changed the estimation results for these countries substantially. Although the explanatory power of the models demonstrated by the adjusted R^2 increased the coefficients of previously significant variables usually decreased or even lost significance. On the other hand, the constant terms of the equations carry highly significant coefficients. A lower quality of the Model 4 estimates is also documented by results of the diagnostic tests that confirm the presence of heteroskedasticity and inappropriate functional form.

The estimation of Model 4 for NMS with a flexible exchange rate regime shows that the variable *a* is significant in two NMS at the 1% level and in the Czech Republic at the 10% level. Whereas the coefficients in the Czech Republic’s and Slovakia’s models are positive the Poland’s coefficient has a negative sign. This result reveals a different approach of central banks to absorb EMP. A positive coefficient indicates that EMP is influenced more by international reserves adjustments and, analogically, a negative sign implies that most of EMP is absorbed by exchange rate changes. The only insignificant coefficient of *a* was estimated for Hungary. Hence, one can conclude that there is a one-to-one trade-off between reserve losses/gains and exchange rate depreciation/appreciation. The Hungary’s central bank tends to “balance” both channels of EMP absorption.

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Table 5: Estimation of Model 4

	Bulgaria	**Czech Republic**	**Estonia**	**Hungary**
constant	-0.6266[a] (0.0850)	-0.2566 (0.1542)	-0.8125[a] (0.0753)	-0.0462 (0.0986)
d	0.5323[a] (0.0732)	0.6867[a] (0.0969)	0.2034[a] (0.0607)	0.8375[a] (0.0930)
y	-1.1628 (0.8740)	-3.0258[b] (1.2096)	-0.4553 (0.2983)	0.0482 (0.9834)
*s**	-0.6203 (0.4108)	0.2936 (0.4127)	-0.2322 (0.1388)	-0.7455[b] (0.3678)
m	0.4298[a] (0.0894)	0.3309[b] (0.1392)	0.1939[a] (0.0693)	0.7212[a] (0.1049)
n	0.0071 (0.0120)	0.0523 (0.0378)	0.0076 (0.0063)	0.0983[b] (0.0382)
q	-0.0026 (0.0552)	-0.1043 (0.2140)	0.0052 (0.0359)	0.1124 (0.0798)
k	0.0469 (0.0673)	-0.4184[b] (0.1922)	0.0189 (0.0541)	-0.1533 (0.1251)
a	0.6089[a] (0.0834)	0.2778[c] (0.1518)	0.7968[a] (0.0761)	0.0383 (0.0962)
Adj. R^2	0.9712	0.8971	0.9759	0.9374
S.E.	0.0314	0.0543	0.0178	0.0435
D-W	2.2511	2.3782	1.9666	2.1268
J-B	1.7408 (0.4178)	3.0699 (0.2154)	13.683 (0.0010)	1.8991 (0.3869)
LM	0.9077 (0.4701)	1.1220 (0.3578)	0.4858 (0.7460)	2.3268 (0.0703)
ARCH	0.0288 (0.8658)	0.2076 (0.6504)	0.2604 (0.6118)	4.0801 (0.0482)
WHITE	2.7097 (0.2243)	0.8177 (0.7061)	6.5063 (0.0002)	1.0725 (0.4667)
RESET	413.32 (0.0000)	1.4304 (0.2515)	322.45 (0.0000)	0.1096 (0.7420)
	Latvia	**Lithuania**	**Poland**	**Slovakia**
constant	-0.4190[a] (0.0945)	-0.5292[a] (0.1481)	0.4373[a] (0.0930)	-0.3226[a] (0.1015)
d	0.5938[a] (0.0896)	0.5351[a] (0.1087)	1.3580[a] (0.0871)	0.5883[a] (0.0870)
y	0.7654 (0.5303)	-0.0247 (0.6680)	-1.7567[c] (0.9513)	-2.7289[a] (1.0320)
*s**	-0.8412[b] (0.3605)	0.0760 (0.3947)		-0.2657 (0.3944)
m	0.4507[a] (0.1005)	0.5629[a] (0.1216)	1.3971[a] (0.1135)	0.5962[a] (0.0940)
n	0.0346[b] (0.0148)	0.0334 (0.0273)		0.1434[a] (0.0389)
q	0.2434[b] (0.1040)	0.0924 (0.0621)	0.0016 (0.0882)	0.1275 (0.2180)
k	-0.4408[b] (0.2164)	-0.3027 (0.2014)		-0.2644[b] (0.1153)
*p**			0.8684 (0.8170)	
*i**			-0.1208[a] (0.0444)	
*y**			-1.5831 (1.8794)	
a	0.3948[a] (0.0917)	0.4898[a] (0.1420)	-0.4731[a] (0.0954)	0.3382[a] (0.0942)
Adj. R^2	0.9073	0.9208	0.9133	0.9516
S.E.	0.0429	0.0413	0.0370	0.0394
D-W	1.5568	2.0012	1.6486	1.4043
J-B	2.5122 (0.2847)	1.6070 (0.4477)	0.6231 (0.7322)	0.0399 (0.9802)
LM	0.7788 (0.5447)	0.2167 (0.9276)	0.9422 (0.4481)	1.7082 (0.1662)
ARCH	0.1893 (0.6651)	0.4099 (0.5248)	1.1914 (0.2797)	0.0157 (0.9005)
WHITE	1.0753 (0.4643)	0.6661 (0.8287)	0.8005 (0.7231)	3.8401 (0.0134)
RESET	12.684 (0.0008)	0.0132 (0.9089)	2.5634 (0.1158)	1.6104 (0.1895)

Note: standard errors in parentheses for regression coefficients and p-values in parentheses for diagnostic tests; [a, b] and [c] denote significance at 1%, 5% and 10% level respectively
Source: Author's calculations

The results for the Czech Republic and Hungary seem to be plausible from the perspective of participation in the ERM II and fulfilment of the exchange rate stability convergence criterion because the pressures on the national currency are not likely to be absorbed exclusively through exchange rate changes.[6] By contrast, the fact that Poland's EMP is primarily absorbed by exchange rate changes may cause serious problems with fulfilment of the convergence criterion that strictly requires the exchange rate stability.

The coefficients of other variables in Model 4 differ only marginally from those in Model 3 (Model 2 for Poland). Likewise, the model's goodness of fit remained almost the same as indicated by the adjusted R^2. With some exceptions regarding heteroskedasticity of the residuals all the models passed the diagnostic tests.

6. Conclusion

In this paper, we calculated and compared EMP and estimated EMP determinants in eight NMS. The EMP development in individual NMS was rather heterogeneous, though some episodes and trends were shared by more countries. Above all, one can observe a dominance of appreciation pressure and very turbulent evolution during the global financial crisis. These recent episodes of excessive EMP disrupted a fundamentally stable EMP development that had persisted since the EU enlargement in May 2004.

We experimented with several modifications of the Girton-Roper model and performed a set of tests to determine the optimal EMP model specification for each NMS. Although the vast majority of existing empirical literature has used the original version we found that it does not hold for NMS. Instead a specification that contains change in the euroe area's money market interest rate, annual growth of the euro area's permanent income and deviation from the purchasing power parity was chosen for Poland. The correct model specification for all remaining NMS also accounts for the deviation from the purchasing power parity and further incorporates change in the euro area's money supply, change in the interest rate differential and foreign capital inflow.

The estimation results suggest that EMP in the region was significantly and positively influenced by growth of domestic credit and money multiplier. Furthermore, growth of domestic income and change in the interest rate differential turned out to be significant EMP determinants in some NMS. We also revealed that EMP determined by foreign disturbances transmitted to NMS particularly through changes in the euro area's money supply and foreign capital inflow.

A stable EMP development with sporadically occurring excessive pressure has a strong policy implication if it is evaluated along with another crucial finding of the paper. The study confirms that EMP in NMS with a flexible exchange rate regime except for Poland is not absorbed exclusively by changes of exchange rate. Instead, changes in international reserves play a dominant role. Hence, one can expect that EMP during the period of participation in the ERM II would not be accommodated by substantial exchange rate changes endangering fulfilment of the exchange rate stability convergence criterion.

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[6] See e.g. Mirdala (2008) for more on how able the NMS monetary authorities are to manage the exchange rate development after the accession to the EU.

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Appendix 1: Correlation coefficients between alternative EMP measures

Bulgaria

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.802	1.000		
G_W	0.999	0.801	1.000	
N_W	0.802	0.999	0.802	1.000

Czech Republic

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.909	1.000		
G_W	0.876	0.825	1.000	
N_W	0.800	0.872	0.957	1.000

Estonia

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.895	1.000		
G_W	0.719	0.718	1.000	
N_W	0.698	0.754	0.950	1.000

Hungary

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.904	1.000		
G_W	0.808	0.742	1.000	
N_W	0.732	0.810	0.946	1.000

Latvia

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.967	1.000		
G_W	0.832	0.759	1.000	
N_W	0.837	0.807	0.985	1.000

Lithuania

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.914	1.000		
G_W	0.830	0.783	1.000	
N_W	0.752	0.827	0.956	1.000

Poland

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.869	1.000		
G_W	0.954	0.835	1.000	
N_W	0.862	0.940	0.925	1.000

Slovakia

	G_U	N_U	G_W	N_W
G_U	1.000			
N_U	0.901	1.000		
G_W	0.868	0.751	1.000	
N_W	0.834	0.846	0.958	1.000

Note: G_U is gross-reserves-unweighted EMP, N_U is net-reserves-unweighted EMP, G_W is gross-reserves-weighted EMP, and N_W is net-reserves-weighted EMP

Source: Author's calculations

Appendix 2: Description of data series

e	Percentage change of nominal exchange rate. NMS national currencies vis-à-vis euro in direct quotation (number of NMS currency units for one euro) Obtained from Eurostat's Economy and finance database (EEF) section Exchange rates and Interest rates, line Euro/ECU exchange rates – Quarterly data. Logged values.
r	Proportional change in domestic international reserves. Obtained from IMF's International Financial Statistics. The change in reserves = change in total reserves excluding gold (IFS line 1 d) minus IMF credit and loans outstanding (IFS line 2 tl) deflated by the seasonally adjusted inherited money base (IFS line 14).
d	Proportional change in domestic credit. Proxied by the percentage change of the seasonally adjusted money base (IFS line 14) minus r.
y	Annual growth rate of the domestic permanent income. Permanent income calculated as two-year moving average of logged values of Gross Domestic Product (IFS line 99bp).
p^*	Percentage change in foreign price level. Eurozone Harmonized indices of consumer prices Obtained from EEF section Prices, line Harmonized indices of consumer prices – Monthly data (index 2005=100). Converted from monthly to quarterly data by averaging the three monthly figures and then logged.
m	Percentage change of money multiplier. Multiplier calculated as ratio of M2 aggregate on money base. M2 obtained from NMS central banks' databases or IFS line 34 + IFS line 35; and money base from IFS line 14.
i^*	Percentage change in the euro area 3-month interbank market interest rate. Interest rate obtained from IFS line 60b.
s^*	Percentage change of the euro area money supply. Money supply obtained as the sum of logged values of demand deposits (IFS line 34), deposits of agreed maturity (IFS line 35a) and deposits redeemable at notice (IFS line 35b).
y^*	Annual growth rate of the euro area permanent income. Permanent income calculated as two-year moving average of logged values of Gross Domestic Product (IFS line 99bp).
q	Differential of the domestic inflation rate from the purchasing power parity condition. Obtained by subtracting the sum of the euro area inflation rate, CPI (IFS line 64) and e from the domestic inflation rate measured by CPI (IFS line 64).

n Difference between the percentage change in the domestic money market rate (IFS line 60b) and the percentage change in the euro area 3-month interbank market interest rate (IFS line 60b).

k Foreign capital inflow deflated by Gross Domestic Product (IFS line 99b). Foreign capital inflow measured either as all capital registered on the financial account (IFS line 78bjdzf) or foreign direct investment (IFS line 78bddzf minus IFS line 78bedzf) or portfolio and other investment (sum of IFS line 78bfdzf, IFS line 78bgdzf, IFS line 78bhdzf, and IFS line 78bidzf).

Appendix 3: Descriptive statistics of EMP and its components

	Bulgaria			**Czech Republic**		
	EMP	e	r	EMP	e	r
Mean	-0.09258	-0.00017	0.09241	-0.06326	-0.00443	0.05883
Median	-0.07766	0.00000	0.07763	-0.04027	-0.00773	0.02670
Max	0.25057	0.00338	0.73992	0.18357	0.08905	0.99023
Min	-0.73987	-0.00601	-0.25057	-1.0333	-0.04704	-0.16161
St.dev.	0.18572	0.00157	0.18582	0.16958	0.02782	0.16108
	Estonia			**Hungary**		
	EMP	e	r	EMP	e	r
Mean	-0.05220	0.00068	0.05287	-0.03319	0.01136	0.04456
Median	-0.05881	0.00000	0.06216	-0.02657	0.00992	0.03668
Max	0.23978	0.01180	0.30933	0.30712	0.13611	0.70550
Min	-0.31099	-0.01160	-0.23979	-0.65612	-0.05504	-0.30865
St.dev.	0.11511	0.00366	0.11479	0.17416	0.03705	0.17420
	Latvia			**Lithuania**		
	EMP	e	r	EMP	e	r
Mean	-0.04849	0.00087	0.04935	-0.07631	-0.00672	0.06959
Median	-0.05081	0.00056	0.05141	-0.06220	0.00000	0.05764
Max	0.38037	0.05548	0.70542	0.16713	0.06325	0.55905
Min	-0.71193	-0.04127	-0.37399	-0.56716	-0.06574	-0.16536
St.dev.	0.14109	0.02033	0.13925	0.14685	0.02563	0.14337
	Poland			**Slovakia**		
	EMP	e	r	EMP	e	r
Mean	-0.05435	0.00622	0.06057	-0.06999	-0.00409	0.06590
Median	-0.03563	-0.00276	0.05651	-0.04995	-0.00372	0.04447
Max	0.40778	0.19464	0.35054	0.36358	0.08658	0.81972
Min	-0.32101	-0.07679	-0.26943	-0.80077	-0.05055	-0.35955
St.dev.	0.12590	0.04691	0.11149	0.17913	0.02318	0.17330

Source: Author's calculations