MANCHESTER 1824

The University of Manchester

Economics Discussion Paper

EDP-0642

New Evidence on the Expectations Theory for UK Term Structure

By

Erdenebat Bataa, Dong H. Kim, Denise R. Osborn

December 2006

Download paper from:

http://www.socialsciences.manchester.ac.uk/economics/research/discuss.htm

Economics
School of Social Sciences
The University of Manchester
Oxford Road
Manchester M13 9PL
United Kingdom

New Evidence on the Expectations Theory for UK Term Structure

Erdenebat Bataa

Centre for Growth and Business Cycles Research, Economics, University of Manchester

Dong H. Kim

Dept. of Economics, Korea University

Denise R. Osborn*

Centre for Growth and Business Cycles Research, Economics, University of Manchester

December 2006

* Corresponding author. Denise Osborn, Centre for Growth and Business Cycles Research, Economics, School of Social Sciences, University of Manchester, Oxford Road, Manchester, UK, M13 9PL. Email: denise.osborn@manchester.ac.uk, Tel: +44(0)161-275-4861. Details of other authors: Erdenebat Bataa, Email: e.bataa@manchester.ac.uk, Tel: +44(0)161-275-4860, Dong Heon Kim, Email: dongkim@korea.ac.kr, Tel: +82-2-3290-2226.
Acknowledgements: The authors would like to thank Chris Orme, Simon Peters and Econometrics seminar participants at the University of Manchester for their useful comments. Erdenebat Bataa would also like to acknowledge financial assistance from the University of Manchester and the Open Society Institute.

Abstract

This paper extends the empirical evidence on the Expectations Theory (ET) in the UK term structure using recent developments in the testing methodology and looking at multiple conventional maturity pairs across the term structure spectrum. Although different tests yield different conclusions about the validity of the ET in some cases, there are maturity pairs and time periods for which all tests seem to agree. All testing methods are surprisingly positive about the ET at the longest end and when the ET is rejected it occurs only at the short end of the maturity spectrum irrespective of the method used. Moreover, none of the tests have rejected the theory in the first sub-sample which ends before the introduction of inflation targeting in 1992.

JEL classification: G10; E43.

Keywords: expectations hypothesis; term structure of interest rates; vector autoregression

Section 1. Introduction

This paper extends the literature on the UK term structure of interest rates by providing new test results on the Expectations Theory (ET) across the whole maturity spectrum from 1 month to 15 years, in contrast to previous literature that considers only portions of it. Tests we employ are the conventional single equation test and Vector autoregression (VAR) based implied regression, implied volatility, Lagrange Multiplier, Distance Metric and Wald tests, most of which have recently been developed and not yet applied to UK data. Moreover, unlike most of the previous literature, I avoid making any asymptotic inference as the sample size is relatively small and recent Monte Carlo studies in Bekaert, Hodrick and Marshall (1997, 2001) and Bataa, Kim, Osborn (2006a) show extreme size distortions of the tests in small samples. Instead, I report finite sample inferences based on the wild bootstrap.

We concentrate on the predictive ability of the spread between longer and shorter rates for future changes in the shorter rate.[1] In terms of methodology this paper is based on Bataa, Kim and Osborn (2006b) who study US term structure and extend the Lagrange Multiplier (*LM*), Distance Metric (*DM*) and Wald (*W*) tests examined in Bekaert and Hodrick (2001). However, the UK analysis here is richer than in Bataa *et al*. (2006b), as we also use the conventional single equation test (*t1*, for short) and Vector autoregression based implied regression (*t2*) and implied variance ratio (*t3*) tests discussed in Bataa *et al.* (2006a). Moreover, in addition to the bootstrap methodology of Bataa *et al.* (2006b) we also use the endogenized AIC bootstrap, recommended in Berkowitz and Kilian (2000) and Kilian (2001).

Our data span from Jan 1979 to May 2004, and we apply the tests not only to the whole sample but also to two sub-samples in order to take account of a possible regime change in short rates induced by the introduction of inflation targeting in Oct 1992. Finite sample inferences lead us to conclude that the ET is mostly rejected at the short end of the term structure and only in the whole and second (sub)samples. However, this pattern may be due to the extreme low power of all the tests against the under/over-reaction hypothesis

---

[1] Other three main implications of the ET are there is no predictable excess return, the spread should predict future changes in the longer rate and the forward rate is an unbiased predictor of future short rate. Tests of these implications are not considered in the present paper but can be found in e.g. Cuthbertson and Nitsche (2003), Hardouvelis (1994) and MacDonald and Macmillan (1994) for the UK.

and the time varying term premium alternatives in small samples as illustrated in Bataa (2006).

The paper is organized as follows. Section 2 briefly describes the ET and ways to test it. Section 3 provides a review of previous UK literature on the subject. Section 4 reports empircial results which is followed by a conclusion.

Section 2. Expecations Theory and Tests

The ET of term strucuture states that a long term interest rate is determined by a sequence of current and expected future short term interest rates :

$$R_{n,t} = \frac{1}{k}\sum_{i=0}^{k-1} E_t R_{m,t+mi} + \pi_{n,m} \; ; \qquad (1)$$

where $R_{n,t}$ and $R_{m,t}$ are long and short rates, E_t is the expectation formed at time t and $\pi_{n,m}$ is the time-invariant term premium which can vary across maturities and $k = n/m$ is defined to be an integer. The implication we are interested in is the ability of the spread between long and short rates to predict future short rate changes. This is often tested in a single equation framework after imposing rationality on the expectations such that

$$R_{m,t+mi} = E_t R_{m,t+mi} + v_{t+mi}, \qquad (2)$$

where v_{t+mi} is orthogonal to the information available at time t. Subtracting $R_{m,t}$ from both sides of equation (1) and using (2) we obtain (3), after some rearrangement and parameterization,

$$\sum_{i=1}^{k-1}(1-\frac{i}{k})\Delta_m R_{m,t+mi} = -\pi_{n,m} + \beta S_{(n,m),t} + w_{(n,m),t} \qquad (3)$$

where $\Delta_m R_{m,t+m} = R_{m,t+m} - R_{m,t}$, $S_{(n,m),t} = R_{n,t} - R_{m,t}$ and $w_{(n,m),t}$ is a moving average (MA) process of order (n-m). Under the null hypothesis of the EH, β should be unity and we refer to the t test for this hypothesis as $t1$.

However, this approach suffers from a finite sample problem mainly due to the MA correction and inefiiciency, when n-m is large, as discussed in Bataa *et al*. (2006a). Therefore, a VAR framework is often preferred. Assuming that there exists a stationary vector stochastic process for $\mathbf{y}_t = \left[\Delta R_{m,t}, S_{(n,m),t}\right]'$, then the demeaned process for $\mathbf{y}_t$ can be represented as a VAR of order p with error covariance matrix $\mathbf{\Sigma} = E(\mathbf{u}_t \mathbf{u}'_t)$,

$$\mathbf{y}_t = \sum_{i=1}^{p} \mathbf{\Phi}_i \mathbf{y}_{t-i} + \mathbf{u}_t . \tag{4}$$

Further, (4) can be written as a first order VAR in companion form such that $\mathbf{z}_t = \mathbf{\Phi} \mathbf{z}_{t-1} + \mathbf{v}_t$, where the companion matrix $\mathbf{\Phi}$ is of dimension $2p \times 2p$:

$$\mathbf{\Phi} = \begin{bmatrix} \mathbf{\Phi}_1 & \mathbf{\Phi}_2 & \cdots & \mathbf{\Phi}_{p-1} & \mathbf{\Phi}_p \\ \mathbf{I}_2 & \mathbf{0} & \cdots & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{I}_2 & \cdots & \mathbf{0} & \mathbf{0} \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{I}_2 & \mathbf{0} \end{bmatrix}$$

While $\mathbf{z}_t$ has $2p$ elements, $\mathbf{z}_t = \left[\mathbf{y}'_t, \mathbf{y}'_{t-1}, ..., \mathbf{y}'_{t-p+1}\right]'$, $\mathbf{v}_t$ is the $2p$ vector $\left[\mathbf{u}'_t, 0, 0, ..., 0\right]'$ which is uncorrelated over time.

Now define vectors $\mathbf{e}_i$, $i = 1, 2$, each of dimension $2p$, with unity in the i^{th} position and zeros everywhere else such that $\mathbf{e}'_1 \mathbf{z}_t = \Delta R_{m,t}$ and $\mathbf{e}'_2 \mathbf{z}_t = S_{(n,m),t}$. Using these definitions, the spread predicted by the EH and its restrictions on the VAR parameters can be shown to be, respectively,

$$S^*_{(n,m),t} \equiv \mathbf{e}'_1 \mathbf{\Lambda} \mathbf{z}_t \tag{5}$$

$$H_0 : \mathbf{a}(\mathbf{\theta}_0) \equiv \mathbf{e}'_2 - \mathbf{e}'_1 \mathbf{\Lambda} = \mathbf{0} . \tag{6}$$

where $\mathbf{\Lambda} \equiv \mathbf{\Lambda}(\mathbf{\Phi}, n, m) \equiv \mathbf{\Phi}[\mathbf{I} - m/n(\mathbf{I} - \mathbf{\Phi}^n)(\mathbf{I} - \mathbf{\Phi}^m)^{-1}](\mathbf{I} - \mathbf{\Phi})^{-1}$. $\mathbf{\theta}_0$ is a parameter vector, $\mathbf{\theta}_0 = vecr(\dot{\mathbf{\Phi}}_0)$ and $\dot{\mathbf{\Phi}} = [\mathbf{\Phi}_1, ..., \mathbf{\Phi}_p]'$, under the null obtained using the Generalized Method of Moments (GMM) orthogonality condition $E[\mathbf{g}(\mathbf{x}_t, \mathbf{\theta})] = \mathbf{0}$ where $\mathbf{x}_t \equiv (\mathbf{y}'_t, \mathbf{z}'_{t-1})'$. Then the *W, LM* and *DM* tests considered in Bekaert and Hodrick (2001) are

$$W = T\mathbf{a}(\hat{\mathbf{\theta}}_T)'(\mathbf{A}\mathbf{B}^{-1}\mathbf{A}')^{-1}\mathbf{a}(\hat{\mathbf{\theta}}_T) \xrightarrow{d} \chi^2(2p) \tag{7}$$

$$LM = T\overline{\mathbf{\gamma}}'_T \mathbf{A}\mathbf{B}^{-1}\mathbf{A}'\overline{\mathbf{\gamma}}_T \xrightarrow{d} \chi^2(2p) \tag{8}$$

$$DM = -2T(J(\overline{\mathbf{\theta}}_T) - J(\hat{\mathbf{\theta}}_T)) \xrightarrow{d} \chi^2(2p) , \tag{9}$$

where hats and bars denote consistent (unrestricted) and restricted estimators, respectively, J is the GMM objective function, $\mathbf{B} \equiv \mathbf{G}'\mathbf{\Omega}^{-1}\mathbf{G}$, $\mathbf{\Omega} \equiv E[\mathbf{g}(\mathbf{x}_t,\boldsymbol{\theta})\mathbf{g}(\mathbf{x}_t,\boldsymbol{\theta})']$, and $\mathbf{A} \equiv \nabla_{\boldsymbol{\theta}}\mathbf{a}(\boldsymbol{\theta}_0)$ and $\mathbf{G} \equiv E\nabla_{\boldsymbol{\theta}}\mathbf{g}(\mathbf{x},\boldsymbol{\theta}_0)$ are the gradients of the constraint function and the orthogonality condition respectively and finally $\boldsymbol{\gamma}_T$ is the estimated Lagrange Multiplier.[2]

Moreover one can express the slope coefficient of (3) and the variance ratio between the actual and theortical spreads as

$$\beta(\boldsymbol{\theta}) = \frac{\mathbf{e}_1'\mathbf{\Lambda\Psi}\mathbf{e}_2}{\mathbf{e}_2'\mathbf{\Psi}\mathbf{e}_2} \text{ and } v(\boldsymbol{\theta}) = \frac{\mathbf{e}_1'\mathbf{\Lambda\Psi\Lambda}'\mathbf{e}_1}{\mathbf{e}_2'\mathbf{\Psi}\mathbf{e}_2} \tag{10}$$

where $vec(\mathbf{\Psi}) = (\mathbf{I} - \mathbf{\Phi} \otimes \mathbf{\Phi})^{-1} vec(\mathbf{\Sigma})$. From the asymptotic distributions of these statitics one can derive the implied regression and varinace ratio tests which have standard normal distributions,

$$t2 = \sqrt{T}(\beta(\hat{\boldsymbol{\theta}}_T) - 1)/(\mathbf{H}'\mathbf{B}^{-1}\mathbf{A}'(\mathbf{A}\mathbf{B}^{-1}\mathbf{A}')^{-1}\mathbf{A}\mathbf{B}^{-1}\mathbf{H})^{1/2} \tag{11}$$

$$t3 = \sqrt{T}(v(\hat{\boldsymbol{\theta}}_T) - 1)/(\mathbf{L}'\mathbf{B}^{-1}\mathbf{A}'(\mathbf{A}\mathbf{B}^{-1}\mathbf{A}')^{-1}\mathbf{A}\mathbf{B}^{-1}\mathbf{L})^{1/2}, \tag{12}$$

where $\mathbf{H} \equiv \nabla_{\boldsymbol{\theta}}\beta(\bar{\boldsymbol{\theta}}_T)$ and $\mathbf{L} \equiv \nabla_{\boldsymbol{\theta}}v(\bar{\boldsymbol{\theta}}_T)$ are the gradients of the implied slope and the variance ratio in (10), respectively, that can be calculated using numerical derivatives.[3]

Bataa *et al.* (2006a) provides simulatation results for these tests that show bootstrapped *LM* and *DM* tests, in general, are most robust to interest rate maturities and persistency in finite samples. However that result is conditional on known lag order, *p*, of the assumed VAR data generating process. Given the discussions in Hall (1994) and Horowitz (2001) that stress the importance of bootstrapping asymptotically pivotal test statistics, *t2* and *t3* might even be better than *LM* and *DM* tests in the presence of VAR lag order uncertainty, as the distributions of (11) and (12) are asymptotically pivotal, while those of (7)-(9) depend on the unknown lag order.

Since Monte Carlo studies of Bekaert, Hodrick and Marshall (1997, 2001) and Bataa *et al.* (2006a) report extreme size distortions for the asymptotic tests in small samples the empirical results below rely on the bootstrap inference only. For that we

[2] See Bekaert and Hodrick (2001) for full details.
[3] See Bataa *et al.* (2006a) for full details.

follow Bataa *et al.* (2006b) in using the estimated constrained VAR parameters $\overline{\mathbf{\Phi}}_1,...,\overline{\mathbf{\Phi}}_p$ and corresponding residual vector $\overline{\mathbf{u}}_\mathbf{t}$ for time period *t*, and generate a bootstrap sample as

$$\mathbf{y}_t^* = \sum_{i=1}^{p} \overline{\mathbf{\Phi}}_i \mathbf{y}_{t-i}^* + \mathbf{u}_t^*,\ \mathbf{u}_t^* = \omega_t \overline{\mathbf{u}}_t,\ t = 1,...,\ T, \tag{12}$$

in which the scalar random variable ω_t follows the Rademacher distribution, taking the possible values of negative and positive unity with equal probabilities. Following Stine (1987) we split the observed data into $T - p + 1$ overlapping blocks of length *p* and one of these is selected randomly as the starting point. For each of the large number of artificial datasets generated, we estimate the VAR order using the same model selection method used for the actual data, following Masorotto (1990) and Kilian (1998), in order to reflect true sampling uncertainty of the lag order estimate, and derive the empirical distributions of the six test statistics under the null. For the first trinity of *W, LM* and *DM* the critical values are simply the 95% quantiles of these distributions. For the various *t* statistics, they are the 2.5 and 97.5% quantiles from the empirical distributions, allowing for two tailed alternatives.

To select the VAR order that ensures no residual autocorrelation we first use SIC and check if there is any evidence of autocorrelation up to 12th order. If autocorrelation is found, the lag length is increased by one. As in Bataa *et al*. (2006b), this process is continued until that lag order where there is no evidence of autocorrelation. However they note a problem associated with the choice of appropriate significance levels used in each recursion. Recently, Kilian and Berkowitz (2000) argue that for the AR(*p*) model, the lag order selection need not be consistent for the lag order for the bootstrap algorithm to be asymptotically valid but the probability of underestimating the true lag order has to be asymptotically zero. Kilian's (2001) simulation results show that parsimonious criteria such as SIC and HQC that tend to under fit in finite samples may result in false long run forecasts. Therefore, we try both approaches: "SIC+autocorrelation test" and AIC.[4]

Finally, we also follow Bekaert and Hodrick (2001) in using a bootstrap bias correction procedure for the estmated VAR parameters, with the stationarity correction suggested in Bataa *et al.* (2006b).

---

[4] The asymptotic distributions in (7)-(9) depend on VAR lag length *p*, which can be consistently estimated by SIC. However, when Bataa *et al*. (2006b) endogenize SIC in the bootstrap it reduces, not increases, the lag uncertainty associated with the lag order estimate.

Section 3. Previous findings for the UK

Most previous studies for the ET using UK data employ only asymptotic *t1* and/or *W* tests that have recently been shown to have the worst finite sample performances in terms of both size and power (Bekaert et al., 1997, 2001, Bekaert and Hodrick, 2001 and Bataa *et al.* (2006a). The exceptions are Attfield and Duck (1982) and Driffil, Psaradakis and Sola (1997) who apply Sargent's (1979) VAR based Likelihood Ratio test, which is equivalent to the Distance Metric test of Bekaert and Hodrick (2001) under Normality. The former study uses quarterly data on 3 month local authority temporary loans and 5 and 10 years of government securities over 1956- 1978, finding that the ET is not rejected when the first two series are used and strongly rejected when the ET for both 3-month and 5-year and 3-month and 10-year maturity pairs are tested simultaneously The latter employs monthly 1 and 3-month Treasury Bill rates from the period 1982-1994 and find no evidence against the theory. MacDonald and Speight (1988) discount Attfield and Duck's (1982) findings on the basis that their VAR specification is comprised of first differences in both short and long rates. This is because Shiller (1979) earlier argued that such a specification throws away important implications of the theory. Secondly, if long and short rates are nonstationary, I(1), but cointegrated, then according to Engle and Granger (1987) the estimated VAR is misspecified as there exists no invertible moving average representation and thus no finite order for the VAR. MacDonald and Speight (1988) therefore take a first difference of the short rate and the spread in the VAR, as in Campbell and Shiller (1987), and test the implication of the theory using quarterly data from 1963- 1987 on 3-month Treasury Bill and 5, 10 and 20- year government bond yields. Their results from Campbell and Shiller's (1987) Wald test provide overwhelming support for the theory. The rest of studies in this review and our results rely on this VAR specification.

Mills (1991) replicates MacDonald and Speight's study over a longer time horizon, but with sub-samples, from 1870-1988 using quarterly 3-month Prime Bank Bill rate and the yield on Consols before 1951, and 3-month Treasury bill rate and yields on 5 and 10 year government bond and War Loan afterwards. His results lead to a rejection of the theory before the World War I, in contrast to Mankiw and Miron's (1986) finding for the US, and during the inter-war period. But after World War II the evidence is consistent with MacDonald and Speight (1988), especially when the longer rates come from government bonds. Taylor (1992) increases the data frequency to weekly and considers 3-month Treasury Bill Rate and the yields on 10, 15 and 20 years of Treasury Bonds from 1985-1989. In contrast to the previous two studies, he finds overwhelming evidence against the

ET and suggests this may be attributable to an increased power of the Wald test caused by the larger sample.

Hurn, Moody and Muscatelli (1995) use monthly data on 1, 3, 6, and 12-month LIBORs from 1975- 1991 and do not reject the null at all by Wald and single equation tests, except for one case at the shortest end of the term structure using the latter test. Cuthbertson (1996) applies the same tests to weekly LIBORs of maturities 1 week, 1, 3, 6 and 12-month from 1981-1992 and finds the theory to be rejected only at the shortest end by the single equation test, which he attributes to short investment period and a slight misalignment of investment horizon associated with weekly observations. In contrast, the Wald test rejects the ET across all maturity combinations except a case where the maturity of the longer rate is 1 year. Interestingly, the variance ratio test produces almost exactly the opposite conclusion. Cuthbertson, Hayes and Nitzsche (1996) use weekly UK Certificate of Deposit rates of maturities up to one year over 1975-1992 to find single equation and variance ratio tests not rejecting at all while the Wald test always rejects, with one exception where the maturity distance between the longer and shorter rates is the greatest.

More recently, Cuthbertson and Nitsche (2003) add the excess holding period return into the VAR as a proxy for the time varying term premium and use 1 month Treasury Bill rate as a short rate, and estimated yield curve data for maturities 2, 3,…,10 years inclusive and also 15, 20 and 25 years as long rates, all of which are observed monthly, over 1976-1999. Their single equation test results confirm their earlier work, not rejecting the theory, and their Wald test rejects only when the maturity of the long rate is equal to or greater than 15 years.

Section 4. Empirical Results

4.1. Data and preleminary analysis

We use the UK term structure data for maturities of 1, 3, 9 and 12 months and 2, 3, 4, and 5 years, sampled at the end of each month, for the period Jan 1979 to May 2004. 1 and 3-month Treasury Bill rates are obtained from DataStream and the remaining series are the Bank of England’s estimated zero coupon yield curve data which are calculated by a spline-based technique as discussed in Anderson and Sleath (2001).[5] The application of this dataset is relatively new and, to our knowledge, has only been used in Cuthbertson and Nitzsche (2003) to test the theory. However they test the ET for only 1 month and very long interest rates, while we consider all possible conventional maturity pairs between 1 month and 15 years.

Since unit root and cointegration properties of the UK interest rates have been extensivly studied in the previous literature, including for the yield curve data we use (see Bataa, 2003, and Cuthbertson and Nitsche, 2003) we abstain from repetition here. These studies find interest rates contain a unit root but the first differences in shorter rates and and the spread are stationary, thus justifying the VAR speficiation we employ.

Table 1 provides descriptive statistics of the variables used in the VAR. There are some noticable differences in the behaviour of the variables across two sub-samples, 1979-1989 and 1994-2004. Our first sub-sample ends in 1989 in order to represent a period before the introduction of inflation targeting started in 1992, allowing that the market may have already reacted to this policy before its implementation. The second sample starts in 1994 for a comparative purpose. In general, the levels of all interest rates have declined since 1979, as witnessed by the negative means of their first differences. The persistency of the interest rate variables, measured by the autocorrelation, has increased considerably across the sub-samples, especially for changes in shorter rate, the shorter the maturity the higher the increase, and for the first lag. In contrast, the volatility of these variables, measured by the standard deviation, has declined, especially for monthly changes in very short rates. For the 3-month rate it decreased by almost 74% while the least decline of 50% is observed for the 5 year interest rate. Previous US studies such as Mankiw and Miron (1986), Simon (1990) and Roberds, Whiteman and Runkle (1996), among others, note the ET performs better in periods where no interest rate smoothing takes place, i.e. periods with more volatile interest rates. The yield curves contain, on average, qualitatively different information in the two subperiods as almost all spreads have negative means in the first subperiod (inverted yield curves) and positive ones in the second (normal yield curves).

Table 2 reports the lag lengths estimated by the two model selection methods, the cases where these disagree are highlighted. They agree more often in the whole sample

[5] Although the Bank of England's dataset covers various maturities, it is largely incomplete for maturities less than 6 months, therefore, Treasury bill rates are used at the shortest end of the maturity spectrum. Observations are missing for March, October and November 1990 for 9 months maturity, which are filled by averaging the boundary observations of these gaps.
Web address of this data source is http://213.225.136.206/statistics/yieldcurve/index.htm.

Table 1. Descriptive Statistics of VAR variables

Series	*Jan 1979- May 2004*								*Jan 1979- Jan 1989*								*May 1994- May 2004*							
	Mean	**Std. dev**	**Min**	**Max**	**Autocorrelation**				**Mean**	**Std. dev**	**Min**	**Max**	**Autocorrelation**				**Mean**	**Std. dev**	**Min**	**Max**	**Autocorrelation**			
					Lag 1	**Lag 2**	**Lag 3**	**Lag 4**					**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**					**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
$\Delta R_{1,t}$	-0.02	0.58	-1.41	3.34	0.01	0.07	-0.01	-0.02	-0.02	0.76	-1.41	3.34	-0.02	0.04	-0.04	-0.04	-0.02	0.21	-0.94	0.47	0.25	0.34	0.26	0.08
$\Delta R_{3,t}$	-0.03	0.61	-2.05	2.84	0.00	0.05	-0.02	0.00	-0.02	0.80	-2.05	2.84	-0.04	0.04	-0.05	-0.02	-0.02	0.21	-1.03	0.41	0.21	0.29	0.22	0.16
$\Delta R_{9,t}$	-0.02	0.52	-2.07	2.06	0.02	0.06	-0.05	0.00	-0.02	0.67	-2.07	2.06	-0.03	0.07	-0.07	-0.03	-0.01	0.23	-0.75	0.58	0.18	0.16	0.02	0.06
$\Delta R_{12,t}$	-0.02	0.51	-2.01	2.01	0.05	0.02	-0.05	-0.02	-0.03	0.64	-2.01	2.01	-0.01	0.03	-0.07	-0.05	-0.01	0.24	-0.76	0.55	0.16	0.12	0.01	0.03
$\Delta R_{24,t}$	-0.03	0.48	-1.74	1.78	0.09	0.02	-0.05	-0.06	-0.03	0.60	-1.74	1.78	0.05	0.03	-0.08	-0.10	-0.01	0.26	-0.73	0.76	0.19	0.06	0.02	0.01
$\Delta R_{36,t}$	-0.03	0.47	-1.68	1.84	0.12	0.03	-0.06	-0.05	-0.03	0.58	-1.68	1.84	0.08	0.03	-0.10	-0.08	-0.01	0.27	-0.65	0.85	0.20	0.06	0.05	0.01
$\Delta R_{48,t}$	-0.03	0.46	-1.67	1.88	0.12	0.02	-0.08	-0.04	-0.03	0.57	-1.67	1.88	0.09	0.03	-0.12	-0.06	-0.02	0.27	-0.65	0.86	0.19	0.05	0.06	0.01
$\Delta R_{60,t}$	-0.03	0.45	-1.61	1.83	0.12	0.00	-0.10	-0.03	-0.03	0.55	-1.61	1.83	0.10	0.01	-0.14	-0.05	-0.02	0.27	-0.63	0.82	0.17	0.04	0.07	0.02
$S_{(1,3),t}$	-0.09	0.26	-1.89	0.56	0.37	0.35	0.36	0.28	-0.17	0.29	-1.89	0.50	0.17	0.20	0.21	0.11	0.01	0.16	-0.81	0.56	0.66	0.51	0.45	0.38
$S_{(1,9),t}$	-0.28	0.64	-2.30	1.28	0.81	0.69	0.61	0.57	-0.54	0.68	-2.30	1.11	0.73	0.58	0.49	0.45	0.02	0.43	-1.38	1.28	0.83	0.71	0.60	0.50
$S_{(1,12),t}$	-0.29	0.78	-2.58	1.68	0.85	0.75	0.67	0.62	-0.61	0.81	-2.58	1.32	0.79	0.66	0.57	0.53	0.09	0.53	-1.35	1.68	0.86	0.76	0.65	0.55
$S_{(1,24),t}$	-0.22	1.13	-3.28	2.69	0.91	0.84	0.78	0.72	-0.70	1.15	-3.28	2.15	0.87	0.78	0.69	0.64	0.35	0.81	-1.78	2.69	0.92	0.85	0.76	0.67
$S_{(1,36),t}$	-0.16	1.34	-3.87	3.17	0.93	0.87	0.81	0.76	-0.72	1.34	-3.87	2.54	0.89	0.82	0.74	0.69	0.51	0.98	-2.01	3.17	0.94	0.88	0.81	0.72
$S_{(1,48),t}$	-0.10	1.46	-4.18	3.44	0.94	0.89	0.83	0.78	-0.70	1.47	-4.18	2.72	0.91	0.83	0.76	0.71	0.61	1.10	-2.17	3.44	0.95	0.90	0.84	0.76
$S_{(1,60),t}$	-0.05	1.55	-4.36	3.67	0.94	0.89	0.84	0.79	-0.67	1.56	-4.36	2.82	0.91	0.84	0.77	0.73	0.68	1.18	-2.29	3.67	0.96	0.91	0.86	0.79
$S_{(1,120),t}$	0.02	1.78	-4.89	3.86	0.95	0.91	0.86	0.82	-0.63	1.82	-4.89	2.75	0.93	0.87	0.81	0.76	0.78	1.40	-2.54	3.86	0.97	0.94	0.90	0.85
$S_{(1,180),t}$	-0.20	1.93	-5.57	3.65	0.96	0.92	0.87	0.83	-1.03	1.88	-5.57	2.51	0.92	0.86	0.80	0.75	0.77	1.50	-2.59	3.65	0.98	0.95	0.91	0.87
$S_{(3,9),t}$	-0.19	0.56	-2.17	1.34	0.80	0.69	0.61	0.53	-0.37	0.65	-2.17	1.34	0.77	0.63	0.55	0.47	0.01	0.33	-0.91	0.87	0.83	0.73	0.62	0.52
$S_{(3,12),t}$	-0.20	0.70	-2.29	1.62	0.86	0.76	0.68	0.61	-0.43	0.78	-2.29	1.62	0.82	0.70	0.62	0.55	0.08	0.44	-1.11	1.21	0.87	0.78	0.68	0.57
$S_{(3,24),t}$	-0.13	1.06	-3.03	2.36	0.92	0.85	0.79	0.72	-0.53	1.12	-3.03	2.36	0.88	0.80	0.73	0.66	0.34	0.74	-1.65	2.22	0.93	0.87	0.79	0.69
$S_{(3,36),t}$	-0.07	1.27	-3.62	2.88	0.94	0.88	0.82	0.76	-0.55	1.32	-3.62	2.74	0.91	0.83	0.77	0.70	0.50	0.93	-1.95	2.88	0.95	0.90	0.83	0.75
$S_{(3,48),t}$	-0.01	1.40	-3.93	3.34	0.94	0.89	0.84	0.78	-0.53	1.45	-3.93	2.95	0.92	0.85	0.79	0.73	0.60	1.06	-2.14	3.34	0.96	0.91	0.85	0.78
$S_{(3,60),t}$	0.04	1.49	-4.11	3.61	0.95	0.90	0.85	0.80	-0.49	1.54	-4.11	3.08	0.93	0.86	0.80	0.74	0.67	1.15	-2.26	3.61	0.97	0.92	0.87	0.80
$S_{(3,120),t}$	0.11	1.74	-4.64	3.79	0.95	0.91	0.86	0.82	-0.45	1.80	-4.64	2.94	0.93	0.87	0.82	0.77	0.77	1.40	-2.50	3.79	0.97	0.94	0.91	0.86
$S_{(3,180),t}$	-0.11	1.88	-5.32	3.62	0.95	0.91	0.87	0.83	-0.85	1.86	-5.32	2.18	0.92	0.86	0.80	0.75	0.76	1.51	-2.56	3.62	0.98	0.95	0.92	0.87
$S_{(9,36),t}$	0.13	0.82	-2.37	2.37	0.95	0.90	0.85	0.80	-0.18	0.81	-2.37	1.61	0.91	0.86	0.80	0.75	0.49	0.66	-1.04	2.37	0.97	0.92	0.86	0.79
$S_{(9,180),t}$	0.08	1.53	-4.27	3.32	0.96	0.92	0.87	0.83	-0.49	1.44	-4.27	2.10	0.92	0.87	0.81	0.76	0.74	1.36	-1.77	3.32	0.97	0.95	0.91	0.88
$S_{(12,24),t}$	0.06	0.43	-1.23	1.25	0.95	0.90	0.85	0.79	-0.10	0.43	-1.23	0.88	0.91	0.85	0.80	0.74	0.25	0.34	-0.54	1.25	0.97	0.91	0.85	0.77
$S_{(12,36),t}$	0.13	0.67	-1.94	2.03	0.95	0.91	0.86	0.82	-0.11	0.66	-1.94	1.27	0.92	0.87	0.81	0.76	0.42	0.56	-0.84	2.03	0.97	0.92	0.87	0.81
$S_{(12,48),t}$	0.19	0.82	-2.32	2.50	0.96	0.91	0.87	0.83	-0.09	0.80	-2.32	1.46	0.93	0.87	0.82	0.78	0.52	0.71	-1.03	2.50	0.97	0.93	0.88	0.83
$S_{(12,60),t}$	0.24	0.92	-2.55	2.79	0.96	0.92	0.87	0.84	-0.06	0.90	-2.55	1.62	0.93	0.88	0.83	0.80	0.59	0.83	-1.15	2.79	0.97	0.93	0.89	0.85
$S_{(12,120),t}$	0.31	1.23	-3.19	3.08	0.96	0.92	0.88	0.84	-0.02	1.20	-3.19	2.20	0.94	0.89	0.84	0.80	0.69	1.14	-1.55	3.08	0.97	0.94	0.91	0.87
$S_{(12,180),t}$	0.08	1.41	-3.83	3.29	0.96	0.92	0.87	0.83	-0.42	1.31	-3.83	2.02	0.92	0.87	0.81	0.75	0.68	1.30	-1.69	3.29	0.97	0.94	0.91	0.87
$S_{(24,48),t}$	0.12	0.41	-1.09	1.26	0.95	0.90	0.86	0.83	0.00	0.39	-1.09	0.97	0.91	0.84	0.80	0.77	0.27	0.39	-0.53	1.26	0.97	0.93	0.90	0.86
$S_{(24,120),t}$	0.24	0.88	-1.96	2.35	0.95	0.90	0.85	0.80	0.08	0.85	-1.96	2.30	0.92	0.87	0.81	0.75	0.44	0.88	-1.22	2.35	0.97	0.94	0.91	0.87
$S_{(36,180),t}$	-0.05	0.90	-2.04	2.46	0.93	0.87	0.80	0.73	-0.31	0.84	-2.04	2.16	0.87	0.79	0.68	0.59	0.26	0.89	-1.71	2.46	0.96	0.93	0.89	0.84
$S_{(60,120),t}$	0.07	0.44	-0.82	1.81	0.91	0.83	0.74	0.64	0.04	0.46	-0.82	1.81	0.87	0.78	0.66	0.54	0.11	0.41	-0.80	1.17	0.96	0.92	0.88	0.82
$S_{(60,180),t}$	-0.15	0.68	-1.61	1.73	0.91	0.83	0.74	0.66	-0.36	0.65	-1.61	1.63	0.83	0.72	0.59	0.49	0.09	0.64	-1.46	1.73	0.96	0.92	0.87	0.81

Note: The table reports the descriptive statistics of the series: changes in shorter term rates, $\Delta R_{m,t}$, and spreads between the long and short rates, $S_{(n,m),t}$ for three samples..

than in the subsumples. The maximum number of lag length is always p_{max}=int[12(T/100)$^{0.25}$] as in Hayashi (2000).

Appendix A illustrates the discrepancy between the theoretical spread, defined in (5), and the actual spread which is expected to be zero under the null, for each maturity pair using both lag length selection procedures. In each case the VAR slope parameters are used with bias-correction, as in Bataa *et al.* (2006b) and without it. When the chosen VAR lag length is the same for both model selection procedures I plot only one of them, and it is evident that it has an important effect on the discrepancy. When the estimated VAR parameters are directly used to construct the theoretical spread, the discrepancy is always more volatile in the whole sample than in the two subsamples, perhaps suggesting that the latter two indeed corrospond to different regimes. It is within corridors of [-1.2;2], [-0.8;1] and [-1.1;1.9] percentage points in the whole and the subsamples respectively. There are some cases where the actual spread is explained by the ET surprisingly well; see e.g. the discrepancies for maturity pairs 1&12, and 12&24 months in the first subsample where the former is based on AIC while the latter uses the joint procedure.

Table 2. VAR lag length

n \ m	1			3			9			12			24			36			60		
	I	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*
3	6	2	1																		
	2	1	1																		
9	3	3	1	3	1	1															
	3	3	5	3	1	2															
12	3	1	1	1	1	1															
	3	3	5	1	1	2															
24	2	1	3	1	1	4				2	2	2									
	2	2	1	1	1	4				1	1	2									
36	2	1	9	2	1	4	2	1	2	1	1	2									
	2	1	1	1	1	4	2	1	2	1	1	2									
48	2	1	9	2	1	4				1	1	1	1	1	1						
	2	1	1	2	1	4				1	1	2	1	1	3						
60	2	1	9	2	1	4				1	1	1									
	2	2	1	2	1	3				1	1	2									
120	2	2	3	2	1	3				1	2	1	1	2	1				2	2	1
	2	2	1	2	1	3				1	1	1	1	1	1				1	1	2
180	2	2	3	2	1	3	1	2	2	1	2	1				2	2	1	9	2	1
	2	2	1	1	2	3	1	1	2	1	1	1				1	2	1	1	1	1

Note: Table reports VAR lag lengths based on AIC (first row) and joint SIC and autocorrelation test (second row) model selection methods for each maturity pair. *I, II* and *III* represent the samples Jan 1979- May 2004, Jan 1979- Dec 1989 and May 1994- May 2004, respectively.

The application of bootstrap bias correction has only negligable effect on the discrepancy in the whole sample, as one would expect. However in the subsamples, especially in the regime of highly persistent interest rates, witnessed by not only autocorrelations reported in Table 1 but also maximum eigenvalues of the companion form VAR parameters reported in Table 3, its introduction has a considerable effect and this effect is increasing as the highest eigenvalue increases. The most extreme case occurs for the maturity pair of

9&180 months in the second subsample, where the discrepancy between the theoretical and the actual spreads hover at around negative 10 percentage points which is empirically highly unlikely.

Table 3. Maximum eigenvalues

n \ m	1			3			9			12			24			36			60		
	I	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*	*I*	*II*	*III*
3	0.870	0.345	0.798																		
	0.619	0.251																			
9	0.893	0.823	0.878	0.871	0.725	0.848															
	0.893	0.823	0.799	0.871	0.725	0.859															
12	0.908	0.705	0.889	0.854	0.768	0.874															
	0.908	0.850	0.809	0.854	0.768	0.871															
24	0.917	0.803	0.821	0.915	0.838	0.850				0.953	0.922	0.945									
	0.917	0.822	0.911	0.915	0.838	0.850				0.947	0.887	0.945									
36	0.932	0.842	0.936	0.935	0.870	0.881	0.953	0.902	0.946	0.956	0.909	0.949									
	0.932	0.842	0.920	0.934	0.870	0.881	0.953	0.902	0.946	0.956	0.909	0.949									
48	0.937	0.859	0.944	0.940	0.885	0.892				0.958	0.916	0.934	0.948	0.865	0.933						
	0.937	0.859	0.925	0.940	0.885	0.892				0.958	0.916	0.951	0.948	0.865	0.950						
60	0.940	0.868	0.948	0.942	0.893	0.897				0.959	0.922	0.936									
	0.940	0.867	0.928	0.942	0.893	0.885				0.959	0.922	0.952									
120	0.946	0.878	0.870	0.947	0.899	0.903				0.958	0.910	0.948	0.945	0.870	0.950				0.897	0.797	0.960
	0.946	0.878	0.943	0.947	0.899	0.903				0.958	0.926	0.948	0.945	0.893	0.950				0.896	0.820	0.961
180	0.950	0.846	0.881	0.951	0.865	0.913	0.955	0.845	0.960	0.953	0.838	0.957				0.919	0.620	0.963	0.865	0.594	0.965
	0.950	0.846	0.953	0.952	0.850	0.913	0.955	0.876	0.960	0.953	0.866	0.957				0.919	0.620	0.963	0.889	0.730	0.965

Note: Table reports the maximum eigenvalues of companion form VAR based on AIC (first row) and joint SIC and autocorrelation test (second row) model selection methods for each maturity pair. *I, II* and *III* represent the samples Jan 1979- May 2004, Jan 1979- Dec 1989 and May 1994- May 2004, respectively.

This finding conjectures that Andrews (2000) result on the inconsistency of the bootstrap when a parameter is on the boundary of the parameter space may aslo be relevant for cases where the parameter is not exactly on the boundary but very close to it. Since the computational burden for these cases were also extremely high we do not bias correct the VAR parameters if the maximum eigenvalue is greater than 0.96.

4.2. Test results

Tables 4-9 present results of the six tests of the ET applied to the whole sample, 1979-2004, the more volatile interest rate regime period of 1979-1989 and the less volatile interest rate regime 1994-2004. In each case, Panel A uses the joint SIC and autocorrelation procedure as the model selection method while Panel B uses AIC. The number of bootstrap iterations for the bias correction is 1000 and that for the estimation of the empiricial distribution is 10000. All inferences are made at 5% significance level and the cases where the ET is rejected are highlighted.

We report the *LM*, *DM* and *W* test statistics (**in bold**), and their empirical *p*-values associated with the null hypothesis that the ET is true, in Tables 4-6. Using the *LM, DM*

Table 4. Lagrange Multiplier test results

Panel A. Model Selection Rule: SIC+Autocorrelation Test

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**
3	**5.3**							**1.91**							**9.15**						
	0.22							0.47							0.04						
9	**10**	**8.98**						**9.99**	**2.58**						**7.68**	**4.91**					
	0.16	0.05						0.12	0.34						0.21	0.27					
12	**3.71**	**5.08**						**7.96**	**0.77**						**7.28**	**2.59**					
	0.44	0.15						0.23	0.71						0.27	0.55					
24	**5.86**	**1.81**		**1.82**				**4.19**	**0.35**		**0.04**				**2.7**	**7.45**		**2.66**			
	0.22	0.47		0.48				0.26	0.87		0.98				0.37	0.49		0.53			
36	**7.6**	**0.98**	**7.32**	**1.48**				**3.64**	**0.87**	**0.1**	**0.34**				**11.4**	**11**	**2.31**	**1.96**			
	0.13	0.67	0.12	0.53				0.23	0.71	0.96	0.86				0.15	0.23	0.62	0.63			
48	**8.76**	**7.28**		**1.22**	**2.6**			**4.25**	**1.25**		**0.58**	**1.69**			**4.02**	**13**		**1.34**	**0.23**		
	0.09	0.1		0.6	0.34			0.18	0.6		0.79	0.52			0.29	0.14		0.73	0.92		
60	**9.55**	**7.8**		**1.06**				**9.17**	**1.47**		**0.74**				**4.45**	**9.81**		**1.09**			
	0.07	0.1		0.65				0.05	0.56		0.76				0.27	0.15		0.83			
120	**9.91**	**7.14**		**1.25**	**2.89**		**2.85**	**9.08**	**0.89**		**0.7**	**1.96**		**1.37**	**5.16**	**12.3**		**1.7**	**1.19**		**5.65**
	0.08	0.16		0.59	0.31		0.32	0.08	0.69		0.75	0.46		0.57	0.17	0.07		0.51	0.62		0.15
180	**7.19**	**1.46**	**1.85**	**2.12**		**3.36**	**3.93**	**5.22**	**1.6**	**0.03**	**0.26**		**2.63**	**1.37**	**5.12**	**12.4**	**2.91**	**1.63**		**1.48**	**2.19**
	0.18	0.55	0.45	0.42		0.26	0.21	0.31	0.74	0.98	0.9		0.57	0.58	0.17	0.07	0.51	0.52		0.55	0.42

Panel B. Model Selection Rule: AIC

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**
3	**21.92**							**2.79**							**9.15**						
	0.18							0.51							0.06						
9	**10.04**	**5.09**						**9.99**	**2.58**						**1.81**	**3.08**					
	0.36	0.39						0.14	0.41						0.54	0.37					
12	**7.27**	**5.09**						**0.90**	**0.77**						**1.67**	**1.98**					
	0.51	0.39						0.71	0.74						0.55	0.51					
24	**5.86**	**1.81**		**8.66**				**2.52**	**0.35**		**5.12**				**4.01**	**7.43**		**2.66**			
	0.42	0.65		0.21				0.38	0.87		0.25				0.72	0.58		0.64			
36	**7.61**	**6.22**	**7.32**	**1.47**				**3.65**	**0.87**	**0.09**	**0.33**				**24.71**	**10.94**	**2.31**	**1.96**			
	0.34	0.33	0.31	0.67				0.25	0.71	0.97	0.89				0.13	0.30	0.71	0.72			
48	**8.76**	**7.28**		**1.22**	**2.60**			**4.26**	**1.25**		**0.54**	**1.68**			**27.10**	**12.94**		**0.78**	**0.40**		
	0.32	0.29		0.72	0.67			0.21	0.63		0.83	0.66			0.08	0.19		0.77	0.87		
60	**9.55**	**7.80**		**1.05**				**4.65**	**1.47**		**0.66**				**28.56**	**14.13**		**1.09**			
	0.30	0.28		0.75				0.20	0.58		0.79				0.05	0.15		0.69			
120	**9.91**	**7.14**		**1.25**	**2.89**		**5.27**	**9.08**	**0.91**		**3.46**	**2.22**		**3.25**	**10.76**	**12.31**		**1.70**	**1.19**		**2.66**
	0.24	0.31		0.69	0.48		0.61	0.10	0.71		0.53	0.75		0.60	0.20	0.11		0.56	0.66		0.44
180	**7.19**	**3.75**	**1.85**	**2.13**		**4.97**	**19.06**	**5.22**	**0.34**	**0.24**	**0.51**		**2.63**	**2.57**	**10.23**	**12.35**	**2.91**	**1.63**		**1.48**	**2.19**
	0.42	0.61	0.66	0.62		0.54	0.37	0.38	0.88	0.98	0.96		0.73	0.73	0.21	0.10	0.63	0.59		0.62	0.51

Note: Table provides *LM* test statistics and empirical p values associated with the null of the ET from the endogenous lag bootstrap procedure.

and *W* tests, there is no evidence against the ET in the whole and the first sub-sample. In the more recent sub-sample, however, *W* detects more evidence against the theory than others and the evidence is uniform at the shortest end of the term structure. Although all tests do not reject the nul at the shortest end with AIC model selection rule the failure to reject is often very marginal and will turn into rejections if one uses 10% significance level.

Table 5. DM test results

Panel A. Model Selection Rule: SIC+Autocorrelation Test

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	3	9	12	24	36	60	1	3	9	12	24	36	60	1	3	9	12	24	36	60
3	11.7							3.52							16.6						
	0.11							0.39							0.03						
9	12	10.5						11.3	2.8						8.44	6.24					
	0.18	0.06						0.19	0.34						0.26	0.24					
12	3.83	5.41						9.78	0.8						8.39	3.06					
	0.49	0.17						0.25	0.71						0.31	0.52					
24	5.97	1.86		1.89				3.45	0.35		0.04				2.92	8.2		3.27			
	0.27	0.47		0.48				0.37	0.87		0.98				0.38	0.57		0.49			
36	7.51	1.01	7.58	1.52				3.65	0.87	0.09	0.33				13.7	12.7	2.59	2.15			
	0.17	0.67	0.14	0.53				0.25	0.72	0.96	0.87				0.25	0.33	0.61	0.62			
48	8.49	7.22		1.25	2.81			4.38	1.26		0.54	1.72			4.47	16.3		1.36	0.24		
	0.14	0.14		0.6	0.33			0.19	0.61		0.81	0.53			0.3	0.21		0.74	0.94		
60	9.42	7.82		1.08				8.3	1.48		0.69				4.93	12.1		1.11			
	0.11	0.13		0.65				0.11	0.57		0.78				0.29	0.2		0.83			
120	11.7	7.99		1.29	3.21		3.39	11.1	0.87		0.66	1.96		1.7	5.46	16.9		1.76	1.23		6.67
	0.08	0.17		0.58	0.29		0.29	0.09	0.7		0.77	0.48		0.52	0.21	0.08		0.52	0.62		0.15
180	8.67	1.51	1.96	2.28		3.86	4.41	6.56	1.76	0.03	0.26		2.84	1.62	5.39	17	3.24	1.66		1.55	2.25
	0.18	0.55	0.44	0.41		0.23	0.21	0.28	0.73	0.98	0.9		0.59	0.54	0.21	0.08	0.51	0.53		0.56	0.44

Panel B. Model Selection Rule: AIC

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	3	9	12	24	36	60	1	3	9	12	24	36	60	1	3	9	12	24	36	60
3	41.33							7.09							16.85						
	0.21							0.34							0.05						
9	12.01	5.41						11.35	2.80						1.92	3.28					
	0.38	0.41						0.22	0.41						0.54	0.38					
12	8.04	5.41						0.81	0.80						1.74	2.09					
	0.55	0.41						0.75	0.74						0.56	0.51					
24	5.97	1.87		9.75				2.33	0.34		5.68				4.43	8.16		3.27			
	0.46	0.66		0.21				0.43	0.88		0.25				0.74	0.67		0.59			
36	7.50	6.24	7.60	1.52				3.61	0.86	0.09	0.32				79.77	12.68	2.59	2.15			
	0.39	0.37	0.33	0.67				0.28	0.72	0.97	0.89				0.07	0.41	0.69	0.71			
48	8.49	7.22		1.25	2.81			4.38	1.25		0.52	1.74			96.30	16.24		0.80	0.40		
	0.38	0.34		0.72	0.66			0.24	0.64		0.83	0.66			0.06	0.27		0.77	0.87		
60	9.41	7.82		1.08				4.84	1.48		0.63				103.7	18.97		1.12			
	0.35	0.33		0.75				0.22	0.60		0.80				0.04	0.20		0.69			
120	11.70	8.00		1.29	3.21		5.78	11.04	0.88		3.69	2.34		3.50	23.02	16.88		1.76	1.23		2.83
	0.25	0.33		0.69	0.47		0.62	0.11	0.72		0.55	0.75		0.62	0.08	0.13		0.57	0.66		0.44
180	8.68	4.05	1.96	2.28		5.73	36.33	6.56	0.33	0.24	0.51		2.82	3.00	19.41	16.99	3.24	1.66		1.55	2.25
	0.41	0.62	0.66	0.61		0.53	0.29	0.36	0.89	0.98	0.96		0.74	0.72	0.10	0.12	0.62	0.60		0.62	0.52

Note: Table provides *DM* test statistics and empirical p values associated with the null of the ET from the endogenous lag bootstrap procedure.

It is worth noting that the rejections at the shortest end of the term structure are consistent with most of the literature. Moreover, *W* test in Table 4 provides rejections for 3-month (1 month with AIC) short rate and 10 and 15 years of long rate implying Taylor's (1992) rejection from the Wald test extends to more recent data.

Table 6. Wald test tesults

Panel A. Model Selection Rule: SIC+Autocorrelation Test

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***
3	**13.96**							**3.47**							**13.09**						
	0.07							0.41							0.04						
9	**11.12**	**9.53**						**9.51**	**2.79**						**6.90**	**6.49**					
	0.23	0.06						0.27	0.33						0.31	0.23					
12	**3.97**	**5.17**						**7.87**	**0.91**						**7.41**	**2.91**					
	0.46	0.17						0.34	0.67						0.34	0.53					
24	**5.04**	**1.85**		**1.96**				**3.46**	**0.13**		**0.12**				**2.74**	**9.78**		**3.07**			
	0.30	0.46		0.46				0.34	0.95		0.95				0.37	0.49		0.52			
36	**5.98**	**1.02**	**6.84**	**1.61**				**3.74**	**0.61**	**0.23**	**0.42**				**20.81**	**19.17**	**2.62**	**2.10**			
	0.22	0.66	0.16	0.50				0.20	0.79	0.91	0.84				0.14	0.22	0.60	0.62			
48	**6.72**	**5.44**		**1.36**	**2.86**			**4.48**	**0.90**		**0.76**	**1.70**			**4.70**	**28.42**		**1.43**	**0.21**		
	0.18	0.17		0.57	0.32			0.14	0.67		0.73	0.50			0.26	0.13		0.72	0.94		
60	**7.48**	**5.89**		**1.18**				**8.53**	**1.00**		**0.75**				**5.73**	**23.58**		**1.02**			
	0.15	0.16		0.61				0.08	0.65		0.75				0.22	0.07		0.83			
120	**8.71**	**5.96**		**1.24**	**3.05**		**2.90**	**10.79**	**0.65**		**0.57**	**1.80**		**1.42**	**8.56**	**39.97**		**2.21**	**1.54**		**12.00**
	0.14	0.22		0.56	0.24		0.28	0.08	0.75		0.78	0.42		0.53	0.12	0.02		0.42	0.52		0.05
180	**6.25**	**1.33**	**1.59**	**1.83**		**3.30**	**3.97**	**7.70**	**1.87**	**0.07**	**0.27**		**3.02**	**1.45**	**7.86**	**35.03**	**4.61**	**2.01**		**1.97**	**3.00**
	0.25	0.52	0.44	0.41		0.22	0.18	0.20	0.67	0.97	0.89		0.53	0.54	0.12	0.03	0.33	0.44		0.42	0.27

Panel B. Model Selection Rule: AIC

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***
3	**35.38**							**7.89**							**13.63**						
	0.21							0.30							0.07						
9	**10.85**	**5.02**						**9.30**	**2.64**						**2.14**	**3.89**					
	0.43	0.43						0.33	0.42						0.51	0.35					
12	**7.05**	**5.02**						**0.93**	**0.79**						**2.10**	**2.57**					
	0.61	0.43						0.71	0.74						0.51	0.46					
24	**4.97**	**1.80**		**8.33**				**2.81**	**0.37**		**3.74**				**4.97**	**10.14**		**3.07**			
	0.52	0.65		0.26				0.36	0.87		0.37				0.70	0.58		0.61			
36	**6.06**	**4.77**	**6.69**	**1.41**				**4.39**	**0.89**	**0.08**	**0.29**				**121.6**	**19.84**	**2.62**	**2.10**			
	0.46	0.44	0.37	0.68				0.21	0.71	0.97	0.90				0.10	0.29	0.68	0.71			
48	**6.91**	**5.54**		**1.17**	**2.60**			**0.21**	**1.24**		**0.45**	**1.38**			**156.4**	**29.38**		**0.94**	**0.44**		
	0.43	0.40		0.73	0.67			0.08	0.62		0.85	0.71			0.10	0.17		0.73	0.85		
60	**7.74**	**6.09**		**1.00**				**0.18**	**1.43**		**0.54**				**187.4**	**38.42**		**1.36**			
	0.40	0.38		0.76				0.07	0.58		0.82				0.08	0.11		0.63			
120	**9.00**	**6.14**		**1.11**	**2.74**		**6.94**	**11.25**	**0.90**		**3.63**	**2.35**		**4.86**	**62.98**	**39.97**		**2.21**	**1.54**		**3.83**
	0.32	0.39		0.71	0.48		0.56	0.11	0.70		0.51	0.73		0.52	0.02	0.04		0.47	0.57		0.29
180	**6.44**	**3.17**	**1.90**	**2.03**		**5.66**	**41.57**	**8.12**	**0.34**	**0.27**	**0.57**		**3.45**	**4.49**	**46.65**	**35.03**	**4.61**	**2.01**		**1.97**	**3.00**
	0.48	0.66	0.64	0.61		0.50	0.29	0.27	0.88	0.98	0.95		0.67	0.59	0.03	0.04	0.43	0.51		0.50	0.36

Note: Table provides W test statistics and empirical p values associated with the null of the ET from the endogenous lag bootstrap procedure.

In Tables 7-9 I report results from the conventional *t*-, the implied regression and variance ratio tests. The first two are test statistics for the slope coefficient of (3), while the third relates to the variance ratio between the theoretical and actual spreads. In each case, either a slope or a variance ratio statistic, both os which should be unity under the ET, and two empirical *p*-values associated with the null are presented. First *p*-value is based on the slope or the variance ratio statistic itself and the second one relies on their studentized statistics.

Table 7. Conventional t test results

Panel A. Model Selection Rule: SIC+Autocorrelation Test

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***
3	**0.51**							**0.61**							**0.68**						
	0.01							0.33							0.05						
	0.00							0.28							0.04						
9	**0.63**	**0.54**						**0.86**	**0.67**						**0.82**	**0.76**					
	0.03	0.00						0.45	0.14						0.33	0.14					
	0.07	0.02						0.51	0.19						0.28	0.21					
12	**0.65**	**0.60**						**0.83**	**0.73**						**0.79**	**0.76**					
	0.07	0.03						0.38	0.28						0.30	0.27					
	0.12	0.07						0.43	0.34						0.21	0.26					
24	**0.69**	**0.65**		**0.40**				**0.84**	**0.76**		**0.38**				**0.63**	**0.62**		**0.33**			
	0.18	0.15		0.13				0.49	0.44		0.43				0.33	0.16		0.29			
	0.16	0.14		0.11				0.52	0.44		0.34				0.21	0.11		0.17			
36	**0.79**	**0.77**	**0.58**	**0.51**				**0.86**	**0.80**	**0.44**	**0.25**				**0.58**	**0.57**	**0.44**	**0.36**			
	0.38	0.42	0.27	0.26				0.57	0.52	0.42	0.37				0.18	0.11	0.35	0.35			
	0.27	0.24	0.17	0.13				0.60	0.49	0.44	0.41				0.03	0.04	0.12	0.13			
48	**0.89**	**0.88**		**0.68**	**0.51**			**0.91**	**0.89**		**0.45**	**-0.08**			**0.61**	**0.59**		**0.44**	**0.11**		
	0.61	0.63		0.51	0.47			0.68	0.65		0.57	0.48			0.66	0.12		0.48	0.39		
	0.55	0.51		0.36	0.23			0.61	0.56		0.51	0.41			0.02	0.00		0.08	0.17		
60	**0.95**	**0.96**		**0.81**				**0.90**	**0.97**		**0.68**				**0.61**	**0.59**		**0.45**			
	0.78	0.76		0.66				0.63	0.80		0.83				0.80	0.34		0.46			
	0.77	0.74		0.60				0.58	0.78		0.64				0.12	0.06		0.03			
120	**1.13**	**1.11**		**1.06**	**1.03**		**0.27**					**1.53**		**0.24**					**1.62**		**-0.36**
	0.83	0.94		0.95	0.97		0.33					0.37		0.51					0.55		0.23
	0.61	0.71		0.91	0.95		0.15					n.a.		n.a.					n.a.		n.a.
180	**0.95**	**0.96**	**0.95**	**1.00**		**1.02**	**0.58**														
	0.56	0.83	0.73	0.85		0.93	0.55														
	n.a.	n.a.	n.a.	n.a.		0.92	0.21														

Panel B. Model Selection Rule: AIC

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***
3	**0.51**							**0.61**							**0.68**						
	0.00							0.28							0.05						
	0.00							0.25							0.04						
9	**0.63**	**0.60**						**0.86**	**0.67**						**0.82**	**0.76**					
	0.04	0.03						0.43	0.14						0.34	0.17					
	0.06	0.08						0.48	0.18						0.35	0.26					
12	**0.65**	**0.60**						**0.83**	**0.73**						**0.79**	**0.76**					
	0.07	0.03						0.48	0.26						0.38	0.31					
	0.11	0.06						0.56	0.33						0.33	0.34					
24	**0.69**	**0.65**		**0.40**				**0.84**	**0.76**		**0.38**				**0.63**	**0.62**		**0.33**			
	0.17	0.14		0.10				0.55	0.45		0.38				0.24	0.15		0.29			
	0.16	0.14		0.09				0.59	0.43		0.31				0.13	0.11		0.18			
36	**0.79**	**0.77**	**0.58**	**0.51**				**0.86**	**0.80**	**0.44**	**0.25**				**0.58**	**0.57**	**0.44**	**0.36**			
	0.40	0.38	0.24	0.26				0.56	0.53	0.41	0.39				0.08	0.12	0.35	0.34			
	0.28	0.21	0.14	0.15				0.59	0.49	0.43	0.43				0.02	0.04	0.13	0.14			
48	**0.89**	**0.88**		**0.68**	**0.51**			**0.91**	**0.89**		**0.45**	**-0.08**			**0.61**	**0.59**		**0.44**	**0.11**		
	0.62	0.62		0.49	0.46			0.68	0.65		0.55	0.46			0.11	0.13		0.58	0.44		
	0.56	0.50		0.34	0.23			0.62	0.54		0.50	0.40			0.00	0.00		0.12	0.20		
60	**0.95**	**0.96**		**0.81**				**0.90**	**0.97**		**0.68**				**0.61**	**0.59**		**0.45**			
	0.77	0.76		0.68				0.79	0.82		0.81				0.14	0.15		0.61			
	0.76	0.74		0.60				0.75	0.80		0.60				0.02	0.03		0.05			
120	**1.13**	**1.11**		**1.06**	**1.03**		**0.27**					**1.53**		**0.24**					**1.62**		**-0.36**
	0.82	0.95		0.94	0.98		0.34					0.71		0.46					0.55		0.27
	0.61	0.72		0.91	0.94		0.17					n.a.		n.a.					n.a.		n.a.
180	**0.95**	**0.96**	**0.95**	**1.00**		**1.02**	**0.58**														
	0.57	0.64	0.73	0.83		0.96	0.60														
	n.a.	n.a.	n.a.	n.a.		0.97	0.25														

Note: Table provides slope coefficients of (3) and empirical *p*-values associated with the null of the ET from the endogenous lag bootstrap procedure based on the slope coefficent itself and its statndardized statistics *t1*.

Table 8. Implied t test results

Panel A. Model Selection Rule: SIC+Autocorrelation Test

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***
3	**0.51**							**0.56**							**0.69**						
	0.01							0.21							0.04						
	0.01							0.19							0.04						
9	**0.60**	**0.60**						**0.75**	**0.69**						**0.86**	**0.79**					
	0.02	0.01						0.25	0.15						0.35	0.13					
	0.01	0.01						0.36	0.14						0.39	0.13					
12	**0.66**	**0.66**						**0.74**	**0.79**						**0.82**	**0.80**					
	0.06	0.04						0.26	0.37						0.32	0.25					
	0.05	0.03						0.36	0.37						0.34	0.19					
24	**0.63**	**0.74**		**0.56**				**0.95**	**1.01**		**0.97**				**0.87**	**0.63**		**0.70**			
	0.06	0.24		0.25				0.81	0.92		0.99				0.52	0.13		0.60			
$	0.06	0.18		0.20				0.86	0.91		0.99				0.44	0.07		0.43			
36	**0.64**	**0.78**	**0.45**	**0.59**				**1.24**	**1.16**	**1.16**	**1.17**				**0.64**	**0.63**	**0.78**	**0.78**			
	0.10	0.39	0.11	0.32				0.38	0.60	0.77	0.82				0.17	0.14	0.70	0.72			
	0.09	0.34	0.14	0.29				0.47	0.62	0.81	0.85				0.05	0.09	0.57	0.58			
48	**0.65**	**0.66**		**0.64**	**0.66**			**1.26**	**1.24**		**1.29**	**1.31**			**0.90**	**0.65**		**0.83**	**0.78**		
	0.13	0.24		0.42	0.55			0.40	0.53		0.70	0.71			0.74	0.17		0.81	0.74		
	0.11	0.19		0.40	0.54			0.49	0.55		0.76	0.80			0.65	0.13		0.71	0.72		
60	**0.66**	**0.67**		**0.66**				**0.94**	**1.27**		**1.39**				**0.89**	**0.79**		**0.82**			
	0.15	0.24		0.47				0.81	0.50		0.61				0.70	0.50		0.72			
	0.12	0.20		0.46				0.85	0.52		0.67				0.61	0.36		0.65			
120	**0.65**	**0.67**		**0.61**	**0.63**		**0.50**	**0.84**	**1.15**		**1.24**	**1.17**		**0.65**	**0.81**	**0.84**		**0.88**	**0.83**		**0.62**
	0.08	0.19		0.36	0.39		0.16	0.39	0.60		0.62	0.80		0.31	0.76	0.72		0.98	0.87		0.64
	0.08	0.19		0.37	0.40		0.17	0.48	0.65		0.71	0.86		0.40	0.54	0.60		0.89	0.84		0.72
180	**0.65**	**0.70**	**0.56**	**0.55**		**0.60**	**0.53**	**0.89**	**0.96**	**0.96**	**1.00**		**0.84**	**0.71**	**0.85**	**0.86**	**0.96**	**0.91**		**0.78**	**0.61**
	0.09	0.29	0.23	0.24		0.18	0.13	0.47	0.74	0.89	0.96		0.57	0.28	0.86	0.80	0.91	0.96		0.75	0.57
	0.08	0.28	0.21	0.22		0.15	0.08	0.54	0.77	0.91	0.96		0.63	0.33	0.74	0.68	0.90	0.99		0.83	0.73

Panel B. Model Selection Rule: AIC

	Jan 1979- May 2004							*Jan 1979- Jan 1989*							*May 1994- May 2004*						
	1	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***	***1***	***3***	***9***	***12***	***24***	***36***	***60***
3	**0.49**							**0.61**							**0.67**						
	0.00							0.28							0.03						
	0.00							0.36							0.02						
9	**0.61**	**0.69**						**0.78**	**0.72**						**0.82**	**0.78**					
	0.02	0.07						0.28	0.16						0.25	0.17					
	0.02	0.05						0.35	0.13						0.30	0.18					
12	**0.60**	**0.69**						**1.05**	**0.83**						**0.82**	**0.81**					
	0.03	0.06						0.81	0.42						0.35	0.37					
	0.03	0.04						0.82	0.41						0.38	0.35					
24	**0.65**	**0.77**		**0.36**				**1.13**	**1.02**		**0.57**				**0.77**	**0.64**		**0.70**			
	0.08	0.26		0.05				0.57	0.93		0.40				0.43	0.14		0.59			
	0.07	0.20		0.05				0.59	0.93		0.55				0.24	0.06		0.42			
36	**0.66**	**0.67**	**0.47**	**0.66**				**1.20**	**1.13**	**1.09**	**1.11**				**0.53**	**0.64**	**0.78**	**0.78**			
	0.11	0.15	0.11	0.36				0.43	0.65	0.84	0.81				0.06	0.15	0.69	0.71			
	0.09	0.12	0.11	0.33				0.47	0.66	0.86	0.84				0.15	0.08	0.56	0.58			
48	**0.67**	**0.69**		**0.71**	**0.68**			**1.22**	**1.19**		**1.19**	**1.04**			**0.53**	**0.65**		**0.86**	**0.80**		
	0.14	0.20		0.47	0.60			0.38	0.55		0.70	0.79			0.07	0.16		0.94	0.87		
	0.11	0.16		0.44	0.56			0.39	0.55		0.77	0.80			0.20	0.13		0.78	0.73		
60	**0.68**	**0.70**		**0.75**				**1.22**	**1.20**		**1.27**				**0.55**	**0.67**		**0.85**			
	0.15	0.22		0.55				0.39	0.52		0.60				0.05	0.19		0.93			
	0.12	0.18		0.52				0.38	0.51		0.67				0.27	0.16		0.78			
120	**0.66**	**0.69**		**0.75**	**0.73**		**0.45**	**0.85**	**1.12**		**0.95**	**0.94**		**0.55**	**0.81**	**0.84**		**0.88**	**0.83**		**0.63**
	0.09	0.13		0.44	0.48		0.24	0.33	0.65		0.69	0.77		0.32	0.42	0.73		0.98	0.88		0.68
	0.09	0.14		0.45	0.48		0.23	0.41	0.67		0.72	0.81		0.43	0.35	0.62		0.90	0.84		0.78
180	**0.66**	**0.70**	**0.67**	**0.67**		**0.63**	**0.41**	**0.90**	**1.04**	**1.00**	**1.02**		**0.87**	**0.75**	**0.84**	**0.86**	**0.96**	**0.91**		**0.78**	**0.61**
	0.10	0.14	0.25	0.25		0.28	0.10	0.44	0.84	0.90	0.96		0.61	0.47	0.51	0.79	0.94	0.95		0.77	0.58
	0.09	0.13	0.22	0.20		0.22	0.07	0.52	0.86	0.90	0.95		0.69	0.50	0.43	0.71	0.93	0.97		0.86	0.74

Note: Table provides slope coefficients of (3) implied by the VAR, as given in (10) and empirical *p*-values associated with the null of the ET from the endogenous lag bootstrap procedure based on the slope coefficent itself and its statndardized statistics *t2*.

Table 9. Variance Ratio Test Results

Panel A. Model Selection Rule: SIC+Autocorrelation Test

	Jan 1979- May 2004							Jan 1979- Jan 1989							May 1994- May 2004						
	1	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**
3	**0.27**							**0.31**							**0.52**						
	0.01							0.15							0.05						
	0.01							0.12							0.05						
9	**0.39**	**0.36**						**0.68**	**0.48**						**0.75**	**0.64**					
	0.02	0.01						0.34	0.14						0.36	0.12					
	0.01	0.01						0.42	0.13						0.40	0.13					
12	**0.44**	**0.44**						**0.64**	**0.63**						**0.69**	**0.64**					
	0.05	0.04						0.31	0.36						0.33	0.24					
	0.05	0.03						0.41	0.35						0.35	0.18					
24	**0.41**	**0.55**		**0.32**				**0.91**	**1.01**		**0.94**				**0.75**	**0.41**		**0.50**			
	0.06	0.24		0.25				0.81	0.92		0.98				0.52	0.12		0.58			
	0.06	0.17		0.17				0.86	0.92		0.98				0.43	0.03		0.30			
36	**0.41**	**0.61**	**0.21**	**0.35**				**1.55**	**1.35**	**1.35**	**1.36**				**0.43**	**0.41**	**0.62**	**0.61**			
	0.10	0.39	0.11	0.31				0.38	0.60	0.78	0.83				0.17	0.13	0.68	0.70			
	0.08	0.33	0.15	0.27				0.46	0.62	0.81	0.86				0.01	0.06	0.51	0.52			
48	**0.43**	**0.44**		**0.40**	**0.44**			**1.58**	**1.54**		**1.68**	**1.75**			**0.82**	**0.44**		**0.69**	**0.61**		
	0.13	0.24		0.42	0.54			0.40	0.53		0.71	0.71			0.74	0.15		0.80	0.69		
	0.10	0.18		0.39	0.52			0.48	0.55		0.76	0.80			0.64	0.10		0.68	0.62		
60	**0.44**	**0.45**		**0.44**				**0.90**	**1.61**		**1.95**				**0.79**	**0.64**		**0.68**			
	0.15	0.24		0.47				0.82	0.50		0.63				0.69	0.49		0.70			
	0.11	0.18		0.45				0.86	0.52		0.69				0.60	0.31		0.59			
120	**0.43**	**0.45**		**0.38**	**0.40**		**0.25**	**0.71**	**1.33**		**1.55**	**1.37**		**0.43**	**0.65**	**0.72**		**0.78**	**0.70**		**0.55**
	0.08	0.19		0.36	0.39		0.16	0.39	0.60		0.62	0.82		0.30	0.76	0.73		0.97	0.87		0.72
	0.08	0.18		0.36	0.40		0.16	0.50	0.65		0.71	0.87		0.40	0.45	0.57		0.87	0.83		0.81
180	**0.42**	**0.49**	**0.31**	**0.30**		**0.36**	**0.29**	**0.81**	**0.92**	**0.92**	**0.99**		**0.71**	**0.51**	**0.72**	**0.75**	**0.93**	**0.84**		**0.61**	**0.37**
	0.09	0.29	0.23	0.23		0.18	0.13	0.47	0.73	0.88	0.95		0.55	0.27	0.86	0.80	0.92	0.97		0.75	0.55
	0.08	0.27	0.19	0.19		0.13	0.07	0.54	0.77	0.89	0.95		0.61	0.32	0.70	0.63	0.91	0.99		0.82	0.72

Panel B. Model Selection Rule: AIC

	Jan 1979- May 2004							Jan 1979- Jan 1989							May 1994- May 2004						
	1	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**	**1**	**3**	**9**	**12**	**24**	**36**	**60**
3	**0.34**							**0.40**							**0.49**						
	0.00							0.23							0.04						
	0.00							0.31							0.02						
9	**0.40**	**0.47**						**0.72**	**0.52**						**0.67**	**0.61**					
	0.02	0.05						0.34	0.14						0.24	0.16					
	0.02	0.03						0.40	0.12						0.30	0.17					
12	**0.39**	**0.47**						**1.10**	**0.68**						**0.67**	**0.66**					
	0.02	0.05						0.83	0.40						0.34	0.36					
	0.02	0.03						0.84	0.39						0.37	0.34					
24	**0.43**	**0.60**		**0.14**				**1.28**	**1.04**		**0.39**				**0.60**	**0.42**		**0.50**			
	0.07	0.25		0.04				0.57	0.94		0.41				0.39	0.13		0.55			
	0.06	0.18		0.05				0.59	0.94		0.58				0.17	0.03		0.30			
36	**0.44**	**0.45**	**0.23**	**0.44**				**1.45**	**1.29**	**1.19**	**1.22**				**0.33**	**0.42**	**0.62**	**0.61**			
	0.11	0.14	0.10	0.35				0.43	0.66	0.85	0.82				0.07	0.13	0.66	0.68			
	0.08	0.10	0.10	0.30				0.47	0.67	0.88	0.86				0.19	0.05	0.50	0.52			
48	**0.45**	**0.48**		**0.51**	**0.47**			**1.50**	**1.41**		**1.42**	**1.11**			**0.32**	**0.44**		**0.74**	**0.64**		
	0.13	0.19		0.46	0.57			0.38	0.55		0.72	0.84			0.07	0.15		0.92	0.84		
	0.10	0.14		0.42	0.50			0.39	0.55		0.78	0.85			0.25	0.10		0.73	0.67		
60	**0.46**	**0.50**		**0.56**				**1.48**	**1.45**		**1.61**				**0.34**	**0.47**		**0.73**			
	0.15	0.21		0.54				0.39	0.52		0.61				0.05	0.18		0.92			
	0.11	0.16		0.50				0.38	0.52		0.68				0.35	0.14		0.73			
120	**0.44**	**0.48**		**0.56**	**0.54**		**0.21**	**0.73**	**1.25**		**0.90**	**0.88**		**0.30**	**0.66**	**0.72**		**0.78**	**0.70**		**0.39**
	0.09	0.13		0.44	0.47		0.18	0.33	0.65		0.67	0.75		0.25	0.42	0.73		0.98	0.87		0.64
	0.09	0.13		0.44	0.47		0.20	0.42	0.68		0.71	0.79		0.40	0.33	0.61		0.89	0.83		0.76
180	**0.44**	**0.48**	**0.44**	**0.44**		**0.40**	**0.18**	**0.82**	**1.07**	**1.00**	**1.05**		**0.76**	**0.56**	**0.71**	**0.75**	**0.93**	**0.84**		**0.61**	**0.37**
	0.10	0.13	0.25	0.25		0.26	0.09	0.45	0.84	0.88	0.94		0.58	0.40	0.51	0.79	0.95	0.95		0.76	0.55
	0.08	0.12	0.21	0.20		0.18	0.06	0.52	0.86	0.88	0.93		0.64	0.44	0.41	0.69	0.95	0.98		0.85	0.74

Note: Table provides variance ratio between the theoretical andactual spreads implied by the VAR, as given in (10) and empirical *p*-values associated with the null of the ET from the endogenous lag bootstrap procedure based on the variance ratio itself and its statndardized statistics *t3*.

For the conventional t test, we often have insufficient observations either to estimate the slope coefficient or to correct for the implied MA(*n-m*) error, and those cases are indicated with n.a. Unlike the results obtained with *W, DM* and *LM*, we find the rejections of the null not only in the second sub-sample but also in the whole sample. All tests reject at the short end, though more often in the whole sample, irrespective of the procedure used to select the lag order.

Finally, (non)rejection decision does depend on whether one bootstraps the slope coefficient and the variance ratio statistics themselves (Sarno, Thornton and Valente, 2006 and Bekaert, Wei and Xing, 2006) or their studentized versions (recommended in Bataa *et al.* (2006a). For example, see matutity pairs 3&36, 3&12 and 3&24 from Tables 7, 8 and 9, respectively, in the second sub-sample with AIC model selection method. In these cases the theory is rejected with the studentized statistics but not with the bootstrapped slope or variance ratio statistics.

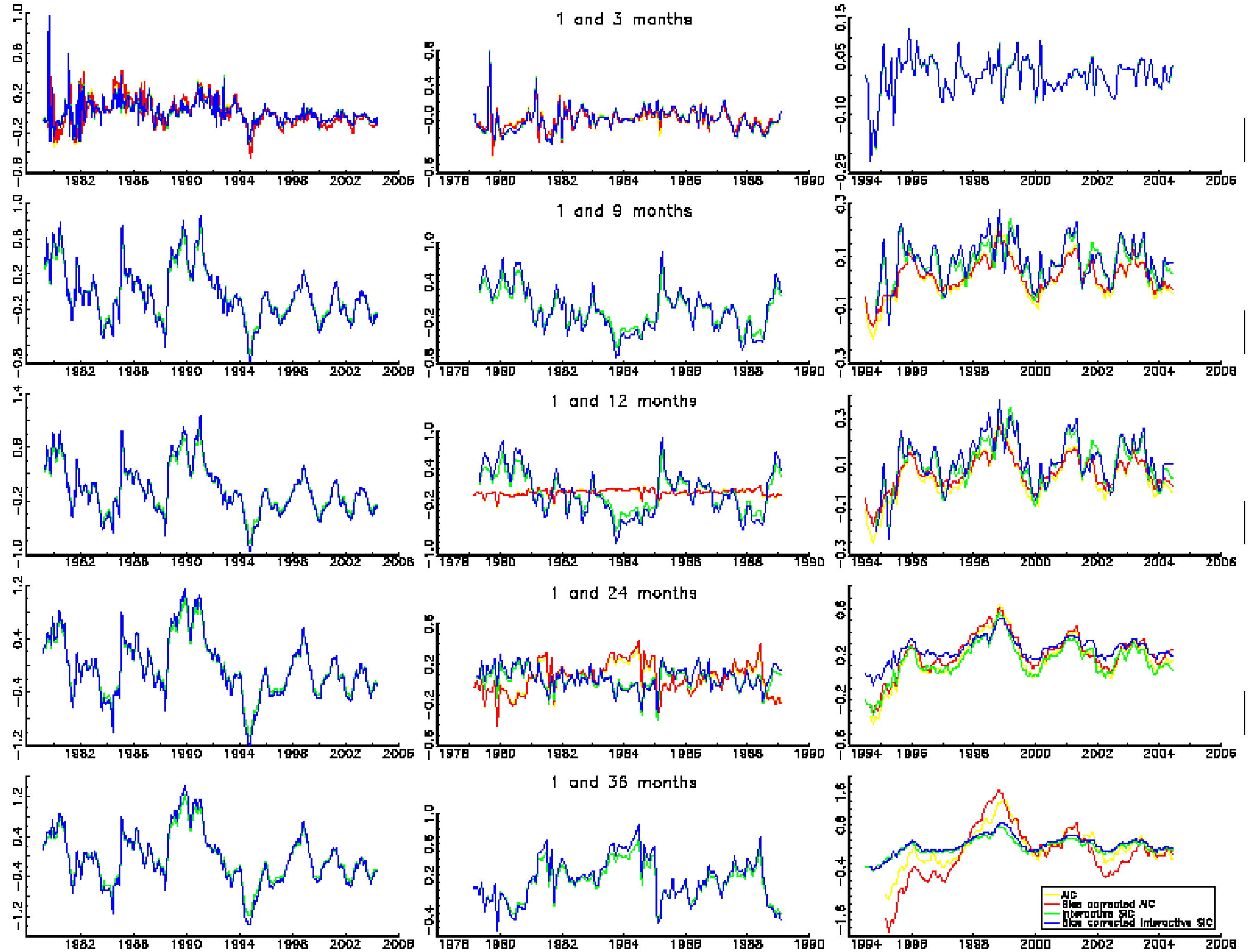
Section 5. Conclusion

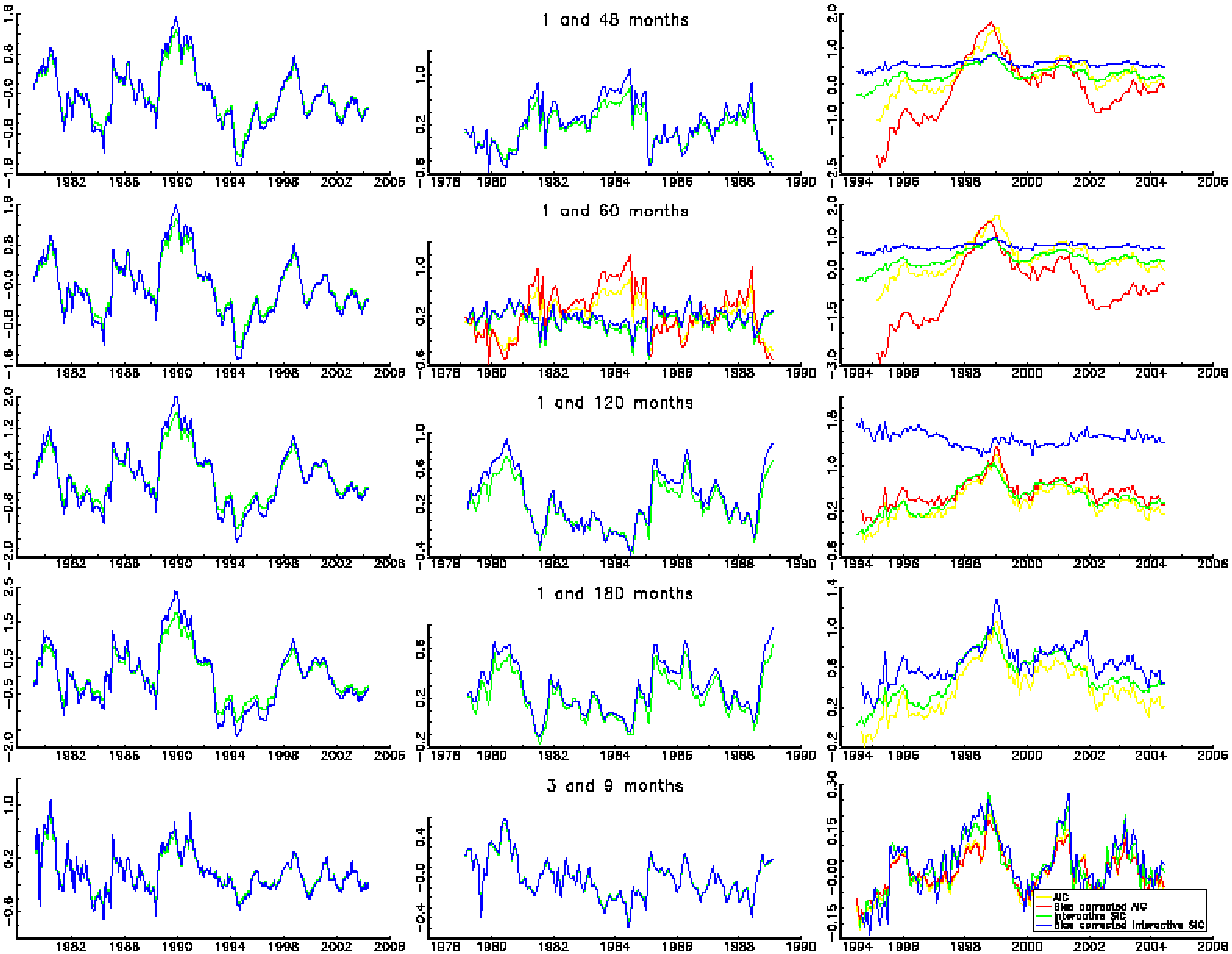
Since the ET theory is of fundamental importance in understanding the transmission mechanism of monetary policy and serves as a theoretical basis for policy involvement in financial markets, the theory has been studied and tested by not only academics but also policy makers. The purpose of this paper is to test the theory for UK data across multiple conventional maturity pairs using a recently developed methodology and to compare the results with those of previous studies.

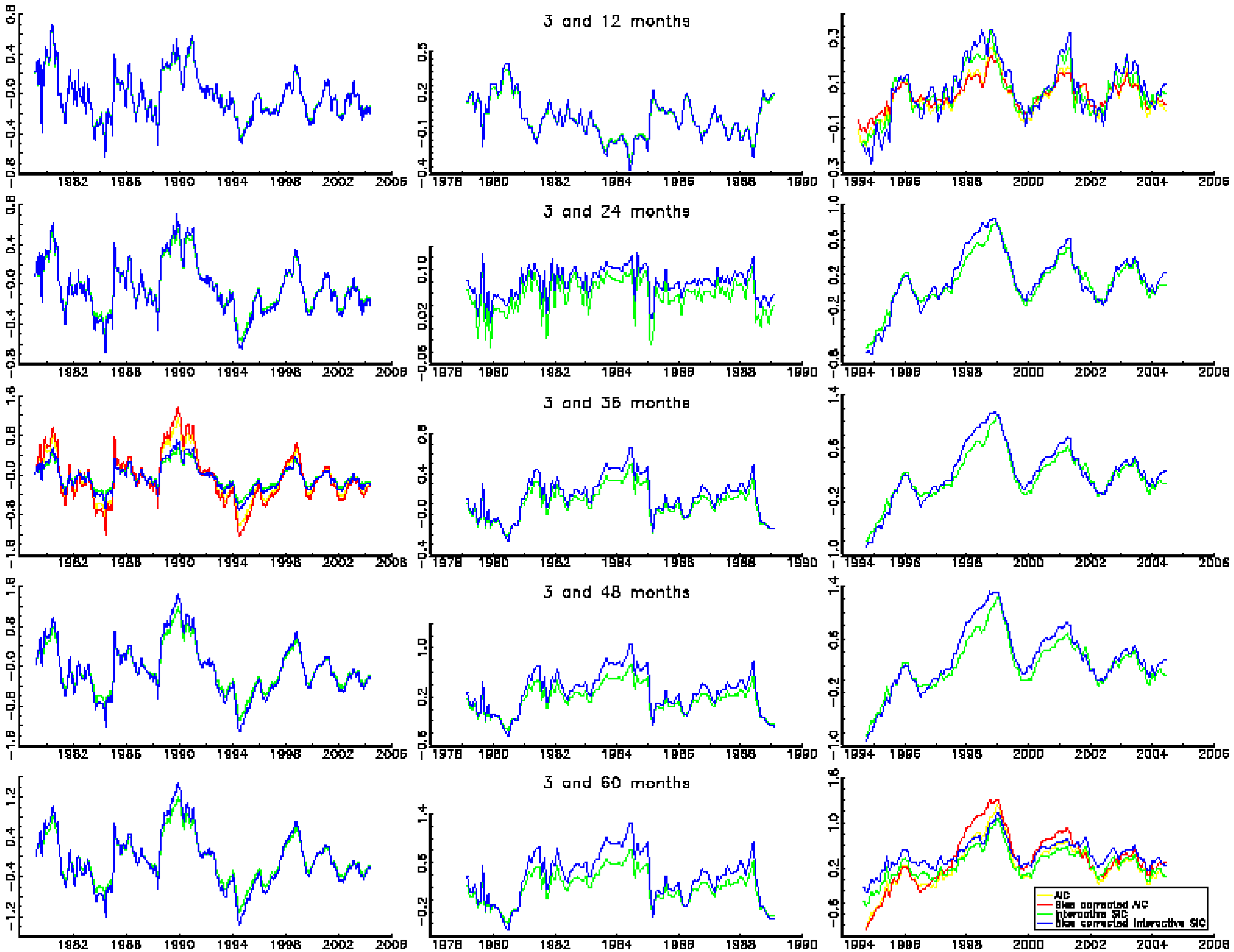
Bekaert and Hodrick (2001) apply their Lagrange Multiplier, Distance Metric tests, along with Campbell and Shiller's (1987) Wald test, to the 1 and 12 months maturity pair in the UK, US, and German term structure data to find no evidence against the ET for the UK. The current paper extends this analysis not only by employing recent and extensive UK term structure data but also by using its extensions in Bataa *et al.* (2006a,b). The tests applied are Lagrange Multiplier, Distance Metric, Wald, implied regression and variance ratio tests and for comparative purpose we also use the finite sample version of the conventional regression test.

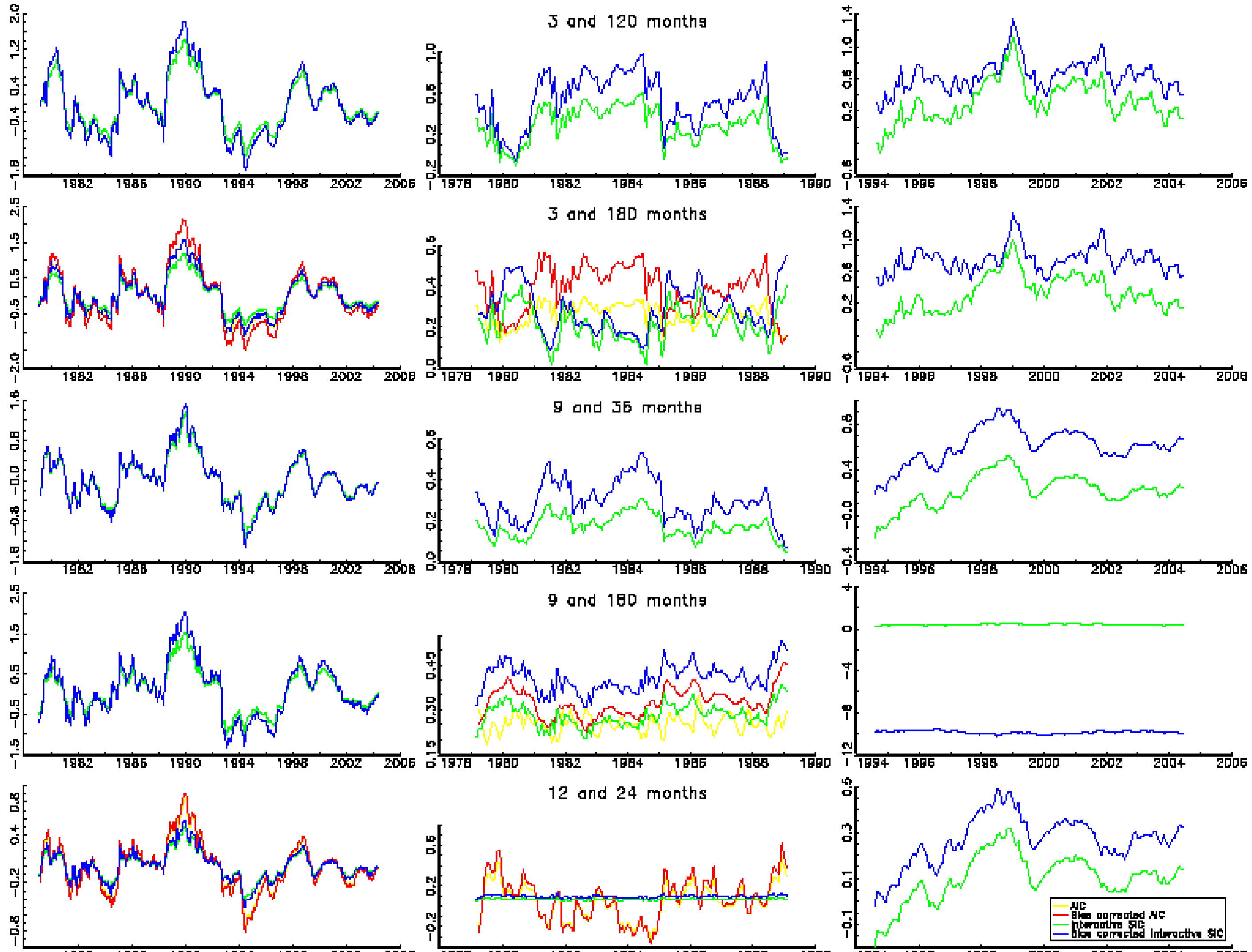
Although different tests yield different conclusions about the validity of the ET in some cases, there are some maturity pairs and time periods for which all methods seem to agree. None of the methods employed favours the theory at the short end of the maturity spectrum, while they are all surprisingly positive about the ET at the longest end. This is consistent with majority of the previous studies. Moreover, none of the tests reject the theory in the first sub-sample which ends before the introduction of inflation targeting in 1992.

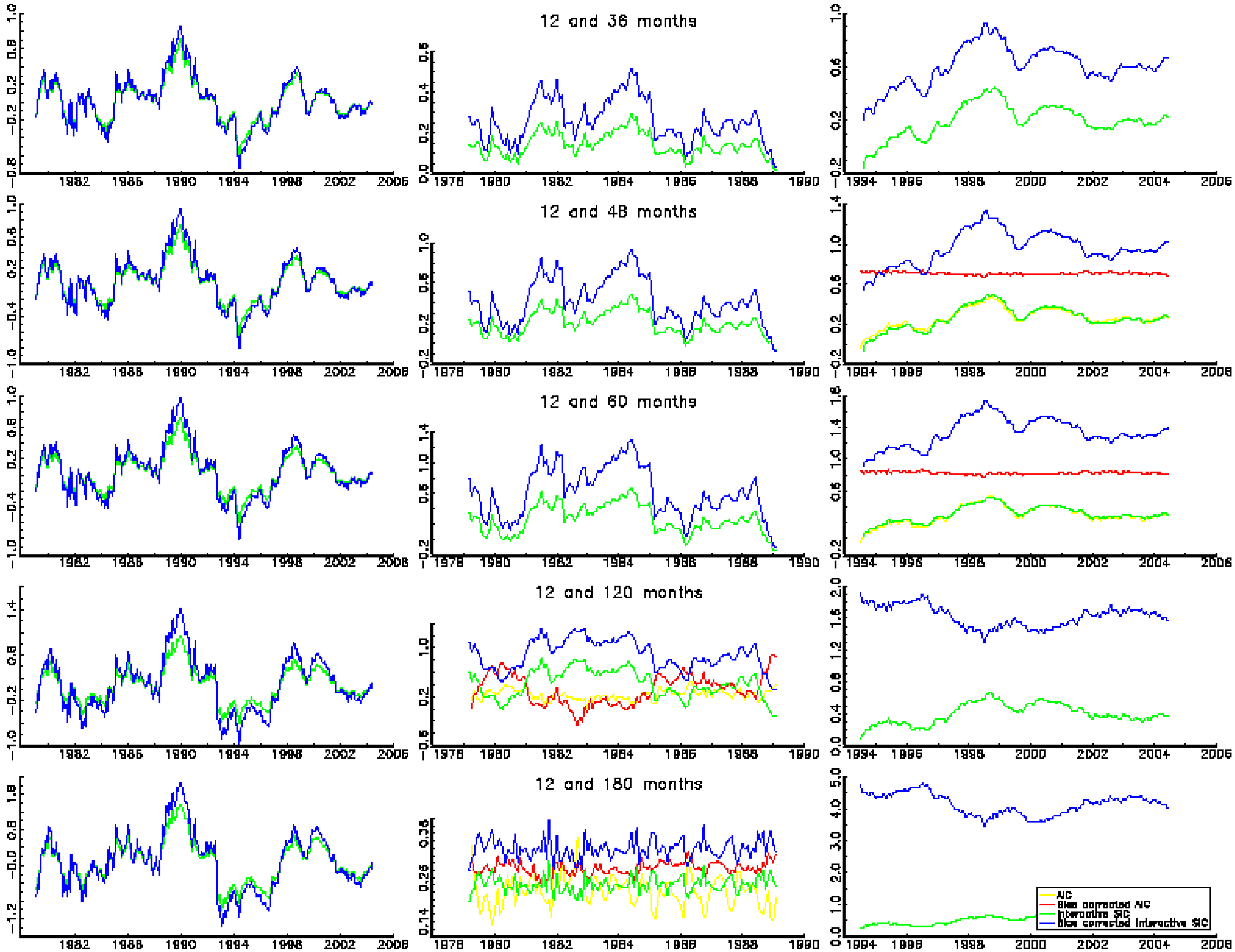
Appendix A. Discrepancy between the theoretical and the actual spreads

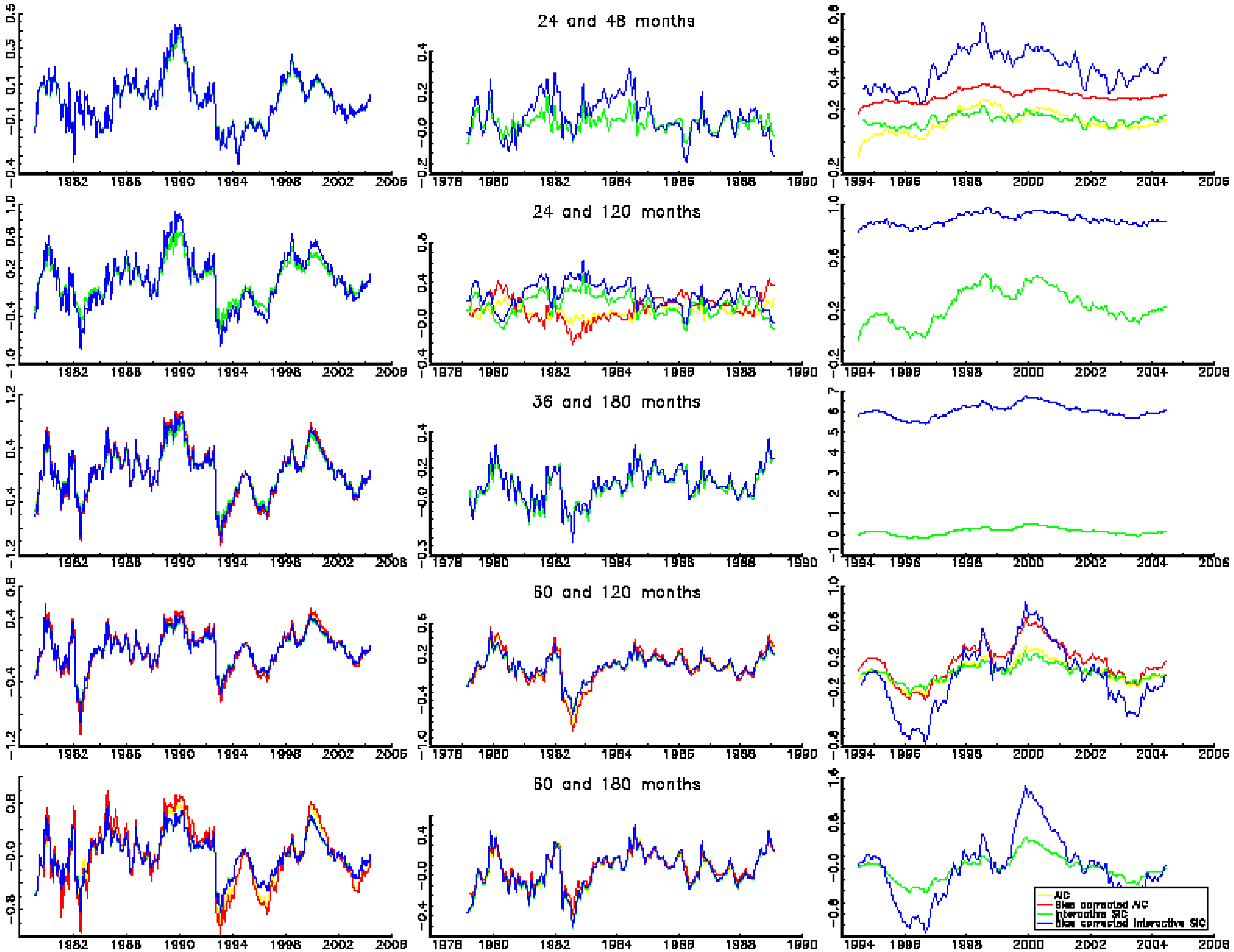



1 and 48 months
1 and 60 months
1 and 120 months
1 and 180 months
3 and 9 months
AIC
Bias corrected AIC
Interactive SIC
Bias corrected Interactive SIC


3 and 12 months
3 and 24 months
3 and 36 months
3 and 48 months
3 and 60 months
AIC
Bias corrected AIC
Interactive SIC
Bias corrected Interactive SIC


3 and 120 months
3 and 180 months
9 and 36 months
9 and 180 months
12 and 24 months
AIC


12 and 36 months
12 and 48 months
12 and 60 months
12 and 120 months
12 and 180 months
AIC
Bias corrected AIC
Interactive SIC
Bias corrected Interactive SIC


24 and 48 months
24 and 120 months
36 and 180 months
60 and 120 months
60 and 180 months
AIC
Bias corrected AIC
Interactive SIC
Bias corrected Interactive SIC

References

Anderson, N. and Sleath, J., 2001. "New Estimates of the UK Real and Nominal Yield Curves", Working Paper No 126. The Bank of England,

Andrews, D.W.K. 2000. "Inconsistency of the Bootstrap when a Parameter Is on the Boundary of the Parameter Space", *Econometrica* 68(2), 399- 405,

Attfield, C.L.F. and Duck, N.W. 1982. "Tests of the Rational Expectations Model of the Term Structure of UK Interest Rates", *Economics Letters* 10, 115-121,

Bataa, E., Kim, D.H. and Osborn, D.R. 2006a. "Does Spread Really Predict Future Short Rate? Explaining Empirical Anomalies in the Expectations Theory", Economics Discussion Paper Series, EDP 06?, University of Manchester,

________________________________ 2006b. "Extectations Hypothesis Tests in the Presence of Model Uncertainty", Economics Discussion Paper Series, EDP 0611, University of Manchester,

Bataa, E. 2003. "An Analysis of Term Strcuture of Interest Rates: The Expectations Hypothesis Theory in the UK", unpublished MSc thesis, University of Manchester,

Bekaert, G. and Hodrick, R.J. 2001. "Expectations Hypotheses Tests", *Journal of Finance* 56(4), 1357-1394,

Bekaert, G., Hodrick, R.J. and Marshall, D.A. 1997. "On Biases in Tests of the Expectations Hypothesis of the Term Structure of Interest Rates", *Journal of Financial Economics* 44, 309-348,

____, 2001. "Peso Problem Explanations for Term Structure Anomalies", *Journal of Monetary Economics* 48, 241-270,

Bekaert, G., Wei, M. and Xing, Y. 2006. "Uncovered Interest Rate Parity and the Term Structure", *Journal of International Money and Finance,* forthcoming,

Berkowitz, J. and Kilian, L. 2000. "Recent Developments in Bootstrapping Time Series", *Econometric Reviews* 19(1), with comment 1-54,

Campbell, J.Y. and Shiller, R.J. 1987. "Cointegration and Tests of Present Value Models", *Journal of Political Economy* 95, 1062-1088,

Cuthbertson, K. 1996. "The Expectations Hypothesis of the Term Structure: The UK Interbank Market", *Economic Journal*, 578- 592,

Cuthbertson, K., Hayes, S. and Nitzsche, D. 1996. "The Behaviour of Certificate of Deposit Rates in the UK", *Oxford Economic Papers* 48, 397-414,

Cuthbertson, K. and Nitzsche, D. 2003. "Long Rates, Risk Premia and the Over-Reaction Hypothesis", *Economic Modelling* 20, 417-435,

Driffil, J., Psaradakis, Z. and Sola, M. 1997. "A Reconciliation of Some Paradoxical Empirical Results on the Expectations Model of the Term Structure", *Oxford Bulletin of Economics and Statistics* 59(1), 29- 42,

Engle, R.F. and Granger, C.W.J. 1987. "Dynamic Specification with Equilibrium Constraints: Cointegration and Error Correction", *Econometrica* 55, 251-276, Hall, P. 1994. "Methodology and Theory for the Bootstrap", in Engle, R.F. and McFadden, D.L. eds. *Handbook of Econometrics* 4. Elsevier Science. Amsterdam, The Netherlands, 2342-2379,

Hardouvelis, G.A. 1994. "The Term Structure Spread and Future Changes in Long and Short Rates in the G7 Countries". *Journal of Monetary Economics* 33, 255-283,

Hayashi, F. 2000. *Econometrics*, Princeton University Press, New Jersey,

Horowitz, J.L. 2001. "The Bootstrap", in Heckman, J.S. & Leamer, E. eds. *Handbook of Econometrics* 5, North-Holland, Amsterdam, The Netherlands, 3159- 3228,

Hurn, A.S., Moody, T., and Muscatelli, A., 1995. "The Term Structure of Interest Rates in the London Interbank Market", *Oxford Economic Papers* 47, 418- 436,

Kilian, L. 1998. "Accounting for Lag Order Uncertainty in Autoregressions: The Endogenous Lag Order Bootstrap Algorithm", *Journal of Time Series Analysis* 19(5), 532- 548,

_______. 2001. "Impulse Response Analysis in Vector Autoregressions with Unknown Lag Order", *Journal of Forecasting* 20, 161-179,

MacDonald R. and Macmillan, P. 1994. "On the Expectations View of the Term Structure, Term Premia and Survey Based Expectations", *Economic Journal* 104, 1070- 1086,

MacDonald, R. and Speight, A. E. H. 1988. "The Term Structure of Interest Rates in the UK", *Bulletin of Economic Research* 40, 287-299,

Mankiw, N.G. and Miron, J.A. 1986. "The Changing Behavior of the Term Structure of Interest Rates", *Quarterly Journal of Economics* 101(2), 211-228,

Masorotto, G. 1990. "Bootstrapping Prediction Intervals for Autoregressions", *International Journal of Forecasting* 6, 229-239,

Mills, T.C. 1991. "The Term Structure of UK Interest Rates: Tests of the Expectations Hypothesis", *Applied Economics* 23, 599-606,

Roberds, W., Runkle, D. and Whiteman, C. H. 1996. "A Daily View of Yield Spreads and Short-term Interest Rate Movements", *Journal of Money, Credit and Banking* 28, 35-53,

Sarno, L., Thornton, D.L. and Valente, G. 2006. "The Empirical Failure of the Expectations Hypothesis of the Term Structure of Bond Yields", *Journal of Financial and Quantitative Analysis,* forthcoming,

Simon, D.P. 1990. "Expectations and the Treasury Bill-Federal Funds Rate over Recent Monetary Policy Regimes", *Journal of Finance* 45, 467-477,

Stine, R.A. 1987. "Estimating Properties of Autoregressive Forecasts", *Journal of the American Statistical Association* 82, 1072- 1078,

Taylor, M. P. 1992. "Modelling the Yield Curve", *Economic Journal* 102, 524-537,