The Information in Term Structure Interest Rate Spreads: The Irish Case

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I INTRODUCTION

T he study of the term structure of interest rates looks at how the yields on bonds vary with time to maturity. Yield curves can be upward sloping, humped or downward sloping and their shape is often taken to be an indication of whether interest rates and/or inflation rates are expected to rise or fall. This forecasting potential results from the decision-making process of profit-seeking investors, which must involve the formation of expectations on future inflation and interest rates. Theory suggests that, if markets are efficient, it should be possible to extract the aggregate of these expectations of inflation and interest rates from observable term structure data. It then only requires that expectations be rational for forecasting power to be deduced.

   The study of the term structure is of interest to policy-makers for many reasons beyond its use as a forecasting tool. However, this paper limits itself to the study of whether interest rate spreads hold information for future interest rates and/or inflation rates, in a manner consistent with theory. In

this it draws on a long series of papers looking at using term structure to forecast interest rates (Modigliani and Shiller, 1973; Fama, 1984, 1990; Mankiw, 1986; Fama and Bliss, 1987; Hardouvelis, 1988), and also on the recent papers which have looked at the predictive power of the term structure for changes in inflation (Mishkin, 1988, 1990; Browne and Manasse, 1989). This paper examines the information in Irish yield spreads, and compares the results from Irish data with the international results.

The second section of the paper briefly reviews theories of the term structure, the next, following Mankiw (1986) and Mishkin (1988) shows how these theories imply that the interest rate spread will have forecasting power. Section IV reports and discusses results, with some comments on the data and econometric problems of the approach taken. Section V concludes.

II THEORIES OF THE TERM STRUCTURE

Theories of the term structure in general rely on the tendency of expected returns from different investments to be equalised. Yields on differently termed bonds will, if expected returns are equalised, have a precise mathematical relationship to each other, which will always hold except for random expectational errors. A number of different forms of this hypothesis have been identified in the literature (see Cox, Ingersoll and Ross, 1981). The simplest is the Local Expectations Hypothesis which states that the difference in expected returns from holding a long versus a short bond for one period is zero.

A less stringent form of the same hypothesis is that the difference in holding period returns be constant. This allows for the fact, postulated by Hicks (1946) among others, that investors may have specific maturity preferences and be prepared to forgo some return to achieve their preferences. Expected holding period returns will in this situation only be equalised after a term premium has been allowed for. Hicks felt that this premium, which he called a risk premium would always be positive and would increase monotonically with the time-to-maturity of the bond. This hypothesis was known as the liquidity theory of the term structure, as it is based on the assumption that more liquidity is always preferable to less.

A more general form of the expectations theory, which allows for the fact that certain market participants may have a preference for longer bonds, is known as the "Preferred Habitat" theory (Modigliani and Sutch, 1966). The pattern of premia over maturity thus depends on preferences which determine the demand and supply of assets of different maturities. Premia will not necessarily be monotonic.

Preferred habitats, if they exist in an extreme form will lead to market segmentation. Culbertson (1966) suggested that institutional factors and risk

aversion would segment the market and that returns in different parts of the maturity spectrum would be independently determined by the demand and supply of assets of that maturity. The premia required to attract investors out of their preferred habitat would thus be infinite.

In all except the last of these theories of the term structure, market expectations of future changes (though not levels) of interest rate can be deduced. This is true as long as premia are finite and constant over time. However, most empirical work on testing the expectations theory of the term structure has not found the theory to be supported by the data.[1] A number of reasons have been suggested to explain away the negative results. All tests of the expectations theory involve some assumption — usually rationality — on the way expectations are formed, so rejections could be due to the inappropriateness of this assumption rather than the invalidity of the term structure theory. A more common explanation is that of time varying term premia; however, as Browne and Manasse (1989) point out, such an explanation is spurious unless the determinants of these premia can be discovered. Empirical attempts to discover whether these premia can be explained by risk and/or volatility have largely been unsuccessful (e.g. Mankiw, 1986).

The current position of term structure theory can be summarised by stating that the shape of the term structure is determined by two groups of factors, namely, expectations of future interest rates, and any and all other reasons that might lead investors to prefer one maturity rather than another. If the second group of factors can be identified or result in a time-invariant term premium, then there will be information in the term structure. However, if the second group of factors is variable and indeterminate, time-varying term premia will obscure the market expectations of interest rates and inflation rates implicit in the pattern of yields.

III INFORMATION IN YIELD SPREADS: THEORY

As discussed in the last section, yields on long and short bonds are connected if traders make investment decisions on the basis of expected returns. Following Mankiw (1986), the exact relationship can be derived by comparing holding period returns. Suppose an investor has one unit to invest, and has a choice of a one-period or long bond. After one period, if s/he chooses the long bond, s/he can sell the bond. The holding period return on the long bond is the coupon payment, assumed to be one unit, and the capital gain or loss, i.e.,

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1. There are a large number of empirical papers on this topic, an example of which is Shiller, Campbell and Schoenholtz (1983). Hurley (1987) rejects one implication to the expectations hypothesis using Irish data.

$$H_t^{n,1} = \frac{1 + P_{t+1}^n - P_t^n}{P_t^n} \tag{1}$$

where

$H_t^{n,1}$ denotes the one period holding return on an n-period bond bought at time t.

P_t^n is the price of the n-period bond at time t and the coupon payment is assumed to be one unit per period.

If n is large, then the bond is approximately a consol, the long-term rate of interest is given by:

$$i_t^n = \frac{1}{P_t^n} \tag{2}$$

A linearised expression for the holding period return in terms of interest rates can be given by:

$$H_t^{n,1} = i_t^n - \frac{(i_{t+1}^n - i_t^n)}{\rho} \tag{3}$$

where ρ is the average long rate.

At time t, the holding period return is a random variable, the expected value of which is equal to the return on the short bond if the pure expectations theory holds:

$$E_t \ H_t^{n,1} = E_t \left[i_t^n - \frac{(i_{t+1}^n - i_t^n)}{\rho} \right] = i_t^1 \tag{4}$$

where E_t denotes an expectation formed at time t.

If a term premium θ is allowed for, and the assumption of rational expectations is made, this can be rewritten to give:

$$i_{t+1}^n - i_t^n = -\rho\theta + \rho(i_t^n - i_t^1) - \rho\nu_{t+1} \tag{5}$$

where ν is an error term.

This implies, for example, that an upward sloping yield curve indicates that the long-term interest rate is expected to rise.

This gives our first forecasting equation:

$$i_{t+1}^n - i_t^n = \alpha + \beta(i_t^n - i_t^m) + \epsilon_t \tag{6}$$

where a negative α indicates a positive term premium and β would be expected to be positive and equal to the average long rate. For $m > 1$ the above equation is approximate only, but should still tell us if yield curve slopes indicate anything about changes in long rates.

Equation 5 can be rewritten as an expression involving expectations of next period's long rate

$$i_t = \sigma \rho i_t + \sigma E_t i^n_{t+1} + \sigma \theta$$

and then solved forward to show the long rate as a geometric average of future shorts:

$$i^n_t = \theta + (1 - \sigma) \sum_{j=0}^{\infty} \sigma^j E_t(i^1_{t+j}) \tag{7}$$

where $\sigma = \dfrac{1}{1+\rho}$.

This can be rewritten to give an equation for the yield spread as:

$$i^n_t - i^1_t = \theta + (1 - \sigma) \sum_{j=0}^{\infty} \sigma^j E_t(i^1_{t+j} - i^1_t) \tag{8}$$

Mankiw suggests a crude test of the above as:

$$i^m_{t+1} - i^m_t = \alpha_2 + \beta_2 (i^n_t - i^m_t) + \tau_t \tag{9}$$

which is only exact in $m = 1$ and $n = 2$. Intuitively, if β is positive this means that a downward sloping yield curve implies short interest rates are expected to fall.

Another potential source of forecasting power, highlighted by Mishkin in a recent series of papers, is the ability of the term structure slope to predict changes in inflation. The prevalent view is that a downward sloping yield curve indicates expectations of falling inflation rates. The equation relating inflation changes to term structure spreads is derived from the Fisher parity hypothesis which states that expected inflation over the next m periods is the difference between the m-period nominal and real interest rates.

$$E_t(\pi^m_t) = i^m_t - rr^m_t \tag{10}$$

where π^m_t is inflation from time t to t + m, and rr^m_t is the m-period real interest rate.

If the expectation of inflation is correct except for a random error, the difference in inflation over m and n periods can be written as follows, i.e.,

$$\pi_t^n - \pi_t^m = i_t^n - i_t^m - (\overline{rr}_t^n - \overline{rr}_t^m) + \zeta_t^{m,n} \qquad (11)$$

where $\overline{rr}_t^m$ is the mean real m-period interest rate. Deviations between mean and actual real interest rates enter as part of the composite error term $\zeta_t^{m,n}$. This gives the third regression equation:

$$\pi_t^n - \pi_t^m = \alpha_3 + \beta_3 (i_t^n - i_t^m) + \xi_t^{m,n} \qquad (12)$$

where the null hypothesis is that $\beta_3 = 1$. If β_3 is significantly different from zero, then the slope of the term structure can be used to predict changes in inflation. Contrastingly, if β_3 is found to be zero, this equation can be shown to imply that the real and nominal term structure move one for one (see Mishkin, 1989).

IV INFORMATION IN YIELD SPREADS: PRACTICE

In the last section it has been shown that the expectations theory of the term structure suggest that, if term premia are constant, changes in long interest rates, short interest rates and inflation rates should all be dependent on the yield spread. Tests of these implications have been performed for many other countries; here we report tests on Irish data.

The interest rate data are yields reported in the Central Bank Bulletins. The inflation rates have been calculated from a monthly CPI. This monthly CPI was constructed by John Frain from quarterly CPI using the spline function available in the Troll program. All data are in annual rates without compounding.

Table 1: *Regression of Change in Long Rate on the Yield Spread, 1971:1-1989:12*

$$i_{t+1}^n - i_t^n = \alpha + \beta(i_t^n - i_t^m) + \epsilon_t^{n,m}$$

Independent Variable (m,n)	(3,12)	(3,60)	(3,180)	(12,60)	(12,180)	(60,180)
Constant	-0.002	-0.037	-0.093	-0.044	-0.115	-0.11
	(0.079)	(0.049)	(0.051)	(0.052)	(0.056)	(0.059)
Yield	0.066	0.125	0.098	0.084	0.108	0.167
Spread	(0.097)	(0.04)	(0.032)	(0.053)	(0.04)	(0.076)
Summary Statistics						
R^2	-0.4%	6.9%	6.5%	1.2%	4.4%	2.8%
DW	1.83	1.45	1.63	1.35	1.57	1.56
SEE	0.898	0.567	0.544	0.582	0.548	0.553

Table 1 gives results of regressions *ex-post* changes for a number of maturity differentials in long rates on the yield spread. From Equation 5 above, one would expect the coefficient on the yield spread to be positive and, since it is the mean long rate to be of the order of magnitude 0.05 to 0.2. A positive term premium should result in a negative constant. The regression coefficients reported do correspond roughly to what was expected; however, the explanatory power of the regressions, as indicated by the R^2, is low. Slightly more explanatory power seems to have been achieved where the rates are from widely-spaced parts of the maturity spectrum, i.e., when n-m is large. The low explanatory power of the regressions corresponds to the estimates of Mankiw (1988) for US, UK, German and Canadian data; the Irish results are better in that the signs of the coefficients are correct.

Table 2: *Regression of Change in Short Rate on the Yield Spread, 1979:1-1989:12*

$$i_{t+1}^{m} - i_{t}^{m} = \alpha + \beta(i_{t}^{n} - i_{t}^{m}) + \tau_{t}^{n,m}$$

Independent Variable (m,n)	(3,12)	(3,60)	(3,180)	(12,60)	(12,180)	(60,180)
Constant	−0.068	−0.053	−0.164	−0.1156	−0.0235	−0.134
	(0.069)	(0.07)	(0.075)	(0.751)	(0.084)	(0.06)
Yield	0.517	0.326	0.27	0.365	0.308	0.259
Spread	(0.085)	(0.057)	(0.048)	(0.075)	(0.061)	(0.078)
Summary Statistics						
R^2	21.0%	19.6%	18.7%	14.7%	15.9%	7.0%
DW	1.43	1.27	1.32	1.5	1.58	1.33
SEE	0.788	0.798	0.80	0.827	0.821	0.564

Table 2 reports regressions of changes in short rates on the yield spread. The theory which suggests that an upward sloping yield curve indicates that short rates are going to rise appears to be upheld by the Irish data; the coefficients are of the right sign, and there is some explanatory power. This result corresponds to that found by Mankiw for other countries; the R^2s for the Irish data are higher.

The final hypothesis to be tested is the hypothesis that inflation changes are predictable using term structure spreads as explored by Mishkin in a series of papers, using data from different parts of the maturity spectrum, and for different countries. Briefly, he found that it is unusual to find predictive power for inflation rate changes in interest spreads; the positive results he did find were more inclined to be at the longer end of the maturity spectrum.

Browne and Manasse (1988), in contrast, found in their multi-country study that short spreads were more inclined to have predictive power.

Table 3: *Regression of Changes in Future Inflation * Rates on the Yield Spread*

$$\pi^n_t - \pi^m_t = \alpha + \beta(i^n_t - i^m_t) + \xi^{n,m}_t$$

Independent Variable (m,n)	(3,12)	(3,60)	(12,60)
Constant	−0.0045 (0.0035)	−0.051 (0.007)	−0.046 (0.003)
Yield Spread	−0.0056 (0.0042)	−0.0007 (0.006)	0.0059 (0.0031)
Summary Statistics			
No. of observations	117	69	69
R^2	0.6%	−0.1%	3.0%
DW	0.437	0.376	0.136
SEE	0.037	0.058	0.025

*Inflation is calculated as $\pi^n_t = \dfrac{12}{n}(\log (CPI)_{t+n-1} - \log (CPI)_{t-1})$.

Our results, reported in Table 3, are not very optimistic on the use of the term structure to forecast inflation changes. Two of the three coefficients have counter-intuitive signs, an upward sloping yield curve would be expected to indicate a rise in inflation was on the way. The best of the three results is for longer-maturity data, which corresponds more to Mishkin's results than Browne and Manasse's. However, even here, the forecasting power is very small.

V CONCLUSION

The rational expectations formulation of the expectations theory of the term structure, suggests that an upward sloping yield curve should indicate future rises in long and short interest rates. In the case of long rates, the empirical evidence does not support this plausible view. For short rates, the empirical evidence is better; the slope of the yield curve does appear to indicate the more likely direction of change of short rates; predictive power is, however, low. The Fisher-parity hypothesis implies that future changes in inflation are dependent of interest rate spreads. This has been tested using Irish data with negative results; the slope of the yield curve does not appear to have information about future changes in inflation rates.

Our results are tentative only, as the data and the econometric methods used are highly simplistic. Better results might be found with data cleaned of all coupon and tax effects and properly compounded in the manner of McCulloch's American data (Shiller and McCulloch, 1987). The econometric method used throughout, namely OLS, is not strictly appropriate, if, as here, there are overlapping observations. Finally, the third set of regressions may be inconsistent as some elements of the composite error term may be related to the independent variable. However, as the results in Browne and Manasse's paper show, very little difference to the conclusions are made using more appropriate and sophisticated estimation techniques. The results reported in this paper are probably a good first approximation to the type of results that would be found if better data and econometrics were used.

Ireland's experience does not seem to have been atypical: the term structure in any country does not seem to be a useful forecasting tool. The usual explanation for this is that observed yields contain term premia which vary over time and that this obscures the information in the pattern of yields. Unless these premia can be reliably and separately modelled, useful predictions of future rates cannot be inferred from term structure spreads.

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