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Monetary policy rules and the information content of the term structure of interest rates

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The study incorporates information on the term structure of interest rates into empirical reaction functions for the Bundesbank and the European Central Bank. The results suggest that the term structure played a statistically significant role for the monetary policy of both central banks.

I. Introduction

The traditional Taylor rule (Taylor, 1993) states that the monetary authority should set the short-term interest rate in proportion to the output gap and the gap between the actual level of inflation and its target. Since the seminal paper of John B. Taylor empirical reaction functions have been formulated for all major central banks. Several papers suggest extending the benchmark Taylor rule in different directions. Most importantly, some authors claim that central banks reveal a forward-looking behaviour and, additionally, show a strong tendency to smooth the interest rate (Clarida *et al*., 1998). Less attention has been paid to the presence of yield curve effects so far. However, the yield curve could play an important role for determining monetary policy. This study investigates the role the term structure of interest rates played for the monetary policy of the Bundesbank and the European Central Bank (ECB). It augments the empirical reaction function popularized by Clarida *et al*. (1998).

II. Theoretical Considerations

The term structure of interest rates is an important feature for the conduct of monetary policy. Although monetary policy is intended to work through aggregate demand, none of the important sectors of real spending depends directly on the overnight rate. Instead, aggregate spending depends on longer-term interest rates. Therefore, gauging how changes in the short rate triggered by the central bank affect the longer-term interest rates and, thus, the entire term structure of interest rates is important for understanding the monetary transmission mechanism.

The yield curve contains important information for monetary policy makers, but the information content at the short end differs from the one at the long end. At the short end, interest rates primarily reflect market expectations about very near-term monetary policy settings of the overnight rate. At this horizon, central banks are especially interested in the implied forward rates in order to understand market expectations regarding future changes in the interest rate instrument. Given such expectations, central banks can evaluate whether their near-term policy intentions are being appropriately communicated to market participants.

An important reason of why central banks move short-term rates in steps is that they can observe the consequences of their action and assess sequentially the need for each incremental rate change. Using the implied forward rates, a central

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bank can see whether its initial rate increase (decrease) carries with it expectations of a whole sequence of increases (decreases) of anticipated future increases. To the extent that a central bank's subsequent interest rate moves were predicted, they would not constitute new policy impulses (Goodfriend, 1998). Any subsequent change should then *ex ante* be priced into the longer term rates. Insofar as the future monetary policy is understood by the private sector, markets can to a large extent 'do the central bank's work for it', in that the actual changes in overnight rates required to achieve the desired incentives can be much more modest when expected future rates move as well (Woodford, 2004, p. 17).

At the medium- and longer-end, say, in a three-to-ten-year horizon, the term structure provides an indication of the market's inflation expectations. Central banks extract inflation expectations both as inputs for forecasting future inflation and economic activity, and as a measure of the credibility of the current stance of monetary policy in achieving the long-run goal of price stability. Schich (1996), for instance, finds evidence that the German medium segment of the term structure contains significant information about future inflation development.

Since monetary policy is often empirically described by monetary policy rules, it seems worthwhile to examine whether the presence of term structure effects do have any implications for those rules. At first glance, there seems to be a major inconsistency between the presence of monetary policy rules and the complexity of term structure effects described above. Monetary policy rules, on the one hand, imply some kind of mechanical usage of the monetary policy instrument in response to the cyclical state of the economy. Term structure effects, on the other hand, contain some degree of ambiguity that might not easily be reconciled with mechanic monetary policy rules. However, the next section demonstrates that monetary policy rules can be estimated in a way that is consistent with the way central bankers think about the term structure.

III. Estimation Results

Following Clarida *et al*. (1998), a general representation of the reaction function can be written as:

$$i_t = (1-\rho)\Big(\bar{r} + E(\pi^*_{t+q}|I_t) + \gamma_\pi E(\pi_{t+q} - \pi^*_{t+q}|I_t) + \gamma_y E(y_{t+l} - \bar{y}_{t+l}|I_t)$$

where i is the short-term interest rate, y is the output level (with the bar indicating potential output), π is inflation (with a star indicating the target level), ρ represents a smoothing parameter, E is the expectation operator given the information set I_t, the γ's represent the reaction parameters with respect to the output gap and the inflation gap respectively, q and l are the horizons of the forward-looking behaviour, and v is the error term. This reaction function is used as a benchmark case in the empirical analysis and German data prior to the introduction of the euro is focused on and Euro area data afterwards.

The data are monthly and cover the period from 1:1980 to 12:1998 for the Bundesbank reaction function and 1:1999 to 8:2004 for the ECB reaction function. The data on the German inflation gap is constructed using the difference of the consumer price index and the so-called price norm that was announced by the Bundesbank on an annual basis. The European inflation gap is the difference between the harmonized consumer price index (HCPI) and 1.5 which one supposes is close to the inflation target the ECB had in mind during the period under consideration. The output gaps are based on the monthly index of German and European industrial production respectively and are constructed on the basis of a linear trend.[1] The short-term interest rate is estimated as the German overnight money market rate for the Bundesbank reaction function and the EONIA (European Overnight Index Average) for the ECB reaction function. In order to estimate the forward-looking monetary policy rule, a GMM estimation is implemented.[2] $q = 12$ and $l = 0$ are set and following set of instruments are used: a constant as well as lagged values of the output gap, the inflation gap, the IMF commodity price index and the short-term interest rate.[3]

[1] In order to avoid starting point and end point problems, the trend over an extended period is computed covering 1970 through 2003 for the German output gap. For the European trend the study did not extent the period under consideration. A HP filter was also used in both cases and the reported results were robust against this change.

[2] Heteroscedasticity was corrected for and autocorrelation of unknown form. In addition, Bartlett weights were chosen to ensure positive definiteness of the estimated variance-covariance matrix.

[3] More specifically, the study used the first six, the ninth and the twelfth lag of the output gap, inflation gap and the IMF commodity price index as well as the first, sixth, ninth and twelfth lag of the short term interest rate. This is close to the instruments suggested by Clarida *et al*. (1998). For the ECB reaction function the IMF commodity price index was left out because J-tests rejected it as a valid instrument.

Table 1. Estimation results

	Specification (1)		Specification (2)	
	Bundesbank	ECB	Bundesbank	ECB
Constant term	3.11	2.66	1.33	−0.70
	(0.693)	(0.233)	(0.977)	(0.612)
Exp. inflation gap	1.63	1.15	1.26	0.95
	(0.188)	(0.322)	(0.124)	(0.239)
Output gap	0.14	0.28	0.05	0.31
	(0.065)	(0.028)	(0.033)	(0.032)
Change in the short-end spread	–	–	−1.81	−2.58
	–	–	(0.528)	(0.439)
Medium-term rate	–	–	0.48	0.75
	–	–	(0.127)	(0.114)
Smoothing parameter	0.95	0.73	0.87	0.87
	(0.012)	(0.047)	(0.02)	(0.012)
Durbin Watson	1.5	1.06	1.22	2.31
J-Stat.	13.3	8.5	11.4	10.1
Adj. R^2	0.97	0.94	0.98	0.98

Note: Standard errors in parentheses.

Table 1 shows the estimation result of our benchmark regression.

The benchmark regression shows that the Bundesbank and the ECB responded to the inflation and the output gap. The coefficients of the inflation gaps imply that the Taylor-principle holds in both cases. However, as is argues in this study, the benchmark specification lacks important arguments from the term structure. Therefore it is tested whether information from the term structure can explain part of the residuals from the benchmark regressions. Since it is reasoned above that the information content of the term structure differs between the short end and the medium-to-long end, the next step employs simultaneously two kinds of term structure information.[4] First, the 5-year interest rate is taken. This is a proxy for expected inflation over horizons of the medium term or, more specifically, for horizons of more than 12 months, which is not covered by the forward-looking inflation term. Second, the spread between the monthly money market rate and the one year interest rate is calculated as information on the short end of the yield curve. The difference between its time t and time $t-1$ value is used as a proxy for the 'change in the short-end spread'. Assuming that the risk premium is constant over time an increasing spread means that implied forward rates (i.e., the expected future short-term interest rates) are increasing more than the actual short rate.

An OLS regression of the residual from the previous regression for the Bundesbank reaction function on the two yield curve variables yield (standard errors are in parentheses):

$$\begin{aligned}&\text{Residual}\,(\nu)\\&= \alpha_1 * \text{'change short end spread'} + a_2 * \text{'medium rate'}\\&\quad -021 \qquad\qquad 0.0071\\&\quad (0.049) \qquad\qquad (0.0027)\\&\quad \text{adj. } R^2 : 0.09\end{aligned}$$

The estimation indicates that part of the residual can be explained with the information taken from the term structure of interest rates so that the benchmark regression is not specified correctly. But the influence of the two yield curve variables differs in signs. This indicates the ambiguity in the interpretation of term structure movements.

Based on the residual regression the policy rules are re-estimated and both yield curve variables are included. The result is shown as specification (2) in Table 1. The parameters on the expected inflation gap and the output gap remain broadly unchanged although the ECB now slightly fails the

[4] German yield curve data were relied on also for the ECB reaction function because the German yield curve is interpreted as a reasonable approximation for the Euro area yield curve. The estimates of the German yield curve are based on the parameters of the Svensson (1994) smoothing technique as made available by the Bundesbank.

Taylor principle. The parameters on the 'change in the short end spread' have the expected negative signs in both cases. If, for instance, an increase in the policy rate triggers expectations of future increases, the initial increase can, *ceteris paribus*, be lower but still has the desired effects on aggregate demand. Both central banks managed to create expectations of a sequence of further interest rate changes. However, the coefficients for the medium-term interest rate are positive indicating that both central banks additionally reacted to rising inflation expectation at horizons greater than that captured by the included forward-looking inflation gap term.

IV. Conclusions

The study shows that the Bundesbank and the ECB reacted to developments in the German term structure. Movements at the short-end of the term structure indicated expected future policy rate changes which, in turn, dampened the (need for) actual responses. Instead, increasing rates at the medium-term triggered both central banks to increase its policy rate, because these movements indicated rising inflation expectations, which they wanted to counteract.

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