E C O N O M I C S   B U L L E T I N

Understanding monetary policy in Central European countries using Taylor-type rules: the case of the Visegrad four

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Abstract

This paper assesses to what extent simple Taylor-type monetary policy rules provide a good description of interest rate setting behaviour in the Visegrad four countries. Six different models are analysed, chosen on the basis of possessing desirable theoretical features. The paper finds that exchange rates feature prominently in three of the four countries' policy rules and that the results are sensitive to the measure of inflation used.

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1. INTRODUCTION

The accession of new member states to the EU and their commitment to eventually adopting the euro has elevated the importance of these economies within Europe. Having faced years of restructuring the Visegrad four countries (Poland, Hungary, the Czech Republic and Slovakia) have been successful at reducing inflation and stabilising output fluctuations. Essential in achieving this outcome has been the commitment of monetary policymakers to controlling inflation, in some cases adopting an explicit inflation targeting regime. This policy – if credible – would have not only the benefit of anchoring expectations, hence ensuring that inflation would remain low, but it would also reduce the volatility of inflation if the policy regime becomes transparent and predictable. In other words, most interest rate movements would be systematic and shocks would be of a small magnitude. An implication of this is that monetary policy can then be reasonably described by a rule.

After a period where monetary policy was focused on exchange rate stabilisation following the collapse of communism, the Visegrad four countries have gradually adopted explicit inflation targeting (with some adjustments), beginning with the Czech Republic in 1997, Poland in 1998 and Hungary in 2001. Slovakia began targeting inflation implicitly from 1999, but officially from 2005 when it also became a member of ERM II. The latter event poses a challenge to the Slovak monetary authorities, as there may be times when targeting inflation may clash with targeting the exchange rate.

Despite the academic popularity of Taylor rules, research on estimating monetary policy rules for the Visegrad four countries is very scarce, and those that have been carried out do not consider all of the issues analysed in this paper. María-Dolores (2005) focuses on estimating Taylor rules for the Visegrad four during the period 1998-2003, with emphasis on the degree of forward or backward-looking behaviour in the policy rule. He finds support for a backward looking Taylor rule for Poland, the Czech Republic and Hungary, whereas for Slovakia monetary policy was better characterised by a forward-looking rule. Most importantly, the long run coefficient on inflation was not statistically different from unity in any of the four countries, with the implication that the Taylor principle - whereby the monetary authority responds to increases in inflation by increasing real rates – did not hold. In that case the results indicate that monetary policy was destabilising, as increases in inflation would not be fully offset by rises in nominal interest rates. This would have the consequence of reducing real interest rates which would then, by stimulating output, exacerbate the rise in inflation.

Mohanty and Klau (2004) expand the analysis by including the real exchange rate and the possibility of non-linearities in the monetary policy rule. They reject non-linear behaviour for Hungary and Poland, but not for the Czech Republic.[1] Furthermore, the only country with a long run coefficient on inflation greater than unity is Poland, although no test is carried out to determine whether it is significantly different from unity.

[1] Slovakia is not considered in their study.

More recently, Frömmel and Schobert (2006) estimate the reaction functions for the Visegrad four using a forward looking rule for inflation and including an exchange rate measure. The main results for the more recent period (2000-2005 except for Slovakia, which was 1998-2005) showed that the coefficient on the inflation rate was insignificant for the four countries.[2] On the other hand, the exchange rate (either nominal or real) was significant in the Czech Republic and Hungary.

The overall results that emerge from previous research is that the monetary policy reaction functions include an exchange rate element during periods of fixed exchange rate regimes, and that monetary policy in the Visegrad four countries has not adhered to the Taylor principle. Although the latter conclusion implies the possible destabilising effects on inflation, this conclusion is in stark contrast to the fact that inflation has remained relatively low in all four countries. One can put forward two explanations for this: either the Taylor principle is not a necessary condition for inflation stability, or previous estimations have modelled the monetary policy reaction functions incorrectly. The different models considered in this paper attempt to shed light on the latter explanation.

2. TAYLOR RULES IN CENTRAL EUROPE

This paper estimates several monetary policy rules which have been proposed in the literature for possessing desirable feature in terms of output and inflation stabilisation. In the standard Taylor rule the interest rate responds to inflation and the output gap contemporaneously, but two simple alternatives will also be considered. The backward looking Taylor rule is chosen on the grounds that it is more capable of ensuring determinacy (Carlstrom and Fuerst, 2000). Moreover, in the context of the economies considered in this paper, which are undergoing structural change, a backward-looking approach may be desirable. Additionally, a forward-looking Taylor rule will be considered on the premise that if monetary policy affects inflation and output with a lag, a pre-emptive approach has potentially stabilising effects.

The suitability of considering a forward-looking rule is strengthened by the fact that all of the central banks considered in this paper mention the forward-lookingness of interest rate setting.[3] Nevertheless, this formulation implies an equivalent backward-looking specification by substituting for expected future values a function of current information.[4] Each of the three formulations mentioned above can be represented as:

$$R_t = m_0 + f(L)R_{t-1} + m_2 E_{t-1}p_{t+k} + m_3 E_{t-1}x_{t+k} \quad (1)$$

where R_t denotes the nominal interest rate, p is the 12 month inflation rate (as a deviation from its target) and x represents the output gap. E_{t-1} is the expectational

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[2] This is not the case when sub-samples are used for each country, but the lagged interest is then close to unity.
[3] See, for example, National Bank of Poland (2003).
[4] See Sims (2003). Alternatively, any forward-looking model can be represented in state space form in which case the expectations of future variables are functions of the state variables.

operator conditional on information up to period t -1 and the subscript k pertains to each of the three monetary policy rules. Lastly, L represents the lag operator.

A general feature of the three Taylor-type rules mentioned above is the fact that the output gap is hard to measure, with the consequence that the performance of the monetary policy rule - in terms of output and inflation stabilisation - will worsen. To overcome this Orphanides and Williams (2002) propose a policy rule where interest rate changes respond to the differenced unemployment rate, that is:

$$\Delta R_t = m_2 E_{t-1} p_t + m_3 E_{t-1} \Delta ue_t \qquad (2)$$

In which ue denotes the unemployment rate. Nevertheless, the equation will also be estimated in the level of the interest rate for comparison with all the other models. An additional issue concerns the objectives of the central bank. The monetary policymaker's loss function is often depicted as a quadratic function of deviations of inflation from a target value and the output gap. However, Walsh (2003) suggests that the Taylor rule should be modified to include the change in the output gap instead of its level, that is, a speed limit policy. His suggestion for this formulation arises from speeches by US monetary policymakers where this kind of policy has been mentioned. Although speed limit policies have not featured in the monetary policy discussions of the countries considered in this paper, analysing a growing economy makes the analysis of the growth of output relative to potential a likely argument in the reaction function. In this case the modified rule would be represented as:

$$R_t = m_0 + f(L) R_{t-1} + m_2 E_{t-1} p_t + m_3 E_{t-1} \Delta x_t \qquad (3)$$

Whilst the assumption that the central bank has quadratic preferences can be a motivating factor for linear Taylor rules, this may well be regarded as unnecessarily restrictive, with an asymmetric structure for preferences accounting for the opportunistic approach to disinflation[5] and allowing for a non-linear interest rate rule. The resulting non-linear policy rule would then be a function not only of the inflation rate and the output gap but would also contain their interaction as well as quadratic terms:

$$R_t = m_0 + f(L) R_{t-1} + m_2 E_{t-1}(p_t) + m_3 E_{t-1} x_t + m_4 E_{t-1}(p_t^2) + m_5 E_{t-1}(x_t^2) + m_6 E_{t-1}(p_t x_t) \qquad (4)$$

Finally, policy rules that directly react to changes in the exchange rate will also be considered. Although the theoretical literature has shown that there are few gains in directly reacting to exchange rate movements,[6] the four countries have at times had a fixed exchange rate policy and their commitment to eventually joining the euro provides an additional role for stabilising the nominal exchange rate in preparation for this. Nevertheless, even when the monetary authorities react to exchange rate movements, it is not clear whether one should use the real or nominal exchange rate, so that both will be considered in the estimations.

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[5] See Blinder (1997) and Surico (2003)

[6] See, for example, Leitemo and Söderstrom (2005).

3. ESTIMATION RESULTS

All the models considered are estimated using monthly data for inflation, the output gap, a short term interest rate, several exchange rate measures and unemployment. The sample periods are 2001:05 to 2006:07 for the Czech Republic; 2002:07 to 2006:07 for Hungary; 1998:06 to 2006:08 for Poland and 1999:06 to 2006:07 for Slovakia. All the data are taken from Eurostat, with the output gap measured as the Hodrick-Prescott filtered index of industrial production. Of the different exchange rate measures used in the estimations, only the one providing the best results for each country will be presented below for brevity.[7]

Crucially, the inflation measure is not derived from the overall HICP index, as done in previous studies on Central Europe. Rather, the inflation rate used is calculated from the overall index excluding energy,[8] which can be interpreted as core inflation. Although this measure of inflation results in a shorter sample period it provides a better fit in the estimation results as it is closer to the inflation rate that central banks generally target. Moreover, using some measure of core inflation tends to indicate a larger response of interest rates to increases in inflation than with other measures. In the case of the forward-looking rules, the forecast period presented is the one that provides the best fit.

The equations – with the exception of the backward-looking Taylor Rule – are estimated with GMM using six lags of each of the explanatory variables and the interest rate as instruments. The J-test confirms the validity of these instruments in all the regressions and the Newey-West criterion is used to choose the lag truncation parameter.

Table I presents the estimation results for the Czech Republic. Comparing the models in terms of Schwarz's Bayesian Information Criterion indicates that the best fit is provided by the speed limit policy, with the Box-Pierce-Ljung statistic indicating no residual autocorrelation. The basic Taylor rule and its forward variant perform poorly in this respect. On the other hand, the non-linear Taylor rule does indicate the existence of some non-linearities, especially for inflation. Alternative specifications were considered with respect to the exchange rate, with the change in the nominal exchange rate (vis-à-vis the euro) providing the best fit, although it is only significant at the 10% level. Overall, this provides support for the Czech Republic's official policy of a flexible exchange rate and is corroborated by the recent abandonment of its timetable for joining the euro.
The favoured representation, the speed limit rule, indicates a large amount of inertia in interest rate changes and a small coefficient on the inflation rate, with the result that the long run coefficient on inflation is less than unity.

It is notable that the coefficient on the change in the output gap is highly significant but negative, which runs counter to the rationale for including the output gap (or its growth rate) in the policy rule, whereby a positive output gap results in an increase in interest rates that will then reduce output via the IS equation. However, it is important

[7] Measures considered were the nominal and real effective exchange rates, and the bilateral exchange rate with the euro.
[8] For Poland inflation is calculated from the HIPC index excluding energy, food, alcohol and tobacco. For the other countries this distinction makes not difference to the results.

to note that detrended output is not the same as the output gap but it represents cyclical output. In a model with flexible prices the output gap would always be equal to zero, and cyclical output (having detrended the original series) would differ from long-run output as a result of, say, temporary technology or taste shocks. In the presence of nominal rigidities however, the output gap is not necessarily zero, but it would be defined as the difference between current cyclical output and its flexible price counterpart (the latter being equivalent to cyclical output in the absence of nominal rigidities). Therefore, the use of cyclical (detrended) output as a measure of the output gap makes sense only if there are no real shocks.[9] This leaves the interpretation of the negative coefficient on differenced cyclical output rather ambiguous, especially when the countries considered in this paper have been facing a period of economic restructuring. Similar issues arise in the use of the Orphanides-Williams policy rule, which finds little support in any of the countries studied in this paper.

The results for Poland are shown in Table II,[10] with the coefficients on lagged interest rates and inflation remaining largely stable throughout all the model specifications. It is noteworthy that the long run coefficient on inflation from all the different models considered (ignoring the effects of the exchange rate on inflation) range from 1.4 to 2,[11] indicating a strong commitment to stabilising inflation. However the preferred model, where the central bank responds to the real exchange rate[12] is hard to interpret, with the coefficient on the exchange rate being positive. This seems to indicate that a real appreciation would result in the monetary authorities raising rates. A similar result to this is obtained by Frömmel and Schobert (2006).

In the case of Hungary, shown in Table III, the Taylor principle generally holds. Although the basic Taylor rule provides a good overall description of interest rate movements, the preferred specification is the one with monetary policy reacting to the exchange rate, in this case the real effective exchange rate. However, in this case the inclusion of the exchange rate has rendered cyclical output insignificant.

Lastly, Table IV presents the results for Slovakia, which displays a substantial amount of variation in the coefficients for lagged interest rates and inflation under the alternative model specifications. The basic Taylor rule and its non-linear specification perform very poorly, with the coefficients on inflation and output in the former being negative. The preferred model, that in which the central bank responds to the nominal exchange rate, results in an insignificant coefficient on output and a low reaction to inflation, but a strong response to exchange rate movements. This is not surprising, given Slovakia's membership of ERM II and its strong commitment to joining the euro in 2008-09. In this respect, although Slovakia's reaction function does not exhibit a strong response to inflation, as in the case of Poland, this is substituted by a strong reaction to the exchange rate.

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[9] Therefore, the use of the word output gap for cyclical output used earlier in the paper was technically incorrect, but was maintained for consistency with the literature.
[10] Results for the non-linear monetary policy rule are very poor and are therefore not presented.
[11] The exception is the Orphanides-Williams specification, but since it performs so poorly it won't be considered any further.
[12] An increase represents a real appreciation.

4. CONCLUSION

Taylor rules have been useful as a descriptive tool of good monetary policy, both in a positive and normative sense. However, several authors have proposed alternative monetary policy rules that aim to improve upon the standard Taylor rule specification to account for the open economy, lags in the monetary transmission mechanism, difficulties in measuring the natural rate of unemployment and inherent non-linearities in the monetary policy reaction function.

This paper has tried to determine if any of these alternative monetary policy rules provides a good account of interest rate setting behaviour in the Visegrad four countries and found that the exchange rate features prominently in three of the four countries (Poland, Hungary and Slovakia). In the case of Slovakia it is the nominal exchange rate, which is not surprising, given its commitment to joining the euro. However, the fixed exchange rate regime exposes the Slovak monetary authorities to the Monetary Trilemma, as the additional commitment to targeting inflation is not borne out by the data: Slovakia's long run coefficient on inflation is 0.2, well below the Taylor principle's value of unity.

In Hungary, monetary policy was found to respond to the real exchange rate whilst the results for Poland are somewhat confusing, as the estimated monetary policy rule indicates a positive interest rate effect from an exchange rate appreciation. The importance of the exchange rate in the monetary policy rule can be interpreted as being caused by political considerations or due to some optimising behaviour. However, recent research[13] casts doubt on the welfare benefits of including the exchange rate in the interest rate reaction function.

The exception to the inclusion of the exchange rate in the policy rule was the Czech Republic, where a speed limit rule – one where monetary policy responds to the change in the output gap – provided the best description of the data. However, the coefficient on "speed" was negative, although this may be due to the fact that detrended output does not yield the output gap, but cyclical output, in which case a negative coefficient would be expected if supply shocks had been dominating output movements.

An additional element of the present paper, ignored in much of previous research on Central European countries, is the consideration of core inflation (HICP inflation excluding energy and food) as the inflation measure that central banks respond to. This modification results in a larger coefficient on the interest rate response to inflation. Given the weight attached to core inflation in the central banks' statements,[14] the low coefficients on inflation obtained by other authors may be a result of the measure of inflation used.

Lastly, since the focus on monetary policy rules is closely linked to the importance of using monetary policy to stabilise inflation, Poland and Hungary represent the most aggressive of the four countries in responding to inflation, with a long run coefficient (ignoring exchange rate effects) on the inflation rate of 1.4 and 1.2, respectively.

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[13] See among others, Leitemo and Söderström (2006).

[14] See Magyar Nemzeti Bank (2007), Czech National Bank (2007), National Bank of Poland (2007) and National Bank of Slovakia (2007).

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Table I. Estimated Policy Rules for the Czech Republic

	Basic TR	**Forward TR**	**Backward TR**	**Non-linear TR**	**TR with ER**	**Speed Limit**	**TR with Unemployment**
c	0.27	0.04	0.42	0.50	0.18	0.13	-0.01
	(0.08)	(0.06)	(0.10)	(0.10)	(0.04)	(0.04)	(0.01)
i_{t-1}	0.88	0.95	0.84	0.83	0.92	0.95	1
	(0.02)	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)	
p_t	0.13	-	-	-0.08	0.08	0.04	-0.01
	(0.02)			(0.06)	(0.01)	(0.01)	(0.01)
p_{t+k}	-	0.13	0.08	-	-	-	-
		(0.02)	(0.03)				
y_t	-0.06	-	-	0.004	-0.03	-	-
	(0.01)			(0.03)	(0.01)		
y_{t+k}	-	-0.06	0.02	-	-	-	-
		(0.01)	(0.01)				
p_t^2	-	-	-	0.07	-	-	-
				(0.02)			
y_t^2	-	-	-	0.013	-	-	-
				(0.007)			
$p_t y_t$	-	-	-	-0.037	-	-	-
				(0.017)			
Δy_t	-	-	-	-	-	-0.02	-
						(0.006)	
Δer_t	-	-	-	-	0.07	-	-
					(0.04)		
Δue_t	-	-	-	-	-	-	-0.08
							(0.12)
B-P-L	23.4	25.5	5.4	3.0	14.3	10.3	12.5
SBC	-3.05	-3.1	-2.92	-3.1	-3.3	-3.48	-3.25
J	9.2	8.2	-	5.7	11.5	9.0	9.9

Notes: Standard errors in parentheses. B-P-L denotes the Box-Pierce-Ljung Q statistic for residual autocorrelation to the 12th order, which is distributed as chi-squared (12) with critical value of 21.03. SBC is the Schwarz Bayesian Criterion and J is a test of overidentifying restrictions. *k* is -1 for the backward-looking model and 12 (6) for inflation (output) in the forward looking alternative.

Table II. Estimated Policy Rules for Poland

	Basic TR	**Forward TR**	**Backward TR**	**TR with real exchange rate**	**Speed limit**	**TR with unemployment**
c	0.28	0.16	0.27	-6.03	0.17	-0.24
	(0.06)	(0.05)	(0.06)	(2.57)	(0.05)	(0.05)
i_{t-1}	1.27	1.40	1.30	1.23	1.37	1
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	
i_{t-2}	-0.35	-0.45	-0.38	-0.35	-0.43	-
	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	
p_t	0.12	-	-	0.17	-	-0.01
	(0.02)			(0.03)		(0.01)
p_{t+k}	-	0.08	0.12	-	0.12	-
		(0.02)	(0.03)		(0.02)	
y_t	0.05	-	-	0.08	-	-
	(0.02)			(0.02)		
y_{t+k}	-	-	0.05	-	-	-
			(0.01)			
p_t^2	-	-	-	-	-	-
y_t^2	-	-	-	-	-	-
$p_t y_t$	-	-	-	-	-	-
Δy_t	-	-	-	-	0.01	-
					(0.65)	
Δer_t	-	-	-	-	-	-
er_t		-	-	1.37	-	-
				(0.56)		
Δue_t	-	-	-	-	-	-1.1
						(0.29)
B-P-L	10.4	-	15	9.17	16.6	66.7
SBC	-1.16	-1.01	-1.03	-1.19	-0.95	-0.64
J	6.66	-	7.7	10.18	9.8	10.6

Notes: Standard errors in parentheses. B-P-L denotes the Box-Pierce-Ljung Q statistic for residual autocorrelation to the 12th order, which is distributed as chi-squared (12) with critical value of 21.03. SBC is the Schwarz Bayesian Criterion and J is a test of overidentifying restrictions. k is -1 for the backward-looking model and 6 (-1) for inflation (output) in the forward looking alternative. The speed limit policy uses lagged inflation.

Table III. Estimated Policy Rules for the Hungary

	Basic TR	**Forward TR**	**Backward TR**	**Non-linear TR**	**TR with real exchange rate**	**Speed limit**	**TR with unemployment**
c	0.29 (0.06)	-0.36 (0.21)	0.47 (0.42)	-0.40 (0.24)	5.29 (0.32)	0.18 (0.11)	0.23 (0.11)
i_{t-1}	0.86 (0.01)	0.88 (0.03)	0.92 (0.08)	0.84 (0.03)	0.83 (0.01)	1.03 (0.03)	1
p_t	0.19 (0.03)	-	-	0.55 (0.14)	0.20 (0.02)	-0.12 (0.06)	-0.059 (0.025)
p_{t+k}	-	0.34 (0.07)	0.05 (0.11)	-	-	-	-
y_t	0.13 (0.01)	-0.09 (0.04)	-	0.16 (0.01)	0.014 (0.0107)	-	-
y_{t+k}	-	-	0.03 (0.06)	-	-	-	-
p_t^2	-	-	-	-0.037 (0.016)	-	-	-
y_t^2	-	-	-	0.03 (0.01)	-	-	-
$p_t y_t$	-	-	-	-	-	-	-
Δy_t	-	-	-	-	-	0.04 (0.02)	-
er_t	-	-	-	-	-0.04 (0.002)	-	-
Δue_t	-	-	-	-	-	-	0.09 (0.23)
B-P-L	5.4	4.4	7.5	6.5	8.1	8.6	8.9
SBC	-0.43	-0.34	-0.46	-0.25	-0.57	-0.28	-0.39
J	10.4	7.4	-	9	8.4	9.5	10.2

Notes: Standard errors in parentheses. B-P-L denotes the Box-Pierce-Ljung Q statistic for residual autocorrelation to the 12th order, which is distributed as chi-squared (12) with critical value of 21.03. SBC is the Schwarz Bayesian Criterion and J is a test of overidentifying restrictions. k is -1 for the backward-looking model and 6 for inflation in the forward looking alternative.

Table IV. Estimated Policy Rules for Slovakia

	Basic TR	**Forward TR**	**Backward TR**	**Non-linear TR**	**TR with nominal exchange rate**	**Speed limit**	**TR with unemployment**
c	0.12 (0.13)	-0.38 (0.14)	0.57 (0.23)	0.58 (0.73)	-52.29 (0.48)	0.31 (0.11)	0.08 (0.09)
i_{t-1}	1.03 (0.05)	0.90 (0.06)	0.61 (0.06)	0.51 (0.08)	0.486 (0.026)	0.94 (0.05)	1
i_{t-2}	-	-	0.06 (0.12)	-	-	-	-
p_t	-0.06 (0.04)	-	-	0.36 (0.30)	0.112 (0.03)	0.001 (0.04)	-0.02 (0.017)
p_{t+k}	-	0.19 (0.07)	0.18 (0.05)	-	-	-	-
y_t	-0.06 (0.04)	-0.22 (0.05)	-	0.83 (0.26)	0.063 (0.039)	-	0.05 (0.023)
y_{t+k}	-	-	0.08 (0.05)	-	-	-	-
p_t^2	-	-	-	-0.004 (0.02)	-	-	-
y_t^2	-	-	-	0.22 (0.13)	-	-	-
$p_t y_t$	-	-	-	-0.15 (0.06)	-	-	-
Δy_t	-	-	-	-	-	0.002 (0.01)	-
er_t	-	-	-	-	0.15 (0.02)	-	-
Δue_t	-	-	-	-	-	-	-0.22 (0.28)
BPL	7.4	18.3	19.3	29	13.8	7.6	7.88
SBC	0.36	0.46	-0.32	0.72	-0.50	-0.32	0.21
J	10.3	10.7	-	5.8	6.97	10	14.16

Notes: Standard errors in parentheses. B-P-L denotes the Box-Pierce-Ljung Q statistic for residual autocorrelation to the 12th order, which is distributed as chi-squared (12) with critical value of 21.03. SBC is the Schwarz Bayesian Criterion and J is a test of overidentifying restrictions. *k* is -1 for the backward-looking model and 6 for inflation in the forward looking alternative.