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MONETARY POLICY, FORWARD RATES AND LONG RATES: DOES GERMANY DIFFER FROM THE UNITED STATES?

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Centre for Economic Policy Research
25–28 Old Burlington Street
London W1X 1LB
Tel: (44 171) 878 2900
Email: cepr@cepr.org

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ABSTRACT

Monetary Policy, Forward Rates and Long Rates:

Carlo A Favero, Fabrizio Iacone and Marco Pifferi
IGIER
Università Bocconi
via Salasco 5
20136 Milano
ITALY
Tel: (39 2) 5838 3306/5836 5327
Email: favero@vm.uni-bocconi.it

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NON-TECHNICAL SUMMARY

This paper is concerned with the response of the term structure of interest rates to monetary policy in Germany and the United States over the period 1991–5.

We analyse the reaction of the whole term structure of spot rates to monetary policy in Germany and the United States. We do so by estimating the term structure of spot rates and of the instantaneous forward rate following the methodology proposed by Svensson (1994). We intepret the instantaneous forward rate as the expectations for the overnight rate prevailing at each point in the future. Exploiting the fact that interventions on policy rates take place on the occasion of regular meetings of the Federal Reserve Open Market Committee in the United States and of the Bundesbank Council in Germany, we estimate the term structure of spot rates and of instantaneous forward rates the day before and the day after regular meetings. From the estimation of the term structures of forward rates we derive expected overnight rates for all future dates, which we interpret as a pure expectational model based measure of expectations for central bank interventions. This measure is not extracted from a time-series model, and it is not subject to the standard objections to (linear, autoregressive) marginal models related to the assumptions of linearity, time invariance and absence of mis-specification. We are thus in a position to assess comparatively the ability of US and German monetary and financial markets to predict policy rates at several future dates: the date after the meeting occurring the next day (here the horizon is one-day, but it is a special day); the day after the second meeting (approximately 45 days ahead); the day after the third meeting (approximately 90 days ahead); and the day after the fourth meeting (approximately 135 days ahead). A measure of policy shocks at different horizons with reference to the same information set can then be derived by using realized overnight rates. This measure of policy shocks is available both for dates on which an intervention was implemented by central banks and for dates on which a policy of no intervention has been decided. Given our measures of unexpected monetary policy, we evaluate the impact on the whole term structure of expected and unexpected monetary policy by regressing the appropriate shift (1-day, 45-days, 90-days and 135-days ahead) on the correspondent measure of policy shocks. We conduct this exercise for Germany and the United States over the period 1991–5 to assess comparatively the predictability of intervention rates in Germany and the United States and to evaluate the sign and the magnitude of the response of the whole spectrum of the term structures in the two countries to expected and unexpected modifications in monetary policy.

We concentrate on the sample period 1991–5, when the comparative analysis of the behaviour of German and US short-term and long-term interest rates has received a considerable amount of attention, following the 'decoupling' of the short-term interest rates which has taken place since the beginning of 1993 and the associated almost perfect 'coupling' of long-term interest rates. The restrictive monetary policy implemented by the FED from 1993 onwards has been associated with a notable reduction in the magnitude of the term spread, with the ratio of the yield on the ten-year government bond benchmark to the interest rate on three-month eurodollars shifting from nearly 2 to 1. At the same time the expansionary monetary policy implemented by the Bundesbank has resulted in an opposite movement of the same term spread from 1 to 2. The traditional interpretation of the two movements hinging on a tight credible monetary policy in the United States and an excessively loose monetary policy in Germany has been challenged by an argument related to the behaviour of risk premium in Germany, which relates the unusual steepening of the German yield curve to the incumbence of EMU and creation of a future European central bank.

Our main results can be summarized as follows:

- Pure expectational model-based predictions of future policy rates are more precise for the German than for the US case, especially when the forecasting horizon is extended to more than one meeting ahead.

- Expected monetary policy shifts have an impact on the very short end of the term structure in the United States (zero to six months), while they maintain a significant effect on the German term structure up to the 18-month maturity.

- Long-term US rate react significantly to unexpected monetary policy shifts, while German long rates do not.

- Given that German long rates do not react to both unexpected and expected monetary shifts, it seems that international factors (stability of Deustche Mark/US dollar exchange rates over long-term horizons) are more relevant than domestic factors in the determination of German long-term interest rates.

1. Introduction

This paper is concerned with the response of the term structure of interest rates to monetary policy in the US and in Germany over the period 1991-95.

We analyse the reaction of the whole term structure of spot rates to monetary policy in the US and Germany. We do so by estimating the term structure of spot rates and of the instantaneous forward rate following the methodology proposed by Svensson(1994). We interpret the instantaneous forward rate as the expectations for the overnight rate prevailing at each point in the future. Exploiting the fact that interventions on policy rates take place in occasion of regular meetings of the FOMC in the US and of the Bundesbank council in Germany, we estimate the term structure of spot rates and of instantaneous forward rates the day before and the day after regular meetings. From the estimation of the term structures of forward rates we derive expected overnight rates for all future dates, which we interpret as a pure expectational model based measure of expectations for central bank interventions. Such measure, is not extracted from a time-series model, and it is not subjected to the standard objections to (linear, autoregressive) marginal models related to the assumptions of linearity, time invariance and absence of misspecification (see Rudebusch,1996, and Christiano, Eichenbaum and Evans, 1996). We are then in the position to assess comparatively the ability of US and German monetary and financial markets to predict policy rates at several future dates : the date after the meeting occurring the next day (here the horizon is one-day, but it is a special day), the day after the second meeting (broadly 45 days ahead), the day after the third meeting (broadly 90 days ahead) and the day after the fourth meeting (broadly 135 days ahead). A measure of policy shocks at different horizons with reference to the same information set can be then derived by using realised overnight rates. Such measure of policy shocks is available both for dates in which some intervention was implemented by Central Banks and for dates in which a policy of no intervention was decided. Given our measures of unexpected monetary policy, we evaluate the impact on the whole term structure of expected and unexpected monetary policy by regressing the appropriate shift (1-day, 45-days, 90-days and 135-days ahead) on the correspondent measure of policy shocks. We have chosen these frequencies to allow comparability of our event-study results with results based on time series data observed, respectively, at daily, monthly, and quarterly frequencies. We conduct such exercise for the US and Germany over the period 1991-1995 to assess comparatively the predictability of intervention rates in US and Germany and to evaluate the sign and the magnitude of the response of the whole spectrum of the term structures in the two countries to expected and unexpected modification in monetary policy.

We have chosen to concentrate on the sample period 1991-1995, when the comparative analysis of the behaviour of US and German short-term and long-term interest rates has received a considerable amount of attention, following the "decoupling" of the short-term interest rates which has taken place from the beginning of 1993 onwards and the associated almost perfect "coupling" of long-term interest rates (see Figure 1). The restrictive monetary policy implemented by the FED from 1993 onwards has been associated with a notable reduction in the magnitude of the term spread, with the ratio of the yield on the 10 year government bond benchmark to the interest rate on three month eurodollars shifting from nearly two to one. At the same time the expansionary monetary policy implemented by the Bundesbank has resulted in an opposite movement of the same term spread from 1 to 2. The traditional interpretation of the two movements hinging on a tight credible monetary policy in the US and an excessively loose monetary policy in Germany has been challenged by an argument related to the behaviour of risk premium in Germany, which relates the unusual slope of the German yield curve to the incumbency of EMU and creation of a future European central bank. We think that a comparative analysis of the response of the term structure to expected and unexpected monetary policy could help in providing some interpretation of the empirical observations. Our choice of sample could be criticised on the grounds of the potential relevance of *peso problems* and of the absence of variety of policy regimes. Figure 1 witnesses the existence of substantial variation in the long and short term interest rates and the presence of both expansionary and contractionary monetary policy regimes. As far as *peso problems* are concerned, we think that they are not crucially relevant to our methodology, which does not impose any a priori restrictions on the distribution of forecasting errors. If markets persistently expect a monetary contraction (or expansion) even if the expected policy is not implemented, our measure of expectations will simply reflect the markets' attitude.

A comparative analysis of US and Germany is also justified by the results of recent investigations on the expectations theory. Gerlach and Smets(1995), using monthly data for a the sample 1970-1994, analyse the predictive power of the term spread about the future course of short-term interest rates , considering Euro-rates at 1,3,6, and 12-month maturities, to find that the prediction of the expectational model are not rejected in 35 of the 51 cases considered. German data behave rather closely to the predictions of the theoretical model while the US are the only country for which the predictions of the expectational models are rejected at all maturities. The fact that the results for the US are different from those for the other countries has also been observed by Hardouvelis(1994).

Our analysis of the reaction of the whole spectrum of spot and forward rates to monetary policy and of the predictability of future policy rates is justified by the results that the evidence empirical failure of the expectational model for the US has been found varying with the maturity spectrum. In fact there is evidence for a stronger rejection at the short-end of the maturity spectrum(Mankiw and Summers, 1984, Shiller, Campbell, Shoenholtz,1983). The same failure has also been related to the low predictability of the short term US interest rates by Mankiw and Miron(1986) who show that the failure of the prediction of the model could be explained by the stabilisation policy of the Fed, which induces a random-walk behaviour in short-term interest rates eliminating any predictable variation. This paper has opened a strand of research relating the empirical failure of the prediction of the expectational model to the Fed's reaction function (Rudebusch, 1992, McCallum,1994).

Lastly we remark that our event-study methodology falls in the vein of the studies by Cook and Hahn(1989)(CH), Nilsen(1995)(N) and Skinner and Zettelmeyer(1995)(SZ). All these studies analyse the reaction of the term structure to modifications in monetary policy in occasion of the occurrence of Central Banks intervention. CH and N separate the anticipated from the unanticipated component of the policy move by carefully reading the "Credit Markets" column in the Wall Street Journal to distinguish whether there existed a clear unambiguous belief among analysts of an imminent change in Fed policy. CH concentrates on the sample 1973-1985, while N takes the sample 1985-1992. SZ identify unanticipated policy shocks by considering changes in the three-month interest rate the day of the announcement of the change in monetary policy. The idea is that the three month rate is sufficiently short term that the monetary authorities may be thought of controlling it and sufficiently long-term that it will not react to an anticipated policy action. The procedure followed by CH, N, and SZ delivers a decomposition of modifications in policy rates into expected and unexpected components available only in occasion of effective intervention by the central bank. We believe that a sample selection problem might be relevant to all these investigations because they exclude from the sample all the decisions to leave policy rates unchanged.

Our approach is more general in the sense that we consider all FOMC's and Buba Council's decisions, independently from the occurrence of intervention: our measure of anticipated intervention, being based on the estimation of the term structure of instantaneous forward rates, allows a symmetric treatment of the central banks' decisions to intervene and to leave policy rates unchanged.

2. Methodology

Our methodology is based on the use of instantaneous forward rate as monetary policy indicators. Forward rates are interest rates on investment made at a future date, the *settlement date*, and expiring at a date further into the future, the *maturity date*. Instantaneous forward interest rates are the limit as the maturity date and the settlement date approach one another. The relation between a yield to maturity and the instantaneous forward rate at that maturity is analogous to the relation between marginal and average cost. So the curve of instantaneous forward rate lies above the curve of spot rates, when this is positively sloped, and below the curve of spot rates, when this is negatively sloped. If the pure expectational model is valid and there is no term premium, then instantaneous forward rates at future dates can be interpreted as the expected spot interest rates for those future rates. As the frequency of observation of our data is daily, the observable equivalent of the instantaneous forward rate is the overnight rate. So the curve of instantaneous forward rates at future dates can be interpreted as indicating the expected overnight rates for those future dates. If the overnight rate is thought of as a rate controlled by monetary authorities, then the curve of instantaneous forward rates can be thought of as an indicator of expected monetary policy, based on the pure expectational model. Monetary policy "surprises" can be generated "ex-post" by computing the distance between observed overnight rates and expected overnight rates.

Applying this framework to the dates of meetings of Central Banks in which monetary policy actions are taken, we believe we can provide evidence on the ability of the expectational model to predict very short-term interest rate movements.

Having performed our analysis on the predictability of policy rates we then concentrate on the term structure of spot rates to analyse shifts of this curve in response to anticipated and unanticipated monetary policy. The prediction of the expectational model here are that only unanticipated monetary policy should be significant in explaining the shifts in the term structure, although the sign of the effect is not determined uniquely by the theory. Goodfriend(1991,1995) has made clear that the impact of restrictive monetary policy depends on the effects of such policy on the market's fear for inflation: a restrictive monetary policy which signals the credibility of Central Bankers policy in fighting the "inflation scares" should be followed by a downward shift of the term structure of interest rates, whilst a restrictive monetary policy which is not effective in fighting "inflation scares" could be followed by an upward shift in the term structure. Lastly, by analysing shifts of the entire yield curve in response to monetary policy we provide evidence on the issue of different explanatory power of the expectational model at different maturities.

To give a more precise background to the description of our results we espouse algebraically the relation between spot and forward rates and we give some details on the estimation methods we have adopted.

2.1. *Spot Rates, the Expectational Model and Forward Rates*

To illustrate our derivation of spot rate let us start by the consideration of a zero coupon bond issued at time t with a face value of 1, maturity of m years and price PZC_{mt}. The simple yield Y_{mt} is related to the price as follows:

$$(1) \qquad PZC_{mt} = \frac{1}{(1+Y_{mt})^{m}}$$

Define the spot rate r_{mt} as $\log(1+Y_{mt})$, which is the continuously compounded yield, and define the discount function D_{mt} as the price at time t of a zero coupon that pays one unit at time t+m, we then have :

$$(2) \qquad PZC_{mt} = \exp(-mr_{mt}) = D_{mt}$$

Consider now a coupon bond that pays a coupon rate of c per cent annually and pays a face value of 1 at maturity. The price of the bond at trade date is given by the following formula:

$$(3) \qquad P_{mt} = \sum_{k=1}^{m} cD_{kt} + D_{mt}$$

Given the observation of prices of coupon bonds, spot rates on zero coupon equivalent can be derived by fitting a discount function based on the following specification for the spot rates:

$$(4)\; r_{kt} = \beta_0 + \beta_1 \frac{1-\exp\left(-\frac{k}{\tau_1}\right)}{\frac{k}{\tau_1}} + \beta_2 \left(\frac{1-\exp\left(-\frac{k}{\tau_1}\right)}{\frac{k}{\tau_1}} - \exp\left(-\frac{k}{\tau_1}\right) \right) + \beta_3 \left(\frac{1-\exp\left(-\frac{k}{\tau_2}\right)}{\frac{k}{\tau_2}} - \exp\left(-\frac{k}{\tau_2}\right) \right)$$

such specification has been originally introduced by Svensonn(1994) and it is an extension of the parametrization proposed by Nelson and Siegel(1987).

Note that our estimated spot rate differs from the yield to maturity often quoted for coupon bonds. In fact the quoted yield to maturity, y_{mt}, is defined by the following relation:

$$(5) \qquad P_{mt} = \sum_{k=1}^{m} c \exp(-k y_{mt}) + \exp(-m y_{mt})$$

Yield to maturities are then averages of spot rates up to the time of maturity. While in general spot rates defined by (3) vary with the maturity, the yield to maturity defined by (5) is constant. Henceforth the term structure of interest rates estimated on yield to maturities is valid only when the term structure of spot rates is flat. Moreover, the yield to maturity for a bond with given maturity depends on the coupon rate, the so-called "coupon effect". Spot rates instead are free from such an effect.

Implied forward rates can be calculated from spot rates. A forward rate at time t with trade date t+t' and settlement date t+T can be calculated as the return on an investment strategy based on buying zero-coupon bonds at time t maturing at time t+T and selling at time t zero coupon bonds maturing at time t+t'. The forward rate is related to the spot rate according to the following formula:

$$(6) \qquad f_{T+t,t'+t,t} = \frac{T r_{T,t} - t' r_{t',t}}{T - t'}$$

so the forward rate for a 1-year investment with settlement in 2 years and maturity in 3 years is equal to three times the 3 year spot rate minus twice the two year spot rate.

The instantaneous forward rate is the rate on a forward contract with an infinitesimal investment after the settlement date:

$$(7) \qquad f_{mt} = \lim_{T \to m} f_{T+t,m+t,t}$$

In practice we identify the instantaneous forward rate with an overnight forward rate, a forward rate with maturity one day after the settlement. The relation between instantaneous forward rate and spot rate is then

$$(8) \qquad r_{mt} = \frac{\int_{\tau=t}^{t+m} f_{\tau t} \, d\tau}{m} \quad \text{or, equivalently}$$

$$(9) \qquad f_{mt} = r_{mt} + m \frac{\partial r_{m,t}}{\partial m}$$

Given specification (4) for the spot rate, the resulting forward function is as follows:

$$(10) \qquad f_{kt} = \beta_0 + \beta_1 \exp\left(-\frac{k}{\tau_1}\right) + \beta_2 \frac{k}{\tau_1} \exp\left(-\frac{k}{\tau_1}\right) + \beta_3 \frac{k}{\tau_2} \exp\left(-\frac{k}{\tau_2}\right)$$

Therefore as k goes to zero the spot and the forward rate coincide at $\beta_0+\beta_1$ and as k goes to infinite the spot and the forward rate coincide at β_0. The forward rate function features a constant, an exponential term decreasing when β_1 is positive, and two "hump shape" terms.

3. Empirical Results

Our empirical results are based on the estimation of spot and forward rate curves the day before and the date after the FOMC meetings and the Bundesbank Council's meetings occurred in the period 1991-1995. We fit curves to the overnight rate, the 1-month, 3-month, 6-months and 12 months eurocurrency rate and the 3-year, 5-year, 7-year and 10-year fixed interest swaps' rate. We have chosen the fixed interest rates on swaps as the natural long-term counterparts of Euro-rates. We also believe that swaps rates are appropriate for international comparisons in that they provide a standardisation of credit and taxes across currencies and a consistent set of rates across the maturity spectrum. Our sample includes thirty-seven FOMC meetings and one-hundred and twenty Bundesbank Council's meetings. Spot and forward curved are estimated with the method described in the previous section, by using the Svensson parameterization whenever the convergence could not be achieved by the implementation of the Nelson and Siegel parameterization. Estimation was implemented in GAUSS. The parameterization strategy has always delivered rapid convergence of estimates at a precision level that we judged satisfactory for our purposes.[1] Curves for US and Germany are estimated with comparable precision: the average root mean squared yield error are 0.67 percentage points in the case of Germany (240 estimated curves, the days before and

[1] The results of the estimation of spot and forward rates at all dates are available upon request

the days after the 120 meetings in our sample) and 0.9 percentage points in the case of the United States (74 estimated curves, the days before and the days after the 74 meetings in our sample).

3.1. The predictability of policy rates

We interpret the instantaneous forward rates as the expected future spot overnight rates and the overnight rates as the policy rates. We then assess the predictability of policy rates by implementing regression analysis and a non-parametric test of predictive performance.

Having estimated spot rate curves and instantaneous forward rate curves the day before and the day after each of thirty-seven meeting of the FOMC and the hundred and twenty meetings of the Bundesbank Council which took place in our sample, our regression analysis is based on the estimation of the following model:

$$(11) \qquad r_{1t_{i+j}+1} - r_{1t_i-1} = \hat{\beta}_j\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right) + \hat{u}_{t_{i+j}+1}$$

j=0,1,2,3 for the US, j=0,3,6,9 for Germany

Where we indicate with $t_i = t_1,..t_k,...\ t_T$ the dates of the Central Banks meeting in which decision on policy rates are taken (T=37 for the US and 120 for Germany), while r_{1t} indicates the overnight rate at time t and f_{mt} indicates the instantaneous forward rate computed at time t for time t+m. Given that FOMC meetings take place about every 45 days and Bundesbank council's meeting take place every two weeks, the estimated parameters, their standard errors and the R^2 of the regressions allow the comparative assessment of the predictability of policy rates in US and Germany one-day ahead, forty five-days ahead, ninety days-ahead, and one hundred and thirty five days ahead.

To supplement regression analysis, we implement the Pesaran-Timmerman(1990) non parametric test of predictive performance to evaluate the accuracy of forecast of the sign of $r_{t_{i+j}+1,t_i-1}$ based on the sign of $\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right)$.

The predictive test failure test implemented is based on the proportion of times that the sign of a given variable y_t is correctly predicted in the sample by the sign of the predictor x_t.

Given indicators variables Y_t, X_t and Z_t which take value of one if $y_t>0$, $x_t>0$ and $y_tx_t>0$, respectively, and zero otherwise, we denote P_y =prob(y_t>0), P_x =prob(x_t>0) and by $\hat{P}$ the proportion of time the sign of y_t is predicted correctly:

$$\hat{P} = N^{-1}\sum_{t=1}^{N} Z_t = \bar{Z}$$

On the assumption that x_t has no power in predicting y_t, $N\hat{P}$ has a binomial distribution with mean NP* where P* =prob(Zt=1)=PyPx +(1-Py)(1-Px). Pesaran and Timmermann(1990) show that a test of the null of predictive failure can be based on the following statistic

$$\text{sign} = \frac{\hat{P} - \hat{P}^{*}}{\left[V\left(\hat{P}\right) - V\left(\hat{P}^{*}\right)\right]^{1/2}}$$

(12) $$\hat{P} = \bar{Z}, \quad \hat{P}^{*} = \hat{P}_y \hat{P}_x + (1-\hat{P}_y)(1-\hat{P}_x)$$

$$V\left(\hat{P}\right) = N^{-1}\hat{P}^{*}(1-\hat{P}^{*})$$

$$V\left(\hat{P}^{*}\right) = N\left((2P_y - 1)^2 P_x(1-P_x) + (2P_x - 1)^2 P_y(1-P_y) + 4N^{-1}P_yP_x(1-P_y)(1-P_x)\right)$$

The sign statistic is asymptotically distributed as a standard normal

Our empirical results are reported in Table 1.

Insert Table 1 here

The regression analysis for the US case show that there the instantaneous forward rate is not informative in predictive very short term movements of the policy rates, while predictability increases and reaches a peak at 45-days and then decreases at 90-days ahead and 135-days ahead. Although the estimated coefficient of the regression of the change in the overnight rate on the difference between the appropriate instantaneous forward and the spot rate before FOMC meeting is always significant, the R^2 of the regressions reaches a peak of 0.33 at 45-days ahead to decrease to 0.15 and 0.17 for the 90-days and the 135-days horizons. The sign test tend to confirm these results, with a clear improvement in the very short-term performance where the null hypothesis of predictive failure is rejected even if the R^2 of the regression is 0.01. Such result points out the explanatory power of the sign of the difference between instantaneous forward and spot rate to predict the change in the spot generated by FOMC meetings even if the former variable does not possess sufficient variation to explain fluctuations in the latter.

When we turn to Germany, both regression analysis and the sequence of sign tests provide evidence for increasing predictability of future policy rates at longer horizons in the future. The R^2 goes from 0.007 in the one-day ahead case to 0.15 in the forty five-days ahead case to 0.37 in the ninety days ahead case to reach eventually 0.44 in the one hundred and thirty five days ahead case. The same pattern is confirmed by the sign test, according to which the hypothesis of predictive failure cannot be rejected only for the one-day ahead case, while the rejection becomes very strong for the two longer horizons. The comparative analysis shows a clearly superior predictive performance of instantaneous forward rates in the case of Germany. Although the coefficients in the regression analysis follow a very similar pattern, they are much more precisely estimated for Germany than for the US. Lastly, we remark that the regular superior predictive performance of instantaneous forward rate for Germany is violated only at the very short-term forecasting horizon. The Bundesbank Council seems to have a taste for surprising the markets in the very short-term but this tendency does not last for longer horizon.

3.2. The reaction of the term structure to expected and unexpected monetary policy

On the basis of our interpretation of instantaneous forward rate as expected future policy rates we proceed to derive measures of expected and unexpected changes in policy rate.
Our measure of expected changes in policy rate j-meetings ahead is :

$\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right)$ where j=0,1,2,3 for the US and j=0,3,6,9 for Germany

Where, as before, we indicate with $t_i = t_1,..t_k,...\, t_T$ the dates of the Central Banks meeting in which decision on policy rates are taken (T=37 for the US and 120 for Germany), while r_{1t}

indicates the overnight rate at time t and f_{mt} indicates the instantaneous forward rate computed at time t for time t+m.

Our measure of unexpected changes in policy rate is then :

$$r_{1,t_{i+j}+1} - r_{1,t_i-1} - \left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right).$$

We then evaluate the response of the whole term structure of forward rates to expected an unexpected monetary policy by proceeding to the following regressions:

(13) $$f_{k,t_{i+j}+1} - f_{k,t_i-1} = \hat{\beta}_{kj}\left(f_{t_{i+j}+1,t_i-1} - r_{1,t_i-1}\right) + \hat{u}_{kt_{i+j}+1}$$

j=0, 3, 6, 9 for US, j=0,1,2,3 for Germany, k=1,...,3650

(14) $$f_{k,t_{i+j}+1} - f_{k,t_i-1} = \hat{\gamma}_{kj}\left(r_{1,t_{i+j}+1} - f_{t_{i+j}+1,t_i-1}\right) + \hat{v}_{kt_{i+j}+1}$$

j=0, 3, 6, 9 for US, j=0,1,2,3 for Germany, k=1,...,3650

where k goes from 2 to 3650 because we have estimated term structure by including the ten-year rate as the rate associated with the longest horizon. In practice the term structure of the spot rate is interpolated through 120 points so that, at each forecasting horizon, we report 120 β's, 120 γ's, and associated standard errors.

Under the null of the validity of the expectational model the β's should not be significant while the γ's should be significant.

To facilitate comparisons with results available in the literature based on the regression of the shifts of spot rates in response to anticipated and unanticipated monetary policy we also report the results of the following regressions:

(15) $$r_{k,t_{i+j}+1} - r_{k,t_i-1} = \hat{\beta}_{kj}\left(f_{t_{i+j}+1,t_i-1} - r_{1,t_i-1}\right) + \hat{u}_{kt_{i+j}+1}$$

j=0, 3, 6, 9 for US, j=0,1,2,3 for Germany, k=1,...,3650

(16) $$r_{k,t_{i+j}+1} - r_{k,t_i-1} = \hat{\gamma}_{kj}\left(r_{1,t_{i+j}+1} - f_{t_{i+j}+1,t_i-1}\right) + \hat{v}_{kt_{i+j}+1}$$

j=0, 3, 6, 9 for US, j=0,1,2,3 for Germany, k=1,...,3650

Technically the results of the estimation of equations (15) and (16) are redundant after the estimation of models (13) and (14) because the effect of monetary policy on any spot rate could be computed by taking the appropriate average of the effect of monetary policy on instantaneous forward rates.

Figures 2-5 report the results for the US, while figures 6-9 reports the results for Germany. Figure 2 reports the shifts of the whole US term structure of instantaneous forward rates in response to anticipated changes in policy rates for the one-day (day before- day after the FOMC meeting) , forty five days (one FOMC meeting after the one taking place the following day), ninety days (two FOMC meetings after the one taking place the following day) and one hundred thirty five days (three FOMC meetings after the one taking place the following day) horizons. The results are in line with the prediction of the expectational model with the exception of a significant effect, for the three longer horizons, of expected shifts in monetary policy on the change in the instantaneous forward rate at the shorter end of the curve. Such effect on forward rates translates into a significant effect on spot rates, reported in figure 3, (from two days to six-months) whose sign is compatible with the traditional "liquidity" interpretation. Figure 4 reports the shifts of the whole US term structure of instantaneous forward rates in response to surprises in policy rates. In this case the behaviour of estimated coefficients changes with the forecasting horizons, in fact for the two longer horizon we observe a significant positive shift in the whole term structure with some anomaly at the short ends which confirms the results obtained in the analysis of the responses to expected shifts in monetary policy. For shorter forecasting horizon the responses of the term structures go rapidly to zero as the maturity increases. Such reaction of the term structure of instantaneous forward rates translates in the reaction of the term structure of spot rates reported in figure 5.

Figure 6 and figure 7 reports respectively the shifts of the whole German term structure of instantaneous forward rates and of spot rates in response to anticipated changes in policy rates for the one-day (day before-day after Bundesbank Council's meeting) , forty five days (three Bundesbank Council's meetings after the one taking place the following day), ninety days (six Bundesbank Council's meetings after the one taking place the following day) and one hundred thirty five days (nine Bundesbank council's meetings after the one taking place the following day) horizons. Although the pattern of results is somewhat similar to the one observed in the US case, the rejection of the prediction of the expectational model is stronger here with a significant effect of expected changes in policy rate extending to the maturities up to six months for forward rates and up to one and a half year . For longer maturities the non significance of expected changes in policy rate observed on US data holds for the German case too.

Figure 8 and 9 reports the shifts of the whole German term structure of instantaneous forward and spot rates in response to unanticipated changes in policy rates at the chosen horizons. Also in this case the response to unexpected policy declines with maturity, but differently for the US case, unexpected monetary policy has never a significant impact on forward rates after the one and a half year maturity, which translates in an impact on spot rates which is never significant after the four year maturity. So German long rates do seem to react neither to anticipated nor to unanticipated monetary policy. Our results suggests that the German interest rates longer than the four-year maturity are not sensitive to domestic factors. Similarly, the evidence reported in figure 1 suggests that international factors are relevant in the explanation of German long-term interest rates: the observed behaviour of long-term US and German rate is compatible with expectations of substantial stability of the D.Mark-Dollar exchange rate at long-term horizons. To provide further evidence on this issue, we have regressed the shifts in the German term structure of spot rates on the correspondent shifts in the US term structure of spot rates. The results, reported in figure 10, reveal the absence of any significant effect on the short end of the curve and the strong significance of the effect at the long end of the curve. Given that our event studies approach selects dates in which the influence of the domestic factors is maximized (meetings of the Bundesbank Council), we think that figure 10 provides strong evidence in favour of the relevance of international factors (US long-term interest rates via expectations for a stable D-mark/US dollar exchange rate over long-term horizons) in the determination of German long-term interest rates. According to this interpretation, the unusually steep slope of the German yield curve observed towards the end of our sample should not be related to the incumbence of EMU and the creation of a future European central bank but rather to the association of long-term German rates with long-term US interest rates, despite the decoupling of short-term German and interest rates. This result of ours is in line with the conclusion reached by Zettelmeyer(1996), who finds evidence against the hypothesis that expectations of EMU have contributed to relatively high long-term German interest rates by showing German long-rates responded in the same direction as French, Belgian, Spanish, Italian and ECU yields in response to events affecting the likelihood of monetary union.

4. Conclusions and Extensions

This paper was aimed at the comparative assessment of data from the US and German term structure over the period 1991-1995, to evaluate the predictability of policy rates and the response of US and German term structure to expected and unexpected shifts in policy rates. We have derived measures of expected and unexpected shifts in policy rates by estimating instantaneous forward rates curve the days before and after meetings in which monetary policy actions are taken. Our main results can be summarised as follows:

- pure expectational model-based predictions of future policy rates are more precise for the German than for the US case, especially when the forecasting horizons is extended to more than one-meeting ahead
- expected monetary policy shifts have impact on the very short end of the term structure in US (zero to six months) while they maintain a significant effect on the German term structure up to the one and half year maturity
- Long term US rate react significantly to unexpected monetary policy shifts while Germany long rate do not
- Given that German long rate do not react to both unexpected and expected monetary shifts, it seems that international factors (stability of D-Mark/US dollar exchange rate over long-term horizons) are more relevant than domestic factors in the determination of German long-term interest rates

Overall our results confirm evidence already existing on the low predictability of US rate and on the irregularities at the short end of US term structure, moreover the prediction of the expectational model seem to hold rather well for long-term US rates, while the model is rejected for the long-term German rates. The positive result for the long-term US rate could be related to the fact that we do not test the model by checking tight cross equation restrictions in a reduced form of a forward looking model, but we rather assess the broad compatibility of the model with the behaviour of observed data. The broad compatibility of the expectational model with the data, despite the rejection of tight cross equation restrictions has already been observed (Campbell-Shiller,1987) on a different data set. Our methodology has an immediate extension to the analysis of the consequences of monetary policy shocks. Research has examined the effects of monetary policy deriving shocks by the estimation and structuralization of Vector AutoRegressive(VAR) models, recently Rudebusch has criticised such methodology by showing that residuals from estimated VAR have very little correlations with monetary policy shocks derived from forward-looking financial markets. Rudebusch(1996) constructs shocks from financial data by using the federal funds future contracts to derive one-month ahead expected funds rate. As recognised by the author, such procedure would not deliver exogenous policy shocks if the Central Bank reacts to information that becomes available within the month. We believe that the implementation of our procedure does enable to extract the innovations in monetary policy occurring between the date before and the date after the meetings relevant for policy-making. We believe that such innovations can be considered as exogenous policy shocks. Such shocks can be then compared with the structural shocks usually identified by the estimation of VARs, similarly the impulse response of the variables of interest to the alternative shocks can be compared and assessed. Such an extension is on our agenda for future research.

TABLE 1: THE PREDICTABILITY OF POLICY RATES IN US AND GERMANY. 1991-1995

	1 day ahead				45 days ahead				90 days ahead				135 days ahead			
	β	t	R^2	sign	β	t	R^2	sign	β	t	R^2	sign	β	t	R^2	sign
US	0.88	0.65	0.01	2.00	1.72	4.77	0.33	2.98	0.75	2.87	0.15	1.03	0.76	3.39	0.17	2.12
GER	0.003	0.009	0.007	-0.416	0.65	4.65	0.15	2.84	0.75	8.32	0.37	5.16	0.77	9.78	0.44	5.74

Results for **United States:**

Indicating with $t_i = t_1,..t_k,... t_{37}$ the dates of the thirty-seven FOMC meeting which took place in our sample, the estimated β's, their t-ratios and R^2 are derived from the following regressions:

$$r_{1t_{i+j}+1} - r_{1t_i-1} = \hat{\beta}_j\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right) + \hat{u}_{t_{i+j}+1} \qquad j = 0,1,2,3$$

where r_{1t} indicates the overnight rate at time t and f_{mt} indicates the instantaneous forward rate computed at time t for time t+m.
The column labeled sign contains the results of the distribution-free procedure proposed by Pesaran-Timmermann(1990) to test accuracy of forecast of the sign of $r_{1t_{i+j}+1} - r_{1t_i-1}$ based on the sign of $\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right)$.
The sign statistic is distributed as a standard normal.

Results for **Germany:**

Indicating with $t_i = t_1,..t_k,... t_{120}$ the dates of the hunder and twenty Bundesbank Council meetings which took place in our sample. The estimated β's, their t-ratios and R^2 are derived from the following regressions:

$$r_{1t_{i+j}+1} - r_{1t_i-1} = \hat{\beta}_j\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right) + \hat{u}_{t_{i+j}+1} \qquad j = 0,3,6,9$$

where r_{1t} indicates the overnight rate at time t and f_{mt} indicates the instantaneous forward rate computed at time t for time t+m.
The column labeled sign contains the results of the distribution-free procedure proposed by Pesaran-Timmermann(1990) to test accuracy of forecast of the sign of $r_{1t_{i+j}+1} - r_{1t_i-1}$ based on the sign of $\left(f_{t_{i+j}+1,t_i-1} - r_{1t_i-1}\right)$.
The sign statistic is distributed as a standard normal.
The results for the two countries are directly comparable because we observe about one FOMC meeting every three BuBa council meetings. The headings of blocks is related to the frequency of FOMC meetings: so 45 days is two meetings ahead, 90 days is three meetings ahead and 135 days is four meetings ahead.

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FIGURE 1: LONG-TERM (10Y) AND SHORT-TERM(3M) RATES IN U.S. AND GERMANY(1991-1995)

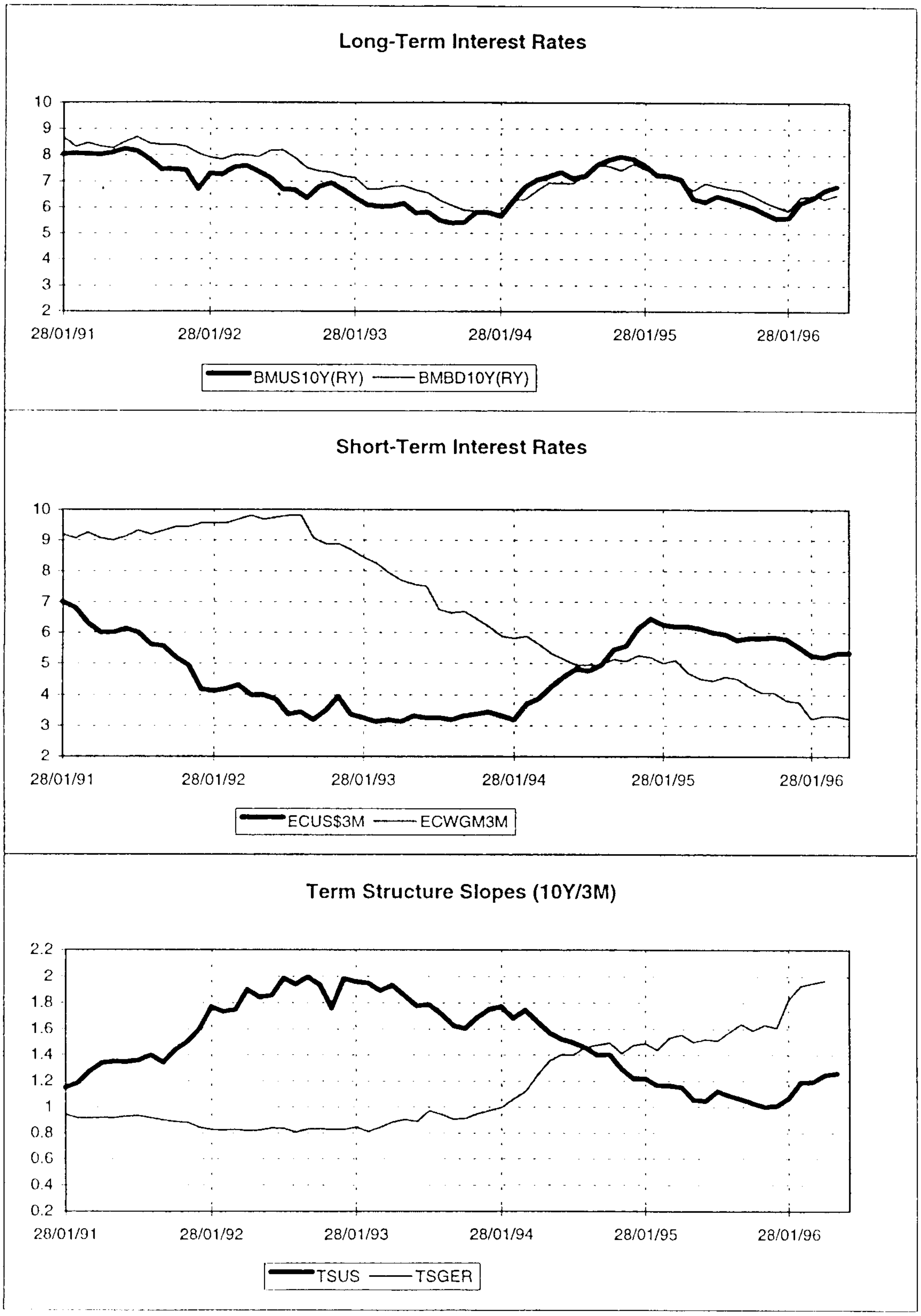
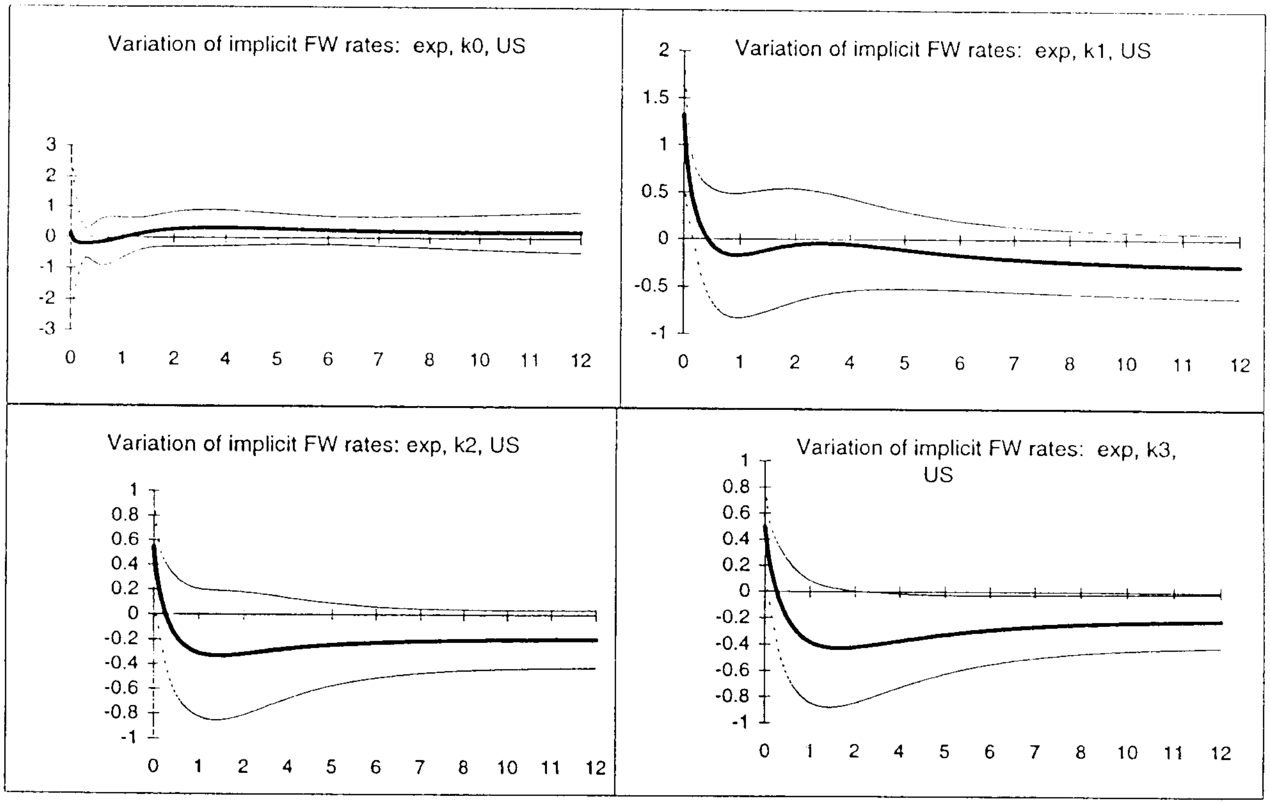
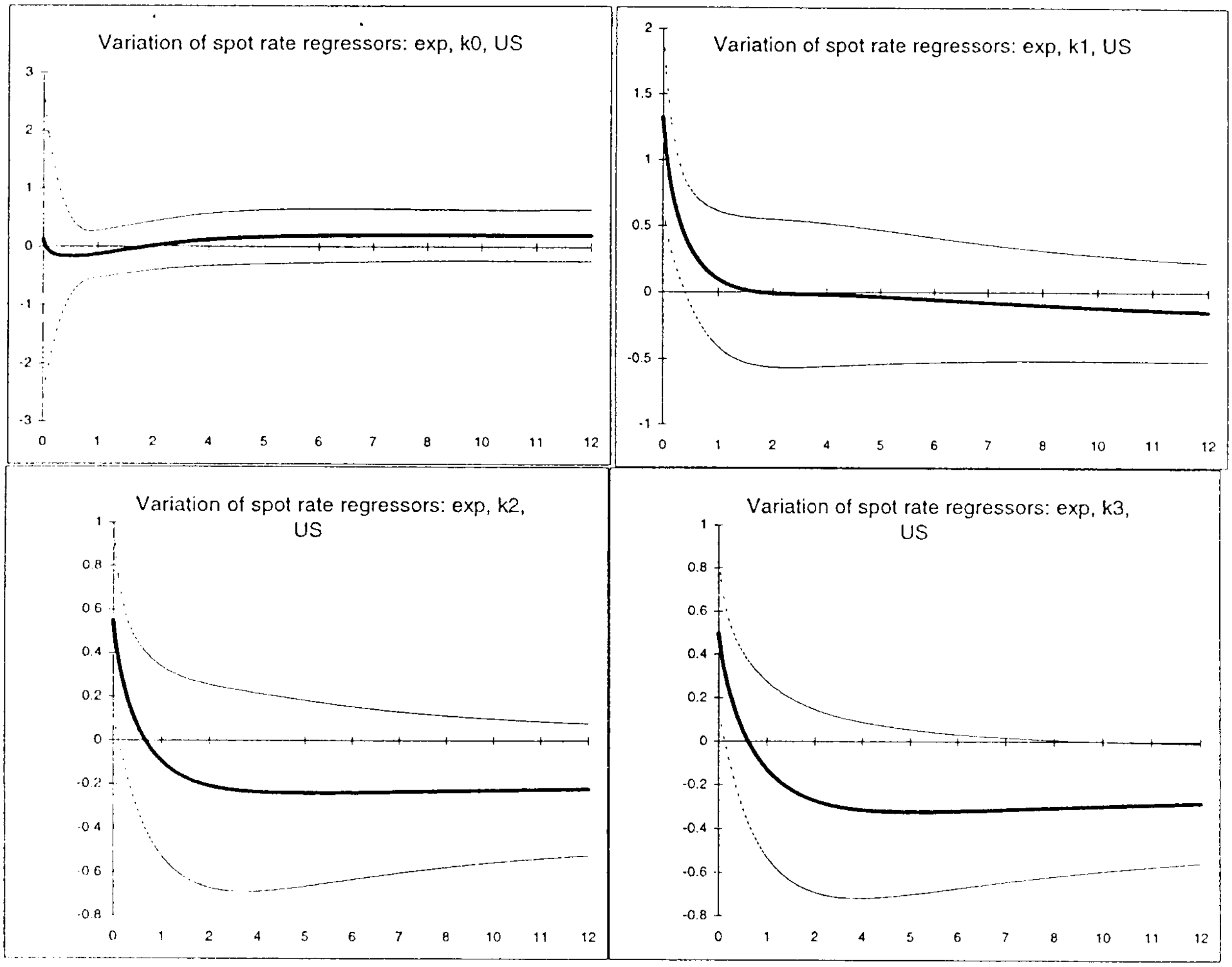


FIGURE 2: THE SHIFT IN THE TERM STRUCTURE OF IMPLICIT OVERNIGHT RATE IN RESPONSE TO EXPECTED SHIFTS IN MONETARY POLICY: THE CASE OF THE U.S.



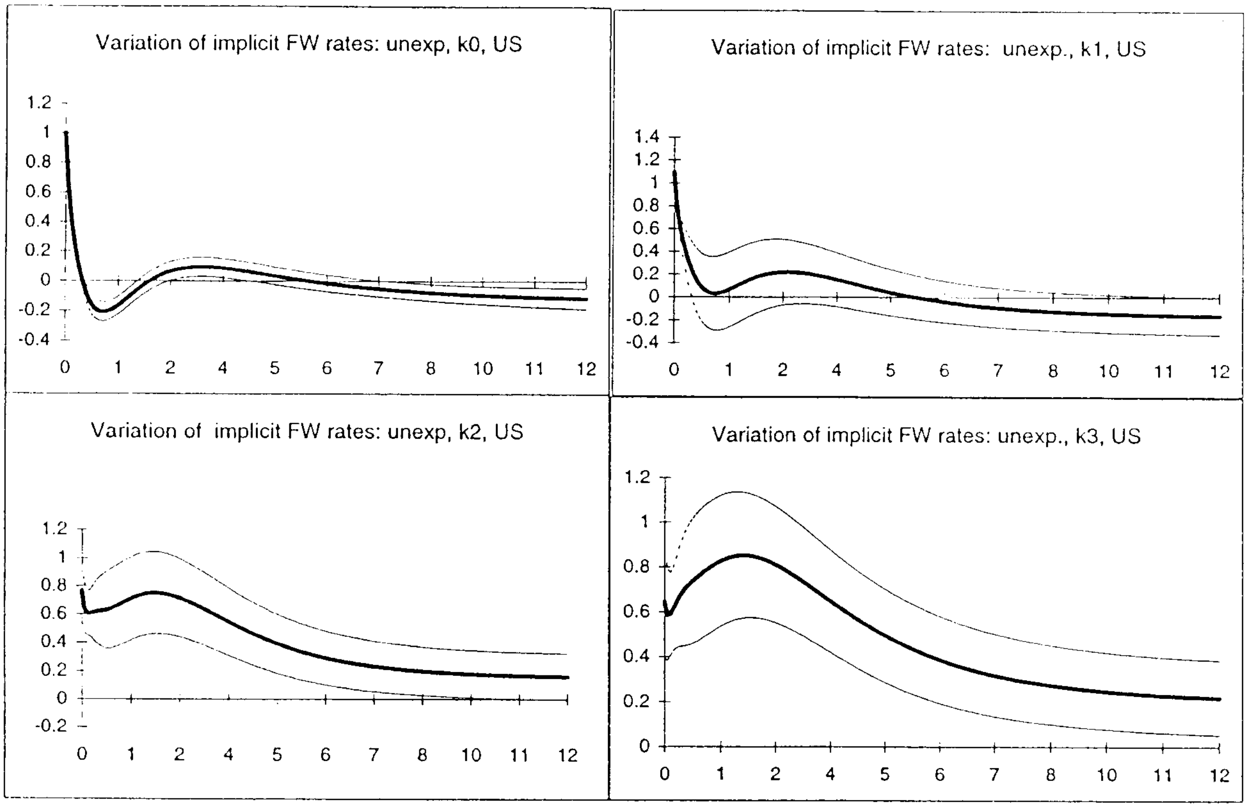
k0: one day ahead (day after meeting - day before)
k1: one meeting ahead (45 days)
k2: two meetings ahead (90 days)
k3: three meetings ahead (135 days)

FIGURE 3: THE SHIFT IN THE TERM STRUCTURE OF SPOT RATES IN RESPONSE TO EXPECTED SHIFTS IN MONETARY POLICY: THE CASE OF THE U.S.



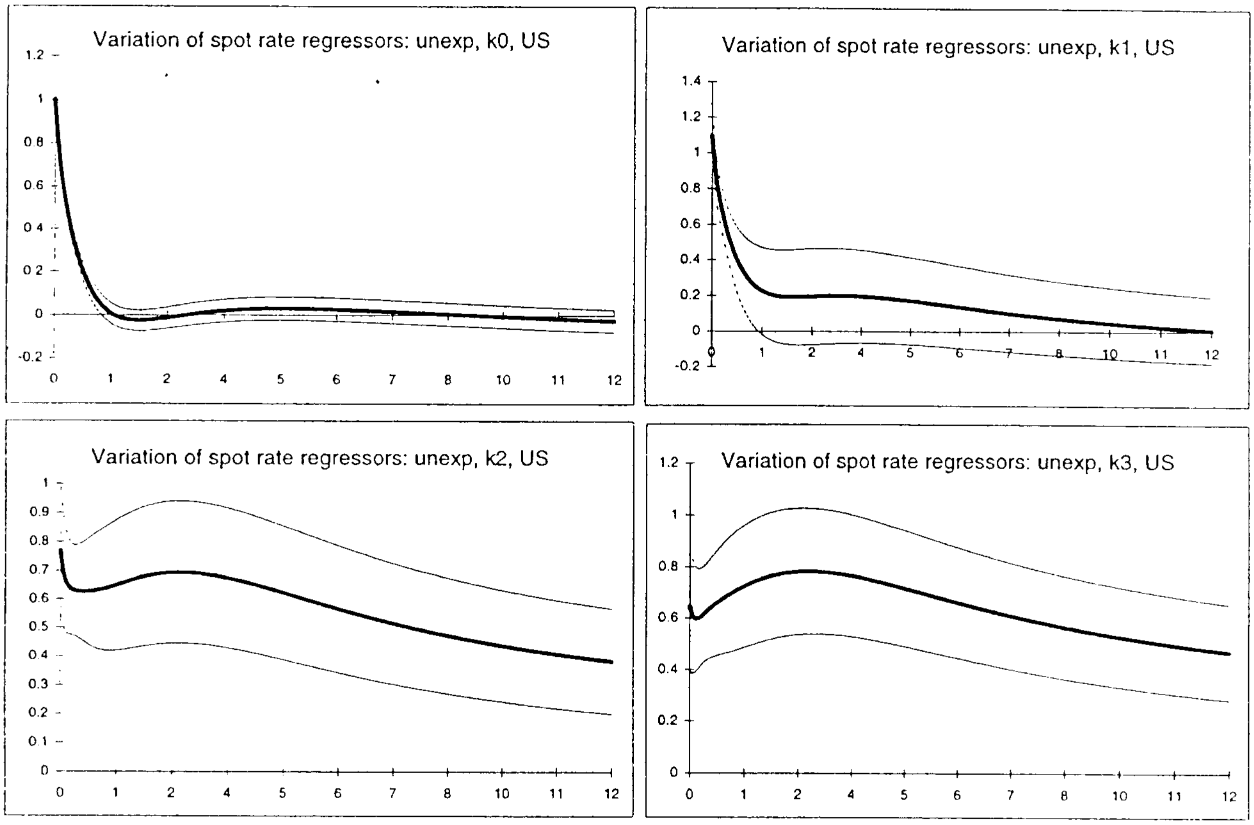
k0: one day ahead (day after meeting - day before)
k1: one meeting ahead (45 days)
k2: two meetings ahead (90 days)
k3: three meetings ahead (135 days)

FIGURE 4: THE SHIFT IN THE TERM STRUCTURE OF IMPLICIT OVERNIGHT RATE IN RESPONSE TO UNEXPECTED SHIFTS IN MONETARY POLICY: THE CASE OF THE U.S.



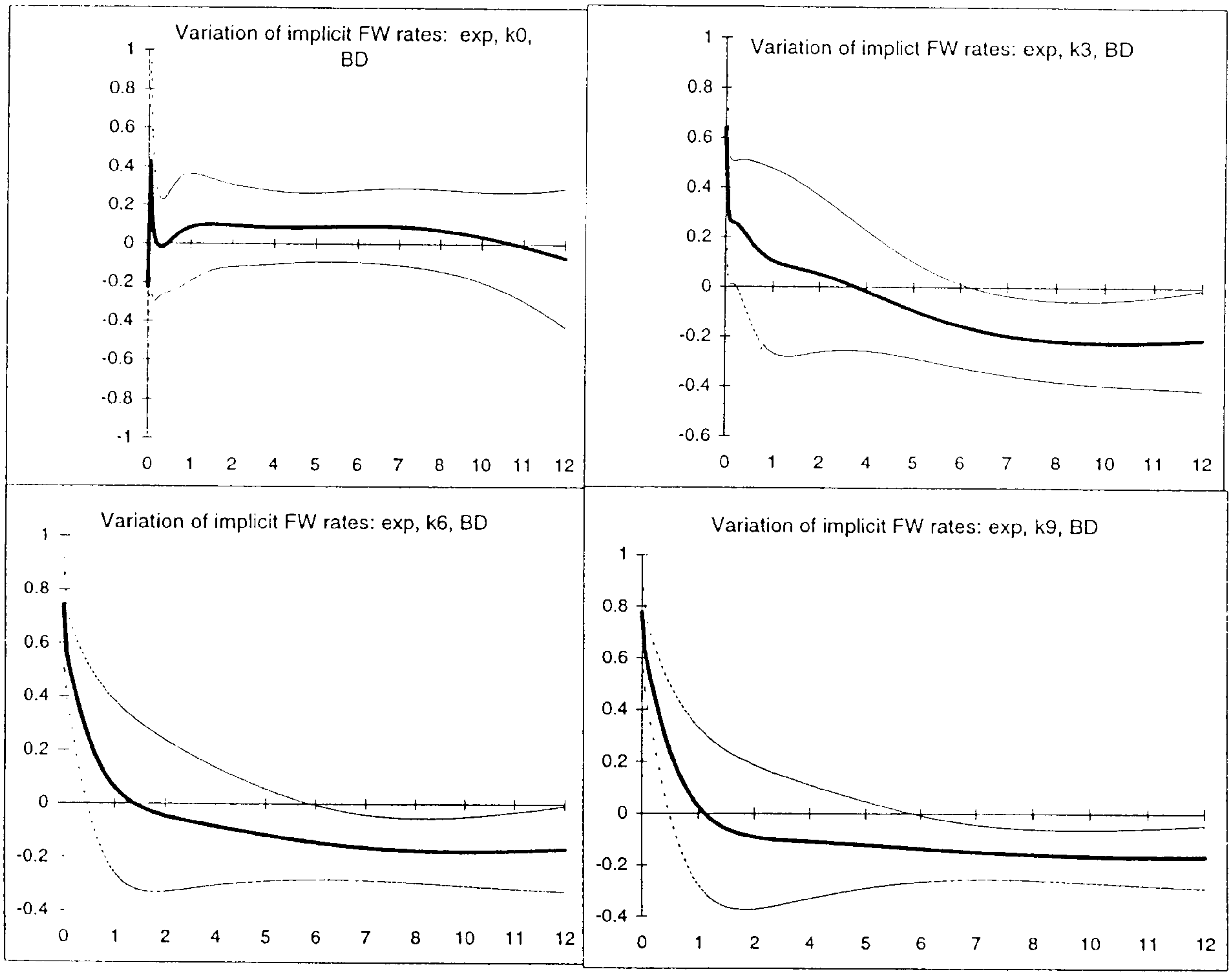
k0: one day ahead (day after meeting - day before)
k1: one meeting ahead (45 days)
k2: two meetings ahead (90 days)
k3: three meetings ahead (135 days)

FIGURE 5: THE SHIFT IN THE TERM STRUCTURE OF SPOT RATES
IN RESPONSE TO UNEXPECTED SHIFTS IN MONETARY POLICY:
THE CASE OF THE U.S.



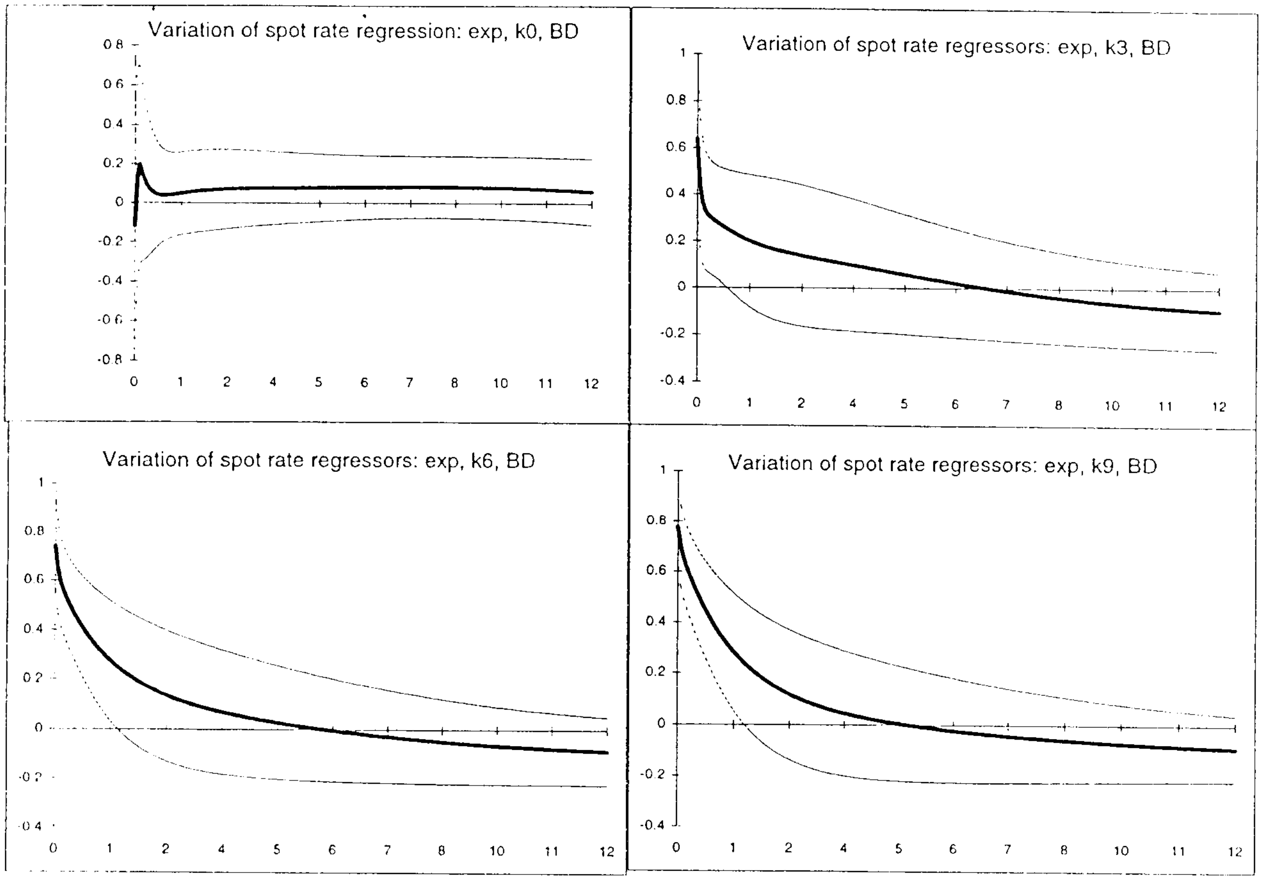
k0: one day ahead (day after meeting - day before)
k1: one meeting ahead (45 days)
k2: two meetings ahead (90 days)
k3: three meetings ahead (135 days)

FIGURE 6: THE SHIFT IN THE TERM STRUCTURE OF IMPLICIT OVERNIGHT RATE
IN RESPONSE TO EXPECTED SHIFTS IN MONETARY POLICY:
THE CASE OF GERMANY



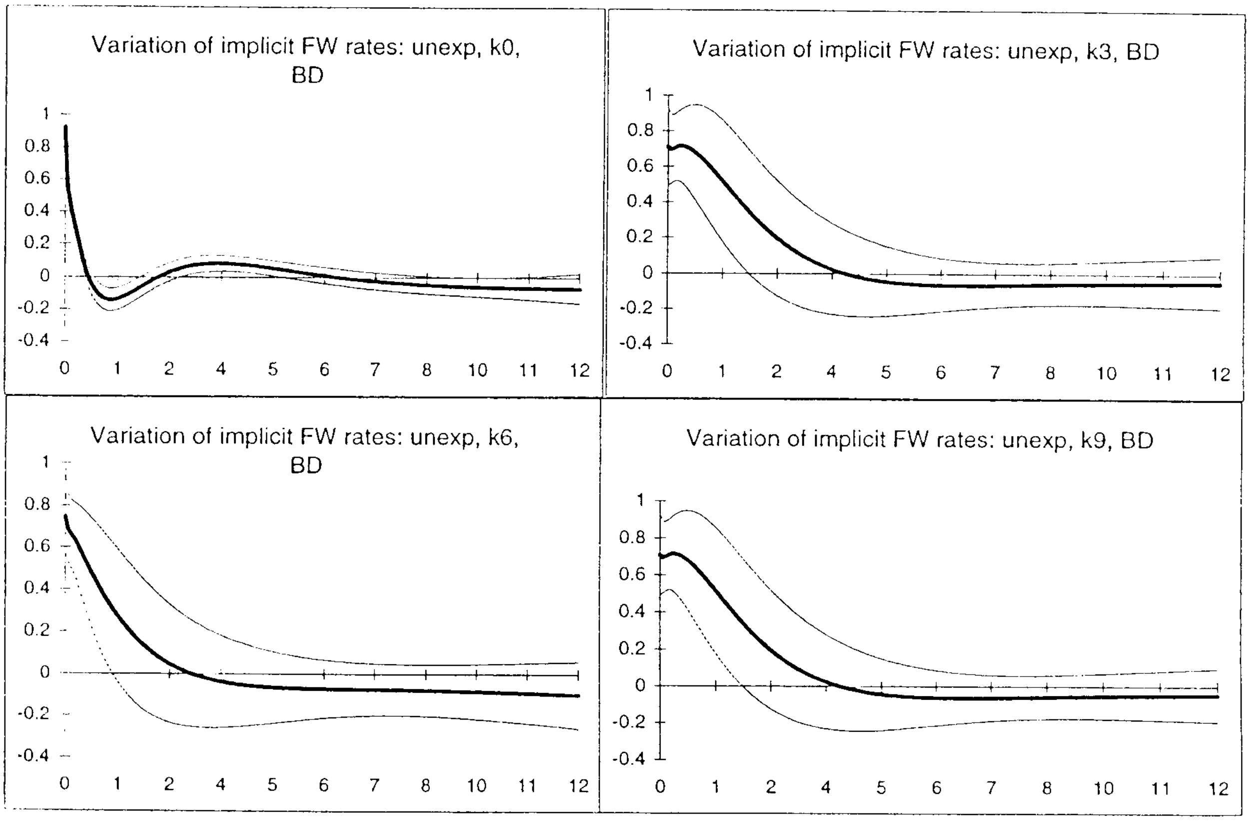
k0: one day ahead (day after meeting - day before)
k3: three meetings ahead (45 days)
k6: six meetings ahead (90 days)
k9: six meetings ahead (135 days)

FIGURE 7: THE SHIFT IN THE TERM STRUCTURE OF SPOT RATES
IN RESPONSE TO EXPECTED SHIFTS IN MONETARY POLICY:
THE CASE OF GERMANY



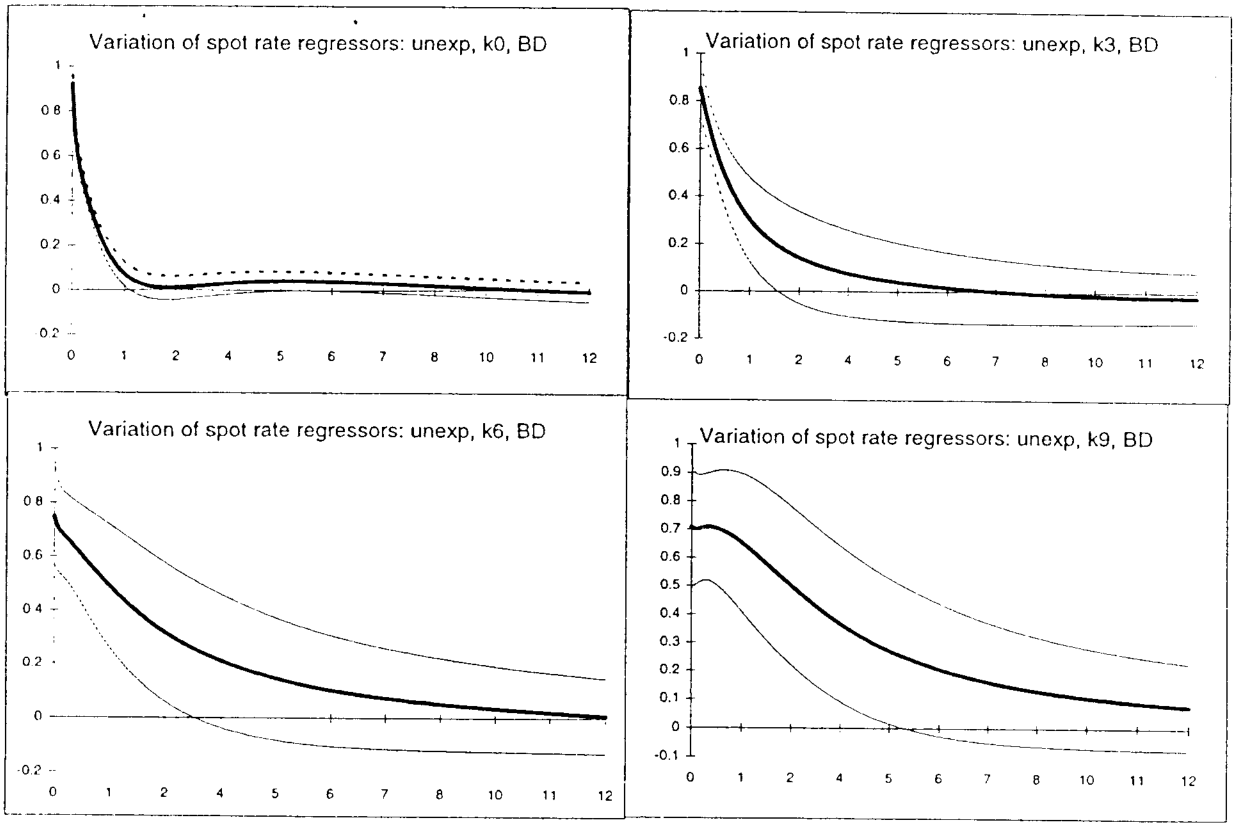
k0: one day ahead (day after meeting - day before)
k3: three meetings ahead (45 days)
k6: six meetings ahead (90 days)
k9: six meetings ahead (135 days)

FIGURE 8: THE SHIFT IN THE TERM STRUCTURE OF IMPLICIT OVERNIGHT RATE IN RESPONSE TO UNEXPECTED SHIFTS IN MONETARY POLICY: THE CASE OF GERMANY



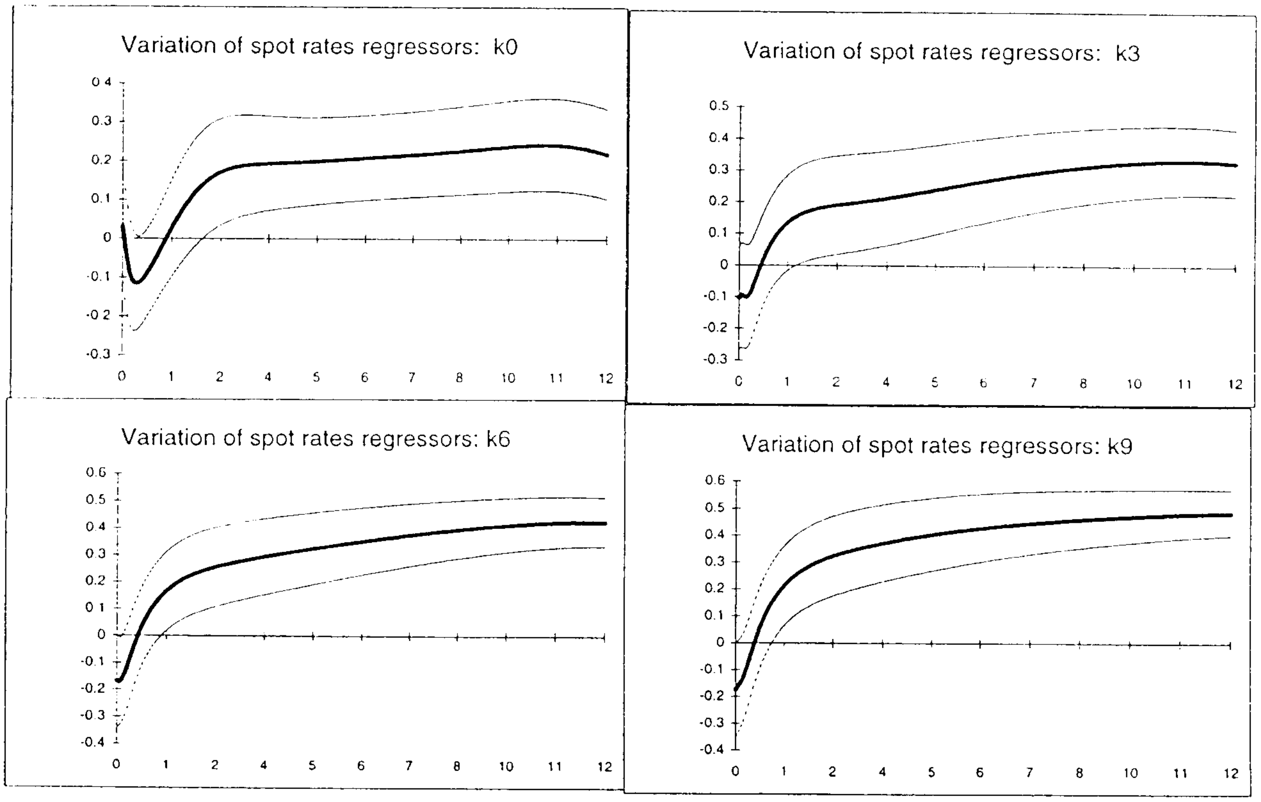
k0: one day ahead (day after meeting - day before)
k3: three meetings ahead (45 days)
k6: six meetings ahead (90 days)
k9: six meetings ahead (135 days)

FIGURE 9: THE SHIFT IN THE TERM STRUCTURE OF SPOT RATES
IN RESPONSE TO UNEXPECTED SHIFTS IN MONETARY POLICY:
THE CASE OF GERMANY



k0: one day ahead (day after meeting - day before)
k3: three meetings ahead (45 days)
k6: six meetings ahead (90 days)
k9: six meetings ahead (135 days)

FIGURE 10 THE SHIFT IN THE GERMAN TERM STRUCTURE
IN RESPONSE TO SHIFTS OF THE US TERM STRUCTURE



k0: one day ahead (day after meeting - day before)
k3: three meetings ahead (45 days)
k6: six meetings ahead (90 days)
k9: nine meetings ahead (135 days)