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RISK PREMIA AND LONG RATES IN IRELAND

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Abstract

Using a number of long-term maturities and monthly data, 1989-1997, we provide a number of tests of the expectations hypothesis (EH) of the term structure. The main insight in this paper is the use of the excess holding period return to provide a proxy for a possible time varying term premium. Nearly all previous studies using the VAR methodology have used only the spread and the change in (short) rates and they have ignored the excess holding period return. Our results are consistent with recent evidence for the UK (Cuthbertson and Nitzsche, 1998), in that we cannot reject the EH. However we do reject the presence of a time varying risk premia.

1. Introduction

The expectations hypothesis (EH) of the term structure (with a constant or zero term premium) implies that the yield spread between the long rate and short rate is an optimal predictor of future changes in short rates, over the life of the 'long bond'. The empirical evidence is mixed. For a wide variety of maturities from 1 to 12 months and for 2, 3, 4 ... 10-years, for a number of countries (notably the US) and time periods the empirical evidence does not support the EH. Although the spread predicts future changes in short rates in the right direction, actual movements in the spread are greater than that required under the null that the EH is the correct model. This is often referred to as the "*over-reaction hypothesis*" and is sometimes also stated in terms of the actual spread being a biased predictor of future changes in short rates. A possible explanation for the failure of the EH is that long rates not only contain information about future short-rates, but also about the risk premium which is time varying (e.g. Fama, 1984, Mankiw, 1986, Tzavalis and Wickens, 1997).

Mankiw and Miron (1986), argue that the EH is likely to perform better empirically under a policy of monetary targeting, rather than interest rate smoothing. Kugler (1988) using US, German and Swiss monthly data on one and three month Euromarket deposit rates found support for the EH only on German data (for the period of March 1974 to August 1986), which he interprets as broadly consistent with the Mankiw-Miron hypothesis. Similarly, Engsted (1994) using Danish money market rates and for longer maturity bonds (Engsted and Tanggaard 1994) finds considerable support for the EH providing the variation in interest rates is relatively large. (i.e. in the post-1992 ERM 'crisis period'). This is to be expected given the analysis of Mankiw and Miron (1986) : if interest rate stabilisation results in random walk behaviour for short rates, then the expected change in short rates is zero and the spread has no predictive power for future short rates, contrary to the EH (See also Rudebusch 1995). It is clear from Mankiw and Miron (1986) that econometric tests of the EH require sufficient variability in expected changes in short rates. It is also the case that very large (unpredictable) changes may increase agents perceptions of the riskiness in holding bonds (bills) and thus invalidate the EH because of the presence of a time-varying term premium (see Engle, Lilien and Robins 1987, Hall, Anderson and Granger 1992, and Tzavalis and Wickens 1995).

Cuthbertson (1996) using the Campbell-Shiller (1991) VAR methodology on data at the short end of the maturity spectrum (i.e. up to one year) finds reasonable support for the EH on UK data. However, Taylor (1992) focusing on longer maturities, 5, 10 and 15 years, finds strongly against the EH (see also MacDonald and Speight 1991). Taylor (1992) noted that the failure of the EH at the long end of the maturity spectrum may be due to the presence of a time varying (yet stationary) risk premium. Drawing on Tzavalis and Wickens (1998), Cuthbertson and Nitzsche (1998) model long maturity rates (2 years – 10 years) in the UK, with a 3-variable VAR which incorporates a time varying risk premium.

In this paper we test the EH of the term structure for Irish rates at the long end of the maturity. This present study compliments Bredin and Cuthbertson (2000) who investigate the EH for maturities up to a year, using Irish, spot rate data. Bredin and Cuthbertson (2000) found broad support for the EH, results which were consistent with UK data, (e.g. Cuthbertson, 1996). Based on the results of Taylor (1992), where the excess holding period yield is found to be time varying when using a single equation format, and Cuthbertson and Nitsche (1998) we modify the standard 2-variable VAR to allow for a time varying risk premium.

The main insight in this paper is the use of the excess holding period return to provide a proxy for a possible time varying term premium. Nearly all previous studies using the VAR methodology have used only the spread and the change in (short) rates and they have ignored the excess holding period return. The exception here is Tzavalis and Wickens (1998) who show using US data on 3, 6 and 12 month maturities that a 3 variable VAR including the holding period return provides useful incremental evidence on the importance of a time varying term premium. Indeed, they find that the ‘over-reaction hypothesis’ is rejected when the excess holding period return is included in the analysis. Our paper also uses a high quality data set for spot rates and so avoids the use of the ‘par yield’ approximation for yields to maturity.

The rest of the paper is organised as follows. The theoretical model is outlined in section 2, while section 3 introduces the various testable models. In section 4 we present the results from previous studies in this area. The empirical results are reported in section 5. We conclude with a brief summary in section 6.

2. Theoretical Model

The rational expectations hypothesis of the term structure (REHTS) states that, after adjusting for risk, the expected return from holding for one period a bond that has n periods to maturity is the same as the same as a certain return from a one period bond, i.e.,

$$E_t h(n,t+1) \equiv E_t[lnP(n-1,t+1)-lnP(n,t)] = r(t) + T(n,t) \qquad (1)$$

where, h(n,t+1), equals the capital gain from holding an n-period bond for one period. The h(n,t+1) is approximated by lnP(n-1, t+1) – lnP(n,t), where P(n,t) is the price at time t of a pure discount bond with a face value of £1 and n periods to maturity. E_t is the rational expectations operator conditional on information available in period t, r_t is the (one period) risk free rate r_t and T(n,t) is a risk premium, perceived at time t, which compensates investors for the risk of investing in long bonds. Under risk neutrality, we assume T(n,t) = 0.[1]

For a pure discount bond with face value of £1 (i.e. a 'zero')

$$lnP(n,t) \equiv - nR(n,t) \qquad (2)$$

where R(n,t) is the spot yield (continuously compounded) on the long bond. Substituting (2) into the expected holding period return gives;

$$h(n, t+1) = nR(n,t) – (n-1)R(n-1, t+1) \qquad (2a)$$

[1] Campbell (1987) has shown that this assumption is also a good approximation in a general equilibrium model.

and so (1) can be re-arranged as;

$$E_tR(n\text{-}1,t+1) - R(n,t) = 1/(n\text{-}1)[\ (\ R(n,t) - r(t)\ ) - T(n,t)\ ] \qquad (3)$$

Solving (3) forward gives;

$$R(n,t) = (1/n) \sum_{i=0}^{n-1} E_t r(t+i) + E_t F(n,t) \qquad (4)$$

Equation (4) implies that, after adjusting for risk, the yield from holding a long bond to maturity equals the expected return from rolling over a series of one period bonds. Subtracting r_t from both sides and re-arranging:

$$S(n,t) = E_t S^*(n,t) + E_t\, F(n,t) \qquad (5)$$

Where;

$$S(n,t) = R(n,t) - r(t) = \textit{actual spread} \qquad (6a)$$

$$S^*(n,t) = \sum_{i=1}^{n-1} [1\text{-}i/n]\ Dr(t+i) = \textit{perfect foresight spread} \qquad (6b)$$

$$F(n,t) = (1/n) \sum_{i=1}^{n-1} T(n\text{-}i,\ t+i) = \text{‘}\textit{average}\text{’ } \textit{risk premium} \qquad (6c)$$

Equation (1) indicates that the expected excess holding period return $E_th(n,t+1)-r(t)$ reflects changes in the (one-period) term premium T(n,t). Equation (5) is the familiar ‘spread equation’ indicating that the *actual* spread S(n,t) is an optimal predictor of expected future changes in short rates $E_tS^*(n,t)$ plus future changes in the *average* term premium $E_t\Phi(n,t)$. $S^*(n,t)$, is the weighted change in short rates assuming investors have perfect foresight. Under the EH, the *expectations* of $S^*(n,t)$ equals the actual spread. $E_t\Phi(n,t)$, is a rolling risk premium, and is the average of the expected future one-period term premia over the rest of the bonds life.

Assuming RE, equation (4) can be used to decompose the innovations in the excess holding period return, eh(n,t+1) = h(n,t+1) – E_th(n,t+1), into news about future short-term interest rates and future term premia. By substituting equation (4) into eh(n,t+1) gives[2],

$$eh(n,t+1) = -(E_{t+1} - E_t)\sum_{i=1}^{n-1} r(t+i) - (E_{t+1} - E_t)\sum_{i=1}^{n-1} T(n-i,t+i) \qquad (7)$$

where $E_t eh(n,t+1) = 0$. The above can be written more compactly as;

$$eh\,(n,t+1) \quad = \quad -\{\, er(n,t+1) \quad + \quad eT\,(n,t+1)\} \qquad (8)$$

where

$$eh\,(n,t+1) \equiv h(n,t+1) - E_t\, h(n,t+1) \qquad (9a)$$

$$er\,(n,t+1) \;{}^{o}\; (Et+1 - Et)\sum_{i=1}^{n-1} r(t+i) \qquad (9b)$$

$$eT\,(n,t+1) \;{}^{o}\; (Et+1 - Et)\sum_{i=1}^{n-1} \; T\,(n-i,\, t+1) \qquad (9c)$$

The term, *er(n,t+1)* is ‘news‘ about future spot rates *r*(*t*+*i*) , and *eT(n,t+1)* is ‘news’ about future term premia. Equation (8) is not a

[2] Given the innovations; eh(n,t+1) = h(n,t+1) – E_th(n,t+1) and using equation 1 we have, eh(n,t+1) = h(n,t+1) – r_t – T(n,t) and using h(n,t+1) = nR(n,t) – (n-1)R(n-1,t+1) this reduces to equation 7.

behavioural equation, but a dynamic accounting identity that imposes internal consistency on expectations, Campbell (1991). The intuition behind equation (8) is as follows. For an n-period bond, if there is an unexpected rise in its one period return h(n,t+1) - E_th(n,t+1) this must be due to an unexpected fall in long rates R(n,t), which in turn must be due to an unexpected fall in current or future short rates (ie. the er(n,t+1) term). Alternatively, the unexpected rise in h(n,t+1) could be caused by an unexpected fall in future risk premia (ie. the term eT(n,t+1).

3. Testing the Model

The above analysis gives rise to a number of tests which can be implemented using the VAR methodology of Campbell-Shiller (1991). We assume throughout that the term premia T(n,t) are stationary (for a contrary view on US data see Evans and Lewis 1994) [3]. Consider the VAR system comprising

$$Z^* = [R(n,t), r(t), h(n,t+1)] \qquad (10)$$

If Z* consists of I(1) variables then equations (1) and (4) imply that the system should contain 2 co-integrating vectors which we can interpret as the spread R-r and the excess holding period yield h(n,t+1) – r(t). Note that the presence of a time varying I(0) term premium should not seriously bias tests of the number of cointegrating vectors. If the above cointegration relationships hold then the vector

[3] A possible reason for the difference between the conclusions from Evans and Lewis (1994), and those of Tzavalis and Wickens (1998), is that the former ignore the effects of the regime shift over the sample period.

$$\boldsymbol{Z_t} = [S(n,t), Dr(t), h(n,t+1) - r(t)] \qquad (11)$$

contains stationary variables. Hence, there exists a trivariate Wold representation (Hannan 1970) which may be approximated by a VAR of order p, which in companion form is

$$\boldsymbol{Z}_{t+1} = \boldsymbol{AZ}_t + \boldsymbol{v}_{t+1} \qquad (12)$$

Using the selection vectors **e1, e2, e3** which are 3p $\times$ 1, with unity in the first, second and third rows respectively and zeros elsewhere, we can use the VAR to forecast $E_t h(n,t+1)\text{-}r(t)$, and the future change in short rates Δr_{t+i} in (5), and 'pick out' the actual spread $S(n,t) = \mathbf{e1'Z_t}$.

Equation (1) implies that the expected excess return $E_t h(n,t+1)\text{-}r(t)$ is a constant only if the term premium is time invariant. In terms of the VAR this implies (since all variables are expressed as deviations from means) :

$$\boldsymbol{e3'A = 0} \qquad (13)$$

Violation of this (linear) restriction indicates that a time varying term premium may be empirically important. The forecast of future changes in short rates in (5) is referred to as the *theoretical spread* and using the predictions from the VAR is given by;

$$S'(n,t) = \boldsymbol{e2}'f(\boldsymbol{A})\boldsymbol{Z_t} \qquad (14)$$

where $f(\boldsymbol{A}) = \boldsymbol{A}[I-(1/n)\,(I-\boldsymbol{A}^n)(I-\boldsymbol{A})^{-1}]\,(I-\boldsymbol{A})^{-1}$

In the absence of a time varying term premium the forecast of Δr_{t+i} from the VAR namely S′(n,t) should 'track' the actual spread S(n,t) = $\mathbf{e1}'\mathbf{Z}_t$ and hence we expect S(n,t) = S′(n,t). We can test the theory by focusing on a number of metrics

$$\boldsymbol{e}1' - \boldsymbol{e}2' f(\boldsymbol{A}) = 0 \tag{15}$$

$$S(n,t) = a + bS'(n,t) + e_t \tag{16}$$

$$s(S(n,t)) / s(S'(n,t)) = 1 \tag{17}$$

$$r(S'(n,t), S(n,t)) = 1 \tag{18}$$

The non-linear cross equation restriction in (15) imply S(n,t) = S′(n,t) and are tested using a Wald statistic. A graph of S(n,t) versus S′(n,t) provides an informal evaluation of the EH (with a constant term premium) while the tests in (16), (17) and (18) provide more formal measures of this association. Since $\beta = \rho.\sigma(S(n,t))/\sigma(S'(n,t))$[4] a rejection of $\beta = 1$ can be apportioned between the over reaction hypothesis or the presence of a time varying term premium. If the standard deviation ratio is greater than 1, while the correlation is close to unity, this would imply that $\beta > 1$, and that although there is strong relationship between S(n,t) and S'(n,t), the long term interest rate is over-reacting to current information about future short

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[4] The estimates of the coefficient spread are calculated using;

$$\hat{b}(n) = r(S_t, S_t') \times \left[\frac{s(S(n,t))}{s(S'(n,t))} \right]$$

i.e. the sample correlation between the spread and the theoretical spread multiplied by the ratio of their sample standard deviations. Hence for, $\hat{b}(n)$ to be close to unity, either both the correlation and the ratio of the standard deviations must be close to unity, or one of them must be approximately the inverse of the other.

rates, i.e. the "*over-reaction hypothesis*". On the other hand, if neither of them are close to unity, although there is over-reaction, the S(n,t) and S′(n,t) are not moving closely, and this is evidence in favour of a time varying term premium. The fact that there is over-reaction in this case may be purely as a result of the time varying term premium.

From the theoretical review in section 2, the variation in the *ex-post* excess holding period returns is as a result of three factors; fluctuations in the term premium, news about term premia and news about short rates. We can now use the VAR methodology to test their importance. From equation (1) and (7) we obtain;

$$h(n,t+1) - r(t) = T(n,t) - er(n,t+1) - eT(n,t+1) \qquad (19)$$

The explanatory power of the final equation in the VAR system will be a measure of the contributions of variations in the term premium. It also follows that the residuals of this final equation are an estimate of the combined contributions of er(n,t+1) and eT (n,t+1).[5] Re-arranging equation 9(b):

$$er(n,t+1) = (E_{t+1} - E_t) \sum_{i=1}^{n-1} r(t+i)$$

$$= (E_{t+1} - E_t) \left[(n-1)r(t) + \sum_{i=1}^{n-1} \sum_{j=1}^{i} \Delta r(t+j)\right]$$

$$= (E_{t+1} - E_t) \sum_{i=1}^{n-1} \sum_{j=1}^{i} \Delta r(t+j) \qquad (20)$$

[5] This draws on a similar idea which has been used in Campbell and Shiller (1988) and Campbell (1991).

Hence an estimate of er(n,t+1) can be obtained from the VAR errors. Using equations (8), (9a), (20) we can obtain the time series for the surprise in the term premia, *eT(n,t+1)*, by calculating *er(n,t+1)* and *eh(n,t+1)* from the residuals of the VAR.

$$eT(n,t+1) = -er(n,t+1) - eh(n,t+1) \tag{21}$$

$$= \mathbf{e2}'\{(n-1)I + (n-2)\mathbf{A} + (n-3)\mathbf{A}^2 + \ldots [n-(n-1)]\mathbf{A}^{n-2}\} v_{t+1} - v_{3t+1}$$

The first term is merely the weighted sum of the surprises in future short rates [ie. $(E_{t+1} - E_t) \sum_{i=1}^{n-1} \sum_{j=1}^{i} \Delta r(t+j)$] where **e2′** 'picks out' the second element in $\mathbf{v}_{t+1}$ which corresponds to the change in short rates. The **A**-matrices represent the degree of persistence in news about future short rates. The term $\mathbf{v}_{3,t+1} = \mathbf{e3}' \mathbf{v}_{t+1}$ is the surprise in the excess holding period return $h(t+1) - E_t h(t+1)$, the third element in the Z-vector of the VAR. If news about future term premia are very small (ie. $eT(n,t+1) \approx 0$) then we expect the surprise in the one period return to wholly reflect 'news' about future short rates, hence eh(t+1) = -er(t+1) and

$$s(er) / s(eh) = 1 \tag{22a}$$

$$r(er,eh) = -1 \tag{22b}$$

In addition, if eT(n,t+1) = 0, the 'R-squared' of the excess return equation in the VAR (ie. the third equation) indicates the proportion of the excess holding period return that is due to news about short rates and '(1-R-squared)' is the proportion attributable to news about the risk premium.

4. Empirical Evidence using Long-Rates

The study by Taylor (1992) and recent work by Cuthbertson and Nitzsche (1998) provide an interesting comparison to our work. Taylor (1992) uses weekly UK data on bond maturities for 10, 15 and 20 years over the period January 1985 to November 1989. Taylor reports comprehensive rejections of the Wald restrictions and find against the variance ratios equaling unity, the smallest value being 1.5 (standard error = 0.14). He does not report the correlation between S_t and S_t' but the graph of these variables (see Taylor 1992 - figure 3) for the 10 year-3 month spread indicates a very low positive correlation (or even a negative one).

Taylor uses a two variable VAR, where $\mathbf{z}_t = (S(n,t), \Delta r(t))$ and hence does not allow the excess holding period return to provide a proxy for movements in the one-period expected term premium. However, Taylor does find that, in a single equation context, the excess holding period return is time varying and depends on the proportion of debt at each maturity (ie. the market segmentation hypothesis). This finding is not incorporated in the VAR analysis in Taylor's study. Another possible drawback in Taylor's study, is use of a VAR in the 13th difference of the short rate which will involve misspecification and biased parameters if the true model involves first differences.

Cuthbertson and Nitzsche (1998) use maturities from 2,3,…,10 years from June 1982 to March 1995. The authors use continuously compounded spot rates from the Bank of England. Cuthbertson and Nitzsche (1998) results are in sharp contrast to Taylor's (1992)[6]. The difference in results may be due to Taylor's use of the yield to maturity rather than spot yields and the consequent approximation involved in the term structure relationship (which requires the yield to maturity to be close to the par yield over the whole data set, see Shiller 1979). Cuthbertson and Nitzsche (1998) avoid the par yield approximation by using spot rates. Cuthbertson and Nitzsche (1998) follow the modification (as suggested by Tzavalis and Wickens 1998) and use a 3-variable VAR with the excess holding period yield as a proxy for a time varying term premium (TVTP). The authors note that, as a result of the incorporation of the TVTP in the VAR analysis, this can 'pick up' variations in the one period term premium.

Cuthbertson and Nitzsche (1998) do find evidence in favour of a (stationary) time varying term premium which influences the *one period* excess return. However, the impact of this time varying term premium on a *weighted average* of future short rates is negligible compared to movements in the long-short spread. This is because the one period term premium is not persistent and hence has a relatively small impact on a weighted average of future short rates. The authors also find that surprises in one period excess returns are due to news about future short rates and not due to revisions about future term premia. These results are supported

[6] The formulation of the Wald restrictions on weekly data (e.g. Taylor, 1992) are different from those applicable for monthly data (e.g. Cuthbertson and Nitzsche, 1998) and as is well known the Wald test of non-linear restrictions can be very sensitive to the form of the non-linearity (Gregory and Veal 1985).

by recent evidence on US Treasury bills by Tzavalis and Wickens (1998), which shows evidence of a TVTP.

5. Empirical Results

5.1 The Data

The data used consists of spot rates for 5, 10 and 15 years and were kindly provided by Davy's Stockbroking firm. The complete data set is sampled monthly (Wednesday, 4pm rates) beginning on the second Wednesday in January 1989 and ending on the second Wednesday of October 1997. The estimation is carried out using the 1 month rate as the representative short rate. Data on the 1 month rate and the 10 year rate is graphed in figure 1. What is clear from the graph is that the two series move together in the long run and there is considerable variability in the spread.

5.2 Unit Roots

Table 1 reports the unit root results. Using both the Dickey-Fuller and the Phillips and Perron tests there is no evidence against the null that the individual series R(n,t) are all I(1), whilst we find that Δr(t) and S(n,t) are I(0). Previous empirical evidence has found that the spread is stationary, (see for instance Hall, Anderson and Granger (1993) for the US and Cuthbertson, Hayes and Nitzsche (1996) for the UK). Given that our central assumption is that the term premium is stationary, we must also test its order of integration[7]. The term premium can be tested for stationarity by using the above tests on the excess holding period returns (Tzavalis and

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[7] A non-stationary term premium casts doubt on the ability of the REHTS to be a valid equilibrium model (see Baillie, 1989)

Wickens, 1997). As can be seen from the test results in table 1, the values for both test statistics suggest the rejection of the null of a unit root in the excess returns (term premium), for all n.

5.3 VAR Analysis

Table 2 contains the results from the 3 variable VAR system. As has already been mentioned, the third equation in the system will provide an estimate of the term premium since $E_t h(n,t+1) - R(t) = T(n,t)$. The lag length is chosen using the Schwartz criteria, except for the rare occasions when additional lags are required to avoid any serial correlation in the residuals. The summary statistics for the Ljung-Box Q statistic show the absence of residual serial correlation for each of the interest rate combinations at the 5% critical value. The restriction that the excess holding period return $E_t h(n,t+1) - r(t)$ is not time varying, namely $\mathbf{e3'A} = 0$ cannot be rejected for maturities n = 5, 10 and 15 years at better than a 5% level of significance (table 3). Given the result that the risk premium is not time varying, the results from the modified 3 variable VAR, should be quantitatively similar to the standard 2 variable VAR, with a constant risk premium.

For illustrative purposes, the graph of the actual spread S(n,t) and the theoretical spread S′(n,t) for n = 10 years shows a close correspondence (figure 2). However, from table 4 the regression of S(n,t) on S′(n,t) shows that although the slope coefficients appear to be close to unity, they are statistically different from 1. The results in table 5 which provide metrics for the relationship between the actual spread S(n,t) and theoretical spread S’(n,t) show a mixed set of results. The Wald test and the standard deviation ratios show broad support for the theory[8], however the correlation coefficients between the actual and theoretical spread are statistically different from unity in all of the cases examined.

5.4 Interpretation

Given the result that the risk premium is not time varying, the results from the modified 3 variable VAR, should be quantitatively similar to the standard 2 variable VAR, with a constant risk premium. This is in fact the case. For example using a 2 variable VAR the correlation coefficients between S(n,t) and S′(n,t) are 0.99 for all cases and the standard deviation ratios range 0.89 for the (5 year, 1 month) combination to 0.99 for the (15 year, 1 month) combination.

As a comparison to previous studies, namely Tzavalis and Wickens (1998) and Cuthbertson and Nitzsche (1998), we also compare the time series behaviour of the unexpected return eh(n,t+1) = h(n,t+1) – E_th(n,t+1) with ‘news’ about future changes in interest rates er(n,t+1). Cuthbertson and Nitzsche (1998) found that although variations in the *one-period* term premium T(n,t+1) do have a pronounced influence on *one period* returns, the spread depends on the *average* of all future expectations of T(n,t+i) (i = 1,2...n) of which the current value T(n,t+1) only has a weight of (1/n). The authors suggest that there is no strong persistence in T(n,t+i)[9].

The results in table 6 offer further support in favour of the EH with a constant term premium. For all maturities the standard deviation ratio σ(er) / σ(eh) and the correlation coefficient ρ(er,eh) are very close to +1 and -1

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[8] The exception here being the 5 year and 1 month combination.

respectively which indicates (see equation 8) that most of the variation in eh(n,t+1) is due to news about future short rates er(n,t+1) and very little is due to ‘news’ about the future *average* risk premium.

6. Conclusions

Testing the EH while allowing for a time varying risk premium requires a 3-variable VAR which not only contains the spread and the change in short rates (as used in earlier work) but also includes the excess holding period return, where the latter variable captures movements in the (stationary) term premium. Unlike previous evidence, using UK long maturity data, we do not find a TVTP. However, it should be noted that although previous studies have found evidence of a TVTP, (e.g. Cuthbertson and Nitzsche, 1998), the influence of the TVTP is negligible on the weighted average of future short rates, compared to that of the long-short spread. Given that we find no evidence of a TVTP, our empirical model reduces to a 2 variable VAR. Our results are consistent with recent evidence for the UK, in that we cannot reject the EH with a constant term premium.

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[9] Tzavalis and Wickens (1998) also find similar results from their variance decomposition of the excess holding period return, using US treasury bills.

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