
MONETARY POLICY RULES FOR EUROPEAN MONETARY UNION ACCEDING COUNTRIES

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Abstract:

The identification of central banks (CBs) behavior in setting interest rates may give a conclusive image on both the objectives and on their prioritization. A standard approach in this respect is the estimation of a CB reaction function as a Taylor rule. Since the formulation of the original version, Taylor monetary policy rule has undergone a number of changes and extensions designed to better reflect the monetary policy decisions of central banks. This paper addresses two extensions of Taylor monetary policy rule strictly targeting the current features of the Central and Eastern European (CEE) states, emerging economies with a high degree of openness in the middle of a convergence process towards the euro area. Models are built on the assumption that the monetary authority follows a strategy of flexible inflation targeting (IT) and are estimated using the generalized method of moments (GMM).

Key words: *Taylor rule, monetary policy, Generalized Method of Moments (GMM)*

1. Introduction

This paper provides an estimation of monetary policy Taylor rules in the context of Central and Eastern European states acceding to the European Monetary Union (EMU), with an independent monetary policy, namely the Czech Republic, Poland, Romania, Hungary, but it will also consider the cases of Slovakia and Slovenia until their accession to the euro area. All these countries apply or have applied an explicit or implicit inflation targeting strategy (see the case of Slovenia *ex ante* euro adoption). For the other states in the region that are also on their way to the single currency, namely Bulgaria, Latvia and Lithuania, the analysis of a Taylor rule-based monetary policy decision making is not relevant because of the lack of monetary policy independence given that under an exchange rate strategy, domestic interest rate is not an exogenous variable (set by the monetary authority) but it is endogenous in nature determined by the money market.

While the empirical literature concludes that monetary policy conducted by major developed countries central banks can be described by such a reaction function

(Clarida et al., 1998), existing arguments for emerging countries, including Central and Eastern European ones is much smaller. Therefore, we identify a relatively limited number of researches targeting the analysis of monetary policy rules used by central banks in the region.

Most studies aimed at estimating Taylor-type monetary policy rules in the case of Central and Eastern European states are geared to the Czech Republic, Poland and Hungary. Mohanty and Klau (2007) included these three economies in their analysis centered primarily on emerging markets in Asia and Latin America. An important finding of the two authors emphasize that monetary authorities in emerging countries tend to focus on other objectives (beyond inflation), highlighting in this respect variations in the exchange rate. Angeloni et al. (2007) compared the results obtained from the estimation of a Taylor-type rule for the Czech Republic, Hungary and Poland, with those identified in the Eurozone taking into account the period 1999 to 2004. Results showed the consistency of monetary policy objective in the three countries subject to analysis to the European Central Bank (ECB) price stability commitment.

Other researches focus on the member states of the Visegrad Group (including attached Slovakia Czech Republic, Poland and Hungary). María Dolores (2005) provide estimates of a simple Taylor rule for the four states, concluding that setting the interest rate for the first three (for the period 1998-2003) could reasonably be described by a simple adaptive Taylor rule (backward-looking). Instead, for Slovakia, a predictive rule (forward-looking) would be able to better describe the behavior of the central bank in determining short-term nominal interest rate. Paez-Farrell (2007) assessed to what extent Taylor-type rules offer an adequate description of the central banks behavior in setting interest rates for the four member states of the Visegrad Group during 1998-2006, taking into account six different specifications of such monetary policy rules. The main conclusion highlights the fundamental role of the exchange rate for the monetary policy rule in three of the four countries (Poland, Slovakia and Hungary).

Frömmel and Schobert (2006) included in their analysis a larger group of countries in the region (the Czech Republic, Poland, Romania, Slovakia, Slovenia and Hungary) and approach the exchange rate as additional explanatory variable. Their study outcomes emphasize the diminishing exchange rate importance in determining the interest rate after the introduction of floating rates. From a global perspective, the findings do not support the validity of the Taylor rule, which has a reduced capacity to provide a reasonable description of the monetary policy implemented by the six countries in the period 1994 – 2005. Frömmel et al. (2011) studied again monetary policy rules in Central and Eastern European countries for the timeframe 1994 to 2008, explicitly considering exchange rate regimes changes, which resulted in a substantial findings improvement compared to the previous conclusions of Frömmel and Schobert (2006).

Vasicek (2009) follows the CB's rationale of setting interest rates in the 12 new European Union member states (Bulgaria, Cyprus, Czech Republic, Estonia,

Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovakia and Slovenia). Given the different specifications of a Taylor-type rule (backward - looking and forward-looking and the successive introduction into the central bank reaction function of the nominal and effective exchange rate, money supply, foreign interest rate, of asset prices) for the period 1999 - 2007, the author pointed out that such a monetary policy rule is not always consistent with official monetary policy.

While all the above studies aim to estimate Taylor-type monetary policy rules taking into account (at most) two specific features of the independent states in the region, namely their nature as emerging economies with a high degree of openness, Orłowski (2008, 2010) emphasized the need to include in the formalized expression of the monetary authority reaction function of a third characteristic- their status as countries in the process of convergence towards the euro area. Thus, Orłowski (2008, 2010) underlined the necessity of a comprehensive approach of the rule accompanying the monetary policy instrument for open economies in the process of convergence. This involves not only the use of forward-looking rules with relatively stable variables and the insertion of the exchange rate but also, in parallel, the inclusion of other Eurozone macroeconomic variables in addition to the national ones (e.g. interest rate in the euro area), as well as EZ target variables (e.g. inflation gap in the monetary policy rule to be determined as difference between the current rate of domestic inflation and the ECB inflation goal or a target inflation derived from the Maastricht Treaty price stability criterion).

2. The Model: Taylor Rule adapted to distinctive features of selected countries

The pioneering contribution in shaping monetary policy decisions of central banks belongs to Taylor (1993). He suggested a simple reaction function that reflects the monetary authority setting of the interest rate given the current inflation deviation from the target (inflation gap) and the percentage deviation of real GDP from potential GDP estimated level (GDP gap). Short-term nominal interest rate set by the central bank is reflected by the formula:

$$i_t^* = \bar{i} + \beta_\pi (\pi_t - \pi^*) + \beta_y y_t \quad (1)$$

where i_t^* is the nominal short-term interest rate of the central bank and \bar{i} is the equilibrium nominal interest rate (the sum of the equilibrium real interest rate consistent with full employment in the long run and current level of inflation), π_t represents the annualized inflation rate, π^* is the target inflation, y_t is the GDP gap (the difference between actual GDP and potential GDP estimated level) and β_π and β_y are the weights assigned by central banks to inflation target, and respectively to real economic activity.

Clarida et al. (1998, 2000) have suggested that some of the variables on the right side of equation (1) should be introduced in the form of expected future values (expectations). This is primarily about the inflation and occurs as a natural element as long as most central banks (especially those that use a strategy of inflation targeting)

set the interest rate given the forecasts of inflation rather than current inflation. As such, the right side variables are inserted in the equation in the form of expectations (E) depending on the information set available at time t (Ω_t) Therefore, equation (1) becomes:

$$i_t^* = \bar{i} + \beta_\pi (E[\pi_{t+m}|\Omega_t] - \pi_{t+m}^*) + \beta_y E[y_{t+n}|\Omega_t] \quad (2)$$

On the other hand, most central banks manifest some degree of inertia in the process of setting short-term nominal interest rate. Thus, its decrease / increase to the target level deemed appropriate is achieved gradually through successive changes of small amplitude in order to avoid harmful effects on the economy. The inertia can be described by a partial adjustment mechanism in the form:

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

where the current central bank monetary policy rate i_t is a combination between the target interest rate i_t^* (obtained under monetary policy rule) and the previous value (usually with a period) of the interest rate i_{t-1} . Parameter $\rho \in [0,1]$ reveals the degree of interest rate inertia (interest rate smoothing) and v_t are its exogenous random shocks.

In order to obtain an equation that can be estimated, we define α as:

$$\alpha = \bar{i} - \beta_\pi \pi^* \quad (4)$$

Given the equation (4), equation (2) is rewritten as:

$$i_t^* = \alpha + \beta_\pi E[\pi_{t+m}|\Omega_t] + \beta_y E[y_{t+n}|\Omega_t] \quad (5)$$

The simultaneous approach of both the monetary policy rule described by equation (5) and the partial adjustment mechanism identified in (3) leads to:

$$i_t = (1 - \rho)\alpha + \beta_\pi E[\pi_{t+m}|\Omega_t] + \beta_y E[y_{t+n}|\Omega_t] + \rho i_{t-1} + v_t \quad (6)$$

By eliminating unobserved forecasted variables in equation (6) and writing monetary policy rule in terms of variable, we obtain:

$$i_t = \rho i_{t-1} + (1 - \rho)(\alpha + \beta_\pi \pi_{t+m} + \beta_y y_{t+n}) + \varepsilon_t \quad (7)$$

Where ε_t , the error term is a linear combination of forecast errors of inflation and GDP and the initial exogenous shocks v_t , given by:

$$\varepsilon_t \equiv -(1 - \rho) \{ \beta_\pi (\pi_{t+m} - E[\pi_{t+m}|\Omega_t]) + \beta_y (y_{t+n} - E[y_{t+n}|\Omega_t]) \} + v_t \quad (8)$$

Unfortunately, previous data on the variables that appear as expectations of monetary authorities are readily available. Therefore, the expected future values of the variables are usually replaced with their present values. This approach introduces endogeneity into the empirical model, the error term including prediction errors $E[\pi_{t+m}|\Omega_t] - \pi_{t+m}$, respectively $E[y_{t+n}|\Omega_t] - y_{t+n}$ correlated with π_{t+m} and y_{t+n} . In this context, instrumental variables estimators (IV) of the generalized method of moments (GMM) are required to solve the endogeneity problems.

Finally, given u_t a vector that includes all the variables in the central bank's information set when choosing the interest rate (e.g. $u_t \in \Omega_t$) orthogonal to ε_t . Possible elements of the u_t vector cover any previous values of the variables that can be useful in forecasting inflation and output gap, but also any contemporary values of useful variables uncorrelated with current exogenous shocks of the interest rate shocks v_t .

Since $E_t[\varepsilon_t|u_t] = 0$, we can present the next set of orthogonality conditions:

$$E_t[\varepsilon_t|f_t] = 0 \quad f_t = i_t - (1 - \rho)\alpha - \beta_\pi(1 - \rho)\pi_{t+m} - \beta_y(1 - \rho)y_{t+n} - \rho i_{t-1} \quad (9)$$

This is a good framework for the generalized method of moments to estimate parameters of interest: ρ , α , β_π , β_y . The central bank's decisional process also depends on several economic indicators that cannot be approximated only by the inflation deviation and output gap. Omission of relevant variables may lead to questionable results (Goodhart and Hofmann, 2002).

Given the group of selected countries, all small open economies, the exchange rate appears as first candidate to the inclusion in the monetary policy rule. The role of the exchange rate in monetary policy rules is amply discussed in the literature. Ball (1999, 2002) showed that a strict inflation targeting strategy that does not pay attention to the exchange rate is dangerous for an open economy because it creates large fluctuations in exchange rates and real economic activity, supporting the introduction of exchange rate in the design of Taylor-type monetary policy rules. Svensson (2000) argued that the reaction function within an inflation targeting strategy identified in an open economy responds to an extensive set of information and first of all, to external disturbances. Taylor (2002) pointed out that monetary policy of such economies is different from that of closed economies, as policymakers of the first manifest a strong aversion to the exchange rate variability and supports the need to insert exchange rates into the reaction functions.

Including exchange rate in the monetary policy rule makes relation (7) become:

$$i_t = \rho i_{t-1} + (1 - \rho)(\alpha + \beta_\pi \pi_{t+m} + \beta_y y_{t+n} + \beta_s \Delta s_{t+p}) + \varepsilon_t \quad (10)$$

where Δs_{t+p} is the effective exchange rate variation.

In addition to their specific of small open economies (which as we have seen, has led to the introduction of the exchange rate into the Taylor-type monetary policy rules), selected countries involve another distinctive feature, EMU-acceding related. Identification of a specific rule for monetary policy instrument for open economies following an inflation targeting strategy and in the same time a convergence process towards the common currency system is a complex task. In this respect, Orłowski (2008, 2010) underlined that a simple Taylor rule in its original version, is not sufficient to reflect the hybrid objectives, often contradictory, of these economies (which include price stability, exchange rate stability, interest rate convergence towards the euro area and, in general terms, integration into global financial markets).

Therefore, a viable option for EU Member States following a convergence process (and especially after the entry into ERM 2) should be a more complex rule, consistent with the Maastricht convergence criteria, even if its applicability would be difficult because of multiple objectives, targeted almost exclusively sometimes, especially in the presence of global financial instability.

In order to solve the compromise generated by the necessity of considering all specific features of selected countries when setting the monetary policy rule, in terms of their convergence process, on the one hand, and maintaining technical feasibility estimation possibilities, on the other hand, we consider appropriate to include

in the equation the Eurozone nominal short-term interest rates, which makes the relation (10) become:

$$i_t = \rho i_{t-1} + (1 - \rho)(\alpha + \beta_\pi \pi_{t+m} + \beta_y y_{t+n} + \beta_s \Delta s_{t+p} + \beta_i^{EUA} i_{t+r}^{EUA}) + \varepsilon_t \quad (11)$$

where i_{t+r}^{EUA} is the Eurozone short-term nominal interest rate.

3. The estimation of Taylor-type monetary policy rules

First, we focus on the estimation of the monetary policy Taylor rule expressed by the relation (10) that, unlike the classical one takes into account the forward-looking monetary policy nature, its dynamics, the inertia degree reflected by the interest rate smoothing and includes the exchange rate. In parallel, it will track and estimate the rule expressed by equation (11) that, by introducing an additional euro area nominal interest rate, captures both the specificity of the analyzed emerging economies with a high degree of openness and their convergence process towards the euro area.

3.1. The estimation methodology

The estimation of monetary policy rule expressed by equations (10) and (11) will be achieved with the help of the generalized method of moments (GMM). The first step in GMM is to write the moment's conditions as a condition of orthogonality between regression and a set of instrumental variables (IV). This involves specifying the list of instrumental variables. The latter refer to the variables considered in central banks decision making and must be strongly correlated with the right-hand side equation variables and uncorrelated with the residuals. However, they must be predetermined when compared to the central bank's monetary policy decision moment. Thus, previous values (different lags) of the equation variables can be seen as instrumental factors, as long as they influence the past behavior of the regressors, while uncorrelated with residuals.

For the GMM estimator to be identified, we must specify at least as many tools as estimated parameters. In our case, instrumental variables considered are: a constant, the previous values of the first six months, the nine and the twelfth month (first 3 lags, the sixth lag and the 12th lag) of inflation, interest rates, GDP output and the real effective exchange rate changes. Therefore, we have 20 instrumental variables and five parameters to estimate.

All tests for the validity of restrictions over-identification (J-statistic) cannot reject the null hypothesis that states the fulfillment of over-identification restrictions. The second step of the estimation is to select the A weighting matrix. GMM weighting matrix was chosen according to Newey-West covariance estimator, robust in the presence of heteroscedasticity and autocorrelation of unknown form.

The time horizon for the variables which are in the form of expectations is considered to be equal ($m = n = p = 3, 6, 12$ or 24 months), reporting only the best results in terms of quality and estimation performance. Although, given the length of

the transmission mechanism, the prediction horizon is about 1-2 years, we have also taken into account in some cases shorter periods for two reasons: to avoid the problem of weak instruments in the GMM framework and the increase of prediction error (difference between expected inflation and its effective future value) with the enlargement of the time window.

3.2. Data

In order to forecast a Taylor-type monetary policy rule for selected Central and Eastern European countries our study uses monthly frequency data. The time horizon stretches starting with the previous month to the one the national monetary authorities have announced the transition to inflation targeting strategy for the first four states mentioned, the following month to the adoption of a monetary policy strategy based on two pillars (similar to ECB's) in Slovenia, or the month following the adoption of inflation targeting informal strategies for Slovakia. For the Eurozone, the analysis begins with the first month of 1999.

Thus, data samples cover the following ranges: Czech Republic: 1998:1 - 2012:12 (180 observations), Poland: 1999:1 - 2012:12 (168 observations), Romania: 2005:9 - 2012:12 (88 observations), Slovakia: 1998:10 - 2008:12 (123 observations), Slovenia: 2001:1 - 2006:12 (72 observations), Hungary: 2001:7 - 2012:12 (138 observations) and the Euro area: 1999:1 - 2012:12 (168 observations). All data are provided by the Eurostat database.

Variables subject to analysis include: short-term nominal interest rate as the three-month interbank market interest rate (3M Euribor for the euro area and its equivalents for the selected countries), the inflation rate measured as annual change in the Harmonized Index of prices consumption (HICP fixed base 2005 = 100, seasonally adjusted using Census X12 procedure), the output gap (real GDP - potential GDP) determined as difference between the current value log of seasonally adjusted industrial production index (fixed-base 2005 = 100) and the trend value obtained by Hodrick-Prescott filter ($\lambda = 14,400$), the real effective exchange rate expressed as an annual percentage change in fixed-base index (2005 = 100) of real effective exchange rate (taking into account the 27 trading partners) for the euro area and for each of the countries considered. The application of generalized method of moments involves the use of stationary series. We verify stationarity based on Augmented Dickey – Fuller test and the results indicate that not all variables are stationary, as some are integrated of order 1 ($I(1)$).

The evidence of nonstationary variables determines the need to identify cointegration relationships between them. The cointegration was tested with the help of Johansen (1991) methodology and the results showed the existence of cointegration equations between variables in all cases. In the literature, when looking at monetary policy rules (forward-looking) estimated by GMM, the variables are assumed to be stationary. For example, Clarida et al. (1998), although tested the stationarity following the ADF method and observed cases of integration of order 1, grounded their econometric approach based on the assumption of stationarity, stressing the relativity

of ADF test results. Despite ADF test outcomes, we consider variables as stationary, at least due to maintaining comparability with those obtained by other authors. Given this assumption results should be interpreted with some caution, although Johansen tests have identified the existence of cointegration equations.

4. Results of monetary policy rules estimation

This section presents and interprets the results of estimating the two Taylor-type rules of monetary policy.

4.1. Results of Taylor-type rule forecast for open economies

The outcomes of estimating a Taylor-type monetary policy rule expressed by equation (10) in the case of Central and Eastern European selected countries that promote an independent monetary policy or did so until the adoption of the euro, respectively for the euro zone imply some distinctive features: forward – looking nature, dynamics, result of inertia presence (interest rate smoothing) and the inclusion of the exchange rate, presented in Table no. 1.1.

Table 1: The estimation of Taylor-type monetary policy rule for selected open emerging economies

	The Czech Republic	Poland	Romania	Slovakia	Slovenia	Hungary
ρ	0.939*** (0.007) [0.000]	0.946*** (0.006) [0.000]	0.866*** (0.022) [0.000]	0.895*** (0.031) [0.000]	0.855*** (0.052) [0.000]	0.891*** (0.022) [0.000]
α	-0.068 (0.393) [0.862]	-0.379 (0.723) [0.308]	3.654*** (1.305) [0.007]	4.072*** (1.015) [0.000]	3.196*** (0.733) [0.000]	2.288** (1.173) [0.053]
β_{π}	1.156*** (0.147) [0.000]	1.874*** (0.156) [0.000]	0.819*** (0.215) [0.000]	0.561*** (0.110) [0.000]	0.425* (0.222) [0.062]	1.139*** (0.222) [0.000]
β_{γ}	0.204*** (0.072) [0.006]	0.795* (0.234) [0.002]	-0.647*** (0.151) [0.000]	0.217** (0.106) [0.044]	0.521*** (0.115) [0.000]	-0.311*** (0.087) [0.001]
β_{ε}	-0.083** (0.032) [0.011]	-0.042*** (0.037) [0.261]	-0.231*** (0.076) [0.004]	-0.254*** (0.090) [0.005]	1.048*** (0.124) [0.000]	-0.121** (0.055) [0.030]
R-squared	0.991	0.995	0.903	0.966	0.849	0.876
S.E. of regression	0.163	0.305	0.981	0.453	0.548	0.655
DW-statistic	1.299	1.394	1.876	1.564	2.040	2.011

J-statistic	0.071	0.070	0.069	0.012	0.094	0.105
Prob(J-statistic)	0.686	0.673	0.986	0.846	0.976	0.552

Source: authorial calculations

Note:

Standard errors are reported in parentheses and *p* - value in square brackets;

*, **, *** denote the rejection of the null hypothesis at 10%, 5%, 1% level of significance;

DW is the Durbin-Watson statistic to test for the serial correlation;

J-statistic is the minimized value of the objective function and Prob (J-statistic) is the *p*-value of the test statistic with the null hypothesis that the over-identification restrictions are all met.

For the Eurozone, the estimation process of the policy rule has led to the following results: $\rho = 0.971$ *** (0.009) [0.000], $\alpha = -1.445$ (2.236) [0.519] $\beta_{\pi} = 1.973$ ** (0.961) [0.042] $\beta_y = 1.563$ *** (0.455) [0.001] $\beta_s = 0.134$ ** (0.060) [0.027] R-squared = 0.989, SE of regression = 0.139, DW-statistic = 1.097, T-statistic = 0.089 and P (J-statistic) = 0.516.

In terms of prediction quality, the results presented in Table no. 1.1 are quite satisfactory (high R-squared values, relatively low standard errors of regression, higher Durbin-Watson statistic compared to the corresponding R-squared). Durbin-Watson values lower than 1.5 in some cases indicates several problems with the serial correlation of errors. However, higher values of Durbin-Watson statistic against the R-squared are a good result in the context of estimating a GMM-based Taylor-type rule. In this respect, Rudebush (2002) showed that most of static regressions also lead to a much higher R-squared than Durbin-Watson statistic, which raises questions about spurious regressions and, accordingly, about the results obtained under monetary policy rules using leveled-variables, often regarded with reservation (Path and Tchaidze, 2005).

As for the estimation results, first, we can see that all β_{π} values are statistically significant. Second, coefficient values above par for the inflation deviation can be identified for the Czech Republic, Poland, Hungary and the euro zone and a threshold value close to one for Romania. Therefore, Taylor principle is respected in all these cases. Taylor (1993) pointed out that inflation stabilization occurs only if the inflation gap coefficient is greater than one. This conclusion, known as the Taylor principle (Woodford, 2001) stresses that a stabilizing monetary policy must increase the nominal interest rate to a greater extent (more than proportionally) than inflation. In other words, inflation will remain under control only if real interest rates rise in response increasing inflation, which translates into a β_{π} coefficient greater than one (Clarida et al., 2000).

For example, in Poland, since it has followed a strategy of inflation targeting, a percentage increase in expected annual inflation led the monetary authority raise interest rates to 0.87% (*caeteris paribus*). Because β_{π} is significantly greater than one, in response to inflationary pressures, the central bank of Poland increased the real interest rate. By contrast, before it adopted the single currency, Slovenia CB raised

short-term nominal interest rate to 0.42% as a reaction to expected inflation yearly increase of 1%, but its response has not augmented the real interest rate ($\beta_{\pi} = 0.425$).

A lower inflation deviation coefficient observed in Slovakia and Slovenia could be the result of the exchange rate inclusion in the considered Taylor rule. As emphasized by Frömmel et.al. (2011), the exchange rate may partly capture the impact on inflation, anchoring expectations about future monetary policy. In this regard, the response to a rise in inflation would be modest, if the initial interest rate was set by the central bank at a level considerably higher than the inflation value. Thus, a lower coefficient would mean that monetary policy has become even more aggressive during disinflation (Golinelli and Rovelli, 2005).

High values of the inflation gap coefficient compared to those related to other macroeconomic variables taken into account by the monetary authorities in their decision making process reveal the strong orientation of selected countries towards the fulfillment of their fundamental objective, of maintaining price stability. This is obvious for the Eurozone also, as the European Central Bank is known for its stabilizing efforts, as demonstrated by high values for β_{π} , 1.93 respectively.

Although estimated coefficients for the output gap turn out to be statistically significant for all selected countries, they are counterintuitive (of opposite sign) for Romania and Hungary. The European Central Bank appears to be strongly oriented towards stabilizing the GDP gap, but also Poland, Slovenia, Czech Republic and Slovakia display a clear orientation of monetary authorities to stabilize real economic activity. Thus, in Poland for example, while *caeteris paribus*, a one percentage point increase in expected real GDP deviation from its potential level has made the national monetary authority increase the nominal short-term interest rate by 79 basis points. This highlights the reaction of the central bank of Poland (and the other central banks for which we found significant positive values of β_{π}) to the real economic activity movements independent of its inflation-related concerns.

This evidence is not likely to jeopardize the inflation target, as the identified β_{y} values are usually much smaller than those of β_{π} (Slovenia is the notable exception, as the results reflect the stabilization target of economic activity and not of inflation. It is reported that although Slovenia has applied an independent monetary policy, it did not use an IT strategy *ex ante* the integration in the euro area.

In the cases of Poland and the Czech Republic, but also in Slovakia until the euro adoption, there is an obvious practice of flexible inflation targeting strategy, leaving room for a parallel stabilization of the real economic activity. However, the estimated coefficients for the output gap must be interpreted with caution as long as their determination is not based on a high degree of certainty.

ρ inertia coefficients (interest rate smoothing) obtained are significant in all cases, placing within the interval (0.855, 0.971). Estimates however are too high to be plausible. For example, the forecasted ρ value for the Czech Republic implies that it took 12 months for only half of intended interest rate adjustments intended to occur (to reach this conclusion we calculated the sum $\sum_{k=1}^{\infty} (1 - \rho)\rho^k \equiv 0,5$). On the same line, for Poland, Romania, Slovakia, Slovenia and Hungary, the time needed to cover half of

the difference between current interest rates and intended to be set for the next horizon are 13, 7, 8, 7 and 7 months, respectively. Although central banks in the selected countries have undoubtedly attempted to reach a compromise between aggressive interest rate changes to avoid causing instability in the financial markets, on the one hand, and enhancing the credibility of monetary policy (which by default would require rapid, strong interest rate responses with a lower level of inertia) on the other hand, the gradual adjustments appear to be very slow.

The importance given by the national monetary authorities to the exchange rate stability is evidenced by the β coefficient values. And in its case, the values are found to be statistically significant for all selected countries, with only one identified counterintuitive response for Slovenia. The methodology for calculating the real effective exchange rate (EUR units per unit of currency) makes its increase lead to the appreciation of the national currency. Therefore, the minus sign of β coefficient translate into a depreciation of the domestic currency, which would attract central bank intervention to raise short-term nominal interest rate.

In Romania, Slovakia and Hungary, the national central banks orientation towards the stabilization of the exchange rate through nominal short-term interest rates seems to be obvious, while in the Czech Republic and Hungary the estimated β values (although correctly signed) appear to have a marginal importance for the monetary policy decision making. This is somehow surprising considering that all these are economies with a high degree of openness. For example, while in the case of Romania, the real depreciation of the national currency against the euro by one percentage point increased the short-term nominal interest rate of 0.23%, for the Czech Republic, the currency depreciation has led to similar interest rate increase by only 0.08%.

4.2. The results of Taylor-type rule estimation in the context of open economies following a convergence process

The focus on estimating the monetary policy rule takes into account the specific feature of analyzed economies in the process of convergence (equation 11) and leads to the results shown in Table no. 1.2. The list of instrumental variables was enriched with the first 3 lags, the sixth lag and the twelfth lag of Eurozone interest rate. Thus, the number of parameters to be estimated increased to 6 and the number of instrumental variables to 25. In all cases the validity of over-identification was confirmed.

Table 2: Estimation of a Taylor-type monetary policy rule for selected open economies following a convergence process towards the euro area

	The Czech Republic	Poland	Romania	Slovakia	Slovenia	Hungary
ρ	0.929*** (0.008) [0.000]	0.939*** (0.006) [0.000]	0.799*** (0.030) [0.000]	0.893*** (0.018) [0.000]	0.853*** (0.041) [0.000]	0.919*** (0.017) [0.000]
α	-	-2.044*** (0.566) [0.000]	3.694*** (0.920) [0.000]	1.829* (0.938) [0.054]	2.317 (2.912) [0.430]	3.426*** (1.301) [0.009]
β_{π}	0.701*** (0.114) [0.000]	1.622*** (0.147) [0.000]	0.586*** (0.099) [0.000]	0.361*** (0.082) [0.000]	0.402** (0.179) [0.030]	0.603** (0.304) [0.050]
β_{y}	0.092*** (0.031) [0.004]	0.457*** (0.125) [0.000]	-0.239*** (0.064) [0.000]	0.119*** (0.043) [0.001]	0.494*** (0.089) [0.000]	-0.179** (0.067) [0.001]
β_{π}	-0.094** (0.021) [0.000]	-0.052** (0.012) [0.261]	-0.439*** (0.054) [0.000]	-0.171*** (0.044) [0.000]	0.978*** (0.124) [0.006]	-0.222** (0.090) [0.015]
β_{π}^{EUR}	0.713*** (0.095) [0.000]	0.905*** (0.247) [0.000]	1.002*** (0.152) [0.000]	0.840*** (0.152) [0.000]	0.320 (0.961) [0.740]	0.683* (0.376) [0.072]
R-squared	0.992	0.996	0.914	0.969	0.849	0.877
S.E. of regression	0.127	0.289	0.926	0.436	0.555	0.654
DW-statistic	1.404	1.480	1.833	1.768	2.035	2.050
J-statistic	0.093	0.081	0.149	0.127	0.101	0.109
Prob(J-statistic)	0.720	0.882	0.903	0.788	0.997	0.815

Source: authorial calculation

Note:

Standard errors are reported in parentheses and p - value in square brackets;

*, **, *** denote the rejection of the null hypothesis at 10%, 5%, 1% level of significance;

DW is the Durbin-Watson statistic to test for the serial correlation;

J-statistic is the minimized value of the objective function and Prob (J-statistic) is the p-value of the test statistic with the null hypothesis that the over-identification restrictions are all met.

The additional inclusion of the convergence feature in the central banks reaction functions of selected countries does not significantly alter previously obtained results. Thus, the primary focus of monetary authorities in the region remains the closing of the inflation gap, fully in line with applied strategy of inflation targeting. This is not a strict IT monetary policy strategy, also allowing for the real economic activity and exchange rate stabilization.

This estimation version of the monetary policy rule implies that for all states in the region, (less Slovenia, where the β_t^{EUA} coefficient is not statistically significant) the adjustments of benchmark interest rates closely follow changes in the short-term EZ nominal interest rate. For example, in the Czech Republic, a percentage point increase in the ECB's expected interest rate has determined the national monetary authority raise interest rates by 0.73% (*caeteris paribus*). The convergence following the interest rates movements in the region against the Eurozone ones is high in all cases and maximum for Romania.

5. Conclusion

The estimation of a central bank reaction function in the shape of a Taylor rule is a useful tool both for identifying the objectives of central banks and for obtaining of a conclusive picture of monetary authorities' priorities. Countries of Central and Eastern Europe distinguish through a set of distinctive features related to their status of emerging economies with a high degree of openness in the process of convergence towards the euro area. Such specificity of states in the region makes the Taylor rule in its original version insufficient to reflect the hybrid objectives, often contradictory, of these economies (price stability, exchange rate stability, convergence of interest rates to the euro area), assuming the inclusion in the central bank reaction function of additional variables.

Therefore, for a more accurate identification of the factors taken into account by the monetary authorities in setting short-term nominal interest rate we have considered the estimation of two Taylor-type rules. The first concerned the anticipatory character (forward-looking) of monetary policy, its dynamics in terms of inertia levels (interest rate smoothing) and inserted the exchange rate. The second included both the specificity of the selected emerging economies with high openness degree and their position of states following a convergence path towards the euro area, by the additional introducing of the euro area nominal interest rates.

We analyzed the feasibility of the two Taylor-type proposed monetary policy rules for countries in Central and Eastern Europe that apply a strategy of inflation targeting, the lack of monetary policy independence making irrelevant to include CEE states with an exchange rate strategy (with endogenous interest rate).

The forecast of monetary policy rule that considers the specifics of selected economies with a high degree of openness shows the strong orientation towards their fundamental objective of maintaining price stability. We identified a Taylor principle in the Czech Republic, Poland and Hungary (nominal interest rate increase to a greater extent than inflation). Inflation targeting strategy does not appear, however, to be used in its strict version, allowing in parallel for the stabilizing of real economic activity and the exchange rate. Thus, in the cases of Poland and the Czech Republic and Slovakia until the adoption of the common currency, there is an obvious practice of flexible inflation targeting leaving space for a parallel stabilization of real economic activity.

This is also true for the exchange rate stabilization through nominal short-term interest rates especially in Romania, Slovakia and Hungary.

The estimation of a monetary policy rule that includes the additional features of selected countries in terms of convergence towards the euro area leads to similar results. Thus, the primary focus of monetary authorities in the region remains the closing of inflation gap, fully in line with their inflation targeting strategy. This is not a strict version of monetary policy strategy, allowing for the stabilization of the real economic activity and the exchange rate. Moreover, the forecast of a Taylor-type monetary policy rule emphasized that changes in the CBs short term nominal interest rates closely follow EZ short-term nominal interest rate variations.

6. References

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