

ESTIMATING FORWARD *PREMIA* OF SHORT-TERM INTEREST RATES BASED ON SURVEY RESULTS*

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1. INTRODUCTION

Financial market participants' expectations regarding future interest rates are important indicators from the central bank's point of view. Such expectations are useful insofar as they make it possible to assess whether or not a given monetary policy decision will surprise the markets and to analyse the efficiency of the communication policy. Market expectations regarding interest rates are also used as technical assumptions in the macroeconomic forecasts regularly conducted by central banks, as in the case of the Eurosystem.¹

Forward interest rates are one of the most widely used indicators to assess market expected future interest rates. In the absence of uncertainty, forward interest rates would be similar to market expected future interest rates. Given the existence of uncertainty, risk-averse investors will demand additional compensation as protection against surprises regarding such rates. Therefore, forward interest rates incorporate a risk premium, called forward premium, and are imperfect indicators of expectations for future interest rates. Such *premia* are not directly observable and several approaches can be used in their estimation.

A widely used approach compares forward interest rates with the corresponding realised future interest rates over a long period of time and approximates risk *premia* by the average historical differences for each horizon between the two variables. However, this approach, which is called "ex post", has several limitations, namely because it provides an average and constant estimate of the risk premium for each horizon, when in fact the risk premium varies over time. Another possible approach consists in estimating the forward risk premium using interest rate expectations from surveys. Interest rate expectations reported in surveys may, in principle, be regarded as direct or "pure" measures of such expectations as they are not affected by the various risk *premia* or by technical market factors, given that respondents do not take positions in the market.² Therefore, the difference between forward interest rates and interest rate expectations reported in surveys may be used as a measure of the forward risk premium. This approach has the advantage of being forward-looking.

This paper presents estimates of the forward risk premium of the German three-month interest rates based on these two approaches. Given the limitations of the *ex post* approach, the focus is on the estimation of the survey-based forward risk premium. Germany is used as a proxy for the euro area, as there are no survey data on interest rate expectations for the euro area prior to December 2002.

This article is structured as follows: in Section 2, data used are briefly described; Section 3 presents estimates for forward risk *premia* of German three-month rates using the *ex post* approach; in Section 4, the forward risk premium is calculated on the basis of expectations regarding the German

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(1) See the June 2006 issue of the ECB Monthly Bulletin.

(2) However, interest rate expectations reported in surveys may also indirectly incorporate a forward risk premium, if respondents use money market forward interest rates as a benchmark when building their expectations.

three-month interest rates reported by Consensus Economics between January 1990 and December 2005. Estimates for the risk premium derived from Consensus expectations suggest that this premium displays considerable variation over time. Therefore, Section 5 presents a number of macroeconomic and financial factors that may influence the risk premium behaviour and assesses the importance of these factors to explain the past behaviour of survey-based risk *premia* of three-month rates in Germany using a simple model. Section 6 concludes.

2. DATA

German three-month forward interest rates were calculated on the basis of the spot rates curve derived using the Svensson method (1994).³ We used the Svensson parameters estimated by the Bundesbank for the period January 1990-December 2005, which are reported to BIS (for further details, see BIS (2005)).

Forecasts for the German three-month interest rate refer to the average forecasts of the panel of respondents to the Consensus survey, which are monthly reported in Consensus Forecasts. The panel is composed of financial experts who provide forecasts regarding interest rates for three –months and one-year ahead. Consensus forecasts are published in the second week of every month, based on forecasts by respondents during the previous two weeks.

One-year ahead expectations data on inflation and economic activity for the German economy were also compiled from Consensus Economics and correspond to the weighted average of monthly forecasts reported for these variables for the years t and $t+1$. For instance, Consensus one-year ahead expectations regarding inflation were calculated as follows:

$$Inf_{i,t}^{(e)} = a_i Inf(t) + b_i Inf(t+1)$$

where i means the month and t means the year in which the forecast is reported.

$Inf_{i,t}^{(e)}$: one-year ahead inflation expectations of Consensus in month i of year t

$Inf(t)$: Consensus forecast for inflation in year t

$Inf(t+1)$: Consensus forecast for inflation in year $t+1$

a_i and b_i are the weights: in January $a_i = 1$ and $b_i = 0$ and throughout the year a_i declines by $1/12$ and b_i increases by the same ratio, so that in December $a_i = 0$ and $b_i = 1$.

This procedure was also applied to the standard deviation of forecasts of the Consensus panel for inflation and GDP in Germany, which were used as proxies for uncertainty surrounding the macroeconomic outlook.

Data on actual inflation in Germany were obtained from Thomson Financial Datastream and refer to the year-on-year rate of change in the consumer price index. Swap interest rates and government bond yields for Germany were also obtained from Thomson Financial Datastream. Finally, Bloomberg data were used for the implied volatility derived from options on futures contracts on German ten-year government bonds.

(3) The Svensson method (1994) consists in the approximation of a curve to the relationship between spot interest rates for different maturities at a given moment, by estimating a functional form where parameters are determined through the minimisation of the square deviations of theoretical prices from observed prices.

3. FORWARD RISK PREMIUM BASED ON THE *EX POST* APPROACH

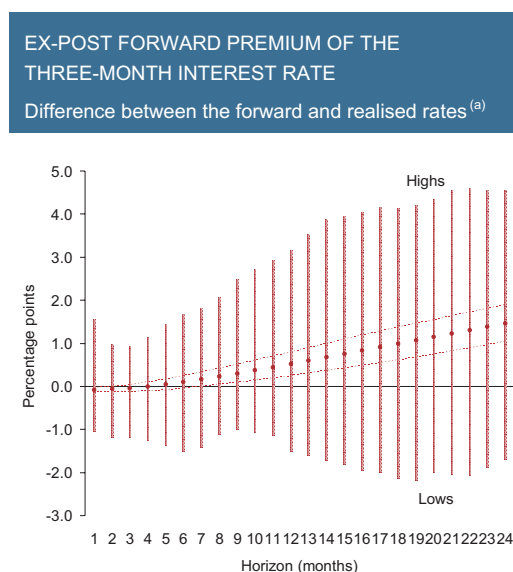
The *ex post* approach to estimate the forward risk premium is based on the comparison of the forward interest rates with realised future interest rates for each horizon, assuming that the risk premium corresponds to the average historical difference between such rates. It should be noted that the differences between forward interest rates and corresponding outturns may reflect not only the existence of a risk premium but also errors in agents' expectations. However, if the period of time under review is relatively long, errors in agents' expectations are expected to be, on average, close to zero.

Chart 1 shows that between 1990 and 2005 the differences between the three-month forward interest rates in Germany and corresponding outturns were significant both in positive and negative terms. On average, and as predictors of future interest rates, forward interest rates showed an increasing upward bias over the horizon. At horizons of up to 6 months, the forward risk premium is close to zero, but it becomes significant over longer horizons, reaching 0.5 and 1.5 p.p. respectively in 1 and 2-year horizons. In fact, taking into account a 95% confidence interval (dotted lines in Chart 1), the bias in the average *ex post* risk premium for each horizon is statistically different from zero for horizons beyond 6 months.

This result is consistent with those of various empirical works testing the “expectations theory of the term structure of interest rates”, which suggest that the risk premium implied in forward interest rates of interbank rates is negligible for very short maturities, albeit becoming statistically significant beyond the 6 months horizons (Durré *et al* (2003), Cassola and Luis (2001) and Brooke *et al* (2000)).

However, the *ex post* approach to estimate the forward risk premium has several limitations. On the one hand, and as previously mentioned, the average deviations between forward interest rates and realised future rates may reflect not only the existence of a risk premium but also systematic errors in agents' expectations in the sample period. On the other hand, this approach provides a constant estimation of the risk premium for each horizon, which is rejected by most empirical studies, pointing to

Chart 1



Note: (a) The dots in the chart represent the average and the dotted lines represent the 95% confidence interval. Given the high autocorrelation of the *ex post* risk premium due to the overlapping nature of data, the confidence intervals were calculated on the basis of the adjusted standard deviation proposed by Andrews (1991).

substantial changes in the risk premium over time. This reflects, for instance, various macroeconomic situations or different investors' attitudes towards risk.⁴

4. SURVEY-BASED FORWARD RISK PREMIUM

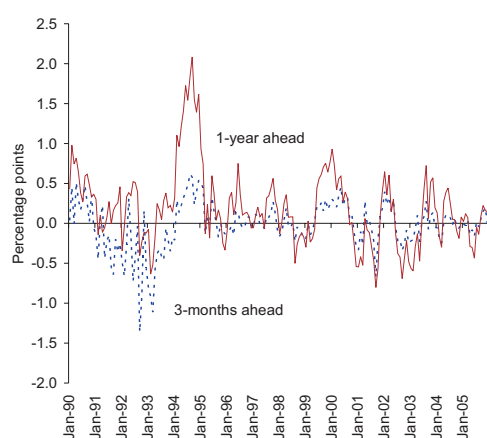
Another possible approach to estimate forward risk *premia* consists in comparing forward interest rates with interest rate expectations reported in surveys. Chart 2 presents risk *premia* calculated as the difference between forward interest rates and Consensus three-month interest rate expectations both for 3-month and 1-year ahead. For both horizons, the risk premium shows high variability over time.

In the period of 1990-2005 the forward risk premium was, on average, zero in the 3-month horizon and of around 0.2 p.p. in the 1-year horizon, i.e. approximately 0.3 p.p. lower than that estimated in the *ex post* approach. During the 1992-1993 recession of the German economy, the risk premium of the three-month interest rate recorded significant negative figures, particularly in the three-month horizon. In the period under review the risk premium reached its highest values in mid-1994.

Despite the positive average value, nearly half of the estimated risk survey-based forward *premia* shows negative figures. This may suggest that Consensus expectations often overestimate the true market expectations. On the other hand, according to a number of empirical papers, estimates for risk *premia* are often negative when the yield curve is negatively sloped (Peacock (2004)).

Chart 2

SURVEY-BASED FORWARD RISK *PREMIA* OF THE THREE-MONTH INTEREST RATE



(4) See, for example, Hordahl *et al* (2006).

5. MODELLING THE BEHAVIOUR OF SURVEY-BASED FORWARD RISK PREMIUM

The estimate of the risk *premia* of forward interest rates based on Consensus expectations suggests that such *premia* show high variability over time and reach a significant magnitude in certain periods. In this section we attempt to model the time variation of the survey-based forward premium using macro-economic and financial variables that according to some theoretical and empirical works are likely to influence its behaviour.

Realised inflation and inflation expectations

A number of studies documented a close link between, on one hand, realised inflation and inflation expectations, and on the other hand, measures of the risk premium.⁵ A positive shock on actual inflation and inflation expectations may increase uncertainty regarding the future profitability of assets, and therefore a rise in the risk *premia* of forward interest rates would be likely. Charts 3 and 4 present realised inflation and one-year ahead Consensus inflation expectations for Germany in the period from January 1990 to December 2005.

Expectations for economic activity

The impact of the economic growth outlook for the risk premium is not clear. On the one hand, in the framework of models with habit formation in consumption, the degree of risk aversion of economic agents is affected by the economic cycle through the change in consumption compared to a given habit level. These models suggest that during a cyclical slump, when consumption is lower than usual, agents are more risk averse and the risk premium tends to increase, and vice versa.⁶ In this context, the risk premium is likely to be counter-cyclical. On the other hand, it can be argued that more favourable expectations for economic activity increase the probability of interest rate hikes, so investors tend to demand a higher risk premium in order to protect themselves against possible capital losses. In that

Chart 3

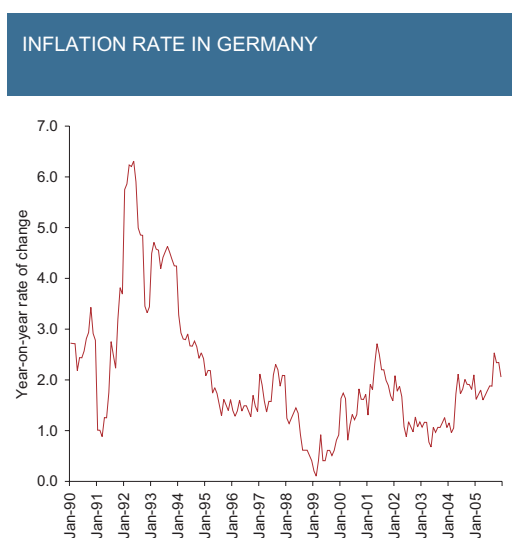
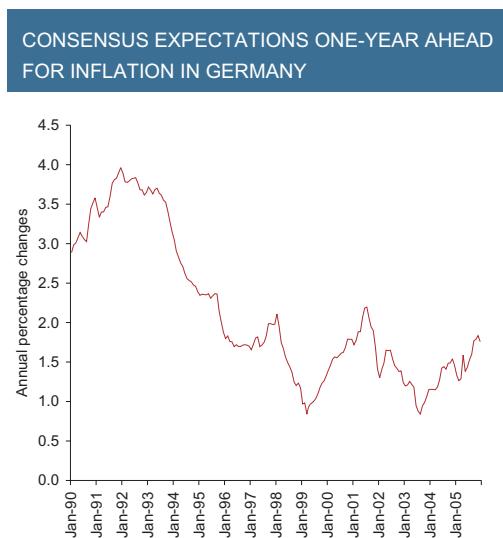


Chart 4

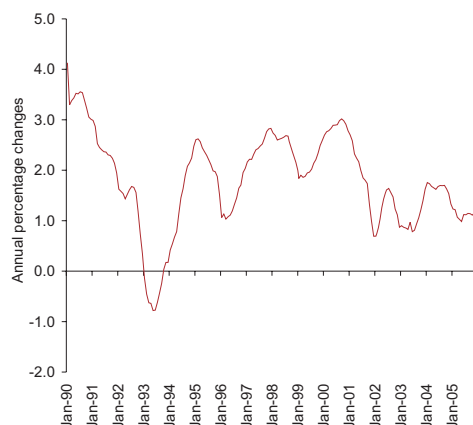


(5) See, for example, Hordahl *et al* (2006).

(6) Campbell and Cochrane (1999).

Chart 5

CONSENSUS EXPECTATIONS ONE-YEAR AHEAD FOR GDP IN GERMANY



case, the risk premium is likely to be pro-cyclical. Chart 5 presents one-year ahead Consensus expectations for economic activity in Germany.

Uncertainty regarding the macroeconomic outlook

Another factor that may influence the risk premium of forward interest rates is related to the uncertainty of economic agents regarding the macroeconomic outlook. Higher uncertainty regarding the outlook for inflation and/or economic activity of a given economy is expected to be associated with a higher demanded risk premium. In empirical literature there is not an obvious indicator of the agents' uncertainty regarding the macroeconomic outlook. In a number of papers, the volatility of the industrial production index, inflation or unemployment rate is used (see e.g. Fornari and Mele (2005)). However, such measures are not forward-looking. In order to measure the agents' uncertainty regarding the macroeconomic outlook, this paper proposes to use the standard deviation of Consensus panel forecasts for inflation and economic activity in Germany, whose developments are shown in Chart 6.

Financial market uncertainty

The behaviour of the risk premium is likely to reflect the investors' uncertainty regarding the future profitability of assets. The implied volatility of options on government bond future contracts is one of the most widely used indicators of financial market uncertainty. This indicator gives a measure of market uncertainty about short-term movements in yields. Chart 7 shows the implied volatility derived from options on 10-year Bunds future contracts.

Slope of the yield curve

One of the explanations for the relationship between the slope of the yield curve and the risk premium of forward interest rates arises from the relationship between the slope of the yield curve and the business cycle. Several empirical studies illustrate a positive relationship between the slope of the yield curve and the subsequent real economic activity.⁷ However, there is some evidence that this relationship has not been stable over time, having been conditioned by structural changes in the economy, the

(7) See, for example, Estrella *et al* (2003) and Estrella (2005).

Chart 6

UNCERTAINTY REGARDING INFLATION AND ECONOMIC ACTIVITY IN GERMANY

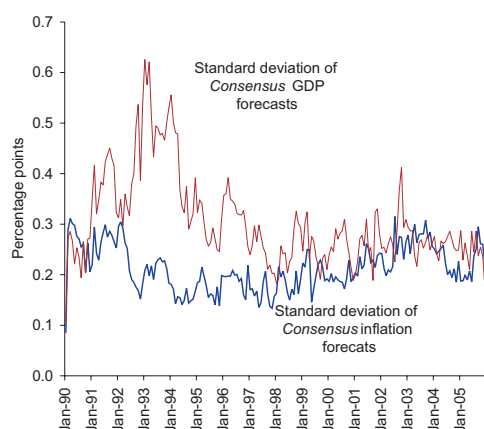
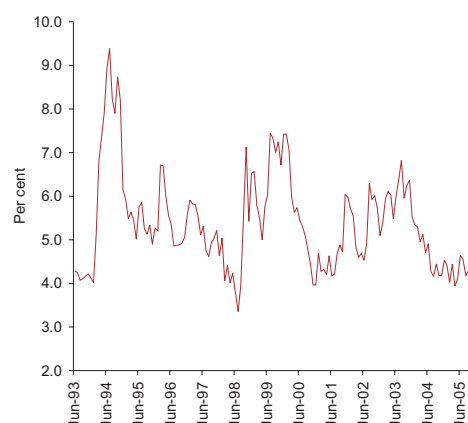


Chart 7

IMPLIED BOND MARKET VOLATILITY IN GERMANY^{a)}

(Percentage per annum)



Note: (a) Implied volatility of the near contract generic future.

conduct of economic policy and the combination of shocks affecting the economy at each moment in time.⁸

Another explanation for the relationship between the slope of the yield curve and the forward risk premium arises from the relationship between the slope of the yield curve and the monetary policy stance. The underlying idea is that a significant positive slope of the yield curve suggests a tighter monetary policy stance in the future, and vice versa, and that such would influence the investors' tendency to take interest rate risk.⁹ More specifically, if investors consider rises in future interest rates to be more probable than declines in those rates compared with their central expectations when the curve shows a significant positive slope, they will tend to demand a higher risk premium to protect themselves against the greater risk of capital losses. Chart 8 presents the slope of the yield curve in Germany, measured by the spread between the two-year government bond yield and the three-month money market rate.

Liquidity premium

The liquidity premium regards the additional profitability required by investors to meet any difficulties in selling assets at times of market stress. Liquidity *premia* vary considerably over time and tend to increase substantially during the episodes commonly known as "flight to liquidity". The spread between the interest rates on 5-year swaps in Germany and government bond yields with a similar maturity was used to capture the impact of such episodes on the risk premium of forward rates.¹⁰ As Chart 9 shows the swap spread is typically positive. This suggests that Treasury bonds tend to be more liquid than swaps.¹¹ In the summer and autumn of 1998 in the context of the Russian crisis, the swap spread increased significantly. Also in 2000 the swap spread widened. This is likely to have been associated with structural changes in the US government debt market that pointed to a considerable decline in the supply of US Treasury securities (Cortes (2003)).

(8) See, for example, Moneta (2003) and Davis and Fagan (1997).

(9) See, for example, Peacock (2004).

(10) Empirically, changes in the liquidity premium are an important factor behind the behaviour of swap spreads (see, for example, Cortes (2003)).

(11) The swap spread is also used as an indicator of the credit risk of the banking system. However, the credit risk of interest rate swaps is limited by the fact that there is no trade of principal.

Chart 8

SLOPE OF THE YIELD CURVE IN GERMANY

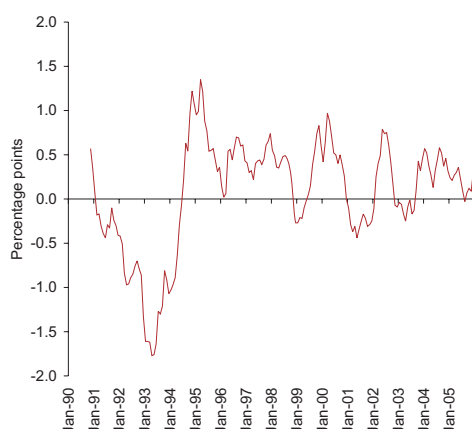
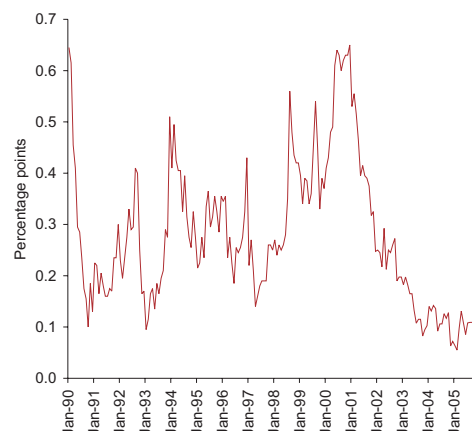


Chart 9

SWAP SPREAD



In order to quantitatively assess the impact of the possible explanatory factors mentioned above on the behaviour of the forward risk premium of the three-month interest rate, the following initial formulation was used to identify the explanatory variables and the respective lags:

$$RP_t = \alpha_1 + \sum_{i=0}^p \beta_{1,i} X_{1,t-i} + \sum_{i=0}^p \beta_{2,i} X_{2,t-i} + \sum_{i=0}^p \beta_{3,i} X_{3,t-i} + \sum_{i=0}^p \beta_{4,i} X_{4,t-i} + \sum_{i=0}^p \beta_{5,i} X_{5,t-i} + \sum_{i=0}^p \beta_{6,i} X_{6,t-i} + \sum_{i=0}^p \beta_{7,i} X_{7,t-i} + \varepsilon_t$$

where RP_t is the forward risk premium, α_1 a constant, p the maximum number of lags for the selection of the explanatory variables $X_1, \dots, X_7$ and ε_t is the residual. The explanatory variables were selected following an approach going from general to particular, where $p = 12$. X_1 corresponds to inflation, X_2 to economic activity, X_3 and X_4 to uncertainty regarding the outlook for inflation and economic activity respectively, X_5 to uncertainty in financial markets, X_6 to the slope of the yield curve and X_7 to the swap spread. Table 1 presents the various proxies that were tested for each explanatory variable.

The equation was estimated using the two-stage least squares method. An instrumental variables method was chosen in order to guarantee the consistency of the estimated coefficients. In fact, a positive shock on the risk premium may also lead to an increase in the slope of the yield curve, implying that this slope would be positively correlated with the residual of the equation and that the estimated regression coefficients would be biased. The instrument chosen was the slope of the yield curve (X_6) with up to a 6-period lag.¹²

Table 2 shows the best specifications for the forward risk premium of the three-month rate for 3-month and 1-year horizons over the sample period between April 1995 and December 2005.

The variables are measured in percentage points. This means that, for instance, a difference of one percentage point between the actual year-on-year inflation rate and the expected annual average inflation a year earlier (surprise inflation) has an impact of 0.09 p.p. on the forward risk premium of the three-month rate for the 3-month horizon and of 0.16 p.p. for the 12-month horizon.

(12) An $R^2 = 0.86$ was obtained in the regression between the endogenous explanatory variable and the instruments considered (first-stage of the two-stage least square method).

Table 1

EXPLANATORY VARIABLES AND PROXIES	
<i>Explanatory variables</i>	<i>Proxies</i>
X ₁ : Inflation	- Realised inflation: German CPI (y-on-y rate of change) - Expected inflation: Consensus forecasts one-year ahead for consumer prices in Germany (weighted average of CPI forecasts for t and t+1) - Surprise inflation: Difference between realised inflation (German CPI, y-on-y) and one-year ahead Consensus forecasts for CPI in Germany one year earlier (annual percentage change)
X ₂ : Economic activity	- Industrial production: IPI in Germany excluding construction (y-on-y rate of change) - Economic activity outlook: Consensus forecasts one year ahead for GDP in Germany (weighted average of GDP forecasts for t and t+1)
X ₃ : Uncertainty regarding the inflation outlook	Standard deviation of the Consensus panel forecasts one-year ahead for CPI in Germany (weighted average of the standard deviation of forecasts for t and t+1)
X ₄ : Uncertainty regarding the economic activity outlook	Standard deviation of the Consensus panel forecasts one-year ahead for GDP in Germany (weighted average of the standard deviation of forecasts for t and t+1)
X ₅ : Financial markets uncertainty	Implied volatility in options on German 10-year government bond future contracts
X ₆ : Yield curve slope	Spread between the German 2-year government bond yield and the 3-month money market interest rate
X ₇ : Swap spread	Spread between the 5-year swap rate in Germany and the 5-year government bond yield

According to the results of Table 2, surprise inflation, the economic activity outlook, implied bond market volatility, and the slope of the yield curve are important variables for explaining the forward risk premium behaviour for both the 3-month and 1-year horizons. Uncertainty regarding future developments in inflation (lagged by 2-month) is also an important variable at the 3-month horizon¹³. All variables have the expected sign. The coefficient associated with the economic activity outlook (lagged 12-month) shows a positive sign, which suggests that the forward risk premium has a pro-cyclical behaviour. Neither the uncertainty regarding economic activity nor the swap spread are statistically significant to explain the forward risk premium of the three-month rate over the considered horizons. A

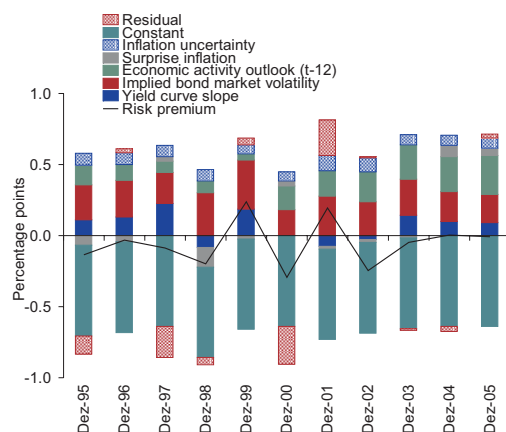
Table 2

FORWARD SURVEY-BASED RISK PREMIUM OF THE THREE-MONTH RATE (t-ratios in brackets)			
	lag	Risk premium 3-month horizon	Risk premium 1-year horizon
<i>Constant</i>		-0.64 (-6.87)	-1.16 (-10.1)
<i>Inflation (surprise inflation)</i>	0	0.09 (5.48)	0.16 (6.32)
<i>Inflation uncertainty</i>	2	0.36 (4.63)	—
<i>Economic activity outlook</i>	12	0.11 (4.63)	0.12 (4.66)
<i>Implied bond market volatility</i>	0	0.05 (3.53)	0.16 (8.01)
<i>Slope of the yield curve</i>	0	0.31 (8.09)	0.75 (13.3)
<i>Dummy 2001:9</i>		-0.64 (-5.51)	-0.61 (-3.38)
		LM~F(7,115)=1.69 (0.12) ARCH~F(7,108)=1.12 (0.35) N~ $\chi^2(2)$ =1.80 (0.41) Hetero ~F(11,110)=1.29 (0.12)	LM~F(7,116)=1.82 (0.09) ARCH~F(7,109)=2.18 (0.04) N~ $\chi^2(2)$ =0.28 (0.87) Hetero ~F(9,113)=1.06 (0.40)

(13) In order to test the robustness, the equations for the risk premium at the 3-month and 1-year horizons were estimated using the ordinary least squares method. In both equations, point estimates of the coefficients associated with the slope of the yield curve (0.36 in the equation for the 3-month risk premium and 0.85 in the equation for the 1-year risk premium) are higher than the estimates obtained using instrumental variables. Also the 0.40 point estimate of the coefficient associated with uncertainty regarding inflation in the equation for the 3-month risk premium is higher than that obtained using instrumental variables. With regard to the other explanatory variables, there are no significant differences between the parameters estimated through both methods.

Chart 10

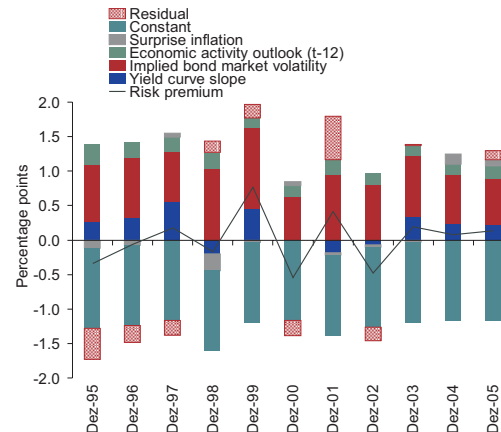
CONTRIBUTIONS TO THE SURVEY-BASED RISK PREMIUM THREE-MONTH AHEAD^(a)



Note: (a) With a view to simplification, the values of the risk premium and respective components are only shown for the month of December in each year.

Chart 11

CONTRIBUTIONS TO THE SURVEY-BASED RISK PREMIUM ONE-YEAR AHEAD^(a)



Note: (a) With a view to simplification, the values of the risk premium and respective components are only shown for the month of December in each year.

dummy with a negative sign was identified in September 2001, which was associated with the unexpected decline in the key ECB interest rates in the aftermath of the terrorist attacks of 11 September. This type of shock has an immediate impact on forward interest rates, being only incorporated in the interest rate expectations reported by Consensus in the survey conducted in the following month.

Charts 10 and 11 show the contributions from each of the identified explanatory variables to the behaviour of the 3-month rate forward *premia* in the months of December of the 1995-2005 period. Among the identified explanatory variables, implied bond market volatility had a very significant impact on developments in risk *premia* at both horizons. In addition, and at the 3-month horizon, the economic activity outlook also had a considerable influence on the behaviour of the risk premium.

6. CONCLUSION

Forward interest rates are imperfect indicators of market expectations regarding future interest rates, given that they incorporate a risk premium demanded by investors to make up for uncertainty surrounding interest rates in the future.

This article uses interest rate expectations reported by Consensus Economics as proxies for the true market expectations regarding interest rates. It can be concluded that the forward risk premium calculated on the basis of such expectations, shows great variability over time, reaching a significant magnitude during certain periods. Attempts have been made to identify factors explaining the behaviour of the time-varying forward risk premium, using a simple model that combines factors directly related to economic fundamentals with factors reflecting financial market conditions.

The results obtained indicate that surprise inflation, economic activity outlook, uncertainty in financial markets and the slope of the yield curve are significant explanatory variables with a positive impact on the risk premium of the German forward interest rates at the 3-month and 1-year horizons. Uncertainty regarding future inflation also has a considerable positive impact on the behaviour of the forward risk premium at the 3-month horizon. By identifying these explanatory factors, it is possible to obtain some

indication of the impact of potential changes in these explanatory factors on forward interest rates, via the risk premium.

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