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Monetary Policy under Alternative Exchange Rate Regimes in Central and Eastern Europe

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Monetary Policy under Alternative Exchange Rate Regimes in Central and Eastern Europe

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Abstract

Monetary policy in CEE is an important determinant in the wage bargaining process, because trade unions have to predict inflation as one component of future real wages. This paper scrutinizes whether countries in CEE that officially announce an inflation target are tempted to act time-inconsistently and switch from the announced inflation target to an exchange rate target in order to sustain higher output via surprise inflation. If market participants discover the time-inconsistency, they will adjust their inflation expectations, which result in higher average rates of price increases. The time-inconsistent behavior in central bank interest rate setting is modeled by several Taylor rules. An empirical application provides evidence that some monetary authorities in CEE such as the Czech Republic and Slovakia have acted time-inconsistent and have focused on the exchange rate in periods of official inflation targeting, which might have contributed to higher average rates of inflation and welfare losses. Furthermore, uncertainty in wage determination process has risen due to a harder predictability of productivity and inflation as components of future nominal wages.

JEL-classifications: E52, E58, F31, O52, P20

Keywords: Monetary policy, Taylor rules, Exchange rate regime, Central and Eastern Europe, Inflation targeting

1. Introduction

[1] I am grateful to Michael Frömmel, **Fehler! Verweisquelle konnte nicht gefunden werden.**, Andreas Hoffmann, Gunther Schnabl and Bernd Süßmuth for inspiring discussions and helpful comments.

Monetary policy in Central and Eastern Europe (CEE) remains an important economic policy issue for European economic policy making (Fendel et al. (2009), Mohanty and Klau (2004)). Although macroeconomic stability in CEE has been growing since the CEE economies entered the European Union (EU) and began preparing for the European Monetary Union (EMU), different monetary policy and exchange rate strategies persist. While Lithuania, Latvia and Bulgaria are pegging their currencies tightly to the euro, the authorities in Romania, the Czech Republic and Poland allow their exchange rates to be largely determined by market forces. The central bank in Hungary has pursued managed floats, while Estonia (since 2011), Slovenia (since 2007) and the Slovak Republic (since 2009) are members of the EMU.

Furthermore, monetary policy is an important determinant in the wage bargaining process, because enterprises and trade unions have to predict productivity changes and inflation as components of future real wage increases. Time-inconsistency in monetary policymaking may increase the uncertainty linked to the wage determination process. This may also apply to monetary policy under alternative exchange rate regimes. According to McKinnon and Schnabl (2006) and Mundell (1973) in small open economies this uncertainty widely depends on the exchange rate strategy. Under fixed exchange rates such as in the Baltics, monetary policy is solely committed to an exchange rate peg. Under a flexible exchange rate regime, such as in the Czech Republic or Poland, monetary policy, however, is permitted a discretionary leeway (Mishkin 2000). Uncertainty for the wage bargaining process increases as the central bank pursues both an inflation and exchange rate target.

We built on Kydland and Prescott (1977) and Barro and Gordon (1983a, b), who model time-inconsistency in monetary policy for a closed economy as they allow the central bank to switch between an output and an inflation target. We apply this framework to small open economies such as in CEE, where the central banks may switch from an inflation target to an exchange rate target to sustain output growth. If central banks can soften appreciation pressure by discretionary interest rate cuts, uncertainty and inflation may rise in the long-term and lead to increasing uncertainty in the wage bargaining process. Then, trade unions and enterprises are hindered to forecast, whether the rising nominal output is due to real productivity or inflation increases.

We model monetary policy rules for five CEE countries, which officially announce or have announced to an inflation target, namely the Czech Republic, Hungary, Poland, Romania and Slovakia, and analyze if central banks react time-inconsistent and switch from the announced inflation target to an unannounced exchange rate target. We extend the seminal Taylor rule (Taylor 1993) for closed economies by an exchange rate term following Clarida et al. (1998) and Taylor (2001). As future expectations of output growth and inflation are important variables in the applied Taylor rule (e.g. Gorter et al. (2008)), we make use of survey data provided by the ifo World Economic Survey (WES). In addition, we include a dummy variable controlling for regime switches in monetary policy making.

Our work is related to several studies analyzing monetary policy in emerging economies. Relatively few previous papers have scrutinized monetary policy in CEE to our knowledge. Frömmel and Schobert (2006) and Frömmel et al. (2009) analyze monetary policy with respect to policy changes and different exchange rate systems in CEE. Fendel et al. (2008) scrutinize interest rate reaction functions in emerging economies considering financial markets expectations, while Mohanty and Klau (2004) give an overview over monetary policy rules in emerging markets in general. By estimating Taylor rules with expectation data from surveys, this study is related to Henzel and Wollmershäuser (2008), who estimate a New Keynesian Philipps curve with ifo WES data and Gorter et al. (2008) and Sauer and Sturm (2007), which estimate Taylor rules with European Central Bank survey data. Our analysis contributes to the literature in two ways: First, we compare a broad range of different kind of Taylor rules for CEE, such as forward looking, backward looking or survey data based monetary policy rules with each other in order to derive implications for the wage bargaining process in CEE. Second, we allow for monetary policy regime switches by modeling asymmetric monetary policy reaction functions.[2]

2. Monetary Policy in Central and Eastern Europe

We analyze monetary policy settings in the five CEE economies, where central banks are or have been committed to an inflation target (Czech Republic, Slovakia, Hungary, Poland and Romania). Those countries that officially have an exchange rate target and peg their exchange rate tightly to the euro such as the Baltics or Bulgaria are not considered in this study. Table 1

[2] The regime switches are modeled by either a dummy variable measuring the additional impact of exchange rate changes in time of an official inflation target or a rolling window regression approach.

gives a short overview about monetary and exchange rate strategies of the analyzed CEE economies in last 15 years. Most of the countries, such as the Czech Republic, Hungary, Poland and the Slovak Republic focused on exchange rate targeting during the nineties and have mostly switched after the 1997/98 Asian and Russian financial crisis to inflation targeting. Romania officially has an inflation target since 2005, while its central bank did not officially announce a monetary policy strategy before that year. To analyze monetary policy in CEE, we derive several monetary policy reaction functions describing the interest rate setting to investigate, whether central banks in CEE are credibly committed to an announced price objective or if they have been tempted to act time-inconsistently and follow an exchange rate target as well.

The analysis of time-inconsistency goes back to the seminal work of Kydland and Prescott (1977) and Barro and Gordon (1983 a,b), which can be seen as the theoretical foundation of the later discussed Taylor rules. They argue, that in a discretionary regime central banks are tempted to act time-inconsistent in the sense of announcing an official inflation target and finally diverge from this target to generate higher output. In detail, central banks may increase money supply and create a higher inflation rate than people expect to achieve a higher economic activity via lower real wages and to reduce the real value of the government's nominal liabilities. However, the public and private sector understand the policymaker's incentives and adjust their inflation expectations. This indicates that the average inflation rate and the corresponding costs of inflation will be higher than otherwise. Therefore, they argue that an enforced commitment on monetary behavior, as embodied in monetary policy reaction functions, helps to eliminate the potential for ex post surprises.

Taylor (1993) first proposed an (empirical) monetary policy reaction function suggesting that interest rates would be changed according to the deviation of inflation from its target and an output gap. In addition to this framework, Taylor (2001) proposed an additional monetary policy reaction function with the exchange rate as a third possible target. He argued that central banks are not only be tempted to generate surprise inflation to temporarily stimulate output. Furthermore, he found that central banks might also switch from the inflation target to an exchange rate target to sustain output via surprise inflation.

In the following we want to make use of monetary policy reaction functions to scrutinize whether the central banks of those CEE economies, which officially refer to an inflation target (see Table 1), are tempted to act time-inconsistent in the way of an unannounced target switching. In detail, we analyze if central banks may switch from the announced inflation target to an exchange rate target to stimulate economic growth.

The reason for a time-inconsistent behavior in CEE may be founded on the fact that in emerging economies monetary policy aims to soften domestic appreciation pressure due to the Balassa-Samuelson effect (Balassa 1964, Samuelson 1964). Therefore, the monetary authority may tend to smooth that appreciation pressure, especially in times of moderate price inflation via discretionary interest rate cuts. As a consequence inflation may rise in the long-term and will be hard to predict. This leads to uncertainty and welfare losses in the public and private sector. Furthermore, due to this time-inconsistent behavior the uncertainty in the wage determination process in the economy will rise for three reasons.

Table 1: Monetary Policy Rules in CEE

Country	Montary Policy Strategy	Exchange Rate System
CZ	• 1994–1997: Exchange rate targeting, credit volume and M2 targeting • since 1998: Inflation targeting	• Free floating since 1997, from 1995 till 1997 managed float
HU	• 1994–2002: Exchange rate targeting (i.e. managed floats) • since 2002: Inflation targeting	• Free floating since March 2008, before managed floats
PL	• 1994–1998: Exchange rate targeting • since 1998: Inflation targeting	• Free floating since 2000, from 1995 till 2000 managed float
RO	• 1994–2005: No official monetary policy commitment • since 2005: inflation targeting	• managed floats since 1994
SK	• 1994–1998: Exchange rate targeting • 1998–2008: Inflation targeting • since 2009: Euro system	• Euro adoption 2009, since November 2005 till December 2008: ERM2, before managed floats

Source: ECB (2008) and European Commission (2007).

First, for trade unions it is hard to distinguish between surprise and non-surprise inflation. They face a loss of predictive power in forecasting future inflation and productivity, which may lead to a decreasing bargaining power. Therefore, enterprises may act more restrained with respect to wage increases.[3] Thus, (real) wages may be lower than in equilibrium.

[3] Another possible scenario could be that the economy struggles into a wage-price-spiral, in which both sides of the wage bargain process try to keep up with inflation to protect real incomes. And may end in the worst case in a hyperinflation.

Second, because of anticipation of the time-inconsistent behavior the central bank may face a loss of credibility of economic agents, enterprises and investors even in later time periods. This may end in further uncertainty and instability, making it even harder to predict future output and inflation as important determinants for the wage setting process.

Third, in emerging market economies there is a general need for greater monetary discipline against the backdrop of their relatively high inflation and low policy credibility (see Monhanty and Klau 2004). Calvo and Mishkin (2003) point out that emerging market economies are very vulnerable to "sudden stops" of capital inflows. Attributing financial crises in emerging market economies to their weak institutional credibility, Calvo and Mishkin (2003) propose that central banks in emerging economies should be subject to a constrained monetary policy making it harder for the central banks to pursue an "overly expansionary monetary policy". If the central bank is not credible in its monetary policy objectives, the confidence of the investors, enterprises and trade unions may decrease as well.

3. The Theoretical Taylor Rules

To model the monetary policy in CEE, we follow Taylor (1993, 2001, 2002) and Clarida et al. (1998), who links the interest rate to an output and inflation gap:

$$i_t = \bar{i} + \alpha(\pi_t - \pi_*) + \beta(y_t - y_*), \qquad (1)$$

where i_t is the nominal central bank interest rate target set by the central bank $(\pi_t - \pi_*)$ the deviation of the contemporary inflation rate π_t from the central bank target π_* and $(y_t - y_*)$ the deviation of the output y_t from its target (potential output) y_*. $\bar{i}$ measures the long-term equilibrium interest rate. The coefficients α and β measure the impact of inflation gap and the output gap and are assumed to be positive. If the inflation rate is higher (smaller) than the target level $(\pi_t - \pi_*) > 0$ $[(\pi_t - \pi_*) < 0]$ the central bank will raise (cut) the interest rate i_t. Similarly, the interest rate will be increased (reduced), if the current output is under (above) the desired level $(y_t - y_*) > 0$ $[(y_t - y_*) < 0]$.

To measure the extent of exchange rate changes on monetary policy, we extend the model by adding exchange rate changes into our open economy monetary policy reaction function (see f.e. Frömmel et al. 2009, Mohanty and Klau 2004):

$$i_t^* = \bar{i} + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*) + \gamma\Delta e_t, \qquad (2)$$

where Δe_t denotes the growth rates of exchange rates. If $\gamma < 0$ a domestic currency appreciation $(\Delta e_t > 0)$ leads to shrinking interest rates as we would expect in CEE.

Following Clarida et al. (1998) we introduce an interest rate smoothing parameter to smooth out shocks in the money market:

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + v_t, \qquad (3)$$

where i_t is the short-term nominal interest rate set by the central bank at time *t,* which depends on the central rate i_t^* and the interest rate of the previous period and the error term v_t, which is assumed to be a white noise process. The (positive) coefficient ρ captures the degree of interest smoothing and is assumed to be between 0 and 1. We insert equation (3) into equation (2) and treat $\bar{i}$ as a constant term, which yields the following contemporaneous Taylor rule:

$$i_t = (1-\rho)\bar{i} + (1-\rho)\alpha(\pi_t - \pi_t^*) + (1-\rho)\beta(y_t - y_t^*) + (1-\rho)\gamma(\Delta e_t) + \rho i_{t-1} + v_t \qquad (4)$$

In contrast to the contemporaneous Taylor rule displayed in equation (4), the Taylor rule can be modeled as a forward-looking Taylor rule using expected future variables as proposed by Clarida et al. (1998, 2000):

$$i_t = (1-\rho)\bar{i} + (1-\rho)\alpha\left(E\left[\pi_{t+j}\mid\Omega_t\right] - \pi_{t+j}^*\right) + (1-\rho)\beta\left(E\left[y_t\mid\Omega_t\right] - y_t^*\right) + (1-\rho)\gamma\Delta e_t + \rho i_{t-1} + v_t$$
(5)

E indicates expected values at *t+j*, where *j* indicates a future time period, which is in the literature mostly one year ahead. Ω_t is the central banks information set available at time t. Based on the forward-looking (5) and contemporaneous (4) Taylor rule we derive four different linear Taylor rules[4] modeling monetary policy in CEE, which are empirically tested in section four.

First, we built on the forward-looking Taylor rule (4) by implementing quarterly real inflation expectation data about the average of this year inflation drawn from the ifo WES survey $\left(E\left[\pi_{t+4}|\Omega_t\right]\right)$, leading to the following linear equation:

$$i_t = \varphi + \mu\left(E\left[\pi_{t+4}|\Omega_t\right]\right) + \tau\left(y_t - y_t^*\right) + \kappa\Delta e_t + \rho i_{t-1} + \varepsilon_t \tag{6}$$

with $\mu = (1-\rho)\alpha$, $\tau = (1-\rho)\beta$, $\kappa = (1-\rho)\gamma$ and $\varepsilon_t = -(1-\rho)\beta\left(y_t - y_t^* - E\left[y - y^*|\Omega_t\right]\right) + v_t$ being a linear combination of the unobserved variables and the error term v_t. The constant term φ is defined as $\varphi = (1-\rho)(\bar{i} - \alpha\pi^*_{t+4})$.[5]

The second Taylor rule is a standard forward-looking reaction function based on future inflation:

$$i_t = \varphi + \mu\pi_{t+4} + \tau\left(y_t - y_t^*\right) + \kappa\Delta e_t + \rho i_{t-1} + \varepsilon_t \tag{7}$$

with $\mu = (1-\rho)\alpha$, $\tau = (1-\rho)\beta$, $\kappa = (1-\rho)\gamma$ and with $\varphi = (1-\rho)(\bar{i} - \alpha\pi^*_{t+4})$. ε_t is defined as $\varepsilon_t = -(1-\rho)\left(\alpha\left(\pi_{t+4} - E\left[\pi_{t+4}|\Omega_t\right]\right) + \beta\left(y_t - y_t^* - E\left[y - y^*|\Omega_t\right]\right)\right) + v_t$.

Third, we consider a Taylor rule taking the contemporaneous inflation into account (see Frömmel et al. (2009)) and transform equation (4) into a linear model:

$$i_t = \lambda + \mu(\pi_t - \pi_t^*) + \tau(y_t - y_t^*) + \kappa(\Delta e_t) + \rho i_{t-1} + v_t \tag{8}$$

with $\mu = (1-\rho)\alpha$, $\tau = (1-\rho)\beta$ and $\kappa = (1-\rho)\gamma$ and with $\lambda = (1-\rho)\bar{i}$.

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[4] Due to the small sample size estimating the original non-linear Taylor with the term $(1-\rho)$ may lead to unstable results due to convergence process of the estimator. Therefore, we retransform our Taylor rules into linear models to generate a higher estimation quality. The size and the significance can be interpreted without any loss in information.

[5] Due to missing data about the future inflation targets π^*_{t+4} of the central bank rate π^*_{t+4} is captured by the constant term. For an empirical example in the literature see Danne and Schnabl (2008).

The last Taylor rule contains inflation, output and exchange rate expectation data from the ifo WES database:

$$i_t = \varphi + \mu\left(E\left[\pi_{t+1}\,|\,\Omega_t\right]\right) + \tau\left(E\left[y_t\,|\,\Omega_t\right] - y_t^*\right) + \kappa E\left[\Delta e\right]_t + v_t \qquad (9)$$

with $\mu = (1-\rho)\alpha$, $\tau = (1-\rho)\beta$, $\kappa = (1-\rho)\gamma$ and with $\varphi = (1-\rho)(\bar{i} - \alpha\pi^*_{t+1})$.

In all our four different Taylor rule specifications the effect of exchange rate changes on interest rate setting is modeled time-independent, regardless whether monetary policy targets differ across the observation period.

Therefore, we introduce an interaction term measuring the effect of exchange rate changes in periods, where the central bank officially relies on inflation targeting.
The dummy takes the value one, if the central bank officially refers to inflation targets and zero otherwise.

$$I_t = \begin{cases} 1, & \textit{Inflation tar.} \\ 0, & \textit{otherwise} \end{cases} \qquad (10)$$

Including this dummy in the Taylor rule with the expected inflation variable (6) yields the following transformation:

$$i_t = \varphi + \mu\left(E\left[\pi_{t+1}\,|\,\Omega_t\right]\right) + \tau\left(y_t - y_t^*\right) + (\kappa + \omega I_t)\Delta e_t + \rho i_{t-1} + v_t, \qquad (11)$$

where the size of the ω coefficient measures the effect of exchange rate changes on the interest rate, which is additionally triggered in the period of official inflation targeting The total effect of the exchange rate on monetary policy decisions during inflation targeting is measured by the sum of the coefficients $\kappa + \omega$. It should be insignificant, if the central bank is strongly committed to the target and acts not time-inconsistent.

Introducing the interaction term into equation (7) yields the following forward-looking Taylor rule:

$$i_t - \varphi = \rho\alpha\pi_{t+4} + \tau\left(Y_t - Y_t^*\right) + (\kappa + \omega I_t)\Delta e_t + \rho i_{t-1} + \varepsilon_t \qquad (12)$$

The contemporaneous Taylor rule derived in equation (8) takes the following form:

$$i_t - \varphi = \rho(\pi_t - \pi_t^*) + \tau(Y_t - Y_t^*) + (\kappa + \omega I_t)\Delta e_t + \rho i_{t-1} + v_t \qquad (13)$$

The Taylor rule based on expectation data (9) with respect to regime switches is displayed in equation (14):

$$i_t - \varphi = \rho\left(E\left[\pi_{t+4}|\Omega_t\right]\right) + \tau\left(E\left[Y_t|\Omega_t\right] - Y_t^*\right) + (\kappa + \omega I_t)E\left[\Delta e\right]_t + v_t \qquad (14)$$

As alternative method for analyzing whether the influence of exchange rate changes differs across the underlying period we implement a rolling window regression scheme. With a window size of 34 observations, which is shifted every period, we estimate the four standard Taylor rules to analyze, if the influence of the exchange rate term varies over time.

4. Empirical Analysis

4.1. Data

Based on the four alternative Taylor rule specifications (*expected inflation, forward looking, contemporaneous, only expectation data*) derived in the last section, we analyze monetary policy rules for the Czech Republic (CZ), Hungary (HU), Poland (PL), Romania (RO) and Slovakia (SK), which have announced official inflation targets within our data sample. The sample starts in the first quarter of 1995 and ends with the last quarter of 2008 (for Romania from 1999 till 2008 due to data availability). Before 1995 data of the considered variables are very fragmented and can therefore not be used in the analysis.

The data partly built on expectation data drawn from the quarterly survey on the World Economic Survey (WES) collected by the ifo Institute for Economic Research in cooperation with the International Chamber of Commerce in Paris and is available on a quarterly basis. The participants of the survey, which are economic experts of international enterprises and institutions, are asked to give their assessment of the general economic situation regarding important macroeconomic indicators of the country they inhabit. Currently, the ifo WES asks about 1100 experts in 90 countries. The WES consists of quantitative and qualitative information: appraisals and expectations of economic experts (see Stangl 2007). We use the survey results regarding expected inflation (quantitative), expected exchange rate movements (qualitative) and expected economic performance (qualitative).

All other data used in the empirical framework is taken from the IMF International Financial Statistics database.

For the interest rate term i_t we use money market rates for the Czech Republic, Poland, Romania, and the Slovak Republic, while due to data unavailability the interest rate for Hungary is proxied by the average of the lending and deposit rate.

The inflation term is calculated in several ways (see last section), which furthermore tests the robustness of our results. First, we implement the forward-looking inflation term (equations (7, 12)), where expected inflation is assumed to be equal to inflation one-year later π_{t+4}. The inflation rate is calculated as the year-over-year change rate of consumer price indices.

Second, we employ a contemporaneous inflation term (see Frömmel et al. (2009)), where the inflation gap is calculated by subtracting an inflation target π_t^* derived from the Maastricht criteria[6] from actual inflation π_t (equations (8, 13)).[7]

The third measurement builds on survey data from the WES, where participants are asked each quarter about their inflation expectations for the current year (equations (6, 11) and (9,

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[6] 1.5 percentage points higher than the average of the three lowest inflation member states of the EU.

[7] Siklos (2006) shows that taking this (external) "Maastricht inflation target" leads to more robust results than using the (internal) central bank target. Furthermore, one has to keep in mind that not all of our considered countries implemented an official numeric inflation target over the whole sample period. Inflation targets may change in the underlying time period due to frequent price changes or macroeconomic shocks (see Frömmel et al. 2009).

14)).[8] Figure 1 displays the inflation rate and the expected average inflation rate from the WES indicating, as expected, that the WES time series has a high explanatory power for (future) inflation movements with a correlation at time period *t* of more than 90 percent for all considered countries.

The output gap $(y_t - y_t^*)$ in equations (6), (7), (8) and (11), (12), (13) is based on real GDP using a Hodrick-Prescott (HP) filter with the smoothing parameter 1600 analogous to Fendel et al. (2008), where y_t refers to real GDP and y_t^* to the filtered HP real GDP time series.

As alternative measurement for the output gap in equations (9) and (14) (only expectation data Taylor rules), we take the survey results of the WES concerning the economic expectations in six months.

In contrast to the quantitative inflation measure drawn from the WES, participants are asked for their qualitative expectations. The participants indicate *up* for an expected rise in the economic performance, *same* for no change and *down* for an expected fall in economic growth within the next six months. The grading scheme consists of giving a grade of 9 to the reply *up*, a grade of 5 to indifferent replies (*same*) and a grade of 1 to *down* replies. Average grades within the range of 5 to 9 indicate that a majority of experts expects an improvement of the economic situation, whereas grades within the range of 1 to 5 expect an economic downturn. Afterwards the individual replies are combined and averaged, which leads to a non-binary time-series. To interpret the direction (but not the size) of this variable in our regression[9] we standardize the grading scheme, whereas a number significantly smaller than zero indicates an expected fall in the economic situation, a value significantly higher than zero an expected rise and not significantly different from zero the same economic performance[10]. Then, we smooth the non-binary standardized time series with the Hodrick-Prescott filter to calculate the output gap by the difference of the standardized and the detrended time series[11].

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8 In comparison to the other questions, the participants give a quantitative answer.

9 Up till now the non-binary time series is distributed around 5.

10 An alternative method of converting qualitative data into quantitative data is the use of a Carlson-Parkin (1975) filter proposed by Henzel and Wollmershäuser (2005). However, due to a small sample size of participants of the WES for the CEE economies, this method cannot be considered in this study.

11 Please note that such as in the case of the later estimation not the size of the coefficient itself, but the sign, can be used for interpretation.

Moreover, the exchange rate changes in the equations (6), (7), (8) and (11), (12), (13) are modeled by the quarter-over-quarter exchange rate changes in volume notation, where <0 indicates a domestic currency depreciation and >0 a currency appreciation against the euro (before 1999: Deutsche Mark).[12]

Furthermore, we include for equations (9) and (14) (only expectation data) a proxy for exchange rate expectations with the help of the WES data. Here, the participants are asked if the domestic currency (i.e. Czech koruna, Polish zloty etc.) is at present overvalued (*1*), about at the proper value (*5*) or undervalued (*9*) to the euro. We make the debatable assumption that participants, in case of an undervaluation of the home currency (and therefore an overvaluation of the euro) expect a future appreciation of the home currency[13] neglecting that participants could also expect no exchange rate movements. We standardize the graded time series and base in on the assumption that a value >0 suggests the expectation of a currency appreciation against the euro and <0 a depreciation against the euro.[14]

To test for instatitionarity in the underlying variables we apply the augmented Dickey Fuller unit root test. We find no evidence for unit roots in the investigated time series and can reject the Null hypothesis of a unit root on the 10 percent significance level. Henceforth, we assume that neither cointegration nor spurious regressions are a matter of concern.

4.2. Results

Based on the theoretical Taylor rules derived in section 3.3, we estimate eight linear Taylor rules for the five CEE economies to analyze possible time-inconsistency in monetary possible. With other words we scrutinize whether monetary authorities behave time-inconsistent and switch from an official inflation targeting to an exchange rate target to enhance higher output growth via surprise inflation. We employ a GMM estimator proposed by Arellano and Bond (1991) and Arellano and Bover (1995) with Newey-West (1987) standard errors to cope with possible endogeneity and autocorrelation. Up to four lags of the

[12] Please note, that for reasons of comparability with the WES exchange rate expectation data, the volume notation for exchange rate changes was chosen.

[13] Please note, that the overvaluation or undervaluation of the currency does not necessarily indicate a expected depreciation or appreciation.

[14] Please note that such as in the case of the output gap based on WES data, just the sign, but not the size of the coefficient itself can be used for interpretation.

endogenous variable as well as of the exogenous variables are used as instruments. The Null hypothesis of validity of instruments with Sargan-Test (Sargan 1958) cannot be rejected for all specifications.[15]

In a first step, we estimate the Taylor rule with the *expected inflation* term drawn from the WES to model inflation expectations in CEE (equation 6). Second, we estimate the Taylor rules with a *forward-looking inflation* term proposed by Clarida (1998) (equation 7). Third, we implement a Taylor rule with a *contemporaneous inflation* term based on the Maastricht inflation target (equation 8). Forth, we estimate the Taylor rule with all available expectation data (*only expectation data*) from the WES, namely expected inflation, the output gap based on expectation about the economic situation in six months and the exchange rate term displaying appreciation or depreciation expectations[16] (equation 9).

In a next step, we run the Taylor rules regressions with the interaction term measuring the impact of exchange changes in monetary policy under different monetary policy frameworks (equations 11, 12, 13 and 14).

Finally, we estimate the Taylor rules proposed by equations (6), (7), (8) and (9) in a rolling regression framework with a window size of 34 to analyze possible time-inconsistency in monetary policy patterns over time.

The results of the estimated Taylor rules for the Czech Republic are displayed in Table 2. For the *expected inflation*, *forward-looking* and *contemporaneous* estimation frameworks the parameters have the expected signs and are significant at the common levels. The interest rate smoothing parameter is relatively high with approximately 0.7 and is for all estimations highly significant indicating that interest rate smoothing is prevalent in the monetary policy of the Czech Republic. The inflation parameter is also positive and highly significant. The output gap has a small, but positive and significant impact on the monetary policy setting.

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[15] The respective p-values are displayed in Table 2 to 8.

[16] Please note, that interpretation of the coefficients demands caution due to the fact that we face qualitative instead of quantitative data.

Table 2: Taylor rules, Czech Republic, 1995–2008

	Expected inflation				*Forward looking*			
	(1)		(2)		(3)		(4)	
Variable	Coef.	Std. Error	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	0.721***	0.186	0.519***	0.165	0.015	0.112	1.709***	0.220
Interest rate (t-1)	0.539***	0.038	0.509***	0.055	0.961***	0.019	0.588***	0.028
Inflation	0.322***	0.075	0.424***	0.085	0.035***	0.013	0.184***	0.034
Output gap	0.022*	0.011	0.003**	0.013	0.022***	0.007	0.094***	0.015
Exchange rate	-0.081***	0.022	0.493***	0.097	-0.029*	0.017	0.362***	0.069
Regime			-0.587***	0.092			-0.426***	
Wald-test			21.84	(0.000)			19.89	(0.000)
R-squared adj.	0.773		0.751		0.760		0.763	
Sargan	0.07		0.07		0.19		0.08	
obs	56		56		52		52	

	Contemporaneous				*Only expectation data*			
	(5)		(6)		(7)		(8)	
Variable	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	0.779***	0.145	0.680***	0.136	-0.769**	0.319	-0.027	0.239
Interest rate (t-1)	0.798***	0.030	0.828***	0.029	0.196***	0.025	0.907***	0.038
Inflation	0.142***	0.035	0.142***	0.036	1.018***	0.088	0.098	0.088
Output gap	0.014**	0.005	0.016***	0.006	-0.004	0.024	0.021**	0.009
Exchange rate	-0.035***	0.009	0.165***	0.042	-1.131***	0.341	3.069***	0.650
Regime			-0.196***	0.043			-1.359**	0.619
Wald-test			17.29	(0.000)			3.49	(0.067)
R-squared adj.	0.783		0.785		0.768		0.712	
Sargan	0.121		0.08		0.102		0.08	
obs	56		56		60		60	

Notes: Wald-test displays the F-statistics and in brackets the respective p-value of the Null hypothesis: $\lambda + \omega - 0$.

The results deliver a strong empirical evidence for a significant impact of exchange rate changes on Czech Republic monetary policy next to inflation and output indicating that a currency appreciation leads to decreasing interest rates.

Although, the Czech Republic did not commit officially to an exchange rate target for the whole observation period, the results deliver evidence that monetary policy possibly behaved time-inconsistent in the sense of switching from the announced inflation target to an exchange rate target to generate higher output.

When interpreting the results of the regressions, where the effect of the exchange rate is modeled by the interaction dummy, taking the value one, when the Czech Republic officially announces an inflation target from 1998 on and zero otherwise, the effect of the exchange rate on monetary policy making is negative (exchange rate plus coefficient) and significant such as in the previous estimation frameworks without the interaction term.[17] This indicates that even if monetary policy in the Czech Republic refers to an official inflation target after 1998, the central bank seems to soften currency appreciation pressure by discretionary interest rate cuts.

This observed time-inconsistency can lead to uncertainty in the economy with higher inflation rates in the long-term and therefore increasing uncertainty in the Czech wage determination process (with probably lower real wages). The results (t-statistics (solid line), coefficient of the exchange rate term (dashed line)) of the rolling window estimation (Figure 2, Chart 1) support our findings. They find an (not officially) announced influence of exchange rate changes and shows a significant impact (solid line) of the exchange rate on monetary policy for most of the observed time period. Just in 2007 Q2 and Q3 there seems to be no significant impact of the exchange rate on the Czech monetary policy pattern.

The empirical results for the Taylor rules of Hungary (Table 3) are mainly in line with the results for the Czech Republic. The regressions reveal a positive and significant impact of the lagged interest rate and inflation on Hungarian monetary policy in all of the four estimation

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[17] The results within frameworks, where mainly *expectation data* is used remain, however, widely support our findings concerning the exchange rate term. On the one hand, the exchange rate term for the overall equation is again negative and significant whereas the overall effect in the time after 1998 (equation 7) is positive, but insignificant.

settings. The output gap is positive, but not significant in all frameworks.[18] However, in comparison to the regressions for the Czech Republic, the impact of exchange rate changes on monetary policy setting is mixed. For the overall period, three estimation set-ups (expected inflation, forward-looking, contemporaneous) indicate a negative and significant impact of the exchange rate changes on the interest rate; thus, the central bank seems to soften currency appreciation pressure by discretionary interest rate cuts.

However, controlling for the regime switch by the interaction term in Hungarian monetary policy after 2002 (from exchange rate to inflation targeting), the impact of exchange rate changes remains negative[19], but is insignificant for most specifications. Only the *contemporaneous* Taylor rule indicates a negative and significant impact of the exchange rate in times of official inflation announcements.

The results of rolling window regression find indeed a strong and significant impact of exchange rate changes on monetary policy (Figure 2, Chart 2). It shows that the exchange rate term has a strong negative impact on monetary policy making after 2002 (period of official inflation targeting).

Even if the influence of the exchange rate on monetary policy in times of inflation targeting is not as clear as for the Czech Republic (for some settings it is in fact negative as well, but insignificant), we may conclude that Hungarian policy makers permit a discretionary leeway in monetary policy decisions to some extent. This may have led to possible welfare losses in the Hungarian wage determination process as well.

The results of the different estimated Taylor rules for Poland are displayed in Table 4. In all regressions inflation, interest rate and output gap have the expected positive sign and are (with the exception of the output gap in (7) and (8)) significant. The exchange rate term[20] is negative and significant, indicating that a domestic currency appreciation leads to a decreasing interest rate.

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[18] In the Taylor rule specification (*only expectation data*) the output gap coefficient is negative and not significant.

[19] In the Taylor rule specification (*only expectation data*) the exchange rate coefficient is positive but highly insignificant. Due to the unconventional transformation of the survey data, this result must been treated with caution.

[20] In the Taylor rule specification (*only expectation data*) the exchange rate coefficient is again positive but highly insignificant.

Table 3: Taylor rules, Hungary, 1995–2008

	Expected inflation				*Forward looking*			
	(1)		(2)		(3)		(4)	
Variable	Coef.	Std. Error	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	1.349***	0.293	1.558***	0.375	0.677**	0.257	0.418	0.500
Interest rate (t-1)	0.609***	0.073	0.583***	0.094	0.837***	0.032	0.819***	0.072
Inflation	0.240***	0.063	0.249***	0.074	0.008***	0.023	0.106***	0.023
Output gap	-0.000	0.002	-0.001	0.002	0.009***	0.001	0.008***	0.002
Exchange rate	-0.045***	0.015	-0.058	0.044	-0.058***	0.014	-0.082	0.071
Regime			0.017	0.083			0.079	0.111
Wald-test			0.87	(0.355)			0.05	(0.943)
R-squared adj.	0.966		0.965		0.967		0.962	
Sargan	0.08		0.09		0.15		0.14	
obs	52		52		48		48	

	Contemporaneous				*Only expectation data*			
	(5)		(6)		(7)		(8)	
Variable	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	1.129***	0.405	1.124***	0.404	1.470***	0.517	1.632***	0.323
Interest rate (t-1)	0.771***	0.061	0.787***	0.059	0.629***	0.094	0.617***	0.055
Inflation	0.126***	0.043	0.139***	0.043	0.220***	0.077	0.221***	0.058
Output gap,	0.005***	0.001	0.001	0.001	-0.103	0.228	-0.128	0.161
Exchange rate	-0.054**	0.023	0.018	0.005	1.136**	0.547	0.693	0.497
Regime			-0.120	0.058			1.555	1.194
Wald-test			30.57	(0.000)			1.77	(0.187)
R-squared adj.	0.956		0.971		0.961		0.957	
Sargan	0.15		0.14		0.11		0.10	
obs	52		52		68		68	

Notes: Wald-test displays the F-statistics and in brackets the respective p-value of the Null hypothesis: $\lambda' + \omega - 0$

Table 4: Taylor rules, Poland, 1995–2008

	Expected inflation				*Forward looking*			
	(1)		(2)		(3)		(4)	
Variable	Coef.	Std. Error	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	2.090***	0.328	0.757***	0.073	1.052***	0.339	0.190	0.126
Interest rate (t-1)	0.703***	0.043	0.730***	0.019	0.843***	0.031	0.892***	0.009
Inflation	0.176***	0.037	0.209***	0.029	0.098***	0.027	0.088***	0.013
Output gap	0.000***	0.000	0.000***	0.000	0.000***	0.000	0.000***	0.000
Exchange rate	-0.023**	0.009	0.104**	0.048	-0.002	0.009	0.076*	0.039
Regime			-0.119**	0.051			-0.087**	0.004
Wald-test			7.73	(0.007)			6.55	(0.014)
R-squared adj.	0.962		0.949		0.973		0.967	
Sargan	0.11		0.05		0.15		0.05	
obs	52		52		48		48	

	Contemporaneous				*Only expectation data*			
	(5)		(6)		(7)		(8)	
Variable	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	0.943***	0.282	1.054***	0.162	0.832***	0.186	0.155	0.458
Interest rate (t-1)	0.865***	0.034	0.811***	0.017	0.825***	0.036	0.777***	0.044
Inflation	0.165***	0.038	0.111***	0.029	0.043*	0.024	0.334***	0.066
Output gap	0.000***	0.000	0.000**	0.000	0.113	0.216	0.207	0.258
Exchange rate	-0.017*	0.009	-0.030	0.108	-0.726	0.502	-2.160	1.451
Regime			0.022	0.103			2.630	2.581
Wald-test			1.03	(0.134)			0.058	(0.810)
R-squared adj.	0.975		0.971		0.949		0.972	
Sargan	0.08		0.14		0.05		0.08	
obs	52		52		68		56	

Notes: Wald-test displays the F-statistics and in brackets the respective p-value of the Null hypothesis: $\kappa + \omega - 0$.

The Polish central bank switched in 1998 from exchange rate targeting to inflation targeting. Analyzing the regressions controlling for the regime switch leads to mixed results. The results of the *expected* (Table 4, 1) and *forward-looking* regression (Table 4, 3) indicates that in the time of official exchange rate targeting (before 1998), a currency depreciation is linked to decreasing interest rates: The effect after 1998 in times of official inflation targeting in estimation framework is negative (exchange rate + regime) and significant.

However, in the *contemporaneous* framework the impact of the exchange rate is insignificant. All in all, this leads us to the conclusion that the Polish monetary policy may have acted time-inconsistent in periods of inflation targeting with a switch from the inflation target in favor of an exchange rate target to sustain output. However, the effect is not as strong observable as for the Czech Republic.

Figure 2 (Chart 3) shows the t-statistics and coefficient of the exchange rate term of the rolling window regression. In comparison to the static estimations, the exchange rate coefficient has a significant positive coefficient and not as expected a negative impact on the interest rate for most of the underlying time period. Therefore, we find just to some extend evidence that Polish monetary policy makers incorporate the exchange rate into monetary policy decisions.

While we find in most of the regression frameworks a possible time-inconsistent behavior (exchange targeting in times of official inflation targeting) in monetary policy, the *contemporaneous* and rolling window specifications find no time-inconsistency and therefore no additional uncertainty arising from Polish monetary policy for the wage setting process.

The estimation results for Romania (Table 5) are in line with the results for the previous considered countries. The interest rate smoothing parameter and inflation parameter are positive and highly significant. The influence of the output gap on the interest rate is positive, but just in half of the specifications significant. The exchange rate parameter is negative, but not in all frameworks significant.

Interpreting the results of the estimation framework allowing for a regime switch in monetary policy[21] leads to the following conclusion: The overall impact of the exchange rate on the interest rate after 2005 (official inflation target) is indeed negative, but insignificant.[22].

The rolling t-statistics indicates are as well negative and indicates a significant impact of currency appreciation on interest rates. In all, the results deliver therefore just small evidence, that in Romanian central bankers act time-inconsistent and switch between an (informal) exchange rate target and an inflation target.

The results for Slovakia are relatively similar to the results of the Czech Taylor rules. The interest rate smoothing parameter is positive and significant. Inflation has a positive and significant impact on the interest rate setting. Surprisingly, the inflation term in the *contemporaneous* model has no significant impact. The output gap with exception of equation (7) and (8) is positive and mostly significant.

The exchange rate term is highly significant indicating that an appreciation of the Slovak crown leads to decreasing interest rates, which is in line with results from other studies (f.e. Frömmel et al. 2009). The exchange rate effect in periods with official inflation targets (from 1998 till 2008) are also negative and significant indicating that Slovakian monetary policymakers permit a discretionary leeway with respect to exchange rate changes.

Analyzing the t-statistics and coefficient of the rolling regression framework supports our findings. We see a strong and negative impact from exchange rates on Slovakian interest rate setting in most of the time of official inflation targeting (from 1998 till 2008). This observed time-inconsistency may have led to higher inflation rates in the long-term and increasing the uncertainty in the Slovakian wage determination process and the whole economy.

[21] Before 2005 the monetary authorities of Romania gave no official commitment to a monetary policy strategy before they announced an inflation target.

[22] In the estimation scheme where we analyze the interest setting behavior (with the expectation of the interest rate) mainly with survey data the exchange rate effect is mixed and not robust such as for the other considered countries.

Table 5: Taylor rules, Romania, 1999–2008

	Expected inflation				*Forward looking*			
	(1)		(2)		(3)		(4)	
Variable	Coef.	Std. Error	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	1.979***	0.447	2.245***	0.462	-0.067	0.970	5.085***	1.280
Interest rate (t-1)	0.428***	0.057	0.624***	0.028	0.388***	0.034	0.132***	0.042
Inflation	0.511***	0.073	0.225***	0.035	1.031***	0.134	0.783***	0.104
Output gap	0.000	0.000	0.000*	0.000	0.001**	0.000	0.001	0.000
Exchange rate	-0.084*	0.050	-0.292**	0.029	-0.049	0.067	-0.495***	0.092
Regime			0.254***	0.069			0.458	0.311
Wald-test			0.248	(0.621)			0.021	(0.885)
R-squared adj.	0.842		0.928		0.829		0.804	
Sargan	0.13		0.14		0.16		0.17	
obs	40		40		40		40	
	Contemporaneous				*Only expectation data*			
	(5)		(6)		(7)		(8)	
Variable	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant ,	3.033***	0.479	3.278***	0.674	1.930**	0.741	-1.811***	0.557
Interest rate (t-1)	0.605***	0.071	0.589***	0.068	0.883***	0.044	0.812***	0.038
Inflation	0.185**	0.069	0.204***	0.067	0.099	0.087	0.347***	0.027
Output gap	0.000	0.000	0.000	0.000	0.000***	0.000	0.000	0.000
Exchange rate	-0.108***	0.039	-0.095*	0.051	-2.152	1.358	10.869***	1.315
Regime			-0.056	0.207			-6.155***	1.690
Wald-test			0.699	(0.498)			17.91	(0.000)
R-squared adj.	0.768		0.767		0.910		0.913	
Sargan	0.10		0.10		0.21		0.18	
obs	40		40		40		40	

Notes: Wald-test displays the F-statistics and in brackets the respective p-value of the Null hypothesis: $\lambda + \omega - 0$.

Table 6: Taylor rules, Slovakia, 1995–2008

	Expected inflation				*Forward looking*			
	(1)		(2)		(3)		(4)	
Variable	Coef.	Std. Error	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant	1.247***	0.202	0.891***	0.191	1.596***	0.443	1.368	0.950
Interest rate (t-1)	0.754***	0.023	0.864***	0.011	0.759***	0.039	0.808***	0.061
Inflation	0.075**	0.029	0.039	0.025	0.132**	0.061	0.235**	0.110
Output gap	0.000	0.000	0.000*	0.000	0.000**	0.000	0.001	0.000
Exchange rate	-0.075***	0.017	0.858***	0.057	-0.155***	0.034	0.220***	0.247
Regime			-0.925***	0.052			-0.783***	0.269
Wald-test			23.59	(0.000)			12.62	(0.000)
R-squared adj.	0.793		0.827		0.789		0.555	
Sargan	0.05		0.05		0.16		0.08	
obs	52		52		48		48	

	Contemporaneous				*Only expectation data*			
	(5)		(6)		(7)		(8)	
Variable	Coef.	Std.	Coef.	Std.	Coef.	Std.	Coef.	Std.
Constant , C(6)	1.137***	0.181	1.495***	0.277	-0.405**	0.174	1.154***	0.163
Interest rate c(1)	0.877***	0.014	0.772***	0.034	0.899***	0.023	0.776***	0.005
Inflation c(2)	0.039	0.039	0.004	0.028	0.091**	0.035	0.060***	0.021
Output gap, c(3)	0.000**	0.000	0.000	0.000	-0.149	0.122	-0.000	0.000
Exchange rate, c(4)	-0.090***	0.018	1.375***	0.122	-1.470***	0.242	1.727***	0.194
Regime*er			-1.459***	0.120			-3.230***	0.420
Wald-test			15.71	(0.000)			9.59	(0.000)
R-squared adj.	0.801		0.767		0.811		0.810	
Sargan	0.11		0.10		0.16		0.10	
obs	52		52		52		52	

Notes: Wald-test displays the F-statistics and in brackets the respective p-value of the Null hypothesis: $\lambda + \omega - 0$.

5. Conclusions

In this study we analyzed the monetary policy in five CEE economies. We scrutinize whether countries that officially announce an inflation target are tempted to act inconsistently and switch from an inflation target to an exchange rate target to sustain higher output growth (via surprise inflation). We analyze the switching behavior between an exchange rate and an inflation target with the help of several empirical Taylor rules including, among other variables, ifo WES expectation data to describe central bank's interest rate setting in CEE.

Especially in countries in the economic catch-up process, macroeconomic stability and credible monetary authority are necessary tools to establish economic growth and welfare. Due to the integration process and due to the fact that all new member countries have to join the EMU, central bankers should aim to increase economic confidence and macroeconomic stability to join the EMU as soon as possible.[23]

If central banks in CEE are not credible in their policy announcement and switch between non-announced exchange rate and inflation targets, they will conduct surprise inflation, which is anticipated by the public and private sector in form of higher inflation expectations. This will result in higher long-term inflation and uncertainty. Furthermore, it is much harder for enterprises to distinguish between real productivity growth and (surprise) inflation. This may result in a possible loss of bargaining power, second round effects as well as in unsteadiness for the wage setting process, where enterprises and trade unions have to predict productivity and inflation as components of future wages.

The results from the econometric analysis support those assumptions. The empirical Taylor rules perform relatively well and are in line with the standard theory (see Clarida et al. 1998). Introducing an interaction term measuring the effect of exchange rate changes on the interest rate in periods of official inflation targeting shows that monetary authorities have partly followed an exchange rate target also in times of an official inflation target.

[23] Another possibility could be to switch to an exchange rate target such as in the Baltics, which leads to further security in capital markets and decreasing competitiveness (see Schnabl and Hoffmann 2008) and ends in higher wages growth due to better predictability in the wage bargaining process (see Schnabl and Ziegler 2011).

In detail, for the Czech Republic and Slovakia we observe that the monetary authorities consider an exchange rate change also in times of official inflation targeting. For Poland, Romania and Hungary the evidence that monetary authorities focus on exchange rate changes in periods of inflation targeting is mixed. However, the results indicate partly that the monetary authorities have softened appreciation pressure by discretionary interest rate cuts without any official announcement.

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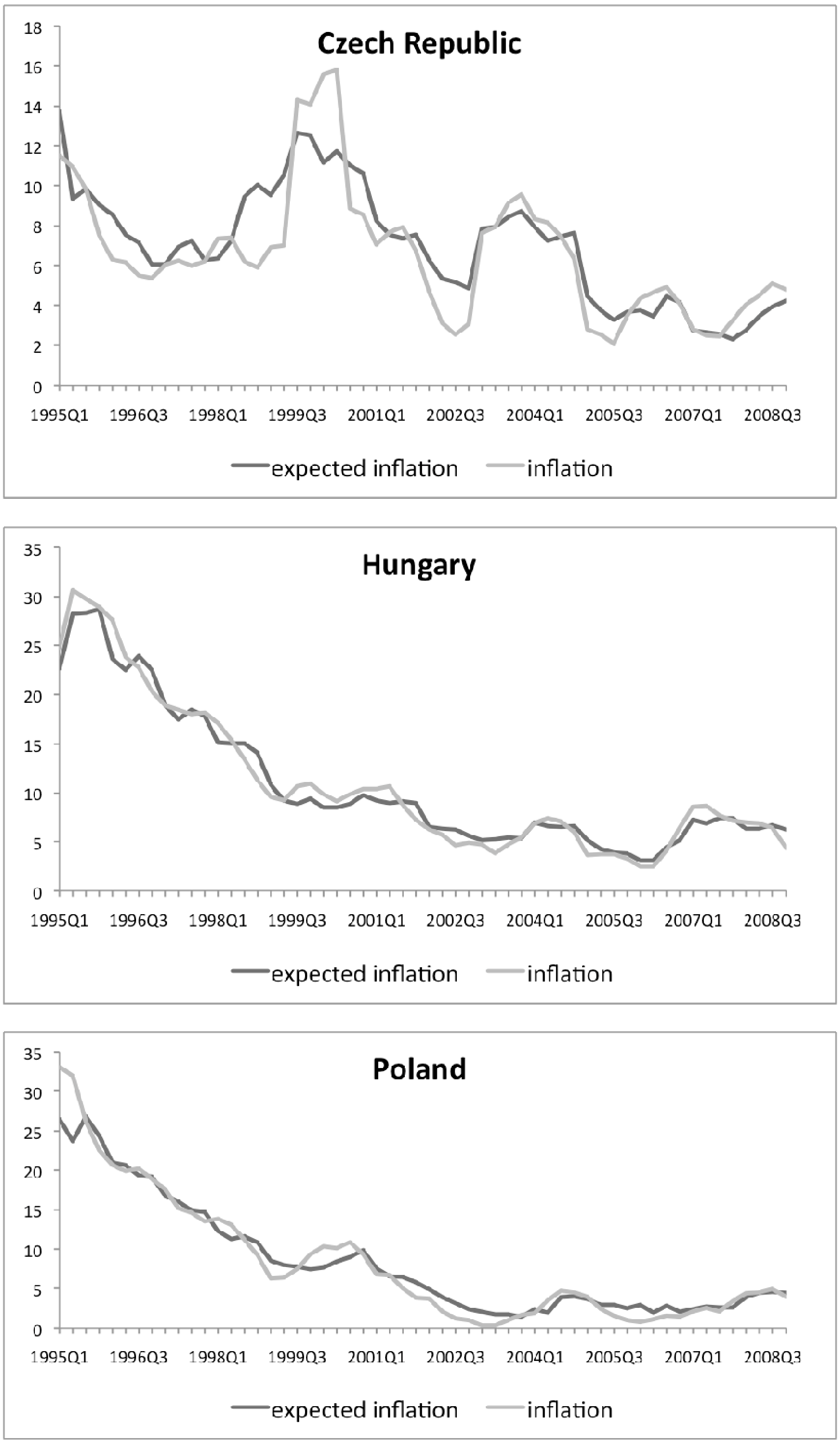
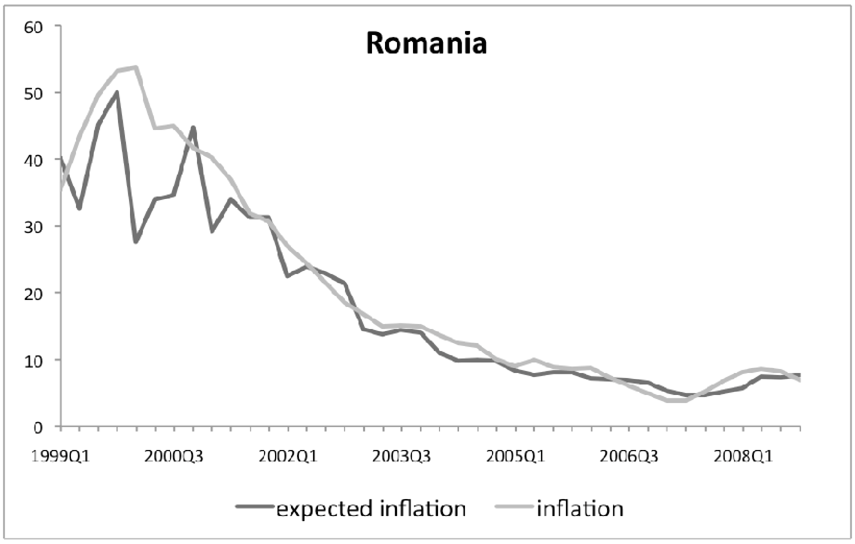
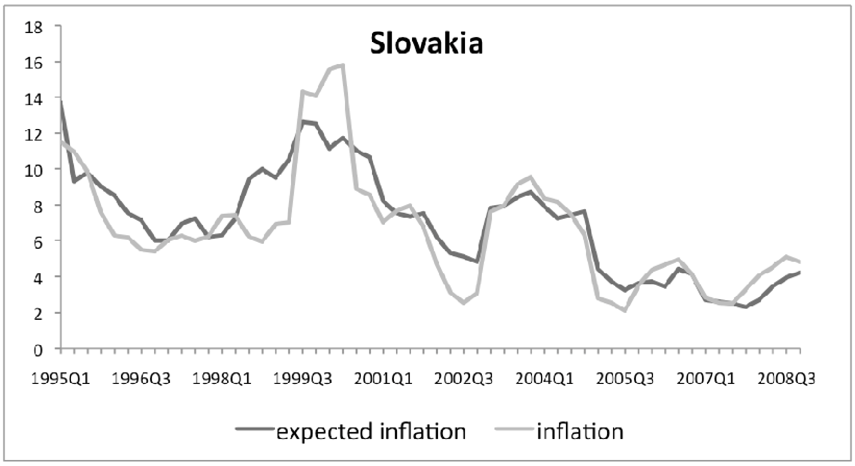
Annex

Figure 1: Inflation and expected inflation (quarterly data y-o-y percentage changes)

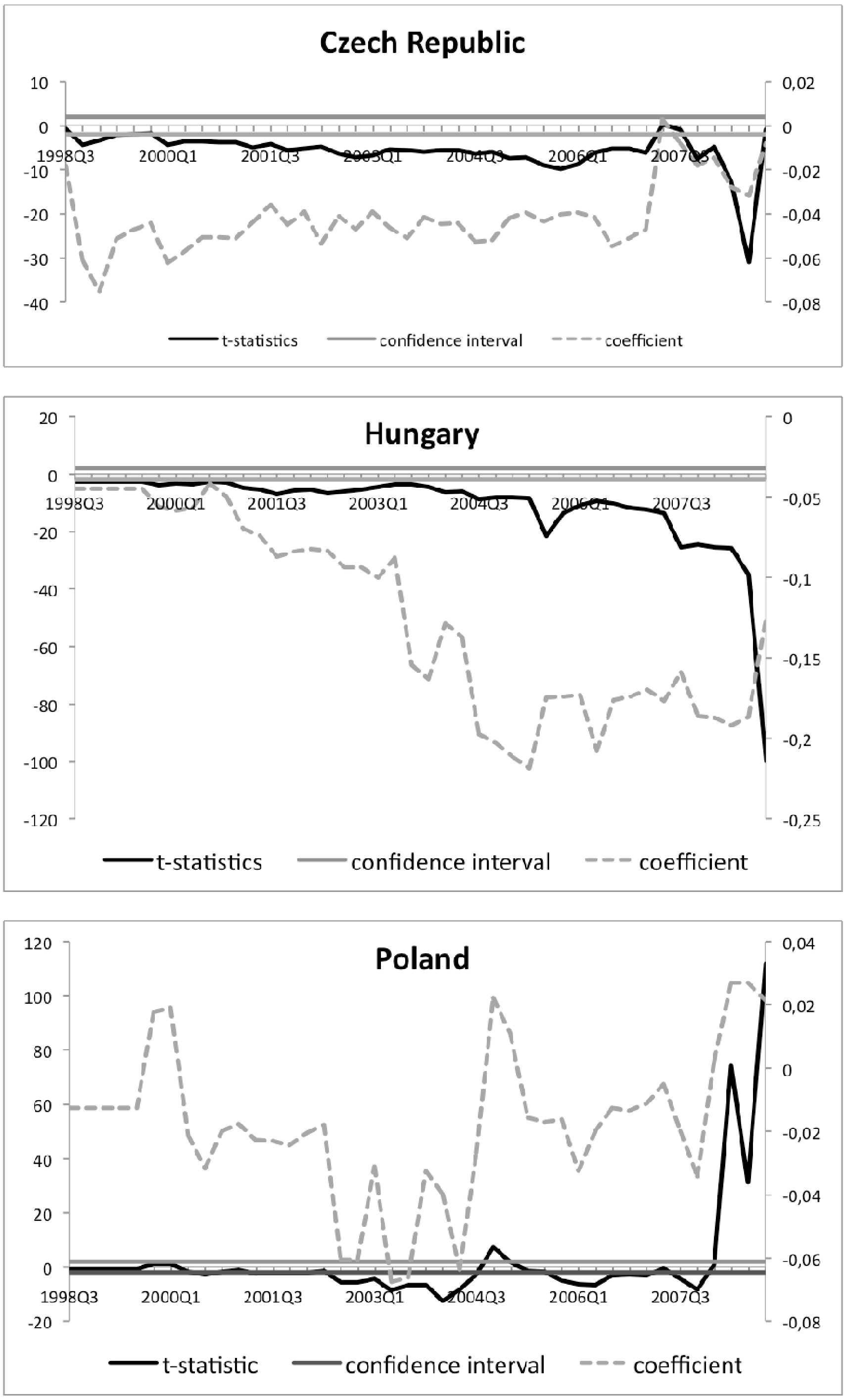


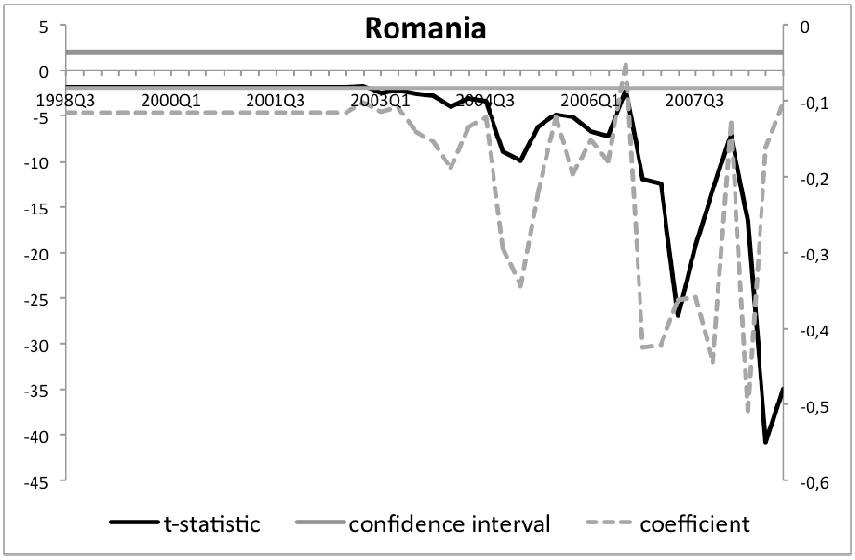


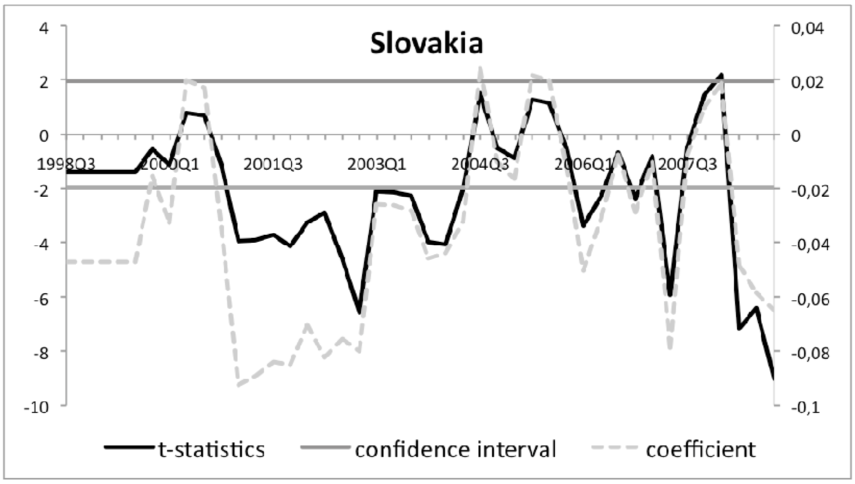


Source: IMF, ifo WES data.

Figure 2: T-statistics (left axis) and coefficient (right axis) of the exchange rate impact of rolling GMM Results







Notes: authors calculations based on IMF data.

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