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The appliance of the Taylor rule in Romania: myth or reality?

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Taylor (1993) proposed a rule for central banks, which links the monetary policy rate to the deviation of the inflation from its target (inflation gap) and the deviation of the GDP from its potential (output gap). We will study, estimating a linear and a non-linear Taylor-type rule, that this rule is applicable in Romania in case of actual macroeconomic environment, therefore we will demonstrate that the Taylor rule can be seen as a reality or a myth of the monetary policy.

Keywords: Taylor rule, inflation targeting, monetary policy rate, inflation gap, output gap, non-linear least squares, exchange rate.

JEL codes: E52, E43, E58, E31, E47.

Introduction

Inflation targeting was adopted in August 2005 as a monetary policy strategy in Romania, maintaining the managed float exchange rate regime. The primary objective of the National Bank of Romania (NBR) is to ensure and maintain price stability. By adopting the inflation targeting strategy, the NBR assumed explicitly the task of consistently pursuing the fulfilment of its primary objective, its accountability in achieving the inflation target being more clearly expressed while enhancing the transparency of monetary policy (NBR 2006). The ongoing nominal and real convergence coupled with EU membership[4] and the obligation to meet the Maastricht criteria put a

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[4] Romania joined the European Union on 1st of January 2007.

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real constraint on policy making in general and monetary policy in particular in the new member states (Vašiček 2012). Taylor (2001) showed that a successful monetary policy should be based on a mix of flexible exchange rate, inflation target and monetary policy rule.

We will estimate a linear and a non-linear model, which could describe the Taylor rule in case of Romania, including exchange rate movements, since they are taken into consideration at monetary policy rate settings.

This paper supplements the literature first by covering the crisis period, allowing the comparison of the monetary policy preferences of the pre- and post-crisis period, secondly by the study of an economy that has been relatively neglected by the researchers whose research area is connected with monetary policy.

The paper proceeds as follows: a review of the research based on the Taylor rule, an outline of the data and the methodology for the Taylor rule, an estimation of a linear and a non-linear Taylor-type rule and testing the correctness of the models, the main findings of the paper and directions for further research.

Literature review

Taylor (1993) proposed a rule for central banks, which links the monetary policy rate to the deviation of the inflation from its target (inflation gap) and the deviation of the GDP from its potential (output gap). The rule describes how central banks raise (reduce) the target interest rate when the expected inflation is higher (lower) than the desired target inflation rate and when the actual output is greater (smaller) than the natural output (Fan et al. 2011). The Taylor rule is a simple linear interest rate rule under the condition that the central bank is minimizing a symmetric quadratic loss function and that the aggregate supply function is linear. Moura and de Carvalho (2010) confirmed that the Taylor rules do describe the way monetary policy is conducted in the seven largest economies of Latin America, a result already identified by Taylor (1993) for the United States.

Clarida et al. (1998, 2000) provided international evidence, suggesting the use of a forward-looking version of the Taylor rule, where central banks target expected inflation and output gap instead of past values of these variables. They also proposed the inclusion of an interest rate smoothing in the estimation of the Taylor rule. The interest rate smoothing implies a gradual adjustment of policy rates to their benchmark level (Hoffmann and Bogdanova 2012). Zheng et al. (2012) concluded that a two-regime forward-looking rule performs very well in modelling actual reactions of China's monetary policy and one can capture a significant asymmetry in the monetary policy reaction of the short-term interest rate to inflation and output gap.

Taylor (2001) extended the rule to include the exchange rate as one of the economic variables the official interest rate responds to. According to Frömmel et al. (2011) during the time periods of more flexible exchange rate arrangements in Czech Republic, Poland and Romania there is a stronger focus on inflation measured by the deviation of domestic inflation from the inflation rate set by the Maastricht criterion.

The central bank can have asymmetric preferences and, therefore, follow a non-linear Taylor rule. If the central bank is assigning different weights to negative and positive inflation and output gaps in its loss function, then a non-linear Taylor rule seems to be more adequate to explain the behaviour of monetary policy (Castro 2011). Several researchers claim the non-linearity of the models in the analysis of monetary policy (Dolado et al. 2005; Kim and Nelson 2006; Boivin 2006; Brüggemann and Riedel 2011; Castro 2011; Vašiček 2012). Castro (2011) highlighted that the monetary behaviours of the European Central Bank and the Bank of England are best described by a non-linear rule, but the behaviour of the Federal Reserve of the United States can be well described by a linear Taylor rule. Vašiček (2012) tried to reveal whether monetary policy could be described as asymmetric in three new member states that apply inflation targeting (the Czech Republic, Hungary and Poland). He didn’t find any rationale for asymmetric policy in terms of non-linear economic relations.

Fendel et al. (2011) results show that for most inflation targeting countries[5] financial markets adopt the Taylor-rule framework and, in particular, the Taylor principle for their forecasts at least at some time horizons. Kurz and Kurz-Kim (2011) modified the Taylor regression by a more realistic assumption on the central bank's behaviour that the central bank gives an absolute priority to stabilizing inflation and supports economic activity only when the inflation situation allows this, which enables them to give a possible explanation – at least for the euro-area data – for the alleged conflict between the economic theory (necessity of a stable relationship in the Taylor rule) and the usual empirical results (non-existence of a co-integrating relationship). According to Siklos and Wohar (2006) since the real interest rate incorporates one or more possible co-integrating relationships, there is an error correction term in Taylor rule equation. They further argue, that a co-integrating relationship may be turned on, or off, in a regime sensitive manner.

Maria-Dolores (2005) estimated Taylor rules for selected Central and Eastern European (CEE) economies and found that the Taylor rule is a good representation of how central banks in countries[6] with floating exchange rates set the interest rate. Paez-Farrell (2007) asked the question whether the central banks from the Visegrad group (the Czech Republic, Hungary, Poland and Slovakia) set the interest rates according to the Taylor rule using different specifications, and found that, except Slovakia, the exchange rate has a prominent role in the Taylor rule, as well as that measures are sensitive to the measure of inflation that is used. Caraiani (2013) emphasizes that the central banks of CEE economies (Czech Republic, Hungary and Poland) reacted to exchange rates and monetary policies were found to be characterized by a moderate (in the Czech case) or low gradualism (for Hungary and Poland), as implied by the smoothing parameter corresponding to the

[5] In case of Brazil, Chile, Mexico, and Poland. Hungary and the Czech Republic were exceptions among the group of inflation targeting economies.

[6] Czech Republic, Hungary and Poland.

interest rate. Caraiani's (2011) findings highlight that the monetary policy rule in Romania including the exchange rate performed better than the monetary policy rules without the exchange rate.

Methodology and data

Taylor's (1993) original formulation of a simple policy rule is as follows:

$$i_t = r^* + \pi_t + \beta_\pi \cdot (\pi_t - \pi^*) + \beta_y \cdot y_t \ , \qquad (1)$$

where i_t is the central bank nominal interest rate,
r^* is the equilibrium real interest rate,
π_t is the current period inflation rate,
π^* is the central bank's inflation target,
y_t is the current period output gap,
β_π and β_y are positive parameters.

The following values of the coefficients captured the interest rate setting of the Federal Reserve Bank over the period 1987 to 1992 quite well: $r^* = 2$, $\pi^* = 2$, $\beta_\pi = \beta_y = 0.5$. The Taylor principle, meaning that the nominal policy interest rate moves more than one-for-one with inflation, is a fundamental aspect leading to stability in theoretical models (Mehrotra and Sánchez-Fung 2011). It is very advisable to adjust the rule according to specific country conditions. Many different versions of this simple rule have been used and tested in many empirical works.

In this study we will test empirically the following modified Taylor-type rule with time-varying coefficients[7]:

$$i_t = a + b \cdot i_{t-1} + c \cdot (\pi_t - \pi_t^*) + d \cdot y_t + f \cdot \Delta e_t + \varepsilon_t \ , \qquad (2)$$

[7] Kim and Nelson (2006) and Fan et al. (2011) analyzed a model with time-varying coefficients in the Taylor rule. One reason for time-varying coefficients is the persistency of the inflation rate. There are periods of high inflation rates and periods of low inflation rates. The target inflation rate may change from time to time as a result.

where i_t is the monetary policy rate of NBR at period *t*,

π_t is the current period inflation rate at period *t*,

π_t^* is the NBR's inflation target at period *t*,

y_t is the current period output gap[8] at period *t*,

Δe_t RON/EUR exchange rate growth,

a is a constant which corresponds to the sum of long-run real interest rate and the inflation target from equation (1),

b and *f* are regression parameters,

c is the inflation reaction parameter (positive),

d is the output gap reaction parameter (positive).

With the help of the lagged monetary policy rate term we manage to smooth the monetary policy rate, which implies a gradual adjustment of policy rates to their benchmark level.

In addition, we will study whether the estimations fit past monetary policy rates better when rules are generalized to incorporate smoothing. The following Taylor-type rule will be estimated:

$$i_t = \rho \cdot i_{t-1} + (1-\rho) \cdot [\alpha + \beta \cdot (\pi_t - \pi^*) + \gamma \cdot y_t + \delta \cdot \Delta e_t] + \varepsilon_t \; , \qquad (3)$$

where i_t is the monetary policy rate of NBR at period *t*,

π_t is the current period inflation rate at period *t*,

π_t^* is the NBR's inflation target at period *t*,

y_t is the current period output gap at period *t*,

Δe_t RON/EUR exchange rate growth,

ρ is the smoothing parameter,

α is a constant which corresponds to the sum of long-run real interest rate and the inflation target from equation (1),

β is the inflation reaction parameter (positive),

γ is the output gap reaction parameter (positive),

δ is a regression parameter,

ε_t error term.

[8] The output gap is measured as the percentage difference between real GDP and the potential GDP.

The study uses quarterly time series data for Romania between 2005:Q4 and 2013:Q1, since in August 2005 there was a shift in monetary policy strategy adopting the inflation targeting. The source of the monetary policy rate and the exchange rate is the interactive database of the National Bank of Romania, while the CPI, inflation target and the output gap derive from the inflation reports published quarterly by the NBR.

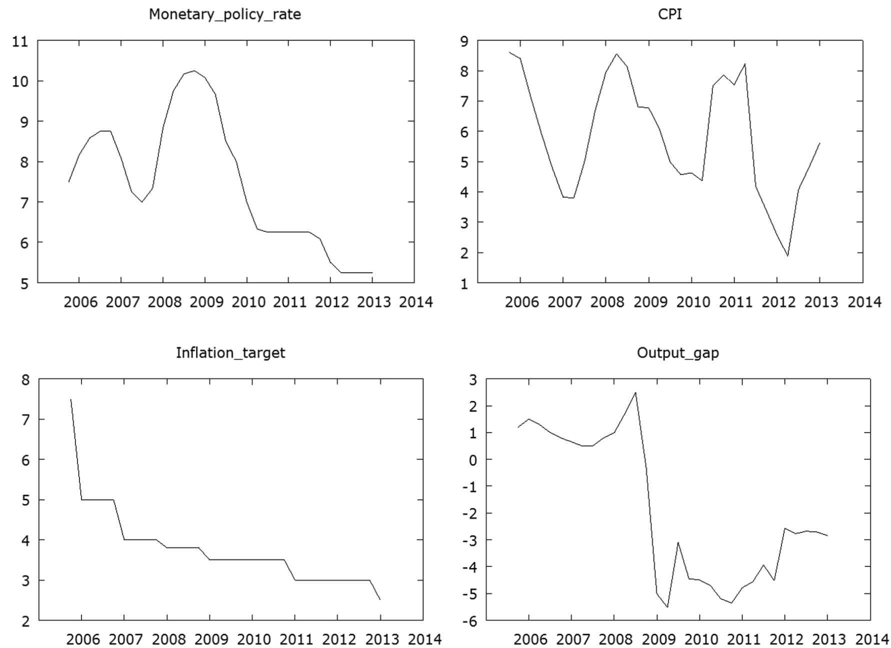
Empirical results

In August 2005 inflation targeting was adopted as a monetary policy strategy in Romania, maintaining the managed float exchange rate regime. Similar to the experience of other central banks from Central and Eastern Europe, which are implementing inflation targeting, it can be observed a decline in the inflation targets which is required primarily in order to consolidate the disinflation process and achieve a sustainable annual inflation rate in the medium term. Starting with 2013 NBR follows a flat multi-annual inflation target, this is an intermediate stage meant to ensure transition towards the phase of long-term continuous inflation targeting – in line with the ECB's quantitative definition of price stability (NBR 2013).

In the first half of 2008, the joint impact of supply- and demand-side factors caused a rise in the inflation rate to 9 percent in July, which called for monetary policy tightening. Consequently, the central bank revised the monetary policy rate upwards, in five consecutive stages, from 8.0 percent to 10.25 percent per annum (NBR 2009a). In 2009 the National Bank of Romania opted for a gradual, albeit steady, adjustment of broad monetary conditions so as to maintain a prudent monetary policy stance and to lay the groundwork for a sound recovery of lending (NBR 2010). The policy rate was lowered gradually. It can be observed in Figure 1 that CPI suffers a quick increase[9] followed by a decrease in

[8] In the second half of 2010 the annual rate of increase of administered prices stepped up from 3.61 percent to 8.68 percent, mostly as a result of the substantial raise in heating rates (also due to the standard VAT rate hike) (NBR 2011).

2011. The large downturn of the Romanian economy in 2009 Q1 and Q2 the annual GDP dynamics fell deep into negative territory, due solely to the abrupt decline in domestic demand, which still remains negative.



Source: NBR Annual Reports and Inflation Reports from 2005 to 2013

Figure 1. The evolution of the monetary policy rate, CPI, inflation target and output gap between 2005:Q4 and 2013:Q1

After the inflation targeting adoption, the currency intervention remained available as a policy instrument. Despite NBR interventions, the exchange rate (see Figure 2) of the RON witnessed a significant nominal appreciation immediately before and after EU accession (Isărescu 2012), which was the result of the improvement of investor sentiment towards sovereign risk (NBR 2007). At mid-2007, the RON appreciated to a five-year high amid capital inflows sparked by EU membership and economic catching-up. Between mid-2007 and late 2008, the RON's exchange rate followed a broad depreciation trend in the midst of intensifying global market tensions (European Commission 2012). In September 2008 the RON/EUR exchange rate posted higher volatility and re-entered a sharp uptrend, similarly to its major peers in the region (NBR 2008). Following agreement in early 2009 to provide Romania with a coordinated package of international financial assistance, financial market pressures eased and the RON broadly stabilized against the euro (NBR 2009b). The RON/EUR exchange rate followed a steeper downward path in the latter part of 2011 Q1. The RON's exchange rate temporarily depreciated at times of heightened global risk aversion (in spring 2010 and autumn 2011). The RON's exchange rate against the euro remained broadly stable in early 2012, though at a moderately weaker level than the 2009-2011 average (European Commission 2012).

Source: http://www.bnr.ro/Interactive-database-1107.aspx, downloaded at 30.10.2014.

Figure 2. The evolution of the RON/EUR daily exchange rate between 03.10.2005 and 29.03.2013

In what follows we will estimate the monetary policy rate. In the case of backward-looking specifications estimations are done trough ordinary least squares (OLS). Equation (2) includes a lagged policy variable, to

Table 1. OLS, using observations 2006:1-2013:1 (T = 29)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.738909	0.297069	2.4873	0.02022	**
Output gap	0.136161	0.0214048	6.3612	<0.00001	***
Δ exchange rate	1.36548	0.422631	3.2309	0.00356	***
Inflation gap	0.184812	0.0305284	6.0538	<0.00001	***
Monetary policy rate (-1)	0.871239	0.0366776	23.753	<0.00001	***

Mean dependent var	7.459770	S.D. dependent var	1.638697
Sum squared resid	1.980959	S.E. of regression	0.287298
R-squared	0.973654	Adjusted R-squared	0.969263
F(4, 24)	221.7357	P-value(F)	1.42e-18
Log-likelihood	-2.235355	Akaike criterion	14.47071
Schwarz criterion	21.30719	Hannan-Quinn	16.61181
rho	-0.102959	Durbin's h	-0.555365

RESET test for specification -
Null hypothesis: specification is adequate
Test statistic: F(2, 22) = 1.97148 with p-value = P(F(2, 22) > 1.97148) = 0.163092

White's test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 19.8418 with p-value = P(Chi-square(14) > 19.8418) = 0.13521

Test for normality of residual -
Null hypothesis: error is normally distributed
Test statistic: Chi-square(2) = 0.0997662 with p-value = 0.951341

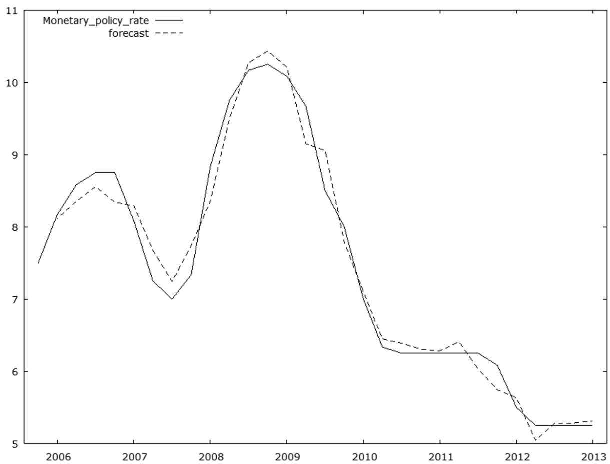
LM test for autocorrelation up to order 4 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.15417 with p-value = P(F(4,20) > 1.15417) = 0.360338

Note: Dependent variable: monetary policy rate

Source: own calculation in Gretl

account for instrument smoothing, and the exchange rate. According to Kurz and Kurz-Kim (2011) one of the most important requirements of the Taylor regression in equation (2) is that either all the variables or the error term must be stationary. The latter means that the variables from (2) must be co-integrated if they are non-stationary. In our case the error term of the OLS regression is stationary, thus we can use the OLS.

Our OLS model can be accepted, since all conditions were met and tested. The relationship between the monetary policy rate and the predictor variables is linear and good specified, since the null hypothesis of the RESET test cannot be rejected. White's test indicates that heteroskedasticity is not present. The error terms are normally distributed and they are not correlated. There is no collinearity between the explanatory variables. All explanatory variables are statistically significant, have the expected sign and they explain in 96.93 percent the variance of the monetary policy rate. The high degree of explanatory power can be seen in Figure 3, which shows the estimated and the actual values of the monetary policy rate. We can observe that in 2008 the policy rate has almost always been higher than the Taylor rule.



Source: own calculations in Gretl

Figure 3. Taylor rule and the monetary policy rate in Romania

We estimate equation (3) by non-linear least squares (NLS) with heteroskedasticity and autocorrelation adjusted (HAC) standard errors, which is based on the Newey-West procedures as it can be seen at table 2. The error term of the second regression is also normally distributed.

In line with the results of Hoffmann and Bogdanova (2012) the monetary policy rate smoothing plays an important role also in Romania. In emerging market economies this smoothing value is around 0.9. In Romania this smoothing coefficient is 0.87, which means that the policy rate adjusted very slowly to their benchmark level in the analysed period.

Table 2. NLS, using observations 2006:1-2013:1 (T = 29)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
ρ	0.871239	0.0366776	23.75	<0.00001	***
α	5.73859	0.900089	6.376	<0.00001	***
β	1.43530	0.455480	3.151	0.0043	***
γ	1.05746	0.293021	3.609	0.0014	***
δ	10.6047	4.07578	2.602	0.0156	**
R-squared	0.973654	Adjusted R-squared		0.969263	

Note: Dependent variable: monetary policy rate

Source: own calculation in Gretl

In line with the results of Fendel et al. (2011) in case of CEE inflation targeting countries and Caraiani (2011) in case of Romania, our results suggest that the Taylor principle holds in Romania and the output gap reaction parameter is significantly positive. In contrast with the results of Fan et al. (2011) we find significant response of monetary policy rate to the output gap. In accordance with the findings of Caraiani (2013), who found clear evidence that central banks reacted to exchange rates, since the associated coefficients to exchange rates are significantly different from zero, it can be affirmed that the NBR reacted to the exchange rate movements in the analysed period, which highlights the importance of including the exchange rate in the Taylor rule.

Conclusion

Contrary to the view held by Hoffmann and Bogdanova (2012), who highlighted that there is a global deviation from the Taylor rule, which can be explained by the systemic influence of other factors in policy rate setting, specifically of concerns about financial instability and about the stabilizing capital flow and exchange rate movements, our results indicate, based on the estimation of both models, that the Taylor rule is adequate in case of Romania. This can be due to the fact that we included the effects of the exchange rate movements in our models, and our results confirm that the NBR reacted to the exchange rate in the analysed period. As in all inflation targeting countries, in Romania there is more focus on the inflation deviation from its target, than on the output gap. The reaction parameters are in concordance with the Taylor rule. In case of positive deviation of the inflation rate from its target and of the real GDP from its potential, i.e. positive output gap, it would be associated with a tightening of monetary policy. Therefore we can affirm that in case of Romania the Taylor rule is a reality, not a myth.

Further research directions could be the estimation of models which can capture all the macroeconomic factors that are taken into account by the NBR when they decide upon the monetary policy rate.

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