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WORKING PAPER

Monetary Policy Rules in Central and Eastern European Countries: Does the Exchange Rate Matter?

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August 2009

2009/611

D/2009/7012/63

Monetary Policy Rules in Central and Eastern European Countries: Does the Exchange Rate Matter?*

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August 2009

JEL classification: E52, E58, P20

Keywords: monetary policy, Taylor rules, transition economies, CEEC, inflation targeting

Abstract:

We estimate monetary policy rules for six central and eastern European countries (CEEC) during the period, when they prepared for membership to the EU and monetary union. By taking changes in the policy settings explicitly into account and by introducing several new methodological features we significantly improve estimation results for monetary policy rules in CEEC. We find that in the Czech Republic, Hungary and Poland the focus of the interest rate setting behaviour switched from defending the peg to targeting inflation. For Slovakia, however, there still seemed to be on ongoing focus on the exchange rate. For Slovenia and only after a policy switch for Romania we find a solid relation with inflation as well.

* Any findings, interpretations, and conclusions are those of the authors and do not necessarily represent the views of the Deutsche Bundesbank. For helpful suggestions we would like to thank Gerdie Everaert, Koen Inghelbrecht, Robinson Kruse, Robert Tamura and two anonymous referees. The paper benefits from Nils Gottfries' comments on an earlier version.

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Monetary Policy Rules in Central and Eastern European Countries: Does the Exchange Rate Matter?

1. Introduction

Monetary policy in Central and Eastern European Countries (CEEC) has drawn increasing attention from academics and practitioners. While preparing for membership to the EU and monetary union, the central banks in CEEC were challenged by high inflation in the earlier periods and then managed to disinflate fairly successfully. The way how this was achieved, however, was different: The Visegrad countries (Czech Republic, Hungary, Poland and Slovakia) focused on exchange rate targeting during the first years, but then gradually made their exchange rate system more flexible and adopted inflation targeting as their monetary policy strategy. Romania and Slovenia never officially had a fixed exchange rate regime. While Romania adopted inflation targeting only in August 2005, Slovenia officially followed a monetary targeting strategy for most of the time before adopting a two-pillar-like strategy in the run-up to monetary union (for the official exchange rate and monetary policy regimes of these six countries see Table 1 and 2).

For these six countries the interest rate setting behaviour of a central bank can provide important insights into the objectives which are most important in its conduct of monetary policy. A standard approach is to estimate a Taylor-like interest rate reaction function. While the empirical literature concludes that the monetary policy by most successful central banks in large industrial countries can be described by such a reaction function (Clarida et al. 1998), evidence for emerging economies and particularly transition economies is poor.

Regime shifts, however, seem to matter. Kahn and Parrish (1998), for example, find that significant structural breaks in the monetary policy reaction function occurred, after New Zealand and the UK introduced inflation targeting. In both countries the significance of the exchange rate lost importance. Neumann and von Hagen (2002) find the same result for a larger country set. Assenmacher-Wesche (2006) estimates reaction functions with time-varying coefficients for Germany, the United Kingdom and the US. These empirical results stress the importance of taking policy changes into account.

Since CEEC are small open economies, one may also argue that besides regime shifts also the exchange rate plays a major role in the reaction function. Ball (1999) argues that pure inflation targeting without explicit attention to the exchange rate is dangerous in an open economy, because it creates large fluctuations in exchange rates and output. In an open economy, the effects of exchange rates on inflation through import prices is the fastest channel from monetary policy to inflation, therefore monetary policy cannot neglect it. The need for considering the exchange rate will be obvious if the monetary authorities explicitly target the exchange rate, as they (initially) did in many CEEC. However, the way the exchange rate enters the reaction function should be different under exchange rate targeting. Under an exchange rate peg monetary policy has to react on potential violations of the peg to keep it credible. Thus the reaction is non-linear, as it will get stronger, the closer the exchange rate approaches the intervention margins. It will also be non-discretionary, because the authorities are obliged to react, as long as they intent to sustain the peg.

In line with e.g. Peersman and Smets (1999) our emphasis is on positive or descriptive rather than normative aspects of policy analysis. We analyse the role of the exchange rate by looking at the interest rate setting behaviour of the central bank and to what extent it has taken exchange rate developments into account. The paper thereby sheds some light on the discussion to which extent the interest setting behavior of these central banks complies with the "fear of floating" hypothesis, as analyzed by Calvo and Reinhart (2002).[1] A central bank that changes interest rates systematically in response to inflation and also to exchange rate shocks is more likely to support evidence on this hypothesis keeping in mind, that the central bank nevertheless still may use interventions in the foreign exchange market as an instrument to steer the exchange rate.

This paper adds to the literature in five ways: First, our analysis covers a longer sample period than most previous studies. We cover a considerable part of the transition period from the mid-nineties to the present or until the country joined the euro area. Second, whereas most works only include the Czech Republic, Hungary, Poland and sometimes Slovakia, we add Slovenia and Romania to the sample. Thus we consider all new EU member states in CEEC which one may assume to have pursued a more or less independent monetary policy during a considerable period of time[2]. Third, the analysis takes explicitly into account shifts in exchange rate and monetary policy regimes that have occurred in all the countries of the sample. Fourth, we introduce a non-linear measure of distance to the intervention margins to

[1] For Central and Eastern European countries, for example, Schnabl (2004), for the credibility of exchange rate regimes see also Frömmel and Schobert (2006) or Fidrmuc and Horvath (2008).

[2] This is not the case for the remaining CEEC that joined EU: The Baltic states and Bulgaria followed very strict exchange rate regimes and partially currency boards. This means they could not pursue an independent monetary policy.

identify those interest rate changes that stem from the peg. To our knowledge we are the first taking this into account. Fifth, we apply the cointegration methodology to interest rate rules as suggested by Gerlach-Kristen (2003), which has rarely been applied to transition economies. These innovations allow us to retrieve more realistic coefficients from our reaction function, and thus our model better describes the interest rate setting behaviour of the monetary authorities.

The paper proceeds as follows: The following section 2 reviews the research on interest rate rules in transition economies. Section 3 introduces our empirical approach and our distance measure. Section 4 describes the data and presents the empirical results, while section 5 summarizes and concludes.

2. Monetary policy rules in CEEC

The Taylor rule, first proposed in 1993, suggests that interest rates would be changed according to the deviation of inflation from a target and an output gap (Taylor, 1993). Other studies often focus on the comparison of the actual setting of policy rates by central banks with what would have been predicted by the Taylor rule as a benchmark. However, as Peersman and Smets (1999) among others emphasize, the Taylor rule should be perceived as a descriptive instrument to understand the interest rate setting behaviour of central banks rather than as a normative guide for monetary authorities. The empirical literature on such interest rate rules for industrial countries has grown significantly during the past decade and has proven the ability of interest rate rules to describe the interest rate setting behaviour of central banks[3].

In contrast, research in the context of emerging market economies and particularly transition economies is of more recent origin and relatively scarce. An important finding is that central banks in emerging market economies tend to look beyond inflation and focus on other objectives as well, most prominently on exchange rate changes. Mohanty and Klau (2004) find that many central banks in their sample of emerging market economies change interest rates systematically in response to exchange rate changes. For some countries the response is even found to be stronger than that to the inflation rate or the output gap.

[3] For monetary policy rules in the context of inflation targeting see Neumann and von Hagen (2002) and the references therein.

There are few papers on monetary policy rules particularly in CEEC. This is due to several reasons. First, the time series available are comparatively short. They usually start in the middle of the 1990s. Second, most CEEC have not followed one single strategy of monetary policy and also gradually made their exchange rates more flexible (see Tables 1 and 2). Third, it is not quite clear which target values for inflation the CEEC followed, as most countries introduced inflation targeting and explicit inflation goals only between 1997 and 2001. The unstable and dynamic economic situation in the CEEC makes this task even more demanding.

However, there have been recently some attempts to describe the monetary policy in selected CEEC using interest rate rules: Maria-Dolores (2005) estimates Taylor rules for the Visegrad countries Czech Republic, Hungary, Poland and Slovakia between 1998 and 2003 and comes to the conclusion that the Taylor rule describes the interest rates well for all countries but Slovakia. Similarly to the original Taylor rule, the rules used by Maria-Dolores (2005) do not consider exchange rate movements. The lagged interest rate, however, is included. The same set of countries is considered by Paez-Farell (2007), whereas the sample periods differ from country to country. He compares different versions of interest rate rules and finds that there is a reaction to exchange rate movements. Angeloni et al. (2007) estimate interest rate rules for the Czech Republic, Hungary and Poland from 1995-2004. They introduce the US dollar interest rate as a proxy for inflationary pressures of global origin and dummies for the years preceding the adoption of inflation targeting. Yilmazkuday (2008) applies Taylor rules to the Czech Republic, Hungary and Poland for the period 1994-2007. He includes the exchange rate in the interest rate rule, but also considers structural breaks. Moons and Van Poeck (2008) focus on the period 1999-2003 and find that the accession countries do not differ substantially from the current EMU members with respect to the interest rate setting behaviour. Furthermore it seems that the potential new entrants have witnessed a notable tendency for increased convergence during the last years. Finally, Horváth (2009) analyzes the policy neutral rate in the Czech Republic from 2001 to 2006 using a time-varying parameter model with endogenous regressors. The results indicate that the policy neutral rate decreases gradually over the course of the sample period showing a substantial interest rate convergence to levels comparable to the euro area.

All of these studies conclude that a Taylor-like rule is helpful in understanding monetary policy of the CEEC. However, in most cases inflation coefficients are found to be far below unity, thus violating the so-called Taylor principle. If the Taylor principle holds, the policy rate should move more than one-for-one with increases in the inflation rate and thereby raises the real interest rate. If the monetary policy rule violates the Taylor principle, it will mean that the central bank does not react adequately on bringing down inflation.[4] This result is counterintuitive as the CEEC have experienced a remarkable degree of disinflation during the last 15 years. The literature suggests mainly two explanations: Angeloni et al. (2007) argue that part of the reaction on inflation is captured by the coefficient on the US interest rate included in their equation. An increase in global inflation would then lead to a composed reaction, which is partly due to domestic inflation via the conventional inflation coefficient and partly due to foreign inflation via the coefficient on the foreign interest rate. One might similarly argue that the exchange rate included in the interest rate rule partially takes the reaction on inflation, as it anchors expectations on future monetary policy. Another argument, proposed by Golinelli and Rovelli (2005) is that the reaction to an increase in inflation may be modest, if the initial interest rate compared to inflation was set high enough. Thus a smaller coefficient means that in the course of the disinflation process monetary policy is getting even more aggressive. The scenario seems to be well applicable to the CEEC. However, one would at least expect the inflation coefficient *to be close to unity* during periods of autonomous monetary policy.

Besides the above mentioned empirical research, the treatment of exchange rate changes in monetary policy rules is also discussed in the theoretical literature. Svensson (2000) compares strict inflation targeting (when stabilizing inflation around the inflation target is the only objective for monetary policy) with flexible inflation targeting (when there are additional objectives for monetary policy). His results also indicate that strict inflation targeting implies a vigorous use of the direct exchange rate channel for stabilizing (CPI-) inflation at a short horizon. In contrast, flexible inflation targeting ends up stabilizing inflation at a longer horizon, and thereby also stabilizes real exchange rates and other variables to a significant extent. In comparison with the Taylor rule, the reaction function under inflation targeting in an open economy responds to more information, in particular to foreign disturbances. The particular importance of the exchange rate for monetary policy rules in the case of emerging economies is also stressed by Amato and Gerlach (2002).

Taylor (2001) argues that a monetary policy rule that reacts directly to the exchange rate, as well as to inflation and output, sometimes works worse than policy rules that do not react directly to the exchange rate and thereby avoid more erratic fluctuations in the interest rate. In Taylor (2002), however, he points out that monetary policy in open economies is

[4] For a more detailed discussion of the Taylor principle see Woodford (2001).

different from that in closed economies. Open-economy policymakers seem averse to considerable variability in exchange rate. In his view they should target a measure of inflation that filters out the transitory effects of exchange rate fluctuations and they should also include the exchange rate in their policy reaction functions. He leaves open to further research, whether the exchange rate should appear on the left- or the right-hand side of the rule – that is, whether the policy instrument should be an interest rate or rather a monetary condition index.

3. Methodology

Following Taylor's (1993) seminal paper, it has become common to describe monetary policy by a linear feedback rule linking the interest rate to the output and inflation gap.

$$i_t = r^* + \pi_t + \alpha \pi_t^* + \beta y_t^* \tag{1}$$

where i is the short-term nominal interest rate set by the central bank, r* the assumed equilibrium real interest rate, π the actual rate of inflation, π_t* the deviation of the actual inflation rate from the (central bank's) target rate and y_t* the percent deviation of real GDP from its target, the output gap. The condition α>1, known as the Taylor principle, implies that the nominal interest rate is moved in response to an increase in inflation sufficiently to raise the real interest rate.

In line with Taylor (2002) we apply a monetary policy rule for open economies, which takes into account the role of the exchange rate. We modify this approach and model the exchange rate component with two variables: Δs_t representing the growth rate of the exchange rate for the whole sample period, and b_t, reflecting the exchange rates' position in the band, if the currency is pegged to an anchor currency.

$$i_t = r^* + \pi_t + \alpha \pi_t^* + \beta y_t^* + \delta \Delta s_t + \gamma b_t \tag{2}$$

To model the impact of the exchange rate we thus use two different tools. On the one hand we use a more general instrument, the growth rate of monthly exchange rates, which we can apply both for all the countries in our set and for the whole sample period. This can be seen as a proxy for the central banks desire to smooth exchange rate fluctuations. One would then expect the interest rate to be raised if the domestic currency depreciates. We use the bilateral exchange rate versus the Euro (before 1999: Deutsche mark) to measure these effects[5].

On the other hand, as an extra feature for the countries that have explicitly pegged their currency during the earlier periods, we use the band distance at which the market rates are located from either band edge. This measure reflects pressure on the exchange rate, as every time the market rate tends to or actually does exceed one of the borders the central bank is obliged to react by interventions and/or interest rate changes. This implicates that there should be a strong influence of the band distance on the interest rate stance of the monetary policy.

Since one would expect a non-linear reaction – the closer the exchange rate approaches the intervention margins the stronger the central bank should react – we do not calculate a simple distance (respectively market rate minus strong edge and weak edge minus market rate), but transform the distance by an exponential function. Thus, our band distance measure is therefore:

$$b_t = \begin{cases} \max\left[\exp(s_t - l), \exp(u - s_t)\right] \text{ if } & \exp(s_t - l) > \exp(u - s_t) \\ -\max\left[\exp(s_t - l), \exp(u - s_t)\right] \text{ if } & \exp(s_t - l) < \exp(u - s_t) \end{cases} \qquad (3)$$

with l the lower boundary of the band (the strong edge), u the upper boundary of the band (the weak edge) and s_t the exchange rate. The boundaries used for the calculation are the official bands set by the monetary authorities. The creation of "artificial" central parities and boundaries for periods of official flexible exchange rate regimes but implicit fixed regimes in contrast would be somehow arbitrary. For most countries there are significant changes over time as often either the bandwidth changed or the basket of currencies used as reference was altered. For the purpose of illustration we show the evolution of the band distance variable over time (Figure 1 and 2) as an example respectively for Hungary (crawling peg) and the Czech Republic (horizontal peg). Two interesting features stand out. First, the exchange rates of Central and Eastern European countries often have had appreciating pressure during fixed regimes and therefore, were close to the strong edge of the narrow bands (see Figure 1 and 2). Second, the values increase dramatically during times of crises, when boundaries are reached or exceeded (see Figure2).

[5] We also included real and nominal effective exchange rates, this does, however, not substantially change the results.

The consideration of the exchange rate, can be interpreted as an implicit application of the logic behind the ‘Tinbergen rule’, stating that one can only satisfy as many objectives as instruments are available. Taylor type rules show in a condensed form how central banks try to reconcile different objectives for inflation, output and exchange rates with only one single instrument, the interest rates. The respective coefficients thus reflect the preference that the monetary policy has towards the different goals, but are also heavily affected by the general environment and more precisely the amount, gravity and nature of shocks hitting the economy. Because country specific monetary transmission mechanisms influence the coefficients as well, Carare et al. (2005) warn against the comparison of coefficient between different countries.

Thus, we expect that monetary policy in CEEC should exhibit different coefficients over time, reflecting the evolution of exchange rate and monetary policy regimes: The initially tight exchange rate pegs should then be reflected by a focus on the band distance, combined with a limited ability to directly target inflation. Schnabl (2008) demonstrates a strong link between exchange rate stability and growth rates for the CEEC during this episode, thus motivating policy actions beyond direct interventions on the exchange rate market. This changes when the pegs are abolished and the central banks focus more on inflation. There could nevertheless still be some monitoring of the exchange rate, which should be reflected by the smoothing element. Moreover the weight for output depends on the nature of the shocks and the room that the inflation target policy has left for any output goals.

In our analysis we do not include the lagged interest rate as a smoothing component. Traditional explanations for smoothing interest rate changes include, for example, fear of disrupting capital markets, loss of credibility from sudden large policy reversals or the need for consensus building to support a policy change (Clarida et al., 1998). Although these aspects seem intuitively appealing, we feel that this approach rather entails an econometric solution in order to get meaningful results in an environment which suffers gravely from autocorrelation. Instead we find it more appealing to confront these problems directly, in a generalized least squares framework. According to Rudebush (2002), who states that a Taylor rule with smoothing generates more interest rate predictability than can be found in the data, the increase in predictability by adding lagged interest rates may indicate inconsistency between the rule and the data.

Whereas the variables in the monetary policy rules are often treated as stationary, we follow Gerlach-Kristen (2003) and apply the cointegration methodology. We do this for several reasons: The treatment of the variables as stationary is often regarded as a critical assumption. Phillips (1986) claims that, if the variables are (nearly) integrated of order one, static regressions in levels are likely to produce spurious results. In this respect Rudebush (2002) shows that such static regressions display an R-square far larger than the Durbin Watson statistic, which may hint at a spurious regression. Therefore, results from monetary policy rules in levels are often regarded as doubtful (Carare et al. 2005). Gerlach-Kristen (2003) states that while interest rates, inflation gap and output gap are likely to be stationary in large samples, in order to draw correct statistical inference it is desirable to treat them as non stationary in relative short samples[6].

We apply various unit root tests (Said and Dickey 1984, Kwiatkowski et al. 1992 and Perron 1989) to the data. The latter is less sensitive to structural breaks. The results suggest that interest and inflation rates are integrated of order one, whereas the output gap, the exchange rate growth and the band distance can be treated as stationary. However, any results should be carefully interpreted, taking into account that the sample size is small.

To test for a cointegration relation between the variables we first perform a residual based (Augmented Dickey-Fuller cointegration) test where critical values of the cointegration tests are found in MacKinnon (1991). In addition we use the Johansen cointegration test on a system with a lag length of four. We evaluate the trace and the maximum eigenvalue statistics with critical values based on MacKinnon, Haug and Michelis (1999). We include all variables when testing for cointegration, because although it is less common to use stationary and non-stationary data in the same analysis, Johansen and Juselius (1992) recommend this approach, if the inclusion of stationary data improves the power of the cointegration test[7].Both tests strongly point towards a cointegrating relation between the variables, which is important for the long run relations of our model. As means of robustness the results are confirmed by a Markov switching-residual based cointegration test (Gabriel et al, 2002), which can take into account more than one switch in the parameters.

In line with Gerlach-Kristen (2003) we do not estimate the full error-correction model, but instead focus on the single-equation approach discussed by Hamilton (1994).

[6] See also empirical work: Crespo Cuaresma et al. (2005) estimate a monetary model of the exchange rate for the same six CEEC as in our study from 1994-2002 using cointegration In the same way Fidrmuc (2009) demonstrates for the same CEEC from 1994-2003 that money demand and all related variables are non-stationary and thus again apply cointegration techniques. This is however less common for Taylor rules.

[7] We would like to thank a referee for clarifying this point. For the sake of brevity we do not report the various unit root and cointegration tests here. They are available from the authors on request.

Even though cointegration yields results that are superconsistent, in small samples there may still occur a potential endogeneity bias. Hamilton postulates we can correct for this by including past and future changes of the included variables. We get the following form of the Taylor rule (where we also include the disturbance term η_t):

$$i_t = c + \alpha\pi_t^* + \beta y_t^* + \delta\Delta s_t + \gamma b_t + \sum_{k=-1}^{1}(\alpha_{\pi k}\Delta\pi_{t+k} + \beta_{yk}\Delta y_{t+k} + \delta_{sk}\Delta^2 s_{t+k} + \gamma_{bk}\Delta b_{t+k}) + \eta_t \quad (4)$$

As the differences included in equation (4) only serve as a correction, we refer to the most important first part of the regression in what follows[8]. This analysis, similar to a dynamic OLS technique, is attributed to the seminal work of Stock and Watson (1993).

Estimating equation (4) for the whole sample period is, however, meaningless, since the monetary policy rule is likely to substantially differ across subperiods. We therefore introduce dummy variables and let the coefficients for the different variables be time-varying, so that we can differentiate between the fixed and the flexible period. We also build in a dummy variable to catch any changes in the intercept. In this sense the outer framework remains the same and the comparability between periods improves. The above tests for cointegration also show that it is justified to use such a combined framework, because even though the parameters may have shifted over time, the variables involved still show a meaningful relation in the long run, so we can seamlessly join in with the growing literature on time-varying cointegration relations. This fragmentation of our sample in two separate periods gives us additional insight in the ‘fear of floating hypotheses’ (Calvo and Reinhart, 2002). It allows us to examine whether central banks in CEEC were setting interest rates during officially flexible exchange rate regimes by still paying some attention to the exchange rate.

The regime switches are defined as the dates when a narrow exchange rate band is widened to ±15% or completely abolished, according to the official exchange rate regime.[9] We regard a ±15% band as wide enough in order not to prevent seriously a central bank from performing an autonomous monetary policy. This is in line with the observation that some of the countries (namely Hungary) announced inflation targeting in combination with such wide bands. The choice is also supported by the empirical observation that the band distance turns out to be close to zero for the periods with a ±15% band (see Figure 2).

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[8] The number of leads and lags of these elements is set to one following the structure set out in Gerlach-Kristen (2003). We thus get a unified framework which would not possible if we would go into individual criteria testing, which we do not deem necessary as it only concerns auxiliary terms.

[9] We retrieve the following dates: For the Czech Republic we find 27/05/1997 (managed float), Hungary 1/05/2001 (±15% band), Poland 25/03/1999 (±15% band) and Slovakia 1/10/1998 (managed float).

We thus determine the date of the regime switches by focusing on the exchange rate regime as given in table 2, instead of the monetary policy changes as given in table 1[10]. This is motivated by the crucial role the exchange rate arrangements played during the first part of the transition period.

Slovenia and Romania, however, never announced any official fixed exchange rate arrangement so we have to apply a slightly different approach. For *Romania* we rely on the classification by Frömmel and Schobert (2006) and set the shift date to 31/12/1998. For *Slovenia*, Frömmel and Schobert (2006) find evidence for an implicit crawling band exchange rate regime before ERM2 membership. After joining ERM2, the implicit crawling band changed to an explicit horizontal band. Due to its wide margins we regard it as a shift to an (almost) floating exchange rate regime.

Since we only distinguish between fixed and flexible exchange rates and since the de facto regime switches might differ from the official ones, we tested several alternative break points around our fixed date (but also on the basis of dates retrieved through the Quandt-Andrews breakpoint test, which also lay in the vicinity of our previous date) and we can state that our framework remains largely robust to the modifications.[11]

Through the above discussed changes, equation (4) evolves to

$$i_t = c + \psi d_t + \alpha_1 \pi^*_{1t} + \alpha_2 \pi^*_{2t} + \beta_1 y^*_{1t} + \beta_2 y^*_{2t} + \delta_1 \Delta s_{1t} + \delta_2 \Delta s_{2t} + \gamma b_t \quad (5)$$
$$+ \sum_{k=-1}^{1} (\alpha_{\pi k} \Delta \pi_{t+k} + \beta_{yk} \Delta y_{t+k} + \delta_{sk} \Delta^2 s_{t+k} + \gamma_{bk} \Delta b_{t+k}) + \eta_t$$

where ψ_i is the dummy for the period i, with i=1 being the fixed exchange rate period, and i=2 the period with flexible exchange rate arrangement and (for most countries) inflation targeting.

Finally we use a GLS approach[12] to correct the standards errors for autocorrelation and apply a White correction for heteroskedasticity (MacKinnon and White, 1985).

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[10] For example, Poland moved over from exchange rate targeting to inflation targeting in 1998, but only moved to a fifteen percent peg from March 1999 onwards. Nonetheless our focus remains on the second date as the peg implies central bank intervention when the exchange rate violates one of its bands. So even though the focus of monetary policy seems to be switched to inflation, its hands may still be tied if it does not alter the peg. The same comment can be made for Slovakia. Although in both cases (we can conclude from our band distance variable that) the exchange rate troubles dwindled after the announcements of the new monetary policy. So of course the influence works in both ways.

[11] The results for these alternative dates and specifications can be retrieved from the authors

[12] We prefer the method described in Johnston and Dinardo (1997), because it gives the possibility to set up a full GLS model, so we do not lose any observations compared to simply transforming the variables. Deeper analysis of the (partial) autocorrelation function of the residuals points towards a AR(1) structure. Besides the

4. Data and Estimation Results

We analyze monthly data for the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia that covers the period between January 1994 and August 2008 (or until the country joined the euro area). Our sample includes data from the IMF's "International Financial Statistics" database, the OECD's "statistical compendium", and various central banks.

For the interest rate we either implement the three month interbank rate or other money market rates depending on availability[13].

The inflation rate is calculated as the annual rate of change in the consumer price. Considering the inflation gap one has to keep in mind that all of the investigated countries are involved in a European integration process. Specifically for inflation this implies that these countries have to apply a twin inflation target. They do not only face an internal target, which is set by the domestic central bank, but they also have to comply with an external target which is embedded in the Maastricht criteria. In many publications and statements of the CEECs' central banks a distinct focus on the inflation differential to EU countries can be observed. This strengthens our beliefs that the main attention should be on the inflation gap based on the Maastricht criterion. On a more empirical level this intuition is supported by Siklos (2006), with the external European target yielding more consistent results than its internal equivalent. Furthermore there are several advantages in using the external criterion. First, not all of the countries adopted an inflation target for the whole period, thus there is only limited availability of internal inflation targets. Second, due to several reasons, e.g. the initially limited reputation of central banks or frequent changes in administered prices in CEEC or other shocks outside the control of the central bank, the official targets might substantially differ from the actual target or had to be adjusted over time. The Maastricht target, however, can be regarded as a medium to long-term objective of these central banks and therefore, seems to be a more reasonable benchmark for inflation.

The output gap is calculated based on industrial production using a Hodrick-Prescott filter (smoothing parameter 14400). It is generally known that the calculation of the rate of

dynamic full GLS we also applied a simple OLS version and a transformed GLS estimation. The results, however, do not substantially differ. They are available from the authors on request.

[13] More precisely we incorporate the three months interbank rate for the Czech Republic, Hungary, Poland and Slovakia and the money market rate for Romania and Slovenia. As a robustness check we also include various other short term interest rates in our analysis without any substantial change in the results.

potential output is a difficult task (the same applies to the natural rate of unemployment). The results strongly depend on the way it has been conceived. If one assumes the original series to exhibit a deterministic trend, a filter is the most appropriate solution, while a stochastic trend demands differentiation of the variable. We follow the classical Taylor rule analysis and calculate the output gap based on a filter[14]. Although one may expect to retrieve better results using real-time data (Orphanides 2001) this is not possible for our sample of countries, as internal estimates are either not available at all or not publicly available.

As a first step we just focus on equation (4) as a simple open economy framework with fixed parameters over time that serves as a benchmark model. The results are reported in the first column of each country-specific segment of Table 3.[15] However the interpretation demands caution as the coefficients will possibly be distorted and inconsistent due to the neglected structural break and the time-invariant coefficients. The long term reaction of the interest rate on inflation is above unity only for the Czech Republic and Slovenia, and at least not significantly different from 1 for Hungary. So broadly speaking we can say that three countries satisfy the Taylor principle. The coefficient for output seems less convincing as only Slovenia has a significant, but counterintuitive sign. The same applies for the exchange rate growth element, which solely gives meaningful results for the Czech Republic. The parameter which seems significant over all the (fixed exchange rate) countries is the band distance coefficient (although for the Czech Republic this holds for a higher level of significance). Only the Slovakian equation does not seem to be quite stable in this initial setting. For the other countries the results in this preliminary setting already depicts a relatively realistic picture of the monetary policy stance.[16]

As a second step we add the dummy intercept and slice up the variables to mimic both periods more truthfully, thus estimating equation (5). The results are reported in the second column of each country-specific section in Table 3. It is certainly interesting to portrait the general features of the time varying components and intercept dummies and their overall impact (this applies for all countries except Slovenia, where the shift reflects a different episode).

[14] In contrast some authors prefer to work with growth rates, although this may lead to over-differentiating (Siklos and Wohar 2005). We also estimated the model with growth rates. This does not affect the estimation output. The results are available from the authors on request.

[15] The constants are not reported as they are not easily interpretable in the cointegration based version of the Taylor rule and serve as an "auxiliary variable" (Gerlach-Kristen, 2003)

[16] The Durbin-Watson statistic and the Breusch-Godfrey (BG) test indicate that the residuals do not show remaining autocorelation.

There is a substantial change in the sliced up coefficients. These differences are most obvious for the inflation coefficient. The number of countries satisfying the Taylor principle rises remarkably in the second period (inflation targeting and flexible exchange rate). This pattern corresponds to our expectations that the central banks had more flexibility to monitor the inflation target during the second period. Moreover, the band distance element seems quite robust for the new specification and is unambiguously significant for the Czech Republic, Hungary, Poland and Slovakia during their fixed exchange rate regimes. In contrast, the exchange rate changes Δs_t are not significant for all countries but Slovakia. Thus, central banks used the interest rate instrument in order to keep the exchange rate well inside officially announced bands, but they hardly used this instrument in order to smooth exchange rate fluctuations. These relatively high coefficients for inflation during the flexible period also are in contrast with past studies on the same or similar countries, which find insignificant or low values for inflation. This is in line with the argument by Angeloni et al. (2008) that in a Tayor rule the reaction to inflation is partially captured by external variables (see introduction), in our case the band distance.

There are similarly some alternations over time for the coefficients of the output gap and the exchange rate growth. But the importance of these particular elements seems to be generally quite low over both periods.

As an intermediate summary we can conclude that the interest rate setting behaviour of the respective central banks only paid attention to the exchange rate during periods of officially fixed regimes. This consideration of the exchange rate is best embodied through the band distance. During periods of officially floating exchange rates, central banks increasingly took a more inflation minded approach. Slovakia is an exception as the coefficient on exchange rate growth is significant during its more flexible exchange rate regime. On a more empirical level we can also state that the new specification raises the explanatory power for all the countries: The R-square is comparable to specifications including the lagged interest rate. Therefore we can assume that our specification gives a more realistic fit of the monetary policy rules for these transition countries.

In our country-specific discussion, we add alternative specifications to the equations in order to include more include country-specific features and in order to conduct some robustness checks. These results can be found in table 4.

For the *Czech Republic* we build in an extra crisis dummy for the turbulent period in the middle of 1997 (more precisely for June). The results show that both inflation coefficients become significant and there is still a substantial rise. Moreover the second period's exchange rate component is now correctly signed. Finally the band distance element remains robust and for the output values there is little change. All of these changes cause a higher R-square, suggesting that this may be a more accurate description.

We test a different break date (based on the Andrews-Quandt test) for *Hungary* besides the official switch to a broad 15 percent band (in May 2001). The intuition behind this is that we now set the date endogenously through our data instead of imposing it externally[17]. The new break date becomes June 1999, which is quite earlier than the official date. Moreover we see a more distinct change in the inflation parameters, although they both remain significantly indifferent from unity.

For *Poland* we estimate an alternative specification to assert what happens if we let our observations for the band distance run through for a longer period (than the officially stated pegged period which ends in April 2000) as we have indications that the monitoring of the peg went on a bit longer. Remarkably the band distance coefficient seems robust and remains significant.

Romania never explicitly announced an exchange rate policy, so no official break date is available. Nevertheless there are good reasons to assume that a break occurred in December of 1998. The inflation coefficient increases for the later period.[18]

For *Slovakia* the estimation results improve with the time varying approach, however, they remain quite shaky. Although the band distance element satisfies our expectations, we can not find any realistic inflation coefficients and the R-square is relatively low. So we feel that the specification may be unfit to realistically model the Slovakian data. We do not consider the ERM2 period for Slovakia for two main reasons: First, the period is comparatively short. Second, the bands in this particular setting are relatively wide. They are, according to our understanding, more a flexible than a fixed exchange rate system. When we add a band distance element specific for the ERM2 period to the regression, the coefficient is almost zero, which could either be due to no pressure on the Slovak koruna during this period or due to changes of the central parity at times of pressure. In fact, the later case is more likely as the central parity of the Slovak koruna was revalued twice during its ERM2 membership and therefore, relieved pressures from the exchange rate from hitting the strong edge of the band.

[17] We did this check for all the countries, but only report the results in case of a considerable effect.
[18] For checking the robustness we shortened the sample period. This does not affect the results.

Similarly to Romania, the *Slovenian* authorities have officially announced only a managed floating exchange rate regime for the period before ERM2 membership. For this particular episode the time-varying approach does not work as there was no explicit change in the exchange rate regime. In contrast, we find a policy switch, when the Slovenian currency joins the ERM2-system. It officially was a change from a managed floating regime towards a comparatively flexible peg to the euro with very wide bands. Implicitly, however, it was a more pronounced policy shift from a de facto crawling band. So the time-varying parameters reflect this specific change in the coefficients. Moreover the band distance variable in this setting only applies for the ERM2-period, but as there was no real trouble towards any of the boundaries, the coefficients are negligible and were thus not included in the estimation. As an alternative specification we turn our attention to the fact that Slovenia's monetary policy in contrast to the other countries in the sample officially focused on monetary aggregates. Until 1997 the focus was mainly on base money and M1, but later it switched to M3 (and in 2001 Slovenia even adopted a two pillar strategy). We build in these subperiods with several dummy variables and come to the following conclusion: The inflation coefficient is relatively stable over all periods, the output coefficients now become significant but are wrongly signed and the money coefficient (which refers to the money gap[19]) is only significant in the third period. This means that we can not retrieve the policy attention for monetary aggregates as it was officially stated.

5. Conclusions

Many central banks in emerging market economies may pay special attention to exchange rate movements, even though they do not officially claim to target the exchange rate. In order to influence exchange rate developments the central bank can use basically two instruments: foreign exchange interventions and interest rate changes. We focus on the later monetary policy instrument by estimating open-economy monetary policy rules in order to analyse to which extent central banks in Central and Eastern Europe have given the exchange rate a special role in their interest rate decisions.

We estimate monetary policy rules based on a cointegration approach and by one has to consider explicitly taking into consideration shifts in exchange rate regimes. The influence of the exchange rate on the interest rate setting behaviour of central banks in CEEC can differ

[19] We also included money growth rates as an alternative, but this does not substantially alter the estimation output.

strongly between periods with different exchange rate arrangements. During periods of more rigid exchange rate arrangements the influence of the exchange rate dominates, i.e. the interest rate policy is mainly influenced by the distance to the intervention margins on which the central bank has to react in order to keep the peg working. During the time periods of more flexible exchange rate arrangements we find a stronger focus on inflation, namely, on the deviation of domestic inflation from the inflation rate set by the Maastricht criterion. This is, in particular, the case for the Czech Republic, Poland and Romania. The inflation coefficient for Slovenia also satisfies the Taylor principle, whereas for Hungary the coefficient is below, but not significantly different from unity.

Slovakia remains a special case in the sample. The inflation coefficients do not satisfy the Taylor principle, and it seems that there has been an ongoing focus on exchange rate movements after switching from a fixed exchange rate regime to a managed float. Slovakia, presumably gives a case of an implicit peg and its results may reflect the discretionary stance of the central bank as observed by central bank members themselves.

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Figures:

FIGURE 1: Derivation of the band distance element from the historical exchange rate peg values for Hungary (Forint/ Deutsche Mark)

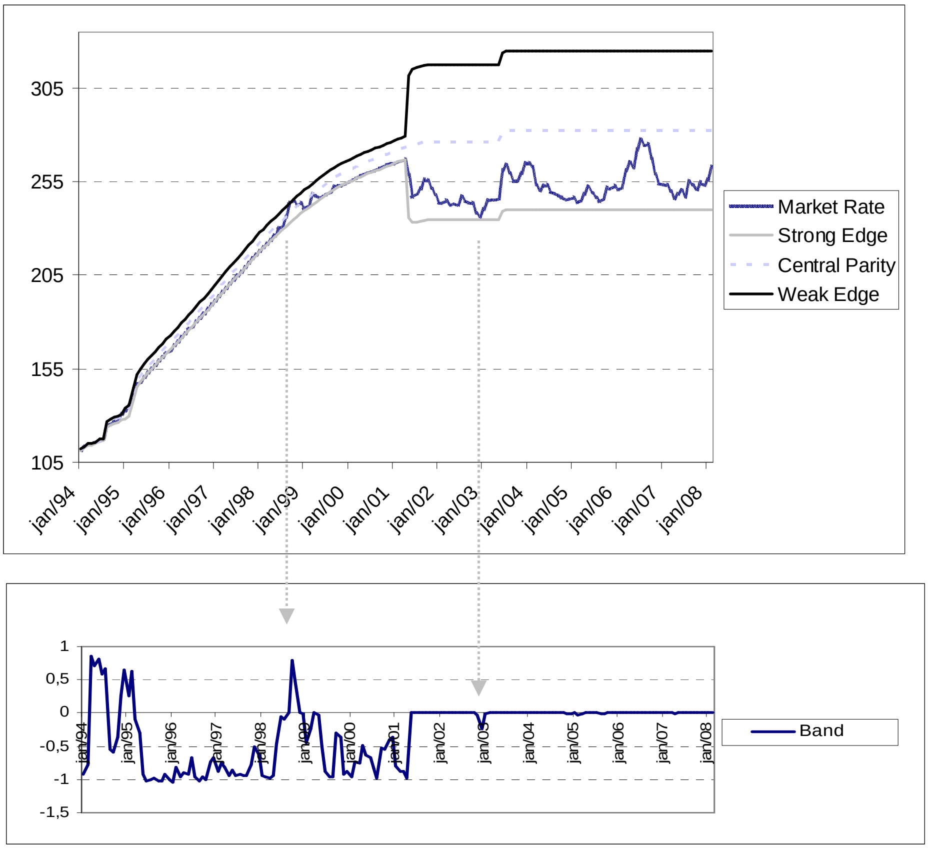
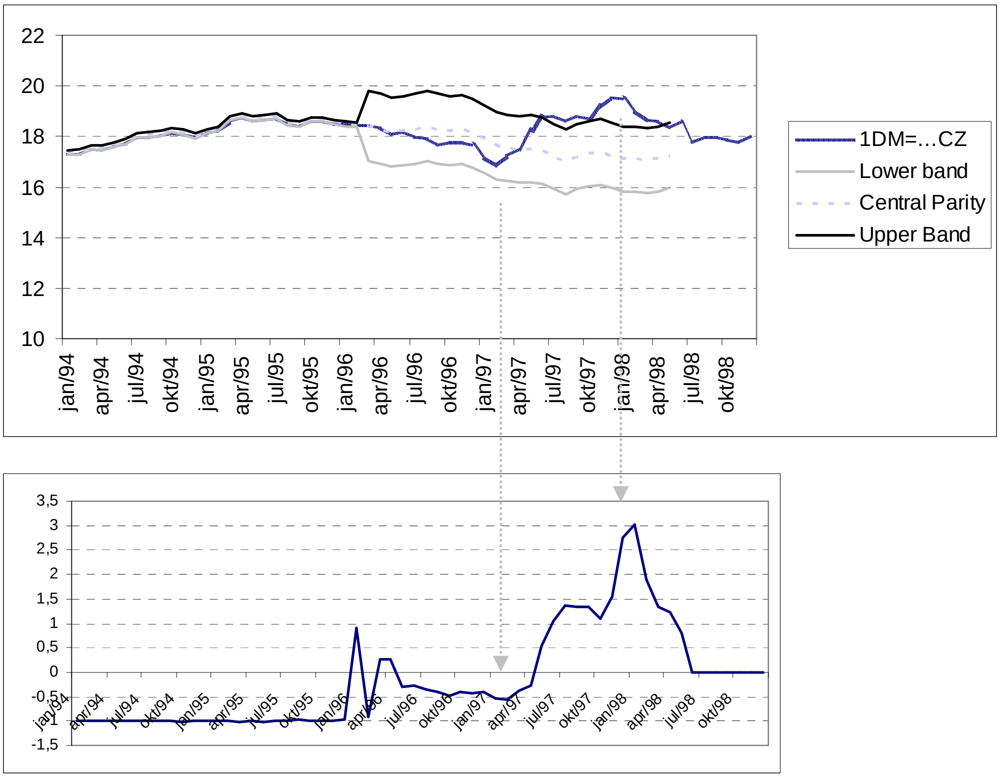


FIGURE 2: Derivation of the band distance element from the historical exchange rate peg values for the Czech Republic (Czech Koruna/ Deutsche Mark)



Tables:

TABLE 1: Official Monetary Policy Strategies for Central and Eastern European Countries

Czech Republic		Hungary		Poland	
1994-1997	Exchange rate and monetary targeting (credit volume and M2)	1994-2002	Exchange rate targeting	1994-1998	Exchange rate targeting
1998-2001	Net inflation[1] targeting	2002-	Inflation targeting (CPI annual average)[3]	1998-	Inflation targeting (end of year CPI inflation)
2002-	Headline inflation targeting with linear and declining target band				

Romania		Slovakia		Slovenia	
1994-7/2005	No official commitment to a monetary policy strategy	1994-1998	Exchange rate targeting	1994-1995	Base money targeting
8/2005-2008	Inflation targeting	1998-2008	Informal inflation targeting	1996	Base money and M1-targeting
		11/2005 – 12/2008	ERM-II	1997-2000	M3-targeting[2]
		2009-	Euro system		
				2001-2006	Two-pillar strategy[4]
				06/2004 – 12/2006	ERM-II
				2007-	Euro system

1 Headline inflation minus regulated prices and changes in indirect taxes
2 In Slovenia also including foreign exchange deposits of private households
3 Exchange rate targeting continues in a wide band (±15%)
4 Similar to the strategy of the European Central Bank the Bank of Slovenia bases its monetary policy indicators on two pillars, i.e. indicators of liquidity, and other economic indicators.

TABLE 2: Official Exchange Arrangements for Central and Eastern European Countries

Czech Republic		Hungary		Poland	
01/01/1994-29/02/1996	Basket peg, 65% DEM, 35%USD, Band: ±0.5%	01/01/1994-31/12/1996	Crawling peg[1], 70% Ecu, 30% USD, Band: ±2.25%	01/01/1994-15/05/1995	Crawling peg, 45% USD, 35% DEM, 10% GBP, 5% FRF, 5% CHF Band: ±1 %
01/03/1996-26/05/1997	Band: ±7.5%	01/01/1997-31/12/1999	70% DEM, 30% USD	16/05/1995-24/02/1998	Band: ±7%
27/05/1997-present	Managed float	01/01/2000-30/04/2001	100% EUR	25/02/1998-31/12/1998	Band: ±10%
		01/05/2001-30/09/2001	Band: ±15%	01/01/1999-11/04/2000	45% USD, 55% EUR
		01/10/2001-25/02/2008	Peg to EUR, Band: ±15%	12/04/2000-present	Free float
		26/02/2008-present	Managed float		

Romania		Slovak Republic		Slovenia	
since 01/01/1994	Managed float	01/01/1994-31/12/1996	Basket peg, 60% DEM, 40%USD, Band: ±1.5%	01/01/1994-26/06/2004	Managed float
		01/01/1997-30/09/1998	Band: ±7%	27/06/2004-31/12/2006	ERM2
		01/10/1998-24/11/2005	Managed float	since 01/01/2007	Official Euro system member
		25/11/2005-31/12/2008	ERM2		
		since 01/01/2009	Official Euro system member		

Source: IMF, Annual Report of Exchange Rate Arrangements and Restrictions, various issues
[1] Until 16.3.1995, the NBH devalued in discrete steps

TABLE 3: Estimates of the cointegrating vector

Coefficients		Czech Republic *Time-invariant*	Czech Republic *Time-varying*	Hungary *Time-invariant*	Hungary *Time-varying*	Poland *Time-invariant*	Poland *Time-varying*	Romania *Time-invariant*	Romania *Time-varying*	Slovakia *Time-invariant*	Slovakia *Time-varying*	Slovenia *Time-invariant*	Slovenia *Time-varying*
α_π	$\alpha_{1\pi}$	**1.133**	-0.120	**0.878**	**0.868**	**0.685**	**0.555**	**0.324**	0.118	0.239	0.316	**1.306**	**1.453**
		(0.000)	(0.805)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**	(0.157)	(0.125)	(0.527)	**(0.000)**	**(0.000)**
	$\alpha_{2\pi}$	-	**1.021**	-	**0.903**	-	**1.134**	-	**1.120**	-	**0.344**	-	1.050
		-	**(0.000)**	-	**(0.000)**	-	**(0.000)**	-	**(0.000)**	-	**(0.002)**	-	(0.059)
β_Y	β_{1Y}	-0.199	-0.093	-0.121	**-0.194**	0.031	0.058	-0.251	-0.940	0.303	0.118	**-0.526**	**-0.592**
		(0.133)	(0.342)	(0.119)	**(0.007)**	(0.666)	(0.505)	(0.378)	(0.150)	(0.352)	(0.666)	**(0.001)**	**(0.000)**
	β_{2Y}	-	**-0.331**	-	-0.108	-	0.060	-	-0.006	-	-0.160	-	**-0.430**
		-	**(0.018)**	-	(0.170)	-	(0.465)	-	(0.981)	-	(0.478)	-	**(0.008)**
γ_B	γ_B	**1.628**	**2.619**	**1.072**	**1.695**	**1.325**	**1.381**	-	-	**3.636**	**5.908**	-	-
		(0.085)	**(0.007)**	**(0.032)**	**(0.000)**	**(0.004)**	**(0.008)**	-	-	**(0.033)**	**(0.001)**	-	-
δ_S	δ_{1S}	**0.338**	0.285	0.120	0.152	-0.015	-0.015	**-0.506**	0.906	1.002	1.208	0.8324	1.443
		(0.035)	(0.137)	(0.203)	(0.489)	(0.044)	(0.307)	**(0.000)**	(0.554)	(0.207)	(0.163)	(0.403)	(0.109)
	δ_{2S}	-	0.243	-	0.095	-	-0.000	-	-0.380	-	**1.245**	-	-3.462
		-	(0.210)	-	(0.418)	-	(0.999)	-	(0.093)	-	**(0.037)**	-	(0.222)
	ψ_D	-	**-9.741**	-	**-1.811**	-	**-6.091**	-	**-53.466**	-	**-7.002**	-	**3.318**
		-	**(0.017)**	-	**(0.034)**	-	**(0.000)**	-	**(0.000)**	-	**(0.050)**	-	**(0.001)**
R^2		0.574	0.696	0.794	0.876	0.651	0.841	0.438	0.578	0.105	0.329	0.631	0.709
DW		1.860	1.759	1.454	1.300	1.313	0.909	1.402	1.245	2.170	1.882	2.234	2.135

"Fixed" are the estimates for the benchmark equation (4) $i_t = c + \alpha\pi_t^* + \beta y_t^* + \delta\Delta s_t + \gamma b_t + \sum_{k=-1}^{l} (\alpha_{\pi k}\Delta\pi_{t+k} + \beta_{yk}\Delta y_{t+k} + \delta_{sk}\Delta^2 s_{t+k} + \gamma_{bk}\Delta b_{t+k}) + \eta_t$, "Variable" for equation (5) with time-varying coefficients: $i_t = c + \psi d_t + \alpha_1\pi_{1t}^* + \alpha_2\pi_{2t}^* + \beta_1 y_{1t}^* + \beta_2 y_{2t}^* + \delta_1\Delta s_{1t} + \delta_2\Delta s_{2t} + \gamma b_t + \sum_{k=-1}^{l} (\alpha_{\pi k}\Delta\pi_{t+k} + \beta_{yk}\Delta y_{t+k} + \delta_{sk}\Delta^2 s_{t+k} + \gamma_{bk}\Delta b_{t+k}) + \eta_t$ P-values in parenthesis. Estimates of the auxiliary coefficient c not reported.

TABLE 4: Estimates of the cointegrating vector for alternative specifications

	Czech R.	Hungary	Poland	Romania		Slovenia
$\alpha_{1\pi}$	**0.799**	**0.772**	**0.528**	0.100	$\alpha_{1\pi}$	**1.295**
	(0.005)	**(0.000)**	**(0.000)**	(0.187)		**(0.000)**
$\alpha_{2\pi}$	**1.115**	**0.967**	**1.057**	**0.983**	$\alpha_{2\pi}$	**1.083**
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**		**(0.002)**
β_{1Y}	-0.125	-0.053	0.026	-1.030	β_{1Y}	**-0.628**
	(0.144)	(0.591)	(0.774)	(0.106)		**(0.000)**
β_{2Y}	**-0.166**	-0.123	0.063	0.082	β_{2Y}	**-0.412**
	(0.024)	(0.151)	(0.464)	(0.588)		**(0.005)**
γ_B	**1.006**	**1.085**	**1.301**	-	δ_{1S}	1.196
	(0.041)	**(0.014)**	**(0.009)**	-		(0.292)
δ_{1S}	0.167	0.168	**-0.103**	**-0.526**	δ_{2S}	0.259
	(0.320)	(0.350)	**(0.001)**	**(0.000)**		(0.929)
δ_{2S}	**0.251**	0.137	**-0.107**	0.324	σ_{1M}	-0.395
	(0.043)	(0.177)	**(0.010)**	(0.352)		(0.432)
ψ_D	**-1.361**	**-3.561**	**-6.683**	**-58.762**	σ_{2M}	0.278
	(0.043)	**(0.003)**	**(0.000)**	**(0.000)**		(0.179)
ψ'_D	**9.742**	-	-	-	σ_{3M}	**-0.219**
	(0.000)	-	-	-		**(0.008)**
R^2	0.814	0.868	0.837	0.623	R^2	0.735
DW	0.899	1.434	0.933	1.396	DW	2.052

For the Czech Republic we used following specification:

$$i_t = c + \psi d_t + \psi' d'_t + \alpha_1 \pi^*_{1t} + \alpha_2 \pi^*_{2t} + \beta_1 y^*_{1t} + \beta_2 y^*_{2t} + \delta_1 \Delta s_{1t} + \delta_2 \Delta s_{2t} + \sum_{k=-1}^{l} (\alpha_{\pi k} \Delta \pi_{t+k} + \beta_{yk} \Delta y_{t+k} + \delta_{sk} \Delta^2 s_{t+k} + \gamma_{bk} \Delta b_{t+k} \gamma b_{t+k}) + \eta_t$$

We opted for the classical structure of equation (5) for Hungary, Poland and Romania, but with their country-specific characteristics (different dummy dates, or adjustments to the sample period).

Finally Slovenian had following specification:

$$i_t = c + \psi d_t + \alpha_1 \pi^*_{1t} + \alpha_2 \pi^*_{2t} + \beta_1 y^*_{1t} + \beta_2 y^*_{2t} + \delta_1 \Delta s_{1t} + \delta_2 \Delta s_{2t} + \gamma b_t + \sigma_{1M} M_{1t} + \sigma_{2M} M_{2t} + \sigma_{3M} M_{3t} \sum_{k=-1}^{l} (\alpha_{\pi k} \Delta \pi_{t+k} + \beta_{yk} \Delta y_{t+k} + \delta_{sk} \Delta^2 s_{t+k} + \gamma_{bk} \Delta b_{t+k}) + \eta_t$$

P-values in parenthesis.

Estimates of the auxiliary coefficient c not reported.