Is the yield curve a useful information variable for the Eurosystem?

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Abstract

This paper deals with the use of the yield curve in monetary policy making. We argue that the yield curve's information content with respect to future inflation and real economic activity depends on correct identification of both the nature of shocks to the economic system and price behaviour. Identification is crucial, as there are alternative interpretations of an observed movement in the yield curve suggesting different monetary policy reactions. We show that identification on the basis of estimated equations may be problematic, using an empirical experiment in which a simple term structure model is applied to data on a large number of countries. This is especially relevant for the Eurosystem, as some evidence emerges for Lucas (1976)-type problems in our simple yield curve model. This finding questions the yield curve´s usefulness for policy evaluation in the early years of Stage Three. All in all, policy analysts should be cautious when using the yield curve as information variable for monetary policy.

1. Introduction

The monetary policy strategy of the Eurosystem[1] consists of three key elements (European Central Bank, 1999). First, a quantitative definition is given of the Eurosystem's primary policy objective, price stability. Second, a prominent role is assigned in the strategy to money, as signalled by the announcement of a quantitative reference value for the growth rate of a monetary aggregate. Third, the information provided to the policy maker by money is supplemented by a broadly based assessment of the outlook for price developments and risks to price stability in the euro area as a whole.[2] This assessment is made using a wide range of economic indicators, because monetary data on their own do not provide a complete summary of all the information about the economy that needs to be used to set monetary policy. Central to the third element of this strategy are information variables. An important question in this respect pertains to the conditions for the use of a particular variable as information variable for monetary policy. Shigehara (1996) and Berk (1998) define an information variable in terms of stability and predictability with respect to non-financial activity. So the relationship between the information variable and non-financial activity needs to be stable (in a statistical sense), and the information variable should possess leading indicator properties with respect to non-financial activity. Non-financial activity includes inflation (logically linked to the ultimate objective of monetary policy, price stability) and real economic activity. [3]

We concentrate in this paper on one widely used information variable: the term structure of interest rates. We define the term structure as the relation between the yields to maturity for different terms to maturity.[4] We study this term structure in a macroeconomic context, and not as a testing ground for theories of expectations formation and asset pricing. Indeed, the objective of this paper is to review the information content of the term structure of interest rates with respect to future movements in inflation and real output, and to investigate whether this yield curve is useful for monetary policy purposes. We tackle this issue both theoretically and empirically. The theoretical discussion concentrates on general issues, highlighting that some important identification problems have to be solved before reliable use can be made of the indicator properties of the term structure. Moreover, policy analysts should be cautious when trying to solve these identification problems using econometric models estimated on historical data (Lucas, 1976). Changes in policy may alter

[1] The Eurosystem comprises the ECB and the national central banks of the member states which have adopted the euro in Stage Three of EMU.

[2] See Berk, Houben and Kakes (1999) for a discussion of the monetary policy strategy of the Eurosystem.

[3] Real economic activity is also of interest for a central bank since monetary actions undertaken to safeguard the objective of price stability in the face of disturbances can elicit real economic effects in the short run, especially when the degree of credibility of monetary policy is low (Fuhrer, 1997).

[4] In this paper we use the terms 'term structure' and 'yield curve' in an interchangeable fashion, which is, strictly speaking, not correct: the term structure is a particular yield curve (i.e. for zero-coupon bonds). See Shiller (1990), Svensson (1994) and Haubrich and Dombrosky (1996) for a discussion, and Deacon and Derry (1994) for details concerning the construction and estimation of various yield curves.

the economic structure, possibly hampering the usefulness of the yield curve as a tool for prospective policy analysis. We will illustrate this in an empirical experiment, in which we apply a simple representation of a model of the yield curve that has been used as a workhorse for many policy discussions in the past to data on a large number of countries. Our motivation to focus on the performance of this model in the very recent past is that financial markets anticipated in their behaviour on the start of Stage Three of EMU before the actual start of Monetary Union. So the Interim Period (ie the period in 1998 after announcement of the participating countries in Stage Three and the bilateral conversion rates, but before the actual start of Stage Three) could provide insight in possible structural breaks and the relevance of the Lucas Critique in this period.[5] This issue is important for the Eurosystem operating in the period directly after the birth of the Euro area. Our findings also help to evaluate the practical usefulness of the yield curve in current policy discussions.

The paper is organised as follows. The next section discusses theories of the yield curve to determine why this concept may possess an information content. A distinction is made between inflation (section 2.1) and real economic activity (section 2.2). Then we supplement this general discussion with a specific analysis, concentrating on the usefulness of the yield curve for the Eurosystem, in light of Lucas (1976)-type of problems. To this end, a simple model is introduced in section 3.1, and the results of fitting this model to the data are presented in section 3.2. Section 4 offers some preliminary conclusions.

2. General discussion on the usefulness of the yield curve for monetary policy

2.1 Yield curve and future inflation rates

We define the information content with regard to future inflation as the ability of the slope of the yield curve (the yield spread) to predict, in a stable way, the change in the future inflation rate.[6] The theoretical basis for the information content consists of the combination of the Fisher equation and the expectations theory of the yield curve (Modigliani and Sutch, 1966). The (one-period) Fisher equation decomposes the one-period nominal interest rate roughly into a one-period *ex ante* real interest rate and the inflation expected one period ahead.[7] The expectations theory of the yield curve is the most prevalent explanation of the term structure, and is based on the arbitrage condition that, after adjusting for risk, the

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[5] See Ericsson and Irons (1995) for a detailed study on the empirical relevance of the Lucas (1976) Critique.

[6] We concur with Mishkin (1990a, 1990b), who remarks that this is a narrow interpretation of the information content since no use is made of additional economic variables in combination with the slope of the yield curve. This criticism notwithstanding, we follow existing practice by using this interpretation.

[7] In a more general form the Fisher equation also incorporates an inflation risk premium and the conditional variance of inflation. These factors - which are quantitatively unimportant (Tzavalis and Wickens, 1996, p.105) - are omitted here for expositional ease.

expected return from holding for one period a bond that has *n*-periods to maturity is the same as the certain return from a one-period bond. Combining these theories gives us the following expression (for a formal derivation, see Tzavalis and Wickens, 1996):

$$R(n,t) = E_t r(n,t) + E_t p(n,t) + f(n) \qquad (1)$$

where $R(n,t)$ denotes the yield to maturity at *t* of a bond with *n*-periods to maturity. E is the expectations operator, and the subscript pertains to the period in which the expectation is formed, using information up to and including *t.* $r(n,t)$ is the average real interest rate over the next *n* periods, $p(n,t)$ is the average inflation rate over the next *n* periods and $f(n)$ is the average risk premium on an *n*-period bond until it matures. This risk premium is *ex hypothesi* constant under the expectations theory of the term structure. All rates are expressed in natural logarithms, save for the inflation rate, which is defined as the first difference of two logarithms.

Equation (1) can be interpreted as an *n*-period Fisher equation. Subtracting from (1) the (similar) *m*-period Fisher equation gives the slope of the yield curve between segments *n* and *m*. For $m=1$ (the spot rate), the following equation emerges:

$$R(n,t) - R(1,t) = E_t[r(n,t) - r(1,t)] + E_t[p(n,t) - p(1,t)] \qquad (2)$$

It follows from (2) that the slope of the yield curve (left hand side) will provide information on the expected real interest rate spread, and on the market's expected inflation path (i.e. the change in the future *n*-period inflation rate from the *1*-period inflation rate). There thus exists a potential identification problem: unless these variables are perfectly correlated, the yield spread is a noisy forecast of either of them. Mishkin (1990b, pp. 79-80) states that the slope of the yield curve will provide an exact measure of the market's expected inflation path if and only if all the following restrictive assumptions are satisfied:

(i) the expected real interest rate is constant over time (horizontal real term structure),

(ii) expectations are formed rationally and

(iii) risk premia are constant over time.

Assumption *i* eliminates the first term on the right hand side of (2). Assumption *ii* implies the unpredictability of forecast errors of inflation at the moment that the expectation is formed (that is, errors in the inflation rates expected at *t* to occur during the life of the bond, are uncorrelated; see Mishkin, 1991). Assumption *iii* eliminates risk premia from equation (2). Violation of any of these assumptions complicates the yield curve's interpretation and reduces its usefulness as a tool in forecasting changes in future inflation.

Equation (2) can be interpreted as a (semi) reduced form of a dynamic macro-economic model where both short-term and long-term interest rates are jointly determined. The foundation of this interpretation lies in finance theory, following the work of, *inter alia*, Merton (1973), Vasicek (1977), Lucas (1978), Breeden (1979), Cox, Ingersoll and Ross (1981, 1985a, 1985b) and Hu (1993), who studied the term structure of interest rates within a stochastic general equilibrium model. Turnovsky (1989) extends the abovementioned models to address policy issues. He embeds the expectations theory of the yield curve in a new classical rational expectations general equilibrium macroeconomic model, based on maximizing behaviour on the part of homogeneous agents operating in frictionless markets, and analyzes the effects of various monetary and fiscal policies on the term structure. Such a model provides us with a relationship between the nominal yield spread and future changes in inflation similar to equation (2) under assumptions (i)-(iii) above.

2.2 Yield curve and future economic activity

In the new classical models mentioned above, there is no predictive value of the yield spread with respect to future economic activity: prices adjust instantaneously. At the other extreme, if prices are fixed, then nominal yield spreads are a reflection of real spreads, which contain information regarding future real economic activity (Mishkin, 1990a, 1991).[8] When price adjustments are not instantaneous, the theoretical relationship between the yield spread and real economic activity is not clear-cut. As can be seen from a standard IS-LM model for a small open economy (see, for example, Dornbusch, 1980, pp. 175-192), the nature of the relationship between yield slope and future real activity depends on the nature of the shocks hitting the economy and the speed of price adjustment.[9] In the presence of real economic shocks and sticky prices, a positive yield spread is indicative of a future economic upswing. On the other hand, when monetary shocks dominate, a positive yield spread indicates a weakening of future economic activity. In the former case the expected outward shift of the IS-curve raises expected future short term rates (because the expected increase in income raises money demand), and this expectation is translated into higher current long-term rates. The information content is thus based on the expected effects of a real-economic disturbance on interest rates. In the latter case, a monetary shock such as the expectation of a future monetary tightening also raises future short-term rates and current long-term rates, but the resulting steepening of the yield curve now indicates a future decline in economic activity. The information content reflects the expected effects of monetary policy via interest rates on economic activity. When prices are flexible in the short run, the abovementioned analysis of shocks becomes more complicated because we have to take inflation expectations into account. In reaction to the monetary shock future real short-term rates will increase, but, if monetary policy is considered to be credible, future nominal short-term rates can

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[8] Mishkin interprets the real yield spread (long minus short) as the difference between long-run and short-run marginal productivity of capital. At the peak of the business cycle, productive potential is fully used, so that short run capital productivity is high *vis-à-vis* capital productivity in the longer run, when activity is expected to weaken. Likewise at the trough, current capital productivity is low, while the expected upswing implies higher long-run productivity. Thus the real yield spread and the future business cycle are positively related. An alternative theoretical explanation of a (positive) relationship between the real yield spread and future real activity is presented by Harvey (1988) with the use of the CAPM.

[9] In this model, spending decisions are influenced by the long term rate, money market equilibrium by the short-term rate, and the long term rate by expected future short-term rates.

decline, especially for those expected to prevail in the more distant future. With a credible monetary policy, the yield spread will decline and will be indicative of a future increase in economic activity: the relationship will again be positive.[10]

It is, however, well-known that inflation and real activity are not independent. The extreme positions of perfect price flexibility and complete price rigidity reflect a debate about adjustment processes (about whether quantities or prices adjust to a change in macroeconomic conditions and with what speed). A synthesis is offered in the New Keynesian approach (Blanchard and Fischer, 1989, pp. 372-504). Using models of imperfect competition, strategic behaviour in the face of information asymmetries and search and contracting models, sluggish price adjustments in labour and product markets are explained as outcomes of rational behaviour (Hall, 1986; Lindbeck and Snower, 1987; Layard et al., 1991; Cross, 1988; Christiano, Eichenbaum and Evans, 1996). The approach is a synthesis as it explains phenomena that are at odds with new classical notions (such as rigidities) from principles such as individual optimising behaviour, as new classicals do. It thereby provides a theoretical description which subsumes both abovementioned positions as extreme cases. Both can occur simultaneously, depending on particular institutional and structural characteristics of the economy. This implies that the yield curve in general possesses information content regarding both future inflation and future economic activity, but that this content differs across countries and in time.

2.3 An evaluation of the information content

As might be expected given the previous discussion, the empirical evidence on the information content of the yield curve is mixed and less clear-cut than the new classical theoretical explanation would lead us to believe (see Berk, 1998, for a recent review of the empirical literature). The composite hypothesis of constant real interest rates, rational expectations, and constant risk premia (ie (i)-(iii) above) is refuted by the data. The relationship between the yield curve and future changes in inflation is highly dependent on the countries studied, the sample period studied and the segment of the yield curve chosen. This implies that, although there is significant information in the yield curve about the future path of inflation in some countries, for some periods and for some segments of the yield curve, the relationship between yield spread and future inflation changes is not stable. On the other hand, a stable relationship seems to exist between the yield spread and future economic activity. The yield curve thus contains information regarding both future price and future real output movements, a proposition which might be consistent with New Keynesian principles. All this leads us to conclude that a central bank should be cautious in using the yield curve as an information variable for policy purposes. Although the empirical evidence in general seems to indicate a positive correlation between the yield slope and non-financial activity, this correlation may be a reflection of different economic phenomena, each warranting different policy reactions. First, a steepening can indicate an upward

[10] The analysis of fiscal shocks also becomes more complicated when price adjustments have to be taken into account. See Blanchard and Fischer (1989, p. 536) for a discussion.

revision of inflationary expectations, in which case a monetary tightening is called for. Second, a steepening may reflect the expectation of an increase in capital productivity, higher real interest rates and an increase in activity. In this case, a tightening may or may not be warranted, depending on the current state of the business cycle. Third, a positive correlation may reflect the expectation of a future monetary tightening by a credible monetary policymaker. The possibility of multiple valid theoretical explanations of a single observed relationship corroborates the findings of Turnovsky (1989) and McCallum (1994), who conclude that the response of the term structure is highly sensitive to the nature of the underlying shocks impinging on the economy.

There are also other reasons why central banks should be cautious in using the yield curve for monetary policy purposes. As with many financial market variables, market-specific, technical factors can distort the information content of the yield curve. An observed movement in the yield spread due to liquidity premia is a case in point. Moreover, as Mishkin (1991) notes, the information content is sensitive to the relative variability of expected future inflation changes and changes in real interest rates, as well as to the correlation between changes in these two variables. Any structural change in regime, such as an alteration in the conduct of monetary policy, is likely to change the correlation and relative variability of changes in expected future inflation and in real interest rates. The forecasting quality of the yield curve for the path of future inflation could therefore change dramatically, making the yield slope a poor guide for monetary policy. [11] In the next section we will look into the impact of a very recent regime change: the creation of EMU.

3. EMU and the usefulness of the yield curve for the eurosystem

The most obvious reason for studying the impact of the birth of the euro area is its potential relevance for current monetary policy making. Indeed the applicability of the Lucas Critique is an important issue for monetary policy in the newly formed Eurosystem. A practical problem of studying this recent regime change, however, is the evident lack of data that can be used in the analysis. We propose as a solution to study pre-1999 behaviour of financial market participants, arguing that financial markets in the course of

[11] Similar arguments can be used to explain the observed differences in the information content across countries and in time. According to Gerlach and Smets (1995), the information content is largest in countries where short-term interest rates are easiest to predict. Predictability can be a manifestation of a credible monetary policy. Regime shifts can destroy this credibility (especially if they occur frequently), causing the behaviour of economic agents to change, which has consequences for the empirical validity of the information content. In a similar fashion, central banks in different countries can pursue identical policies, but, because of differences in credibility, this policy can induce different behaviour of economic agents across countries. The implication is that the information content of the yield curve differs across countries

1998 would seem to have anticipated on the start of Stage Three of EMU.[12] On this assumption, and given the fact that interest rate observations are readily available with a minimal time lag, pre-1999 data will possibly provide insight in the impact of a structural change on behaviour.[13]

3.1 Data and methodology

The model of the term structure that we apply is a nutshell-representation of the expectations theory of the yield curve discussed in section 2, as equation (1) is augmented to take account of time-varying risk premia. The specification was originally constructed by Modigliani and Shiller (1973), and has been used intensively, *inter alia*, by the Federal Reserve Board in its MPS structural macroeconometric model for the US economy (Mauskopf, 1990).[14] Blanchard (1984) used this specification in order to investigate the empirical relevance of the Lucas Critique for the case of the change in policy regime associated with the advent of Paul Volcker as chairman of the Federal Reserve Board.

The model expresses the long-term interest rate at t, denoted by $R(n,t)$, as a weighted sum of forward rates equal to expected future spot rates, plus a risk premium. The expectations of future short term rates themselves are taken to depend on a linear function of current and lagged values of inflation π and short-term rates $R(m,t)$. The lags are restricted to lie on a third-order polynomial (without end-point constraint). This specification assumes that changes in the short-term interest rate ultimately are reflected in entirety in changes in the bond rate and changes in the inflation rate have a transitory effect on the bond rate. The latter effect is in addition to the permanent response of long-term interest rates to changes in the inflation rate as reflected in the short-term interest rate. Modigliani and Shiller (1973) motivate the transitory effect of inflation on bond yields by assuming that the central bank can (because of nominal rigidities) influence the short-term real interest rate, and drive it to a level which is below its equilibrium level (ie the level equilibrating the commodity markets). This will show up as an acceleration in the

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[12] There is for example some evidence of an EMU functioning *de facto* in the period May 1998-December 1998, ie after the announcement of the countries that participate in Stage Three and the fixing of bilateral exchange rates to be applied for the conversion of national currencies into the euro and before the actual start of Stage Three. For example, 95% of the movement of the exchange rate of participating countries in this period was determined by the anticipation of the start of the euro as of January 1999 (De Grauwe, Dewachter and Veestraeten, 1998).

[13] In addition, the start of EMU will initiate a process that could lead to important institutional and structural changes, not only in financial markets, but also in labour and product markets (Wellink, 1998). Nominal rigidities could well diminish, which in turn has consequences for the information content for the yield curve, as described above.

[14] The successor of the MPS model, the FRB/US model, also includes a term structure equation based on the expectations theory (see Reifschneider et. al, 1999). The specification, however, is different from the one used here because of a different treatment of expectations in FRB/US *vis-à-vis* MPS (Brayton, et. al, 1997).

price level. The risk premium V is proxied by a moving average of the variance of short-term interest rates. Our model reads as follows:

$$R(n,t) = \alpha_0 + \beta_0 R(m,t) + \sum_{i=1}^{19} \beta_i R(m,t-i) + \sum_{i=0}^{19} \gamma_i \pi(t-i) + \delta_0 V(t) + \varepsilon(t)$$

$$\varepsilon(t) = \rho\varepsilon(t-1) + u(t) \qquad (3)$$

were the disturbance term ε is modelled as a stationary first-order autoregressive process, with parameter ρ. *u* is defined as white noise.

This model obviously does not represent state of the art yield curve modelling, and is subject to several caveats. Firstly, the treatment of expectations is not derived from any well-articulated economic theory and can thus be considered as ad hoc. In the specification above, expectations are implicitly subsumed in the lags of the various explanatory variables in the equation. In combination with the a-theoretical specification of the lag structure it is impossible to disentangle expectations from other determinants of the pattern of lag coefficients. Therefore, despite the fact that Modigliani and Shiller (1973) showed that equation (3) is not inconsistent with the relation that would hold under the expectations theory of the yield curve with rational expectations, it is fair to conclude that the treatment of expectations in equation (3) is only implicit and has important adaptive elements (see in this respect also Brayton et.al, 1997). Although rational expectations may at times be consistent with using past values of a particular variable to forecast its future values, the conditions under which this procedure is optimal are rather restrictive (Mauskopf, 1990). [15] A second caveat concerns the fact that model (3) was originally constructed for the US economy, which makes it perhaps somewhat less applicable to small open countries which are prominent in our sample (see below). However, recent research (Berk and Knot, 1999) indicates that, although international links in bond yields are important, national factors still exert an important influence. A final important caveat pertains to the treatment of the risk premium in equation (3). Although this equation is more general than the constant premia implied by the expectations theory of the term structure, the specification adopted in (3) is ad hoc, and certainly open to debate.

Whilst we acknowledge these criticisms, our choice to use this nutshell model is guided by the objective of this paper, namely to study the term structure in a macroeconomic context characterized by structural institutional change. Given the available data and the need

[15] It is however well-known that, although appealing as a theoretical construct, the rational expectations hypothesis in combination with the expectations theory of the yield curve has been rejected many times in careful economic studies (Mankiw, 1996).

to quickly provide preliminary insights into the economic impact of EMU our choice for a simple, well-known tool is appropriate.

We applied equation (3) on quarterly observations on 3 month and 10 year interest rates, obtained from BIS and Datastream databases. The sample period runs from the first quarter of 1970 until the final quarter of 1998. By including Austria, Belgium, Germany, France, Ireland, Italy, the Netherlands, Denmark, the United Kingdom, Switzerland, Japan and the United States in the analysis, we cover the majority of countries forming the Eurosystem, countries that have decided not to participate in this Eurosystem, as well as the major countries outside the EU.

3.2 Empirical results

The results of fitting equation (3) to the data are reported in table 1 (p. 18-20). The table gives the results of the estimation as the years 1996 through 1998 are added to the sample. The simple equation (3) tracks the movements in bond yields in the countries under investigation surprisingly well, considering its simplicity. There are relatively few signs of misspecification. Exceptions include deviations from normality for France, Italy and Japan. For some of these countries, this is due to outliers. In addition, there were some signs of heteroskedasticity in the case of Ireland and Switzerland. The risk premium proved to be insignificant throughout, corroborating the earlier results of Shiller, Campbell and Schoenholtz (1983) with a similar measure.[16]

In order to investigate whether market participants in 1998 changed their behaviour in a structural way in anticipation to the start of Stage Three of EMU, we conducted subsample stability tests, the results of which are reported in table 2 (p. 21). We tested (using a Chow test) for a structural break in the last year of each of the respective subsamples, that is we investigated the hypothesis that 1996 was significant different from 1995, 1997 from 1996 and 1998 from 1997. It can be seen from the table that the model exhibits stable behaviour for all countries for the years 1996 and 1997. For 1998, however, there are significant signs of structural instability for Germany and (to a lesser extent) the UK. The model of course does not prove that EMU is the cause of this instability.[17] Nevertheless it is important that behavioural change of financial market participants in the case of Germany is detected by the model.

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[16] This result may be due to the particular form by which the risk premium is measured however, since there is also ample evidence of significant risk premia in bond yields (for recent evidence, see Mankiw, 1996, and the studies in Angeloni and Rovelli, 1998).

[17] The creation of EMU entails a structural change the effects of which could stretch out beyond participating countries. The findings of instability in the UK are therefore not necessarily inconsistent with EMU-related behavioural change.

4. Concluding remarks

This paper started by discussing some general problems regarding the interpretation of the information contained in the yield curve for monetary policy purposes. We argued that the information content of the yield curve for monetary policy depends on (i) the correct identification of the nature of shocks (ie real, monetary or supply shocks) hitting the economy and (ii) the functioning of product and labour markets (ie the degree of price flexibility). However, even the policy maker that has been able to acquire these necessary insights would still have to confront the Lucas-type problems that are illustrated by our empirical analysis. The empirical analysis and the model are not intended to be used to test the expectations theory of the yield curve or any other theory, for that matter. Indeed, such an attempt in our opinion would prove to be futile, because of the failure of the model employed to specify exactly what is being tested. The latter point is not the issue here; the model serves its purpose in that it is a simple representation of the expectations theory of the term structure, and is relatively easy applicable to data on a large number of countries. Moreover the model is a representation that has been used as a workhorse for many policy discussions in the past.

Taken together, the outcome of the theoretical discussion and the results of our empirical experiment indicate, in our view, that care should be taken in using the yield curve as information variable for the monetary policy of the Eurosystem, especially in its early years.

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Table 1 Estimated long rate equations

final quarter of estimation[1]	intercept	short rate current	short rate sum lags	inflation current	inflation sum lags	risk premium	AR(1)
Austria							
1995-4	2.83	0.13	0.43	0.19	0.48	0.06	0.67
	(1.75)	(1.96)	(2.06)	(5.71)	(5.89)	(0.38)	(6.08)
1996-4	0.39	0.23	0.77	0.16	0.39	0.05	0.77
	(0.19)	(3.51)	(2.83)	(4.30)	(3.45)	(0.27)	(6.71)
1997-4	1.38	0.24	0.65	0.15	0.38	0.06	0.76
	(1.06)	(3.76)	(3.71)	(4.11)	(3.44)	(0.32)	(7.70)
1998-4	0.27	0.24	0.79	0.16	0.40	0.05	0,76
	(0.29)	(3.86)	(5.78)	(4.52)	(3.72)	(0.29)	(7.81)
Belgium							
1995-4	4.42	0.08	0.30	0.20	0.55	0.04	0.80
	(3.29)	(2.85)	(1.59)	(3.96)	(3.24)	(0.69)	(11.76
1996-4	3.61	0.09	0.41	0.18	0.48	0.04	0.78
	(3.73)	(3.27)	(3.05)	(3.72)	(3.53)	(0.74)	(11.59
1997-4	3.24	0.09	0.46	0.17	0.45	0.04	0.78
	(4.03)	(3.39)	(3.95)	(3.71)	(3.60)	(0.84)	(11.76
1998-4	2.54	0.10	0.52	0.18	0.46	0.05	0.78
	(3.70)	(3.51)	(4.93)	(3.85)	(3.63)	(0.86)	(11.91
Germany							
1995-4	7.17	0.16	-0.02	-0.08	0.11	-0.04	0.81
	(5.42)	(3.38)	(0.09)	(1.32)	(0.49)	(0.61)	(11.20
1996-4	7.03	0.16	0.01	-0.09	0.10	-0.04	0.80
	(5.57)	(3.52)	(0.02)	(1.41)	(0.50)	(0.59)	(11.20
1997-4	6.54	0.17	0.08	-0.10	0.08	-0.03	0.80
	(5.94)	(4.08)	(0.39)	(1.65)	(0.39)	(0.45)	(11.37
1998-4	4.60	0.17	0.37	-0.06	0.01	-0.04	0.87
	(3.71)	(3.49)	(1.33)	(0.92)	(0.04)	(0.62)	(12.49
France							
1995-4	5.60	0.14	0.18	0.08	0.51	-0.02	0.88
	(1.81)	(2.64)	(0.46)	(1.25)	(2.56)	(0.22)	(12.38
1996-4	3.78	0.16	0.39	0.08	0.46	-0.03	0.85
	(1.65)	(3.54)	(1.36)	(1.35)	(3.50)	(0.46)	(11.23
1997-4	3.45	0.16	0.43	0.08	0.45	-0.04	0.84
	(1.91)	(3.73)	(1.81)	(1.45)	(3.72)	(0.53)	(11.34
1998-4	1.82	0.16	0.62	0.10	0.43	-0.05	0.84
	(1.32)	(3.72)	(3.22)	(1.86)	(3.80)	(0.66)	(10.89

Table 1 Estimated long rate equations (continued)

	intercept	short rate		inflation		risk
final quarter of estimation[1]		current	sum lags	current	sum lags	premium
Ireland						
1995-4	6.56	0.07	0.08	0.05	0.48	-0.01
	(3.39)	(2.10)	(0.46)	(1.14)	(7.50)	(0.38)
1996-4	6.38	0.07	0.10	0.05	0.48	-0.01
	(3.45)	(2.09)	(0.57)	(1.22)	(7.69)	(0.42)
1997-4	5.30	0.07	0.18	0.06	0.49	-0.01
	(3.42)	(2.18)	(1.21)	(1.43)	(7.99)	(0.24)
1998-4	3.39	0.08	0.33	0.06	0.50	0.00
	(2.33)	(2.37)	(2.17)	(1.41)	(7.11)	(0.01)
Italy						
1995-4	3.84	0.25	0.61	0.03	0.19	-0.09
	(0.86)	(5.37)	(1.43)	(0.78)	(1.33)	(1.28)
1996-4	2.11	0.27	0.74	0.04	0.17	-0.08
	(0.54)	(5.95)	(1.96)	(1.03)	(1.26)	(1.24)
1997-4	1.45	0.26	0.81	0.04	0.15	-0.08
	(0.50)	(5.88)	(2.80)	(1.06)	(1.33)	(1.21)
1998-4	-0.28	0.25	0.96	0.04	0.12	-0.08
	(0.12)	(5.89)	(4.12)	(1.26)	(1.14)	(1.15)
Netherlands						
1995-4	4.76	0.14	0.31	0.10	0.33	-0.02
	(2.53)	(3.45)	(1.11)	(1.61)	(2.35)	(0.24)
1996-4	4.26	0.14	0.38	0.09	0.32	-0.01
	(2.75)	(3.74)	(1.64)	(1.55)	(2.41)	(0.23)
1997-4	3.55	0.15	0.48	0.08	0.29	-0.01
	(2.85)	(3.98)	(2.53)	(1.42)	(2.27)	(0.23)
1998-4	2.23	0.16	0.68	0.07	0.24	-0.01
	(1.86)	(4.20)	(3.52)	(1.27)	(1.47)	(0.24)
Denmark						
1995-4	3.26	0.06	0.30	0.19	0.99	0.03
	(0.65)	(0.84)	(0.45)	(1.58)	(2.17)	(0.30)
1996-4	1.79	0.06	0.48	0.20	0.89	0.01
	(0.43)	(0.92)	(0.85)	(1.70)	(2.2)	(0.11)
1997-4	0.27	0.07	0.67	0.20	0.77	0.00
	(0.09)	(1.11)	(1.56)	(1.75)	(2.36)	(0.02)
1998-4	-0.19	0.07	0.73	0.20	0.73	-0.00
	(0.10)	(1.22)	(2.78)	(1.82)	(3.21)	(0.01)

Table 1 Estimated long rate equations (continued)

final quarter of estimation[1]	intercept	short rate current	short rate sum lags	inflation current	inflation sum lags	risk premium	AR(1)
United Kingdom							
1995-4	7.09	0.15	0.09	-0.07	0.33	-0.07	0.55
	(4.13)	(4.82)	(0.55)	(2.49)	(7.12)	(0.94)	(5.08)
1996-4	5.83	0.16	0.20	-0.07	0.33	-0.06	0.58
	(4.43)	(5.06)	(1.56)	(2.48)	(7.06)	(0.83)	(5.69)
1997-4	4.51	0.17	0.31	-0.08	0.34	-0.05	0.62
	(4.37)	(5.19)	(2.90)	(2.65)	(6.60)	(0.72)	(6.45)
1998-4	2.74	0.18	0.47	-0.09	0.32	-0.05	0.72
	(2.35)	(4.97)	(3.61)	(2.76)	(4.55)	(0.58)	(8.05)
Switzerland							
1995-4	2.88	0.13	0.38	-0.03	0.03	-0.01	0.80
	(4.46)	(6.31)	(3.03)	(1.10)	(0.18)	(0.20)	(11.04)
1996-4	2.93	0.13	0.37	-0.03	0.02	-0.01	0.80
	(5.10)	(6.51)	(3.13)	(1.17)	(0.14)	(0.19)	(11.39)
1997-4	2.67	0.13	0.40	-0.03	0.06	-0.00	0.80
	(5.38)	(6.84)	(3.44)	(1.03)	(0.36)	(0.08)	(11.53)
1998-4	2.22	0.13	0.44	-0.02	0.13	0.00	0.80
	(5.25)	(6.88)	(3.77)	(0.67)	(0.81)	(0.00)	(11.25)
Japan							
1995-4	-0.27	0.25	0.91	-0.02	0.62	-0.15	0.83
	(0.13)	(3.33)	(2.30)	(0.23)	(1.75)	(1.68)	(14.27)
1996-4	1.86	0.25	0.59	-0.06	0.50	-0.16	0.82
	(1.35)	(3.32)	(2.06)	(0.77)	(1.60)	(1.80)	(11.98)
1997-4	1.52	0.26	0.69	-0.08	0.39	-0.15	0.81
	(1.31)	(3.68)	(3.11)	(1.08)	(1.57)	(1.80)	(11.98)
1998-4	0.34	0.23	0.88	-0.04	0.41	-0.13	0.82
	(0.34)	(3.35)	(4.69)	(0.53)	(1.59)	(1.54)	(13.24)
United States							
1995-4	1.82	0.30	0.86	-0.02	0.03	-0.01	0.62
	(2.41)	(8.74)	(9.03)	(0.45)	(0.28)	(0.17)	(5.98)
1996-4	2.37	0.29	0.82	-0.02	0.00	-0.02	0.59
	(4.11)	(8.84)	(9.74)	(0.54)	(0.01)	(0.27)	(5.74)
1997-4	1.98	0.29	0.85	-0.00	0.02	-0.02	0.63
	(3.63)	(8.44)	(9.62)	(0.24)	(0.24)	(0.36)	(6.33)
1998-4	1.11	0.28	0.90	0.01	0.10	-0.04	0.77
	(1.43)	(7.34)	(6.86)	(0.24)	(0.75)	(0.71)	(9.02)

[1] Beginning quarter is 1975:1. Absolute t-values are in parentheses. SE=standard error of the serially correla

Table 2 Stability of estimated long rate equation

final quarter of estimation:	1996-4
Austria	2.32
	(0.07)
Belgium	1.05
	(0.39)
Germany	0.75
	(0.56)
France	0.54
	(0.71)
Ireland	0.14
	(0.97)
Italy	1.19
	(0.32)
Netherlands	0.41
	(0.80)
Denmark	0.32
	(0.86)
UK	0.36
	(0.83)
Switzerland	0.59
	(0.67)
Japan	0.93
	(0.45)
US	1.08
	(0.37)

Note: reported are values of the Chow test for a structural break in the last 4
ending with the date mentioned in the column heading.Corresponding p-value
** (*) significant at 1% (5%). Beginning period is 1975-1