International Journal of Forecasting 16 (2000) 39–58
www.elsevier.com/locate/ijforecast

Interest rate spreads as predictors of German inflation and business cycles

Detelina Ivanova[a], Kajal Lahiri[a,*], Franz Seitz[b]

[a]Department of Economics, The University at Albany-SUNY, Albany, NY 12222, USA
[b]University of Applied Sciences Amberg-Weiden, Hetzenrichter Weg 15, D-92637 Weiden, Germany

Abstract

We have studied the comparative performance of a number of interest rate spreads as predictors of the German inflation and business cycle in the post-Bretton Woods era. The two-regime Markov-switch model that we used as a nonlinear filter allows the dynamic behavior of the economy to vary between expansions and recessions in terms of duration and volatility. We found that the bank term structure, the public term structure, and the spread based on the call rate predicted all recessions with a comfortable lead, although they lagged some of the recoveries by a few months. The bank–public spread generates a series of false signals, and missed completely the upturn in the mid-1970s, but detected the last two recoveries with an average lead of nearly 12 months. The source of the predictive power of interest rate spreads lies in the information they contain not only about monetary policy, but also about an assortment of general macroeconomic shocks. The filter probabilities from three of the interest rate differentials also foreshadowed the long swings in the German inflation rate remarkably well, with a lead time of 2–4 years without any false signals.

Keywords: Turning-point forecasts; Markov-switch model; Bundesbank policy; Term structure; Germany

1. Introduction

In recent years a number of studies have examined the usefulness of spreads between yields on long-term and short-term financial instruments as predictors of future output growth and inflation. Bernanke (1990), Fama (1990), and Friedman and Kuttner (1993, 1998), among others, have established the predictive power of various interest rate differentials in VAR-based models for US output growth, using the concept of Granger causality. Harvey (1991) and Sauer and Scheide (1995) applied a similar methodology to German data, and offered evidence that the slope of the yield curve (i.e. the difference between yields on long-term and short-term assets) contains useful information for predicting business cycle fluctuations over and beyond what is contained in real money measures. Harvey (1991) showed that forecasts of German output growth based on the term structure of interest rates outper-

*Corresponding author. Tel.: +1-518-442-4758; fax: +1-518-442-4736.
E-mail address: KL758@cnsvax.albany.edu (K. Lahiri)

0169-2070/00/$ – see front matter
PII: S0169-2070(99)00029-1

form consensus forecasts of the five leading German research institutions.

The aforementioned papers have a drawback in that they do not distinguish between recessions and economic booms in an explicit way for the purpose of business cycle prediction. Estrella and Hardouvelis (1991), Dueker (1997), Dotsey (1998) and Estrella and Mishkin (1998) have used a probit model with a dummy dependent variable representing recessions to establish the superiority of the spread between long-term and short-term Treasury bond rates in forecasting US recessions. Estrella and Mishkin (1997) and Funke (1997) used these interest rate differentials to demonstrate that a similar relationship holds for the German business cycle. Bernard and Gerlach (1996) also applied the probit methodology to a sample of eight countries including Germany and the US and found that the spread provides useful information about the likelihood of future recessions as far as 2 years ahead. The predictive power was highest for Germany followed by Canada and the US. The authors also showed that a leading indicator constructed by the OECD contains information beyond that of the spread only for horizons of less than two quarters.

Both the VAR and the probit methodologies suffer from the problem of having to choose a fixed lead time with which the spreads indicate shifts in the business cycle, and to restrict this lead to be the same for all peak and trough turning points. The probit model, in addition, relies on ex post realized recession dates to examine the performance of the interest rate spreads, so its predictions greatly depend on the choice of business cycle dating. As noted by Stekler (1991), the process of predicting turning points of regimes is different from making quantitative predictions; consequently, forecasting methods designed exclusively to predict regime changes have been developed. The regime-switch approach adopted by Lahiri and Wang (1994) and Layton (1996) avoids these pitfalls, since it uses a Markov-switch model to generate ex ante forecasts for points of transition between the regimes of recession and expansion. These probability forecasts are then compared to the existing business cycle dating to establish the accuracy of prediction. Lahiri and Wang (1996) also applied the Markov-switch methodology to various US interest rate differentials and found that the framework allows reliable predictions of both recessions and recoveries with comfortable lead times.[1] In the case of Germany the Markov-switch methodology using interest rate spreads has the added advantage that its predictive performance is much less likely to be affected by the structural break associated with German unification in 1990 than the traditional VAR models (cf. Harvey, 1991). In this paper we follow Lahiri (1996) and examine the ability of yield spreads of various German financial instruments to predict the turning points of the German business cycle using the two-regime Markov-switch model as the filter. The resulting turning-point predictions are then compared to the comprehensive recession dating provided by the Economic Cycle Research Institute (ECRI) under the Directorship of Geoffrey Moore.

The use of interest rate differentials for inflation forecasts also has precedence in the literature. Using the classic Fisher (1930) equation and the rational expectations hypothesis, Mishkin (1990a,b, 1991) and Jorion and Mishkin (1991) showed that the spreads between long-term and short-term rates are good predictors of future inflation. Gerlach (1997), Schich (1996), Davis and Fagan (1997), and Estrella

[1] Dueker (1997) combines a probit model with the Markov-switching methodology. Ahrens (1999) also applies the regime switching approach to predict US recessions. He finds that the yield curve is a reliable predictor.

and Mishkin (1997) applied variations of this framework to German data and showed that the term spreads contain useful information about future inflation at horizons of more than 3 years. Berk (1998) offers an overview of the evidence on the information content of the yield curve slope for prediction of both real activity and inflation for a number of market economies. In this paper, however, we concentrate on predicting inflation turning points — i.e. points at which major swings in inflation are about to develop. We use the probabilistic inference from our Markov-switch models to predict these turning points. Our predictions are compared with the actual path of German inflation. We found that a number of alternative measures of the yield curve slope predict inflation turning points with a 2- to 4-year lead time with remarkable regularity. This result is consistent with the findings in Estrella and Mishkin (1997) who used a different methodology.

The paper proceeds as follows: Section 2 presents the theoretical arguments for the relationship between the term spread and economic activity and inflation. In Section 3 we introduce the data used in the paper. Section 4 briefly discusses the regime switching methodology. Section 5 contains the estimation results and a discussion of their implications for German business cycle analysis. Section 6 applies the regime-switching methodology to the forecasting of inflation turning points. Section 7 offers a summary and some tentative policy conclusions for the European Central Bank.

2. Theory

The theoretical justification for the use of the term structure slope — the difference between long-term and short-term rates for similar financial instruments — can be found in the expectations theory of the term structure of interest rates.[2] In short, the expectations theory postulates that for similar financial instruments the long-term yields are an average of current and expected future short-term yields, so that the investors are indifferent between investments in short- or long-term assets for a given holding period. Manipulation of short-term rates is a proven instrument of monetary policy.[3] When the central bank raises short-term rates agents view this as a temporary shock, and hence adjust their expectations of future short-term rates by less than the full amount of the increase. By the expectations hypothesis the long-term rate then rises less than the short-term rate, resulting in a flattened or even an 'inverted' yield curve.

Indeed, if the policy of the central bank is perceived as credible, the monetary tightening should affect short- and long-term rates differently. All spot rates have a real interest rate component and an inflationary expectations component. In a low inflation environment, short-term rates are dominated by the real rate component, and hence nominal short term rates rise because real rates rise due to tight credit. The dynamics of the long-term rates, however, depend heavily on the inflationary expectations component and its effect on the real rates. If the tightening is viewed as a credible commitment to lower inflation by the central bank, reduced inflationary expectations will moderate the effect of a higher ex ante real rate, and the long-term rates will rise less than the short-term rates. A tightening of monetary policy reduces available credit, and leads to a postponement of investment and consumption; hence an 'inverted' yield curve is associated with an upcom-

[2]For a detailed discussion of the expectations theory of the term structure of interest rates see Cox et al. (1981) and Campbell (1995).

[3]See Taylor (1999).

ing recession and decline in future economic activity. Since the effects of monetary policy are felt in the real sector only with some lag, the inversion of the yield curve could be used to anticipate the onset of a recession.[4]

A similar logic underlies the rationale for the use of the spread between yields of short-term securities of different risk. For example, the spread between a short-term private company bond and a short-term government bond serves as an indicator of both the stance of monetary policy and the market's perceptions of the likelihood of business bankruptcy and default.[5] The incidence of corporate default fluctuates in a pronounced pattern with the business cycle, and if investors in private bonds anticipate a downturn and hence conclude that the probability of default of the private bond is greater, they will demand a higher rate of return on this bond compared with the risk-free government bond, and the spread will widen. To the extent that investors' expectations are rational and on average correct, and that tight monetary policy also tends to widen the spread, its movements should contain systematic information about future movements in output. Thus, the spread typically widens in advance of recessions and narrows again around recoveries.

An inversion of the yield curve will occur only if the tightening of monetary policy is perceived as credible, hence the rise in real rates is offset by lower inflationary expectations. If inflationary expectations are rational, they will be correct in the long-run, and thus the inversion of the yield curve will eventually be followed by a downward movement of inflation. Conversely, an upsloping yield curve is indicative of increasing expected future inflation. Therefore, movements in the term structure should also be indicative of future inflation turning points.

3. Data

We have used monthly data spanning the period 1973:04–1998:02 on the following series: yield on public bonds 1–2 years maturity, yield on public bonds 9–10 years maturity, yield on bank bonds 1–2 years maturity, yield on bank bonds 9–10 years maturity, Bundesbank Lombard rate, and call money rate. We generate five indicator series: a public term structure series Public_TS (the spread between the yield on public bonds with 9–10 years maturity and the yield on public bonds with 1–2 years maturity), a bank term structure series Bank_TS (the spread between the yield on bank bonds with 9–10 years maturity and the yield on bank bonds with 1–2 years maturity), a private–public spread Bank_Public (the spread between the yield on bank bonds with 1–2 years maturity and the yield on public bonds with 1–2 years maturity), a term structure series based on the Lombard rate Lombard_TS (the spread between the yield on public bonds with 9–10 years maturity and the Lombard rate), and a term structure series based on the call money rate Call_TS (the spread between the yield on public bonds with 9–10 years maturity and the call rate).[6]

[4] In recent years economists have identified a number of alternative channels through which monetary policy affects real economic activity. See Lahiri and Wang (1996) for a summary and Görgens et al. (1999) (Chap. 11.5) for evidence on Germany and the European Monetary Union.

[5] For a detailed argument, relating to the 6-month commercial paper–Treasury bill spread in the US see Friedman and Kuttner (1998).

[6] We should mention that we have tried other spread series such as the spread between the yield on public bonds and the 3-month money market rate, the spread between the yield on public bonds with 9–10 years maturity and the 3-month money market rate, and the spread between the 3-month and 1-month money market rates. Their performance was similar, if not slightly inferior to the performance of Bank_TS and Public_TS, hence we do not report the results for these series in detail.

The public and the bank term structures are undoubtedly influenced by the stance of monetary policy, but also reflect a variety of other conditions in the credit market. Given the low liquidity of the market for bank bonds in Germany until the mid-1990s the public term structure is expected to reflect these factors more than the bank term structure, but the performances of the two series bear remarkable similarity nevertheless. The bank–public spread, in addition, captures factors such as default risk and private financing needs, especially in building and construction in the context of Germany.

The Call_TS series, by contrast, should capture predominantly the actions of monetary authorities, since it is based on the rate which is perceived as the best indicator of the monetary policy stance of the Bundesbank.[7] This is also true for the Lombard_TS series, see Bernanke and Mihov (1997). For this reason we refer to the first three series as market indicators and the last two as policy indicators. Comparisons among the performance of these five series in predicting business cycle and inflation turning points should, therefore, yield important identifying information as to whether the predictive power of interest rate spreads is due to the information they contain about monetary policy stance, or about other exogenous shocks.

The interest rates and yields were taken from the database of the Deutsche Bundesbank. The five series are shown in Figs. 1–5, with shaded areas representing recession (i.e. peak-to-trough) periods. Since well accepted official business cycle dating for Germany does not exist (like the NBER business cycle dating for the US), we have used the business cycle chronologies derived by ECRI (1999). These recession dates largely coincide with the business cycle phases estimated by Oppenländer (1997) using capacity utilization and other criteria, and with those obtained in Artis et al. (1997) using a four-step filter for the index of industrial production. The monthly data for the inflation rate use the CPI and are taken from the IMF databank. Reference chronologies for inflation cycles are not provided by any institution for Germany, so we adopt a methodology similar to that in Artis et al. (1995) to identify inflation cycle turning points. We assume that troughs always follow peaks and vice versa, and that peak-to-trough and trough-to-peak periods

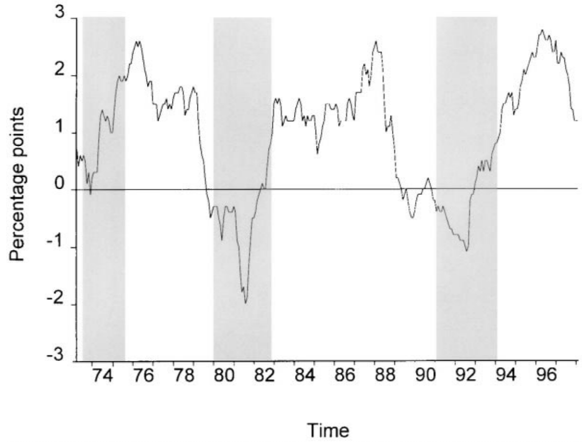

Fig. 1. Public_TS.

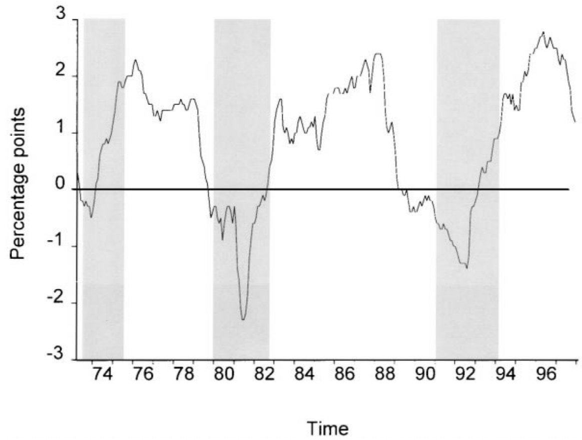

Fig. 2. Bank_TS.

[7] According to Von Hagen (1999), the call rate has been the focus of short-run Bundesbank operations since the early 1970s.

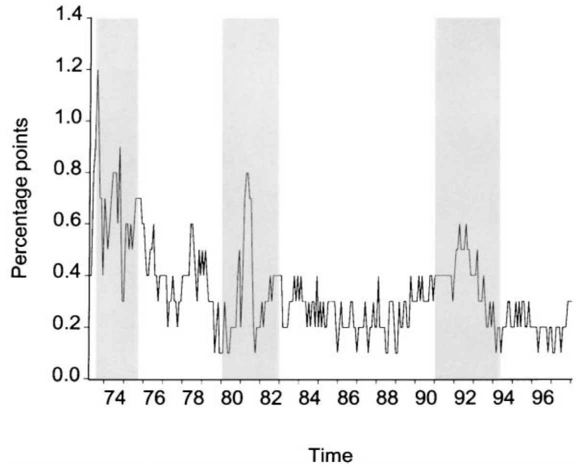

Fig. 3. Bank_Public.

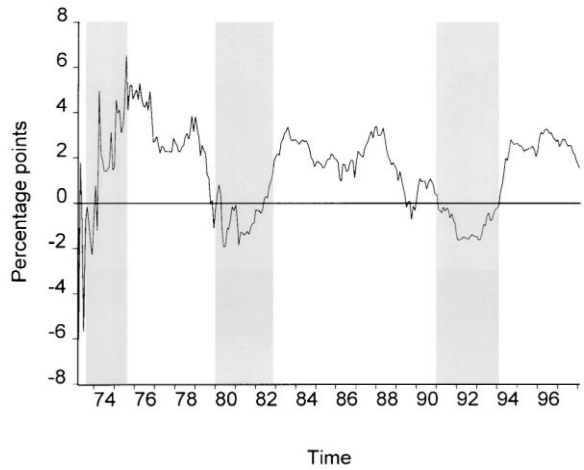

Fig. 4. Call_TS.

last at least 12 months.[8] Such a requirement is necessary for capturing cyclical rather than short-term movements. A cyclical turning point is thought to occur at the most extreme value of inflation between two consecutive regimes.

[8]The assumption of the length of the swings may seem ad hoc, but the chronology we derive is actually robust to considerable variation in the duration of the cycle required.

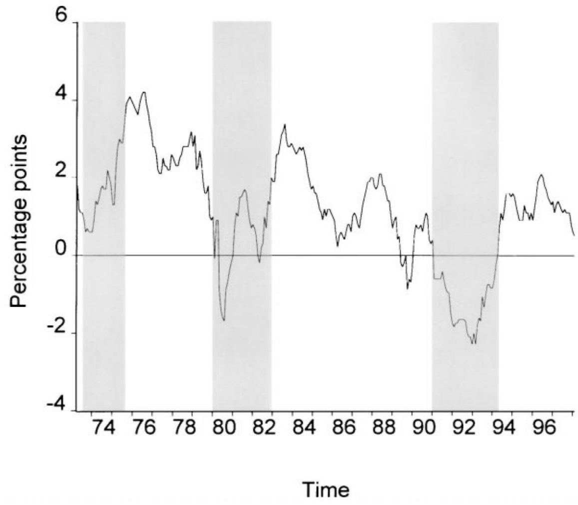

Fig. 5. Lombard_TS.

4. Methodology

Using the regime-switching approach developed by Hamilton (1989) and following Lahiri and Wang (1996), we model each of the yield differentials analyzed as being determined by a two-regime, first-order Markov process. For the public and bank term structure series and the series based on the Lombard rate and the call rate we would expect the two regimes to correspond to the normal and 'inverted' yield curve, and for the bank–public spread to the normal and 'widened' spread. The observed spread series Y_t is assumed to be drawn from two different unobservable states $S_t = 1,2$. If the state at time t is S_t then $y_t \sim N(\mu^2_{S_t}, \sigma^2_{S_t})$. The state S_t is assumed to follow a first-order Markov process, that is:

$$P(S_t = j | S_{t-1} = i, S_{t-2} = k, \dots) = P(S_t = j | S_{t-1} = i) = p_{ij}$$

and $\sum_{j=1}^{2} p_{ij} = 1, i = 1, 2$

The parameters to be estimated include the state-dependent means μ_{S_t} and variances $\sigma^2_{S_t}$ and the transition probabilities p_{11} and p_{22}. To estimate the model we use the EM algorithm, developed by Hamilton (1990), which maximizes the likelihood function

$$P(y_1, y_2, \ldots, y_T; \lambda, y_0) = \sum_{S_1=1}^{2} \ldots \sum_{S_T=1}^{2} P(y_t, \ldots y_T, S_1, \ldots S_T; \lambda, y_0)$$

to produce the maximum likelihood estimates of the parameter vector $\lambda = (\mu_1,\ \mu_2,\ \sigma^2_1,\ \sigma^2_2,\ p_{11},\ p_{22})$. The estimate of λ is used to make probabilistic inference about the unobservable state S_t. A by-product of the EM algorithm are the 'filter' probabilities $p_{it|t} = P(S_t = i | y_t, y_{t-1} \ldots, y_1, y_0; \lambda)$, $i = 1,2$, that the process is in state i at time t, conditional on information available at time t. These probabilities offer real-time inference about the prevailing state, as they rely only on data available at the time of the forecast. When $p_{1t|t} > p_{2t|t}$ we infer that the process is in state 1, and vice versa. A change of regime occurs at time t if $p_{it-1|t-1} > P_{jt-1|t-1}$ and $p_{it|t} < p_{jt|t}$, $j \neq i$, $i,j = 1,2$. Since we take y_t, the underlying spread variable, to be a leading indicator of the business cycle and inflation, the regime changes can be interpreted as turning-point signals.

Something should be said about the simplicity of the adopted model: in each of the two unobservable states we have assumed the spread variable to be independent of its past values, in spite of the fact that our test for the appropriate linear model for the augmented Dickey–Fuller test of nonstationarity revealed that past lags of the spread variables are statistically significant. The omission of the autoregressive terms from the regime-switching models is justified for two reasons. First, as shown by Lahiri and Wang (1994, 1996), models which include autoregressive terms may fit the data better but usually produce inferior turning-point forecasts compared to the simple model we have adopted. Second, the effect of the autoregressive parameters will largely be captured by the probabilities of remaining in the current state.

5. Prediction of business cycle turning points

Since Hamilton's (1989) model was developed as an alternative treatment of nonstationary time series, we first test the stationarity of our data. The results of the augmented Dickey–Fuller tests are shown in Table 1. Stationarity is rejected for four out of the five term structure series at the 5% level. The bank–public spread is shown to be stationary. Nevertheless, because additional specification tests, which we discuss later, did not reject the hypothesis of two distinct regimes, we proceeded with the estimation of the regime-switching models.[9]

We use the EM algorithm of Hamilton (1990) with no Bayesian priors to estimate the regime-switching model described above. Parameter estimates together with their corresponding standard errors are displayed in Table 2. As expected, the term structure series Public_TS, Bank_TS, Call_TS and Lombard_TS seem to follow regimes, which correspond to normal

Table 1
Augmented Dickey–Fuller test for nonstationarity

Series	ADF t-statistic	5% critical value	1% critical value
Public_TS	−2.09	−2.88	−3.44
Bank_TS	−2.07	−2.88	−3.44
Bank Public	−4.56	−2.88	−3.44
Call_TS	−2.86	−2.88	−3.44
Lombard_TS	−2.04	−2.88	−3.44

[9] There are strong a priori and theoretical arguments for treating differences in interest rates on public and bank bonds as stationary over the long run (see, for instance, Seitz, 1998a).

Table 2
Parameter estimates of the two-regime Markov-switching model[a]

Parameter	Public_TS	Bank_TS	Bank_Public	Call_TS	Lombard_TS
μ_1	1.664	1.629	0.244	2.614	1.683
	(0.039)	(0.041)	(0.008)	(0.071)	(0.063)
μ_2	−0.212	−0.404	0.515	−0.544	−1.072
	(0.058)	(0.063)	(0.02)	(0.115)	(0.101)
σ_2^2	0.253	0.271	0.006	0.880	0.929
	(0.028)	(0.03)	(0.0009)	(0.093)	(0.085)
σ_2^2	0.334	0.378	0.028	1.313	0.442
	(0.047)	(0.054)	(0.004)	(0.180)	(0.097)
p_{11}	0.985	0.986	0.978	0.985	0.988
	(0.008)	(0.008)	(0.012)	(0.008)	(0.006)
p_{22}	0.979	0.979	0.961	0.978	0.942
	(0.013)	(0.013)	(0.019)	(0.013)	(0.030)

[a] Standard errors shown in parentheses.

Table 3
Specification tests for the two-stage Markov model

Test	Public_TS	Bank_TS	Bank_Public	Call_TS	Lombard_TS
H_0: $\mu_1 = \mu_2(\chi^2(1))$	803.16	842.03	210.85	597.74	590.82
H_0: $\sigma_1^2 = \sigma_2^2(\chi^2(1))$	2.07	2.73	29.78	4.39	14.29
Omitted AR term ($\chi^2(1)$)	296.35	298.9	302.96	251.28	299.55

(positive mean) and ‘inverted’ (negative mean) yield curves. Similarly, the Bank_Public spread appears to widen in anticipation of a recession ($\mu_2 = 0.515$% per annum) and contract before expansions ($\mu_1 = 0.244$% per annum). The Wald test of H_0: $\mu_1 = \mu_2$ (shown in Table 3) clearly rejects the hypothesis of equal means across states for all five series. The error variance also tends to be higher in Regime 2 (except, interestingly, for Lombard_TS); however, the Wald test of H_0: $\sigma_1^2 = \sigma_2^2$ shows that the variance of errors for Public_TS and Bank_TS does not depend on the state of the process — a result which is in contrast to the frequent finding of strong cyclical heteroskedasticity (French & Sichel, 1993; Lahiri & Wang, 1996)[10]. Finally, following Hamilton (1996) we conduct an LM test for the effect of the omitted autoregressive term in the process specification, and find evidence that y_{t-1} does affect the process. In the interest of parsimony, however, we let this effect be captured by the transition probabilities p_{11} and p_{22} which exceed 0.94 for all series, indicating that both regimes tend to be highly persistent.

Figs. 6–10 show the filter probabilities of a recessionary state $P(S_t = 1 | y_t, \ldots, y_1, y_0, \lambda)$ for each of the five series, with shaded areas representing ECRI recession periods. It is noteworthy that in each case of a turning-point signal the probability of a state changes very promptly from 0 to 1 in the course of no more than 3 months. For exact dating of the turning-point signals we have adopted the following rule: a change from regime i to regime j is signalled at time t if $p_{it-1|t-1} > p_{jt-1|t-1}$ and $p_{it|t} < p_{jt|t}$. Over our sample there were three

[10] The last two tests are discussed in Engel and Hamilton (1990).

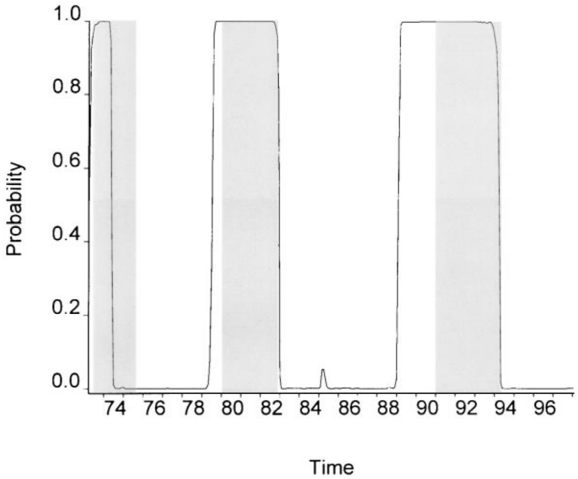

Fig. 6. Filter probability of recession (Public_TS).

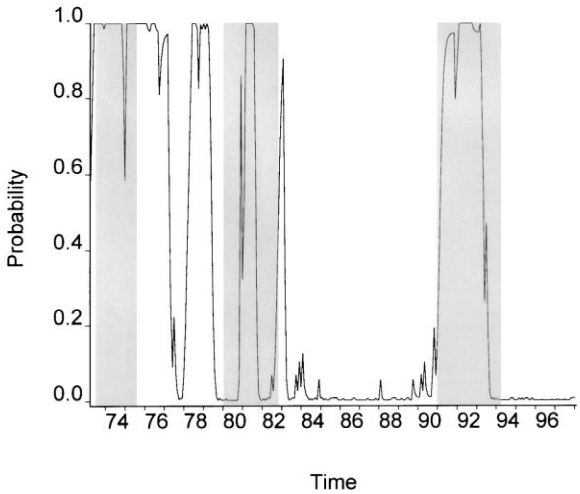

Fig. 8. Filter probability of recession (Bank_Public).

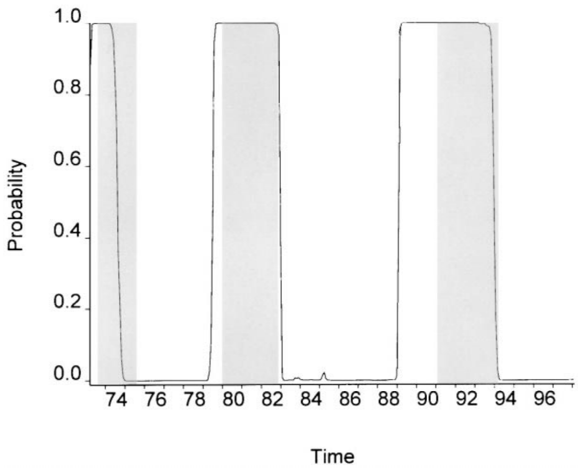

Fig. 7. Filter probability of recession (Bank_TS).

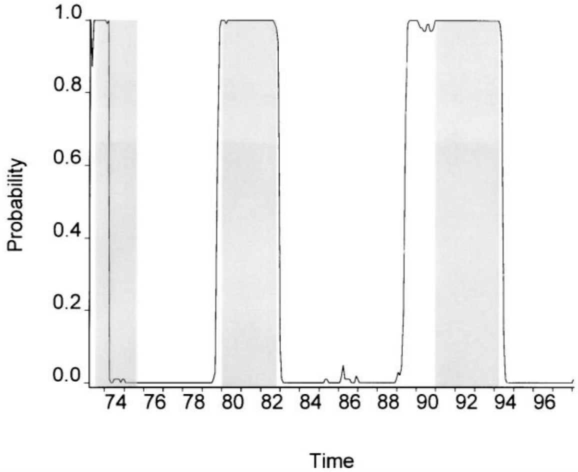

Fig. 9. Filter probability of recession (Call_TS).

peaks and three troughs; Tables 4 and 5 summarize the indicator performance of the five series.

The fundamental difference between the market term structure series (Public_TS, Bank_TS) and the private–public spread (Bank–Public) is reflected in their indicator performance. All three series anticipated peaks with a lead time of at least 4 months (except for the peak of 1991, which is detected by Bank_Public with a 2 month lag), but both term structure series seem to have anticipated the 1991 recession by about 2 years.[11] This long lead time should be attributed to the German unification in 1990. The jump in government spending and the additional demand from East Germany created the so-called 'unification boom' and mitigated the effects of the monetary restriction which started

[11]This variability in the lead time could be indicative of the sensitivity of the relationship between interest rate spreads and real activity to the nature of the shocks affecting the economy; see Berk (1998) for details.

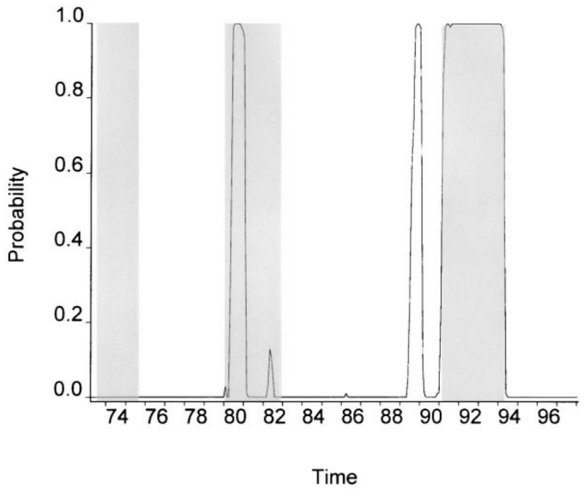

Fig. 10. Filter probability of recession (Lombard_TS).

Germany — France and the Netherlands — whose business cycles have been more or less synchronized with that of Germany in the past, experienced the onset of the recession much earlier; see Mishkin (1999).

The two market term structure series (Public_TS and Bank_TS) issued no false signals over the sample period, but predicted the recovery of 1982 only with a small lag. The bank term structure performs marginally better than Public_TS as it signals the recovery of 1994 with 3 months lead, whereas the signal from Public_TS comes simultaneously with the start of the expansion. It is interesting to note that Funke (1997) found term spreads to perform best at 4 quarters leading time. By contrast, the private–public spread misses the trough of 1975 but signals the last two recoveries with leads of 10 months and 13 months, respectively. Although it captured four of the six turning points with a comfortable lead, it also issued four false signals over the

Table 4
Peak turning-point signals[a]

Peak date	Public_TS	Bank_TS	Bank_Public	Call_TS	Lombard_TS
08:1973	+4	+4	+4	+4	Missed
01:1980	+5	+5	+21	+3	−5
01:1991	+23	+22	−2	+19	−2

[a] (+) denotes lead time in months; (−) denotes lag time in months.

Table 5
Trough turning-point signals[a]

Trough date	Public_TS	Bank_TS	Bank_Public	Call_TS	Lombard_TS
08:1975	+14	+11	Missed	+16	Missed
11:1982	−2	−2	+13	−2	+21
04:1994	0	+3	+10	3	−1

[a] (+) denotes lead time in months; (−) denotes lag time in months.

in late 1988, delaying the recession by about 2 years and increasing inflationary pressures.[12] Two of the main European trading partners of

[12]Because of this pressure, excessive wage growth and increasing fiscal deficits the Bundesbank continued to further raise central bank rates until mid-1992.

sample period.[13] The private–public spread issued false trough signals in July 1979 (before the actual onset of the recession of the early 1980s) and in March 1983, when the German economy had been already in recovery. It also issued false peak signals in February 1981, when the economy was in recession for over a year, and in December 1982, right after the economy had started on a recovery course.[14]

The multiple false signals issued by the spread between the two short-term rates are a result of the prevailing economic uncertainty at the end of the 1970s and the beginning of the 1980s due to the second world oil price shock and the volatility of the policy of the Bundesbank. During that period the day-to-day money market rate increased steadily from the end of 1978 till mid-1980, then declined in the second half of 1980, only to rise further in 1981. The volatility of monetary policy seriously reduced the credibility of the Bundesbank in this period. As a result the changes in the short-term rates did not affect significantly long-term rates and hence did not cause changes in the slope of the term structure, so the two slope measures did not issue false signals. By contrast, the Bank_Public spread is derived from two short-term rates, which were strongly affected by the volatility in Bundesbank policy, hence the false signals.[15,16]

For Germany, however, the performance of the private–public spread has an advantage over the yield curve slopes since it predicts the last two troughs with an average lead time of nearly 12 months. Another reason why it may be worthwhile tracking this indicator is that, despite the abundance of false signals in the 1980s, the performance of the private–public spread may improve following the development and deepening of both the market for public bonds and that for bank bonds in the post-unification period.

We are also presenting the performance of the term structure series based on the Lombard rate and the call money rate. The call rate spread performed similarly, if not slightly inferior to the two market term structure series. It issued no false signals, and indicated all peaks and troughs. Its signals for business cycle peaks came 2–3 months after the signals from Public_TS and Bank_TS and it lags the last two recoveries by 2 and 3 months, respectively. The performance of the Lombard rate spread, however, differs markedly from that of all previously discussed series. Lombard_TS missed completely the peak and trough of the 1970s. It signalled the peaks of 1980 and 1991 with lags of 5 and 2 months, respectively, predicted the trough of 1982 with close to 2 years lead, and then lagged the recovery of 1994 by 1 month. It also issued a false peak signal in August 1989, and then issued a false recovery signal in March 1990, when the start of the recession was 10

[13]Since our data begins in 04:73 and the first signal for a recessionary state appears in this month we have put a tentative lead time of 4 months for the peak of 08:73 for all three series, although potentially the lead time can be longer.

[14]Our findings are somewhat different from the forecasting performance of the US interest rate spreads. According to Lahiri and Wang (1996) the yield curve slopes in the US anticipated both peaks and troughs (although the latter were signalled with a smaller lead), whereas the private–public spread leads peaks but lags troughs. However, the propensity for the private–public spread to give false signals is strikingly similar for both countries.

[15]The higher uncertainty in the late 1970s and early 1980s is also considered to have caused a higher and more variable risk premium, thus loosening the relationship between long- and short-term rates.

[16]Comparison with the German growth cycles issued by ECRI reveals no association of these signals with fluctuations in growth.

months away. The false peak signal in August 1989 picked up the monetary tightening which started in mid-1988. The German unification shock offset this effect and the signal eventually reverted, indicating falsely that a recovery was on the way. As rates continued to go up steadily until mid-1992, the tightening was eventually felt in the money market, and all series indicated a peak point, this time correctly associated with the beginning of the recession in January 1991.[17]

The comparison between the five series suggests that, although monetary policy shocks affect the term structure of interest rates, they are by far not the only factor reflected in it. Since market-based term structure series partly outperform those based on indicators of the monetary policy stance, we should conclude that the source of the predictive power of interest rate spreads is also the information they contain about economy-wide conditions other than the actions of the monetary authorities. This confirms the findings in Estrella and Hardouvelis (1991) and Plosser and Rouwenhorst (1994) that the predictive power of the spreads stems also from information about factors other than the stance of the monetary policy. Estrella and Mishkin (1997) and Smets and Tsatsaronis (1997) have argued that the credibility of the monetary authority is crucial for a stable and predictable relationship between the term spreads and real economic activity. We, however, find that the credibility issue is more important for the private–public spread and spreads based on policy indicators than for market term structure indicators like Public_TS and Bank_TS.

Since all term structure series with the exception of Bank_TS use the same measure of long-term yields, namely the yield on public bonds with 9–10 years maturity, we examined how much of the information contained in the market-based short-term series (the yield on public bonds with 1–2 years maturity and the yield on bank bonds with 1–2 years maturity) can be explained by monetary policy shocks. For that purpose we estimated bivariate VARs with yields on short-term public bonds and the Lombard rate, and also with yields on short-term bank bonds and the Lombard rate. The variance decomposition analysis showed that variations in the Lombard rate explain only 16% of the variation in the short-term public bonds yield, and 20% of the variation in the short-term bank bonds yield, again lending some support to the hypothesis that short-term market-based rates contain predominantly information about shocks independent of monetary policy shocks.[18]

As noted by Schich (1996, 1997), conceptually it is preferable to use zero-coupon yields instead of yields to maturity. Yield-to-maturity spreads provide distorted estimates of the zero-coupon yield spreads due to both mathematical and tax-induced coupon effects, although those tend to be negligible for maturities of 10 years and less. We compare the spread between the zero-coupon yields on 9–10 years public bonds and 1–2 years public bonds with our Public_TS series, which is based on the corresponding yields to maturity. The correlation between the two spreads is 0.98. In addition, we used the zero-coupon spread in our Markov-switch model, and obtained turning-point signals identical with those from Public_TS. This sug-

[17]The inferior performance of the Lombard_TS spread may also be a hint that the Lombard rate was not a good indicator of monetary policy in Germany for this particular episode. This is in contrast to the findings of Bernanke and Mihov (1997).

[18]The variance decomposition in bivariate VARs for short-term public bonds and the call rate, and for the short-term bank bonds and the call rate showed that variation in the call rate can explain 24% of the total variation in short-term public bonds yield, and 23% of the total variation in short-term bank bonds yield. On the other hand, variation in the Lombard rate explains 48% of the variation in the call rate.

gests that the effect of the distortion of information present in the yield-to-maturity spreads is negligible in the case of turning-point prediction, and is in agreement with the result of Schich (1996) who found that the information content of the term structure is not significantly affected by the choice of zero-coupon or yield-to-maturity yield curves for the purposes of quantitative prediction.

6. Prediction of inflation turning points

The usefulness of the term structure slope for prediction of future inflation is also fairly well documented in the literature. Mishkin (1990a,b) uses the classic Fisher (1930) equation and the rational expectations hypothesis to derive a single-equation model for forecasting *k*-period ahead inflation using the spread between a very short-term rate and the rate on assets maturing *k*-periods ahead.[19] Jorion and Mishkin (1991) and Estrella and Mishkin (1997) offer evidence of the performance of similar models in multicountry studies. Schich (1996) finds that the medium-term segment of the term structure has significant ability to forecast inflation changes in Germany. This confirms the conclusion in Mishkin (1990a) that at the short end of the term structure the variability of expected inflation changes is dominated by the variability of the slope of the real term structure, and this obscures the predictive power of the shorter maturity spreads. The ability of the term spreads to predict inflation depends in addition on the effects of a (time-varying) risk premium, an inflation risk premium, and the conditional variance of inflation, although Evans and Wachtel (1993) found the last two terms quantitatively unimportant.

The question of forecasting inflation cycle turning points, however, has been largely neglected in the literature. Existing studies are confined predominantly to the United States (Boughton & Branson, 1991; Roth, 1991), Spain (Cabrero & Delrieu, 1996) and the United Kingdom (Artis et al., 1995). Dasgupta and Lahiri (1991) use estimates of ex ante real interest rates to derive inflationary expectations from nominal rates, and use the inflationary expectations for both quantitative and turning-point predictions of US inflation. They also offer an extensive comparison between the performance of their interest rate-based indicator of inflation and a composite leading index of inflation developed in Niemira (1986), and conclude that the performance of the composite leading indicator can be significantly enhanced if inflation forecasts based on interest rates are included. For Germany, Seitz (1998b) constructs an index of leading indicators on inflationary trends and concludes that it anticipates the general price movements quite clearly, although early identification of inflation turning points with a constant horizon is not always possible. What is interesting in Dasgupta and Lahiri (1991) and Seitz (1998b) compared to the others mentioned above is the increasing importance of financial variables in the course of time, especially interest rates, in predicting price trends.[20]

A forecast of inflation turning points can be of interest given the well-documented tendency of inflation to persist, i.e. to stay on an acceleration or deceleration course for a prolonged period of time. The lags in the transmission of monetary policy require central bankers to act preemptively to prevent such upturns or downturns, and dictate the need for forecasts of inflation up to 24 months ahead; see Batini and Haldane (1999) and Rudebusch and Svensson

[19] The methodology is based on Mishkin (1981), which has been extended and generalized in Kinal and Lahiri (1988).

[20] It is fairly well established in the literature that inflation in Germany contains a cyclical component; see Chadha and Prasad (1994) and Serletis (1996).

(1999). For example, if inflation is low at present, but an upturn is signalled in the medium term the monetary policy stance needs to be tightened immediately to prevent an inflation surge. A forecast of inflation turning points may, therefore, be seen as complementary to the quantitative forecasts commonly used by central banks.

The methodology developed initially by Burns and Mitchell (1946) for predicting business cycle turning points and defining a composite leading index was successfully utilized by Moore (1986) for prediction of inflation cycles.[21] We study the ex ante regime switch probabilities generated in the last section to examine if they can also anticipate the German inflation cycle. Since Mishkin (1990a,b) and Schich (1996) have shown that spreads between rates with longer maturities (1 year and over) typically perform better in quantitative inflation forecasts, we use three of our term structure measures (Public_TS, Bank_TS and Call_TS) to see whether the filter probabilities based on these term structure series forecast with any lead time points when inflation changes its course from acceleration to deceleration and vice versa.[22]

Our estimation of the regime-switching model for the three term structure slopes produced filter probabilities that the economy is in a regime of 'normal' or 'inverted' yield curve (estimates of parameters are shown in Table 2). As outlined in Section 2, we can use these probabilities to infer about periods of credible monetary tightening and hence about future changes in the course of inflation. Fig. 11 shows the 12-month inflation rate, computed as log

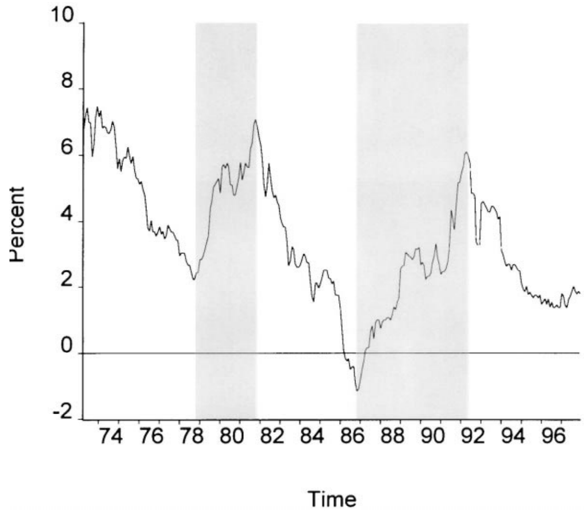

Fig. 11. 12-month German CPI inflation.

$CPI_t - \log CPI_{t-12}$, with shaded areas denoting inflation trough-to-peak periods. Figs. 12–14 show plots of the probability of a regime of upsloping yield curve, or monetary expansion, with shaded areas representing inflation upswings. As before, we consider a turning-point signal to be issued at time t if $p_{it-1|t-1} > p_{jt-1|t-1}$ and $p_{it|t} < p_{jt|t}$. A signal for a switch from a regime of upsloping yield curve to a

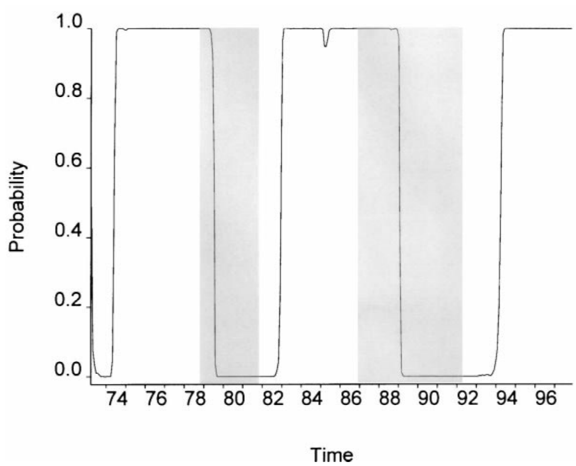

Fig. 12. Filter probability of monetary expansion regime (Public_TS). Shaded areas are inflation upswings.

[21]This methodology was applied to a number of market-oriented economies by Klein (1986).

[22]Due to a number of false signals and missed turning points, Lombard_TS and Bank_Public failed to deliver good inflation turning-point forecasts. Consequently, we do not present those results here for conservation of space.

Table 6
Turning-point signals for future deceleration of inflation[a]

Date of actual turn	Public_TS	Bank_TS	Call_TS
10:1981	+26(08:1979)	+26 (08:1979)	+24 (10:1979)
04:1992	+38 (02:1989)	+37 (03:1989)	+34 (06:1989)

[a] (+) denotes lead time in months; (-) denotes lag time in months; date of signal is given in parentheses.

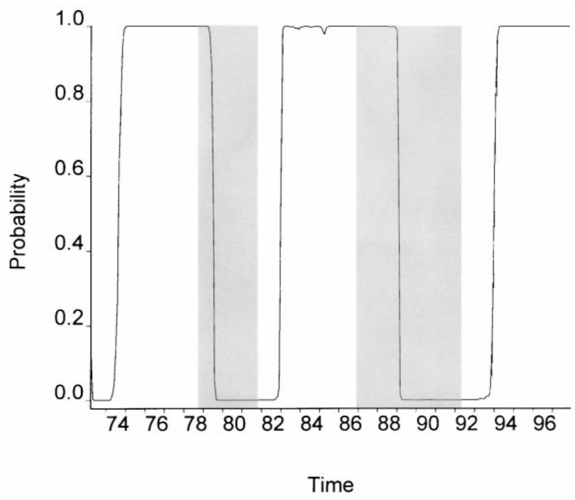

Fig. 13. Filter probability of monetary expansion regime (Bank_TS). Shaded areas are inflation upswings.

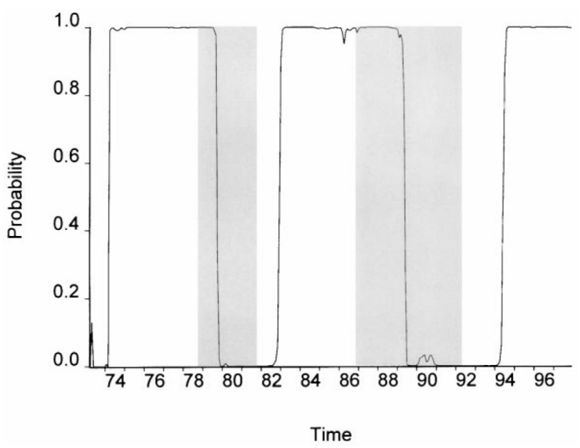

Fig. 14. Filter probability of monetary expansion regime (Call_TS). Shaded areas are inflation upswings.

regime of 'inverted' yield curve is considered a signal for a major swing in upcoming inflation from an acceleration course onto a deceleration course. Tables 6 and 7 show the performance of the three slope variables in predicting German inflation turning points. Downswings are anticipated with an average lead of about 2.5 years by all three series, and upswings are anticipated with an average lead of 4 years with no false signals. These exceptionally long lead times make the term structure slopes suitable candidates for classification as long-leading indicators of inflation, by analogy with Moore's (1991) idea of distinguishing between short- and long-leading indicators of real activity. The noticeable difference between the average lead times for upswings and downswings may be due to the differential response of the Bundesbank to under- and overshootings of its monetary target, raising rates in response to an overshooting but not lowering them in response to overshooting (see Mishkin, 1999).

Our results are in agreement with the multinational comparison in Estrella and Mishkin (1997) and the analysis of Schich (1996) for Germany, who show that the power of interest rate spreads to forecast inflation is greatest at the 3- to 5-year horizons. The long lead by which the signals from the term structure series precede the actual inflation turning points should not come as a surprise.[23] First, a tighten-

[23]For comparison, the leading indicators of the UK inflation cycle developed by Artis et al. (1995) have an average lead time of more than 1 year.

Table 7
Turning-point signals for future acceleration of inflation[a]

Date of actual turn	Public_TS	Bank_TS	Call_TS
10:1978	+52 (06:1974)	+49 (09:1974)	+54 (04:1974)
12:1986	+47 (01:1983)	+47 (01:1983)	+47 (01:1983)
Not realized yet	(04:1994)	(01:1994)	(07:1994)

[a] (+) denotes lead time in months; (-) denotes lag time in months; date of signal is given in parentheses.

ing in the money market requires time to affect the real sector through the various transmission channels. Then, even after the real sector has felt the tightening and investment and consumption have cooled off, prices remain sticky in the short run, and only adjust after a certain period. Since fluctuations in output precede those in prices, the lead time for inflation turning points following a contractionary monetary policy is longer than that for business cycle turning points. All series issue an inflation acceleration signal in the early 1994, but as of mid-1999 Germany was still enjoying a very low inflation. This result has to be evaluated against the background of the worldwide fall in inflation rates due to more stability oriented monetary policies and increased international competition. The adoption of explicit or implicit[24] inflation targeting by central banks in many of the industrialized countries, including Germany and the United States, has ensured both lower and less variable inflation in the 1990s. In this context it is uncertain whether a forecasting model such as the Markov-switch model, which learns by episodal examples, will continue to perform with such impressive regularity in the future. Substantial policy interventions can certainly defer the onset of an impending inflation cycle, but this will come at the risk of inviting a recession.

[24]For a discussion of monetary policy rules in practice see Bernanke and Mihov (1997) and Clarida et al. (1998).

7. Summary and conclusions

We have studied the comparative performance of a number of interest rate spreads as predictors of the German inflation and business cycle in the post-Bretton Woods era. We used a public term structure spread, a bank term structure spread, a bank–public spread, and term spreads based on the Bundesbank Lombard rate and the call money rate. The call rate and the Lombard rate are most frequently used as indicators of the monetary policy stance, and hence these spreads capture monetary policy specific factors. On the other hand, the public term structure, the bank term structure and the bank–public spread use market rates and, hence, although influenced by the Bundesbank policy, reflect a variety of other economy-wide shocks on a more comprehensive basis.

The findings in this paper once again confirm the usefulness of yield spreads for forecasting inflation cycles and economic downturns. The two-regime Markov-switch model allows the dynamic behavior of the economy to vary between expansions and recessions in terms of duration and volatility, and fits all five series well. We found that over the period 1973:04–1998:02 the bank term structure, the public term structure, and the spread based on the call rate predicted all recessions with a comfortable lead, although they lagged some of the recoveries by a few months. The bank–public spread generated a series of false signals, and missed completely the upturn in the mid-1970s, but detected the last two recoveries with an average lead of nearly 12 months. Interestingly, the spread series based on the Lombard rate performed notably worse than the three market-based series, suggesting that the source of predictive power of market rate spreads is the information they contain about factors independent of monetary policy. The filter probabilities from the three interest rate differentials — bank term structure, the public term structure, and the spread based on the call rate — also foreshadowed the long swings of the German inflation rate remarkably well with a lead time of 2–4 years without any false signals.

The major advantage of using interest rate variables as indicators of the business cycle and inflation is that they are market data, promptly available and not subject to revisions. The fact that their predictive power reflects information about economy-wide conditions over and above the stance of monetary policy suggests that monetary authorities can benefit from incorporating the term spread signals in their forecasts and policy-making. With a considerable amount of uncertainty prevailing in the beginning of the third stage of the European Monetary Union and the lack of reliable SNA data, interest rate spreads can provide useful guides to necessary policy changes for the newly founded European Central Bank (ECB). The ECB has chosen a monetary policy strategy which relies on two pillars: a prominent role of money and a broadly based assessment of the outlook for future price stability in the Euro area as a whole (ECB, 1999). For this second pillar the ECB uses information from financial market prices, e.g. interest rates, implied forward rates and term structure spreads, to forecast future inflation. This commitment to low and stable inflation would require the ECB to prevent inflation from getting onto an acceleration course when such a course is likely to come. Interest rate spreads, therefore, can be of substantial help in predicting not only what the level of inflation will be, but also where inflation is headed. In light of the facts that economic developments in Germany have been a major influence in the business cycle dynamics in the European Monetary Union (its GDP share is about 33% of the overall GDP), and that the Bundesbank has been notably successful in keeping inflation low, our results suggest that German interest rate spreads would be worthy indicators of both real activity and inflation for the ECB to follow, at least in the near term.

Acknowledgements

We thank the Editor-in-Chief, three anonymous referees and the participants of a session on Business Cycles at the 19th International Symposium on Forecasting (June 27–30, 1999) at Washington, DC, for many helpful comments and suggestions, and to Manfred Kremer of Deutsche Bundesbank for providing us the interest rate data. Needless to say, the responsibility for any errors and shortcomings in the paper remains ours.

References

Ahrens, R. (1999). Examining predictors of US recessions: A regime-switching approach. *Swiss Journal of Economics and Statistics 135*, 97–124.

Artis, M. J., Bladen-Hovell, R. C., Osborn, D. R., Smith, G., & Zhang, W. (1995). Predicting turning points in the UK inflation cycle. *Economic Journal 105*, 1145–1164.

Artis, M. J., Kontolemis, Z., & Osborn, D. R. (1997). Business cycles for G7 and European countries. *Journal of Business 70*, 249–279.

Batini, N., & Haldane, A. G. (1999). Forward-looking rules for monetary policy. In: Taylor, J. B. (Ed.), *Monetary Policy Rules*, University of Chicago Press, Chicago, pp. 157–202.

Berk, J. M. (1998). The information content of the yield curve for monetary policy: A survey. *De Economist 146*, 303–320.

Bernanke B. S. (1990) On the predictive power of interest rates and interest rate spreads. *New England Economic Review*, November–December, Federal Reserve Bank of Boston, pp. 51–68.

Bernanke, B., & Mihov, I. (1997). What does the Bundesbank target? *European Economic Review 41*, 1025–1053.

Bernard H. & Gerlach S. (1996) Does the term structure predict recessions? The international evidence. *Working Paper No. 37*, Bank for International Settlements, Basle.

Boughton, J. M., & Branson, W. H. (1991). Commodity prices as leading indicators of inflation. In: Lahiri, K., & Moore, G. H. (Eds.), *Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge University Press, Cambridge, pp. 305–338.

Burns, A. F., & Mitchell, W. C. (1946). *Measuring business cycles*. *NBER Studies in Business Cycles*, Vol. 2, Columbia University Press, New York.

Cabrero A. & Delrieu J.C. (1996). Construction of a composite indicator for predicting inflation in Spain. *Working Paper No. 9619*, Banco de España, Servicio de Estudios.

Campbell, J. Y. (1995). Some lessons from the yield curve. *Journal of Economic Perspectives 9*, 129–152.

Chadha, B., & Prasad, E. (1994). Are prices countercyclical? *Journal of Monetary Economics 34*, 239–257.

Clarida, R., Gali, J., & Gertler, M. (1998). Monetary policy rules in practice: Some international evidence. *European Economic Review 42*, 1033–1067.

Cox, J. C., Ingersoll, J. E., & Ross, S. A. (1981). A re-examination of traditional hypotheses about the term structure of interest rates. *Journal of Finance 36*, 769–799.

Dasgupta, S., & Lahiri, K. (1991). A leading indicator of inflation based on interest rates. In: Lahiri, K., & Moore, G. H. (Eds.), *Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge University Press, Cambridge, pp. 339–354.

Davis, P., & Fagan, G. (1997). Are financial spreads useful indicators of future inflation and output growth in EU countries? *Journal of Applied Econometrics 12*, 701–714.

Dotsey, M. (1998). The predictive content of the interest rate term spread for future economic growth. *Federal Reserve Bank of Richmond Economic Quarterly 84*, 31–51.

Dueker, M. J. (1997). Strengthening the case for the yield curve as a predictor of US recessions. *Federal Reserve Bank of St. Louis Review 79*, 41–51.

Economic Cycle Research Institute (ECRI) (1999). *International Cyclical Outlook 4*, 1–32.

Engel, C., & Hamilton, J. D. (1990). Long swings in the dollar: Are they in the data and do markets know it? *American Economic Review 80*, 689–713.

Estrella, A., & Hardouvelis, G. A. (1991). The term structure as a predictor of real economic activity. *Journal of Finance 46*, 555–575.

Estrella, A., & Mishkin, F. S. (1997). The predictive power of the term structure of interest rates in Europe and the United States: Implications for the European Central Bank. *European Economic Review 41*, 1375–1401.

Estrella, A., & Mishkin, F. S. (1998). Predicting US recessions: Financial variables as leading indicators. *Review of Economics and Statistics 80*, 45–61.

European Central Bank (1999) The stability-oriented monetary policy strategy of the Eurosystem. *Monthly Bulletin*, January, pp. 39–50.

Evans, M. D., & Wachtel, P. (1993). A modern look at asset pricing and short-term interest rates. *Journal of Money, Credit, and Banking 25*, 475–511.

Fama, E. F. (1990). Term structure forecasts of interest rates, inflation, and real returns. *Journal of Monetary Economics 25*, 59–76.

Fisher, I. (1930). *The Theory of Interest*, Macmillan, London.

French, M. W., & Sichel, D. F. (1993). Cyclical patterns in the variance of economic activity. *Journal of Business and Economic Statistics 11*, 113–119.

Friedman, B. M., & Kuttner, K. N. (1993). Why does the paper-bill spread predict real economic activity? In: Stock, J. H., & Watson, M. W. (Eds.), *New Research in Business Cycles, Indicators, and Forecasting*, University of Chicago Press, NBER, Chicago, pp. 213–249.

Friedman, B. M., & Kuttner, K. N. (1998). Indicator properties of the paper-bill spread: Lessons from recent experience. *Review of Economics and Statistics 80*, 34–44.

Funke, N. (1997). Predicting recessions: Some evidence for Germany. *Weltwirtschaftliches Archiv 133*, 90–102.

Gerlach, S. (1997). The information content of the term structure: Evidence for Germany. *Empirical Economics 22*, 161–179.

Görgens, E., Ruckriegel, K., & Seitz, F. (1999). *Europaische Geldpolitik*, Werner Verlag, Dusseldorf.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica 57*, 375–384.

Hamilton, J. D. (1990). Analysis of time series subject to changes in regime. *Journal of Econometrics 45*, 39–70.

Hamilton, J. D. (1996). Specification tests in Markov-switching time series models. *Journal of Econometrics 70*, 127–137.

Harvey, C. R. (1991). Interest rate based forecasts of German economic growth. *Weltwirtschaftliches Archiv 127*, 701–718.

Jorion, P., & Mishkin, F. S. (1991). A multi-country comparison of term structure forecasts at long horizons. *Journal of Financial Economics 29*, 59–80.

Kinal, T., & Lahiri, K. (1988). A model of ex ante interest rates and derived inflation forecasts. *Journal of the American Statistical Association 83*, 665–673.

Klein, P. A. (1986). Leading indicators of inflation in market economies. *International Journal of Forecasting 2*, 403–412.

Lahiri, K. (1996). Zinsdifferenzen als neue Fruhindikatoren — Theorie und Evidenz. In: Oppenländer, K. H. (Ed.), *Konjunkturindikatoren*, Oldenbourg-Verlag, München, Wien, pp. 216–237.

Lahiri, K., & Wang, J. G. (1994). Predicting cyclical turning points with leading index in a Markov switching model. *Journal of Forecasting 13*, 245–263.

Lahiri, K., & Wang, J. G. (1996). Interest rate spreads as predictors of business cycles. In: Maddala, G. S., & Rao, C. R. (Eds.), *Handbook of Statistics*, Vol. 14, Elsevier Science, Amsterdam, pp. 297–315.

Layton, A. P. (1996). Dating and predicting phase changes in the US business cycle. *International Journal of Forecasting 12*, 417–428.

Mishkin, F. S. (1981). The real interest rate: An empirical investigation. *Carnegie-Rochester Conference Series on Public Policy 15*, 151–200.

Mishkin, F. (1990a). What does the term structure tell us about future inflation? *Journal of Monetary Economics 25*, 77–95.

Mishkin, F. (1990b). The information in the longer maturity term structure about future inflation. *Quarterly Journal of Economics 55*, 815–828.

Mishkin, F. S. (1991). A multi-country study of the information in the term structure about future inflation. *Journal of International Money and Finance 19*, 2–22.

Mishkin, F. S. (1999). International experiences with different monetary policy regimes. *Journal of Monetary Economics 43*, 579–605.

Moore, G. H. (1986). *A Revised Leading Index of Inflation*, Center for International Business Cycle Research, Graduate School of Business, Columbia University.

Moore, G. H. (1991). New developments in leading indicators. In: Lahiri, K., & Moore, G. H. (Eds.), *Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge University Press, Cambridge, pp. 141–147.

Niemira M. P. (1986) *Updated PW Leading Indicator of Inflation*, PaineWebber, New York, December 26.

Oppenländer, K. H. (1997). Zum Konjunkturphänomen. In: Oppenländer, K. H. (Ed.), *Konjunkturindikatoren*, Oldenbourg-Verlag, München, Wien, pp. 4–23.

Plosser, C. I., & Rouwenhorst, K. G. (1994). International term structures and real economic growth. *Journal of Monetary Economics 33*, 133–155.

Roth, H. (1991). Leading indicators of inflation. In: Lahiri, K., & Moore, G. H. (Eds.), *Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge University Press, Cambridge, pp. 275–302.

Rudebusch, G., & Svensson, L. E. O. (1999). Policy rules for inflation targeting. In: Taylor, J. B. (Ed.), *Monetary Policy Rules*, University of Chicago Press, Chicago, pp. 203–259.

Sauer, C., & Scheide, J. (1995). Money, interest rate spreads, and economic activity. *Weltwirtschaftliches Archiv 131*, 708–722.

Schich S. T. (1996) Alternative specifications of the German term structure and its information content regarding inflation. *Discussion Paper No. 8/96*, Economic Research Group of the Deutsche Bundesbank, Frankfurt.

Schich S. T. (1997) Estimating the German term structure. *Discussion Paper No. 4/97*, Economic Research Group of the Deutsche Bundesbank, Frankfurt.

Seitz, F. (1998a). Geldnachfrage, Zinsen und Zinsstruktur. *Konjunkturpolitik 44*, 256–286.

Seitz, F. (1998b). An index of leading indicators on inflationary trends and the business cycle. In: Oppenländer, K. H., & Poser, G. (Eds.), *Social Structural Change — Consequences for Business Cycle Surveys*, Ashgate Publishing, Aldershot, pp. 269–284.

Serletis, A. (1996). International evidence on the cyclical behavior of inflation. *Economics Letters 51*, 205–212.

Smets F. & Tsatsaronis K. (1997) Why does the yield curve predict economic activity? Dissecting the evidence for Germany and the United States. *Working Paper No. 49*, Bank for International Settlements, Basle.

Stekler, H. O. (1991). Turning point predictions, error, and forecasting procedures. In: Lahiri, K., & Moore, G. H. (Eds.), *Leading Economic Indicators. New Approaches and Forecasting Records*, Cambridge University Press, Cambridge, pp. 169–182.

Taylor, J. B. (1999). The robustness and efficiency of monetary policy rules as guidelines for interest rate setting by the European Central Bank. *Journal of Monetary Economics 43*, 655–679.

Von Hagen, J. (1999). Money growth targeting by the Bundesbank. *Journal of Monetary Economics 43*, 681–701.

Biographies: Kajal LAHIRI is Professor of Economics, Statistics and Health Policy and Management at the State University of New York at Albany. He has published extensively in the areas of econometric theory, forecasting, monetary economics, and the economics of health and disability. Currently his major areas of research include business cycle forecasting, the econometrics of panel data, and the analysis of household survey data. He is an associate editor of the Journal of Econometrics and the International Journal of Forecasting.

Franz SEITZ is Professor of Economics at the University of Applied Sciences, Amberg-Weiden, Germany. He previously held a position in the Economics Department of the Deutsche Bundesbank. His main fields of interest include monetary theory and policy and empirical macroeconomics.

Detelina IVANOVA is a Ph.D. candidate in Economics at the State University of New York at Albany. Her research interests include the use of survey data for econometric forecasting, analysis of subjective probability forecasts, and business cycle prediction.