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On the Predictive Power of the Malaysian T Bills Term Spread in Predicting Real Economic Activity

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ABSTRACT

The ability of financial market interest rates to predict real economic activity has gained considerable attention of economics and financial researchers. In this regard, the term spread, i.e. the difference between long term and short term yield is argued to be an effective indicator to predict economic cycle. We investigate this proposition for the Malaysian economy using the T bills discount rates. Our results of both, single and multi-equation system of vector autoregression (VAR), support the case for Malaysia. Current T bills spread is shown to be a significant indicator for annual output growth for up to six months ahead. We also show that information conveyed by the term spread is unique and not of those implied by the monetary policy. Our results also indicate that, the power of term spread is limited for the near term prediction and over the long run money dominates spread in predicting output.

ABSTRAK

Keupayaan kadar faedah pasaran kewangan untuk meramal aktiviti ekonomi benar telah mendapat perhatian penyelidik-penyelidik ekonomi dan kewangan. Sehubungan itu, jurang kematangan kadar faedah dipercayai mampu menjadi satu petunjuk yang berkesan dalam meramal kitaran ekonomi. Kajian ini mengkaji proposisi ini keatas ekonomi Malaysia dengan berlandaskan kadar diskaun bil perbendaharaan. Hasil analisa satu persamaan dan sistem persamaan berbilang vektor autoregrasi (VAR) menyokong kes ini bagi Malaysia. Jurang bil perbendaharaan semasa merupakan satu petunjuk yang signifikan bagi pertumbuhan keluaran tahunan bagi tempoh enam bulan yang akan datang. Kajian juga menunjukkan bahawa maklumat yang disalurkan oleh jurang kematangan ini adalah unik dan tidak dipengaruhi oleh polisi monetari. Keputusan kajian juga menunjukkan kuasa ramalan jurang kematangan hanya terhad bagi tempoh jangka pendek dan bagi tempoh jangka panjang keupayaan ramalan aggregat wang mengatasi keupayaan jurang kematangan.

INTRODUCTION

The use of financial market interest rates to predict economic activities has received considerable attention of economics and financial researchers. Interest rates reflect the opportunity cost of currency, thus, becoming a critical variable that determines the consumption path for economic agents. The consumption-based asset pricing models (e.g. Merton, 1973; Lucas, 1978; Breeden, 1979; Harvey, 1988) dictate that in an intertemporal resource allocation process economic agents maximized their lifetime consumption by investing the non-consumed resources in portfolios that yield future returns. In this regard, the price vector of financial assets (or equivalently the interest rates vector) becomes a crucial variable that determines an individual's lifetime consumption pattern. According to Lucas (1978, pp. 1431) ' ..one would expect a consumer's current consumption and portfolio decisions, c_t and z_{t+1} to depend on his beginning of period portfolio *(initial endowment)*, z_t, the prices he faces *(equivalently interest rates)*, p_t, and the relevant information he possesses on current and future states of the economy *(current and future economic condition)*, y_t.'[1] The term structure of interest rates shows the link between the yield to maturity and time to maturity of securities that differ only in the time to maturity, with all other factors held constant. Three classes of explanations have been provided to explain the underlying framework for the behaviour of the term spread; pure/unbiased expectation theory, segmented market theory and liquidity-premium theory. Theoretically, whether or not the spread carries information about future interest rate movement largely rely on the underlying theoretical framework that explains its behaviour. Both the expectation and segmented market theories represent the extreme ends of the belief that the movement of the spread and the liquidity-premium theory mediates between the two. The expectation framework validates a significant link between short and long yields while the segmented market approach rejects any link between the two. Thus, studies that investigate the predictive content of the term spread are in line with the expectation theory. The expectation theory first expressed by Irving Fisher (1896) and later developed further by Friedrich Lutz (1940), postulates that the *expected* yield on one-period investment is the same regardless of the maturity strategies of the investors. However, this is only true if there exists a complete certainty in the market when forward rates could be used to exactly forecast the future short term interest rates. Given this assumption, the yield on long term security is said to be equal to the average of short term yields that investors expect to prevail over the life of the long term security. Thus, the observed spot rates contain important information about the market expectation of the future interest rate movement. Meiselman (1962) developed and applied an error-learning model to term structure of interest rate and found evidence that is consistent with the pure expectation theory that forward rates represent an unbiased estimate of the expected future short term rates. Fama (1976) concludes that forward rates as implied by the term structure are good predictors of future spot rates and his result parallels the efficient market hypothesis which requires unbiasness in the forming of expectation. A second theory of term structure, the liquidity-premium theory states that given an uncertain world, the term structure is influenced not only by investors'expectations of the interest rates movement but also by investors' demand of term premiums for holding longer term securities. Therefore, this implies that forward rates would be a *biased* estimate of future interest rates. In other words, the amount of risk or liquidity premium would now be embodied into the forward rates (see Stiglitz, 1970; Robert, 1980). Given the presence of term or liquidity premium, if a positive bias does exist, investors holding long term security will receive a higher expected return than those investors holding short term security with the option of reinvesting the short term security at each maturity.[2] The third theory of term structure, the segmented market theory rejects the relationship between short and long term yields and states that it is the interaction of supply and demand in the market which is segmented by the maturity preferences of the borrowers and lenders that determine the yield of the security. This theory implies that due to institutional and regulatory factors, borrowers and lenders do not deviate from their rigid maturity preferences regardless of the attractiveness of the yields of securities in other maturity segments. One of the first proponents of the segmented market theory of term structure of interest rates was Culbertson (1957) and tests for this theory include Van Horne (1980) and Modigliani and Sutch (1966) among others. [3]

Recent empirical evidence (e.g. Friedman & Kuttner, 1992; Bernanke, 1990) show that information conveyed by these financial market rates is significant and even in some cases argued to be superior than those conveyed by other commonly used economic indicators. In particular, the term spread, i.e., the difference between long and short term yields, is believed to have vital information about future economic conditions. [4] Earlier works on the prediction power of term structure focus on its ability to predict future interest rates movement. Evidence produced by Fama(1984), Hardouvelis (1988) and Mishkin (1988) are consistent with the hypothesis that vital information about future movement of interest rate is embodied in the current observed spot rates. Steep yield curve is normally associated with increasing interest rates trend and vice versa. In a different perspective, several recent studies (e.g. Stock & Watson, 1989; Harvey, 1991; Sauer & Scheide, 1995; Haubrich & Dombrosky, 1996; Bonser-Neal & Morley, 1997; Dotsey, 1998) examine the notion that term spread incorporates valuable information about future economic activities. The stylized fact that term spread is counter cyclical, i.e. inverts prior to a recession and goes strongly positive ahead of expansion years are confirmed by significant evidence provided by these studies. These existing findings are largely limited to evidence for the case of U.S. and several western developed countries. The experience of developing economies are lacking despite many having gradually developed their financial markets to a higher stage of efficiency over the years.

In this paper we perform the analysis of predictive power of term spread on the Malaysian financial market. Specifically, we investigate the ability of Malaysian T bills term spread to predict Malaysian output growth proxied by the Industrial Production Index. Our results indicate that current spread contains vital information about Malaysian future annual output growth up to about six months ahead. We also show that the predictive power of the T bills' spread is unique and not depending on the path of monetary policy. This calls for the incorporation of T bills spread as an additional indicator in forecasting Malaysian economic performance. The evidence are supported both by the single and multi-equation vector autoregression (VAR) analyses. In the next section we discuss the existing findings and explanations of the link between term spread and economic activities. This is then followed by the description of data and tests employed in Section 3. Section 4 discusses the findings and its implication and the paper concludes with a brief summary.

TERM SPREAD AND ECONOMIC ACTIVITIES

The stylized fact that term spread inverts prior to economic slowdown was first identified by Kessel (1965). He notes that the difference between yield on long and short term rates narrowed before approaching economic contraction and widened before economic upswing. The same trend is also identified by Fama (1986, pp. 176) noting that 'upward sloping term structures during good times to humped and inverted term structures of expected returns during recessions...produces challenging evidence for eventual explanation by term structure'. According to Laurent (1989) the lag between changes in the shape of yield curve and subsequent changes in real economic activity is approximately two quarters. His regression estimates using current quarterly change in the real GNP as dependent variable and lagged quarterly spread as explanatory variables, however, indicate insignificant power despite positive signs for spread's coefficients. Various other authors have also documented the same pattern using more recent data of different data sets.

In a comprehensive search for best index of leading indicators, Stock and Watson (1989) isolate the spread between the ten-year and one-year U.S. Treasury bond as an important component of leading indicators in predicting future economic activity. This is consistent with Harvey (1988) who finds that the term structure contains significant information about the consumption path for the U.S. which are particularly strongest in the 70s and 80s. Harvey notes that the ability of term structure to predict consumption pattern is superior to other measures such as lagged consumption growth, lagged stock returns and also forecast of seven other leading econometric models.

Strongin (1990) performs the bi-variate and tri-variate vector autoregression (VAR) analysis to identify term spread's ability to forecast output (GNP, investments and consumption) and prices. The positive responses of output measures toward increased in term spread are traced through the impulse response functions. The increase in output following increase in spread is supported by significant one-way causality pattern running from spread to output. The bi-variate variance decomposition analysis indicates that variation in spread explains up to about forty two percent of variance of output. However, the ability to forecast inflation is relatively weak. [5] Strongin's tri-variate VAR analysis indicates that term spread dominates money in forecasting real activity. The term spread retains virtually all of its explanatory power and its impulse response functions is largely unaffected by the addition of monetary aggregate in the set of endogenous variable. Evaluation of the predictive power of term spread by Estrella and Hadouvelis (1991) shows that the yield spread proxied by the difference between the annualized bond equivalent yield of the ten-year bond and three-month T bill is able to predict growth in real output up to about 16 quarters ahead for the period beginning from 1955 to 1988. The results strongly support the significant relationship between term spread and economic performance. The spread explains about one third of variations in real output in this period. The findings indicate that the predictive power of the yield curve slope also apply to consumption and investment but not for government spending. The forecasted probability of recession based on slope of yield curve four quarters earlier are shown to be accurate with respect to actual NBER-dated recessions.[6] Similar to Strongin, they also note that the superiority of term-spread is not contingent upon monetary policy. Using Fed Funds rates as proxy for monetary policy, they show that the significance of spread coefficients remain even with the inclusion of monetary indicator in the regression equation. This shows that information in the yield curve is mostly about variables other than monetary policy.

Extension of evidence of the predictive power of the term spread using multi- country data set are conducted by several studies (e.g. Hu, 1993; Plosser & Rouwenhorst, 1994; Sauer & Scheide, 1995; Bonser-Neal & Morley, 1997; Estrella &

Mishkin, 1997). Hu (1993) indicates the superiority of slope of yield curve over stock priced-based model and univariate time series (ARMA) model in predicting real output growth in the G-7 industrialized countries. Based on the error-correction model (ECM), Sauer and Scheide (1995), examine the significance of term-spread in predicting economic activity in three European countries-France, Germany and Italy. The results indicate that term spread posseses additional information over and above what is captured by real monetary aggregate in Germany. However, spread contribution in France and Italy is weak. Harvey (1991) also supports the effectiveness of term spread forecast in Germany. Compared to stock returns-based model the RMSE of output forecast is lower when term spread is used. The term structure forecast is also shown to be more accurate than the official DIW forecast of which form the base for the Deusche Bundesbank and consensus forecast of five major research institutes. Bonser-Neal and Morley (1997) provide the analyses for 11 industrial nations. The spread's ability to forecast output is tested using quarterly and monthly data. The accuracy of spread-based forecast models in predicting output growth are country and time dependent and it varies with strongest evidence for Canada, Germany and the United States (with R^2 of about 30 to 50 percent) to the weakest power for Japan and Switzerland (with R^2 of less than 10 percent).

Changes in monetary policy could be the possible explanation for the leading positive association between the spread and economic activity.[7] Expansionary monetary policy, for example, reduces short term rates in immediate term via the liquidity effect.[8] However, long term rates are less influenced by changes in monetary policy. The greater reduction of short term rates produces a steep yield curve which then associates with positive output growth that appears after some lag. In this respect, positive spread prior to output growth and vice versa is merely a reflection of monetary policy. In such cases, the predictive content of term spread is not unique. Another possible explanation is related to the consumption-based model quoted earlier in the introduction. When near economic outlook is bleak, economic agents cut down their current consumption and demand more short term bonds (i.e. increase savings). This attempts to smooth the consumption pattern in line with Friedman's (1957) Permanent Income Hypothesis and Ando-Modigliani's (1963) Life Cycle Hypothesis which pushes up prices of short term bonds and reduces its yield. Thus, increasing term spread by itself is a unique indicator of economic activity in the near term.

Studies discussed above generally support the significant predictive power of term spread. Movement of spread contains vital information about future economic conditions and should be used by public and private policy makers in judging current and future status of the economy. Despite significant findings, evidence regarding term spread predictive power in developing countries are still lacking. We therefore provide evidence of the predictive power of term spread using data on Malaysian T Bills market. In addition to the single equation approach which was mostly used by previous researchers, except Strongin (1990), we also provide results based on system VAR analysis. It is argued that the predictive power of term spread should be able to be identified given the increased efficiency of the market following the liberalization and advancement process which have taken place since the early eighties.

DATA AND METHODOLOGY

We perform our analysis using monthly data set on the Malaysian T bills market for a ten year period

(1987:1 to 1996:5). Discount rates of T bills for three maturity periods, i.e. 3 months, 6 months and 12 months are gathered from the Monthly Statistical Bulletin of Bank Negara Malaysia (Central Bank of Malaysia).[9] Thus, we have three term spread (12 -3 months, 12 - 6 months and 6 - 3 months) to be analyzed in our analysis. We use the Industrial Productions Index and narrow M1 money aggregate to measure output and monetary aggregate respectively. Both series are downloaded from the International Financial Statistics compiled by the International Monetary Fund.

Our focus of the analysis is to determine the usefulness of T bills' term spread to predict future annual output growth up to twelve months ahead. We therefore first investigate the correlation between current spread ($SPREAD_t$) and future annual growth of output ($_{t+i}Y_{t+i+k}$ with i = 1 to 12 and k = 12). We use conventional Pearson correlation coefficient to dictate the pattern of association between the two. Next we perform the regression analysis of spread on annual output growth based on the following regression equation:

$$_{t+i}Y_{t+i+k} = \alpha_0 + \alpha_1 SPREAD_t + \varepsilon_t \qquad (1)$$

where $_{t+i}Y_{t+i+12}$ denotes annual output growth i month ahead (i = 1 to 12 and k = 12), $SPREAD_t$ is current term spread for period t and ε_t is random error term normally distributed with zero mean and time invariant variance, i.e. $\varepsilon_t \sim N(0, \sigma^2)$. We use Cochrane-Orcutt (1949) procedure to correct for autocorrelation in error term if problems occur. To identify the dynamic of spread influence on output we then decompose output variance by the variance decomposition analysis derived from bi-variate vector autoregression (VAR) involving both output and spread. A bi-variate VAR of Sims (1980) that include both variables is used in the system. Let Z_t be a vector of m endogenous variables, the VAR system is specified as follows:

$$AX_t = B(L)X_{t-1} + \upsilon_t \qquad (2)$$

where A is a m x m matrix of impact multipliers, B(L) is a k^{th}-order matrix of structural polynomials in the lag operator L, $B(L) = B_1L + B_2L^2 + \dots + B_kL^k$, υ_t is a m x 1 vector of structural disturbances with zero mean, $E[\upsilon_t] = 0$, and covariance matrix $\Sigma_\upsilon = E[\upsilon_t \upsilon_t']$ for all t, and υ_t's are serially uncorrelated. The variance decomposition analysis identifies the sources of shocks that contribute to the forecast error variance of each of the variables in the system. This is achieved by decomposing the n-step ahead forecast error variance into each one of the shocks in the system. In a bi-variate setting (say x and y), the n-step ahead forecast error for x is given by:

$$x_{t+n} - E_t x_{t+n} = \phi_{11}(0)_{xt+n} + \phi_{11}(1)_{xt+n-1} + \dots + \phi_{11}(n-1)_{xt+1} + \phi_{12}(0)_{yt+n} + \phi_{12}(1)_{yt+n-1} + \dots + \phi_{12}(n-1)_{yt+1} \qquad (3)$$

The variance of the forecast error (3) is :

$$\sigma_x(n)^2 = \sigma_x^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \dots + \phi_1 1(n-1)^2] + \sigma_y^2[\phi_{12}(0)^2 + \phi_{12}(1)^2 + \dots + \phi_{12}(n-1)^2] \qquad (4)$$

Decomposition of the forecast error variance is performed by weighting each term of the right hand side of (4) with the variance of the forecast error ($\sigma_x(n)^2$). Dividing the first term of the right hand side of (4) with the forecast error variance gives the proportion of x forecast error variance which is due to its own shock and dividing the second term of (4) with the forecast error variance generates the proportion which is due to *y*. The influence of term spread on output growth can be identified by the breakdown of the forecast error variance for output growth.

Our next goal is to investigate whether the information conveyed by the term spread is unique or merely a reflection of monetary policy. We first repeat the regression analysis similar to (Eq. 1) by adding an indicator of current monetary policy proxied by annual growth of narrow money, MON_t as follow:

$$_{t+i}Y_{t+i+k} = \alpha_0 + \alpha_1 SPREAD_t + \alpha_2 MON_t + \varepsilon_t \qquad (5)$$

The uniqueness of information incorporated in the term spread is supported if the significance of spread's coefficient, α_1, remains intact. This shows that term spread possesses additional information which is not reflected in monetary policy. We also re-run the VAR analysis by incorporating a third variable of money growth in the system. From the tri-variate system we again determine the decomposition of output variance. The importance of spread is then examined based on the percentage of output variance which is explained by spread versus money.

RESULTS AND DISCUSSION

Table 1 provides the correlation coefficients between current spread and output growth one to twelve months ahead. On average, there are significant positive associations between term spread and output growth for up to six months ahead particularly for 12-3 months spread and 12 - 6 months spread and finally 6 - 3 months spread. The average correlation coefficients for theses spreads are 0.32 and 0.31 respectively. The 6-3 months spread is significantly correlated with the output growth for up to four months averaging at 0.26. These coefficients are significantly different from zero at a 5 per cent level, supporting the importance of term spread in predicting output. Results of regressions with only spread as independent variable (Eq. 1) are reported in Table 2 and 3. Results in Table 2 provide a strong case for the use of term spread in predicting annual output growth. The coefficients for spread are positive and significantly different from zero up to about six months ahead. Thereafter, spread is no longer significant in predicting output. The percentage of output variation (for the first six months) is explained by the spread range from 1 to 11 per cents. Results in Table 2 , however, suffer autocorrelation problems as indicated by low Durbin-Watson statistics. Table 3 provides the regression estimates after correcting for autocorrelation. The power of term spread in predicting output remains particularly for 12-3 months and 12-6 months spread measures. The predictive power remains up to about six months ahead and these are positive and significant at 5 per cent level. The predictive power is less for the 6-3 months spread where only three (first, fourth, and seventh month ahead) are significantly different from zero. It is also important to note the improved R^2 for the 12-3 months and 12-6 months spread averaging at 12.3 per cent and 11.7 per cent respectively for the six month horizon. The same applies to the 6-3 months spread despite less significant coefficients. Our correlation and regression estimates are therefore in support of the ability of term spread to predict output growth. Higher current term spread level indicates that annual output growth up to six months ahead is higher. Thus, spread should be adopted as one of the indicators for predicting Malaysian annual output growth.

Our next results concern the uniqueness of information carried by term spread. The regression

Table 1
Pearson Correlation Coefficients Between Current T Bills Term Spreas and Future Output Growth

Output Growth: i Months Ahead	12-3 Months Spread Coeff.	12-3 Months Spread P-value	12-6 Month Spread Coeff.	12-6 Month Spread P-value	6-3 Months Spread Coeff	6-3 Months Spread P-value
1	0.339	0.0005	0.259	0.0084	0.337	0.0005
2	0.316	0.0013	0.300	0.0023	0.227	0.0226
3	0.350	0.0004	0.349	0.0004	0.224	0.0250
4	0.343	0.0005	0.310	0.0018	0.270	0.0069
5	0.312	0.0017	0.331	0.0009	0.167	0.1004
6	0.238	0.0187	0.282	0.0051	0.079	0.4400
7	0.156	0.1294	0.110	0.2852	0.170	0.0982
8	0.064	0.5397	0.084	0.4186	0.008	0.9419
9	-0.005	0.9587	-0.042	0.6909	0.054	0.6083
10	0.047	0.6529	0.039	0.7125	0.043	0.6828
	0.016	0.8833	-0.030	0.7752	0.081	0.4410
12	-0.064	0.5447	-0.052	0.6253	-0.060	0.5740

Table 2

Regression Estimates: Predicting Output Growth Using T Bills Term Spread

$_{t+i}Y_{t+i+k} + \alpha_0 + \alpha_1 \text{ SPREAD}_t + \varepsilon_t$

Dep. Variable: Output Growth *i* Months Ahead	12-3 Months Spread				12-6 Month Spread				6-3 Months Spread			
	α_0	α_1	$\bar{R}^2(\%)$	DW	α_0	α_1	$\bar{R}^2(\%)$	DW	α_0	α_1	$\bar{R}^2(\%)$	DW
1	11.61	3.96	10.62	1.6	12.02	4.26	5.80	1.59	11.37	8.61	10.50	1.62
	(25.58)**	(3.61)**			(27.56)**	(2.69)**			(23.35)**	(3.59)**		
2	11.67	3.69	9.07	1.5	12.00	4.92	8.05	1.55	11.67	5.81	4.18	1.51
	(25.27)**	(3.31)**			(27.63)**	(3.12)**			(22.83)**	(2.32)**		
3	11.52	3.97	11.35	1.6	11.85	5.59	11.31	1.61	11.60	5.59	4.05	1.56
	(25.71)**	(3.70)**			(28.26)**	(3.69)**			(23.12)**	(2.28)**		
4	11.49	3.89	10.88	1.6	11.84	4.92	8.68	1.64	11.43	6.76	6.33	1.51
	(25.68)**	(3.60)**			(27.87)**	(3.21)**			(23.17)**	(2.76)**		
5	11.59	3.57	8.82	1.5	11.86	5.26	10.00	1.54	11.73	4.25	1.77	1.41
	(25.51)**	(3.22)**			(27.92)**	(3.43)**			(23.15)**	(1.66)*		
6	11.66	2.68	4.69	1.4	11.83	4.41	6.99	1.47	11.88	1.98	0.00	1.42
	(25.33)**	(2.39)**			(27.63)**	(2.87)**			(23.45)**	(0.78)		
7	11.75	1.75	1.39	1.4	11.93	1.72	0.16	1.46	11.60	4.21	1.85	1.40
	(25.24)**	(1.53)			(26.99)**	(1.08)			(23.25)**	(1.67)*		
8	11.87	0.71	0.00	1.4	11.91	1.31	0.00	1.41	11.96	0.19	0.00	1.42
	(25.15)**	(0.62)			(26.74)**	(0.81)			(23.58)**	(0.07)		
9	11.94	-0.06	0.00	1.4	11.97	-0.65	0.00	1.40	11.80	1.32	0.00	1.42
	(25.22)**	(-0.05)			(26.73)**	(-0.40)			(23.22)**	(0.51)		
10	11.86	0.53	0.00	1.4	11.91	0.61	0.00	1.40	11.83	1.06	0.00	1.42
	(24.88)**	(0.45)			(26.35)**	(0.37)			(23.10)**	(0.41)		
12	11.87	0.17	0.00	1.1	11.92	-0.47	0.00	1.19	11.70	2.00	0.00	1.18
	(24.77)**	(0.15)			(26.22)**	(-0.29)			(22.79)**	(0.77)		
	12.17	-0.66	0.00	1.27	12.11	-0.75	0.00	1.27	12.21	-1.35	0.00	1.27
	(27.38)**	(-0.61)			(28.68)**	(-0.49)			(25.57)**	(-0.56)		

Notes: 1. ** and * indicate significance at the 5% anf 10% and 10% level respectively.
2.DW represents Durbin-Watson *d* statistic.

Table 3
Regression Estimates (Corrected for Autocorrelation): Predicting Output Growth Using T Bills Term Spread

$$_{t+i}Y_{t+i+k} + \alpha_0 + \alpha_1\ SPREAD_t + \alpha_2\ MON_t + \varepsilon_t$$

Dep. Variable: Output Growth *i* Months Ahead	12-3 Months Spread				12-6 Month Spread				6-3 Months Spread			
	α_0	α_1	$\bar{R}^2$(%)	DW	α_0	α_1	$\bar{R}^2$(%)	DW	α_0	α_1	$\bar{R}^2$(%)	DW
1	11.71	3.51	12.89	1.96	12.11	3.04	9.30	1.98	11.55	6.97	13.07	1.98
	(21.23)**	(2.79)**			(21.83)**	(1.69)*			(19.69)**	(2.75)**		
2	11.68	2.89	11.86	2.07	11.96	3.52	11.14	2.09	11.80	3.29	9.36	2.11
	(21.09)**	(2.32)**			(22.20)**	(2.01)**			(18.99)**	(1.28)		
3	11.51	3.56	13.30	2.00	11.83	4.86	13.28	2.01	11.73	3.50	8.27	2.05
	(21.45)**	(2.93)**			(23.09)**	(2.88)**			(19.07)**	(1.36)		
4	11.59	3.48	13.43	1.98	11.93	3.97	11.22	1.98	11.61	5.22	11.11	2.02
	(21.20)**	(2.81)**			(22.82)**	(2.31)**			(18.74)**	(2.04)**		
5	11.57	3.01	13.00	2.10	11.82	4.19	13.23	2.11	11.79	2.47	9.37	2.13
	(20.32)**	(2.35)**			(22.13)**	(2.44)**			(18.29)**	(0.95)		
6	11.65	2.15	9.69	2.09	11.77	3.88	11.74	2.09	12.03	-0.38	7.32	2.13
	(19.71)**	(1.64)			(21.16)**	(2.21)**			(18.24)**	(-0.15)		
7	11.75	1.37	7.73	2.10	11.95	0.14	6.76	2.12	11.49	4.56	9.79	2.10
	(19.10)**	(1.00)			(19.82)**	(0.07)			(17.75)**	(1.76)*		
8	11.85	0.38	6.40	2.10	11.84	1.43	6.93	2.09	12.07	-1.63	6.69	2.11
	(18.87)**	(0.27)			(19.65)**	(0.77)			(18.23)**	(-0.61)		
9	12.03	-0.67	6.68	2.11	12.02	-1.89	7.41	2.11	11.81	1.19	6.66	2.09
	(18.63)**	(-0.48)			(19.15)**	(-0.99)			(17.90)**	(0.45)		
10	11.77	0.77	6.84	1.84	11.82	1.28	6.99	1.84	11.85	0.29	6.54	1.84
	(18.26)**	(0.55)			(18.98)**	(0.67)			(17.86)**	(0.11)		
12	12.05	0.71	11.01	2.05	12.15	0.10	10.72	2.04	11.93	2.23	11.57	2.05
	(19.66)**	(0.54)			(20.68)**	(0.05)			(18.89)**	(0.93)		
	12.20	-0.69	11.72	2.14	12.13	-0.68	11.60	2.14	12.20	-0.98	11.62	2.13
	(18.80)**	(-0.51)			(19.39)**	(-0.38)			(18.35)**	(-0.40)		

Notes: 1. ** and * indicate significance at the 5% anf 10% and 10% level respectively.
2.DW represents Durbin-Watson *d* statistic.

estimates when monetary indicator is added to the regression equation (Eq.5) are reported in Table 4 and 5. Table 4 shows that even after adding the monetary variable the significance of spread's coefficients for the six months identified earlier remains intact. This is true for the 12-3 months and 12-6 months spread. Thus, inclusion of money variable does not affect the importance of term spread. This is further strengthened by the insignificant changes in the R^2 (in the first six months)which remain relatively the same as those reported in Table 2. Despite not contributing significantly in predicting output for the first six months horizon, money variable does show an important contribution for the longer horizon, i.e. tenth month onward. This lagged effect of money growth on output is consistent with literature on the transmission mechanisms of monetary policy. In all estimations, coefficients for monetary indicator are significant at the longer end of the horizon tested. Thus, term spread can only be a reliable indicator for output for the shorter period but over the long run monetary variable dominates. Similar with Table 2, evidence of Table 4 suffers autocorrelation problems as shown by the low Durbin-Watson statistics. Corrected estimations are reported in Table 5. The same conclusions discussed earlier apply. Spread is superior than money in predicting output changes in the first six months period but money appear to be significant for the longer horizon. The R^2 for all estimations have also improved. For the first six months, spread's ability to explain output variation reached to about fourteen per cent (for 12-3 months spread, four months ahead). The R^2 for the longer period has also increased quite significantly to about twenty three percent. This is mainly due to the superiority of money variable in determining output for the longer term.

The variance decomposition analyses from the bi-variate and tri-variate VAR estimations are presented in Table 6 and 7. The bi-variate analysis shows that innovations in term spread are responsible for variation in output variance for up to twenty four months period. The largest contribution is for the 12-6 months spread, followed by 12-3 months spread and 6-3 months spread which on average explained about 16.39%, 12.80%, and 8.75% of output variance respectively. The explanation power is significant (twice the standard error) beginning from the fifth month for 12-3months and 12-6 months spread and seventh month for the 6-3 months spread. Results of tri-variate analysis in Table 7 are consistent with the single equation estimates. In the shorter horizon term spread is more influential as compared to money growth. As an example, for the case of 12-3 months spread, spread is superior to money up to thirteen months ahead. Compared to decomposition of variance presented in Table 6, the percentage of output variance explained by term spread is qualitatively the same. Fluctuation of output after the fourteenth month is mainly due to money innovation. Again, parallel to the single equation estimation, changes in money growth is superior in explaining output pattern for longer horizon estimates. Term spread's ability to predict changes in output for the near term is unique and is not merely a reflection of monetary policy. Thus, inclusion of spread in public as well as private forecasting models is supported by evidence found in this study. Fluctuation in the Malaysian T bills term spread is critical in evaluation of output cycle in the Malaysian economy.

SUMMARY AND CONCLUSIONS

In recent years there is a widespread use of financial market interest rates to predict economic activity. In particular, various researchers have shown that

Table 4
Regression Estimates: Predicting Output Growth Using T Bills Term Spread and Money Growth

$_{t+i}Y_{t+i+k} + \alpha_0 + \alpha_1\ SPREAD_t + \alpha_2\ MON_t + \varepsilon_t$

Dep. Variable: Output Growth	12-3 Months Spread					12-6 Month Spread					6-3 Months Spread				
i Months Ahead	α_0	α_1	α_2	$\bar{R}^2$(%)	DW	α_0	α_1	α_2	$\bar{R}^2$(%)	DW	α_0	α_1	α_2	$\bar{R}^2$(%)	DW
1	12.46	3.57	-0.04	10.12	1.66	13.41	3.36	-0.07	6.10	1.63	12.73	7.64	-0.07	10.82	1.67
	(9.35)**	(2.87)**	(-0.67)			(10.40)**	(1.91)**	(-1.15)			(10.08)**	(3.01)**	(-1.16)		
2	13.63	2.78	-0.10	10.36	1.55	14.03	3.61	-0.10	9.78	1.53	14.34	3.89	-0.13	7.91	1.50
	(10.19)**	(2.23)**	(-1.56)			(11.05)**	(2.07)**	(-1.70)*			(11.08)**	(1.49)	(-2.24)**		
3	12.06	3.72	-0.03	10.62	1.61	12.46	5.19	-0.03	10.66	1.60	13.21	4.43	-0.08	4.88	1.53
	(9.23)**	(3.05)**	(-0.44)			(10.08)**	(3.06)**	(-0.53)			(10.27)**	(1.71)**	(-1.36)		
4	9.66	4.76	0.09	12.03	1.62	10.45	5.83	0.07	9.07	1.65	10.71	7.30	0.04	5.72	1.50
	(7.47)**	(3.91)**	(1.51)			(8.42)**	(3.41)**	(1.19)			(8.37)**	(2.79)**	(0.60)		
5	10.97	3.87	0.03	8.09	1.53	11.31	5.62	0.03	9.26	1.57	12.37	3.74	-0.03	1.03	1.39
	(8.24)**	(3.05)**	(0.49)			(9.08)**	(3.26)**	(0.47)			(9.37)**	(1.37)	(-0.52)		
6	10.20	3.38	0.07	5.02	1.53	10.32	5.41	0.08	7.65	1.52	11.70	2.13	0.01	0.00	1.42
	(7.63)**	(2.66)**	(1.16)			(8.31)**	(3.15)**	(1.29)			(8.87)**	(0.77)	(0.15)		
7	9.73	2.74	0.10	3.01	1.50	10.39	2.75	0.08	0.84	1.52	10.01	5.44	0.08	2.66	1.42
	(7.25)**	(2.12)**	(1.60)			(8.12)**	(1.54)	(1.28)			(7.78)**	(2.04)**	(1.33)		
8	10.10	1.57	0.09	0.31	1.47	10.17	2.46	0.09	0.78	1.45	10.75	1.13	0.06	0.00	1.45
	(7.39)**	(1.20)	(1.38)			(7.91)**	(1.37)	(1.44)			(8.17)**	(0.41)	(1.00)		
9	10.28	0.74	0.08	0.00	1.50	10.63	0.23	0.07	0.00	1.48	10.07	2.65	0.09	0.34	1.50
	(7.50)**	(0.56)	(1.29)			(8.21)**	(0.13)	(1.10)			(7.68)**	(0.98)	(1.43)		
10	8.36	2.19	0.17	6.06	1.56	8.73	2.66	0.16	5.40	1.52	8.82	3.34	0.15	4.66	1.58
	(6.24)**	(1.71)*	(2.78)**			(6.88)**	(1.51)	(2.66)**			(6.80)**	(1.25)	(2.51)**		
11	6.86	2.50	0.25	14.06	1.52	7.54	2.28	0.23	11.82	1.49	6.96	5.53	0.23	14.62	1.52
	(5.29)**	(2.04)**	(4.11)**			(6.07)**	(1.34)	(3.75)**			(5.57)**	(2.18)**	(4.11)**		
12	6.95	1.75	0.26	18.70	1.48	7.18	2.34	0.25	18.58	1.47	7.43	2.19	0.23	17.23	1.44
	(5.91)**	(1.59)	(4.72)**			(6.46)**	(1.54)	(4.72)**			(6.50)**	(0.95)	(4.51)**		

Notes: 1. ** and * indicate significance at the 5% anf 10% and 10% level respectively.
2.DW represents Durbin-Watson *d* statistic.

Table 5

Regression Estimates(Corrected for Autocorrelation): Predicting Output Growth Using T Bills Term Spread and Money Growth

$$_{t+i}Y_{t+i+k} + \alpha_0 + \alpha_1 \, SPREAD_t + \alpha_2 \, MON_t + \varepsilon_t$$

Dep. Variable: Output Growth *i* Months Ahead	12-3 Months Spread					12-6 Month Spread					6-3 Months Spread				
	α_0	α_1	α_2	$\bar{R}^2(\%)$	DW	α_0	α_1	α_2	$\bar{R}^2(\%)$	DW	α_0	α_1	α_2	$\bar{R}^2(\%)$	DW
1	12.25	3.32	-0.03	12.12	1.95	13.17	2.67	-0.06	8.86	1.96	12.54	6.64	-0.05	12.63	1.96
	(8.01)**	(2.41)*	(-0.38)			(8.77)**	(1.39)	(-0.76)			(8.62)**	(2.53)**	(-0.76)		
2	13.64	2.09	-0.10	12.64	2.09	14.02	2.47	-0.11	12.28	2.10	14.28	2.19	-0.13	11.44	2.11
	(8.92)**	(1.52)	(-1.37)			(9.52)**	(1.32)	(-1.50)			(9.49)**	(0.84)	(-1.81)*		
3	12.26	3.24	-0.04	12.64	2.01	12.68	4.39	-0.04	12.74	2.02	13.51	2.59	-0.09	8.86	2.06
	(8.17)**	(2.41)**	(-0.53)			(8.84)**	(2.39)**	(-0.64)			(8.89)**	(0.98)	(-1.28)		
4	9.63	4.24	0.10	14.29	1.99	10.50	4.67	0.07	11.33	2.00	10.35	5.66	0.06	10.90	2.04
	(6.41)**	(3.12)**	(1.40)			(7.25)**	(2.51)**	(1.06)			(6.71)**	(2.14)**	(0.90)		
5	11.49	3.05	0.01	12.06	2.10	11.82	4.19	-0.01	12.30	2.11	12.87	1.90	-0.06	8.93	2.14
	(7.45)**	(2.17)**	(0.06)			(8.14)**	(2.25)**	(-0.01)			(8.16)**	(0.71)	(-0.75)		
6	10.27	2.75	0.07	9.56	2.07	10.31	4.65	0.08	11.87	2.07	11.79	-0.27	0.01	6.34	2.13
	(6.61)**	(1.94)*	(0.95)			(7.09)**	(2.50)**	(1.09)			(7.44)**	(-0.10)	(0.16)		
7	9.83	2.17	0.10	8.37	2.09	10.71	0.84	0.06	6.48	2.12	9.76	5.35	0.09	10.29	2.10
	(6.21)**	(1.49)	(1.31)			(6.93)**	(0.43)	(0.87)			(6.37)**	(2.01)**	(1.24)		
8	10.24	1.03	0.08	6.51	2.06	10.11	2.23	0.09	7.36	2.05	11.02	-1.08	0.05	6.18	2.10
	(6.34)**	(0.70)	(1.08)			(6.58)**	(1.14)	(1.21)			(6.98)**	(-0.40)	(0.72)		
9	11.63	-0.50	0.02	5.69	2.10	11.99	-1.87	0.01	6.37	2.11	10.95	1.61	0.04	5.95	2.07
	(6.99)**	(-0.33)	(0.26)			(7.45)**	(-0.93)	(0.02)			(6.97)**	(0.58)	(0.60)		
10	8.49	1.98	0.16	10.44	1.70	8.80	2.55	0.16	10.33	1.71	9.09	1.95	0.14	9.03	1.73
	(5.47)**	(1.39)	(2.29)**			(5.90)**	(1.33)	(2.19)**			(6.05)**	(0.72)	(1.99)**		
12	8.74	1.83	0.16	14.54	2.07	9.33	1.41	0.14	13.29	2.07	8.93	3.53	0.15	14.70	2.07
	(6.15)**	(1.42)	(2.50)**			(6.80)**	(0.81)	(2.18)**			(6.48)**	(1.45)	(2.37)**		
	7.04	1.17	0.26	23.50	2.04	7.20	1.49	0.25	23.46	2.05	7.39	0.97	0.24	22.96	2.07
	(4.97)**	(0.92)	(3.93)**			(5.32)**	(0.89)	(3.93)**			(5.32)**	(0.42)	(3.80)**		

Notes: 1. ** and * indicate significance at the 5% anf 10% and 10% level respectively.
2.DW represents Durbin-Watson *d* statistic.

Table 6
Variance Decomposition Analysis for Output Growth

Step	Std Error	12-3 Months Spread	Std Error	12-6 Months Spread	Std Error	6-3 Months Spread
1	2.77	0.00	2.69	0.00	2.74	0.00
2	2.82	1.53	2.74	0.95	2.81	0.10
3	2.84	2.05	2.81	4.85	2.84	0.17
4	2.94	4.48	2.87	5.05	2.99	4.43
5	3.11	10.92	3.10	14.31	3.06	4.27
6	3.14	12.18	3.18	18.63	3.06	4.26
7	3.22	14.01	3.22	18.33	3.24	10.30
8	3.28	15.40	3.31	20.43	3.27	10.17
9	3.39	14.51	3.41	19.31	3.38	9.81
10	3.43	15.11	3.45	19.66	3.42	10.03
11	3.48	15.51	3.48	19.82	3.48	10.59
12	3.57	15.41	3.55	19.30	3.56	10.11
13	3.59	15.33	3.57	19.23	3.59	10.91
14	3.60	15.40	3.57	19.24	3.59	10.91
15	3.62	15.38	3.59	19.09	3.61	11.19
16	3.63	15.38	3.60	19.23	3.62	11.38
17	3.63	15.59	3.61	19.52	3.62	11.39
18	3.65	15.53	3.62	19.41	3.64	11.38
19	3.65	15.57	3.62	19.41	3.64	11.41
20	3.65	15.57	3.62	19.41	3.64	11.42
21	3.66	15.51	3.63	19.40	3.64	11.39
22	3.66	15.52	3.64	19.45	3.65	11.39
23	3.66	15.65	3.64	19.58	3.65	11.50
24	3.68	15.69	3.65	19.64	3.66	11.47

Table 7
Variance Decomposition Analysis for Output Growth

Step	Std Error	12-3 Months Spread	Money Growth	Std Error	12-6 Months Spread	Money Growth	Std Error	6-3 Months Spread	Money Growth
1	2.46	0.00	0.00	2.40	0.00	0.00	2.39	0.00	0.00
2	2.52	1.46	2.15	2.45	0.64	2.11	2.46	0.21	2.35
3	2.54	1.78	3.03	2.49	3.76	2.33	2.47	0.24	2.70
4	2.64	4.74	4.65	2.55	4.28	4.24	2.59	4.17	3.58
5	2.74	8.98	6.28	2.71	13.28	4.85	2.62	4.07	5.27
6	2.76	9.93	6.39	2.77	16.59	4.70	2.63	4.20	5.55
7	2.79	11.48	6.70	2.78	16.44	5.34	2.77	12.11	5.12
8	2.81	12.53	6.60	2.82	18.44	5.20	2.78	12.38	5.25
9	2.87	12.52	8.36	2.88	17.90	6.93	2.88	12.96	8.07
10	2.91	13.13	9.17	2.90	18.08	7.54	2.94	15.40	8.01
11	2.95	15.01	9.04	2.93	19.11	7.48	3.00	17.36	7.83
12	3.07	14.85	12.61	3.01	18.16	10.78	3.11	16.82	10.11
13	3.11	14.53	12.32	3.05	17.86	10.54	3.13	16.62	10.03
14	3.15	14.24	14.31	3.09	17.75	12.24	3.17	16.17	12.37
15	3.20	14.63	15.45	3.12	17.43	13.45	3.22	16.23	13.08
16	3.21	14.74	15.65	3.15	17.95	13.87	3.23	16.24	13.13
17	3.23	14.61	16.72	3.18	17.52	15.95	3.25	16.05	13.74
18	3.31	14.24	19.04	3.25	16.93	18.43	3.31	15.50	14.65
19	3.34	14.20	19.65	3.28	16.65	19.72	3.34	15.30	15.16
20	3.36	14.08	20.39	3.31	16.43	20.83	3.36	15.14	15.51
21	3.42	13.77	22.60	3.38	15.78	24.02	3.40	14.82	17.22
22	3.44	13.63	23.22	3.41	15.50	25.13	3.41	14.98	17.42
23	3.50	13.26	25.32	3.47	15.22	27.03	3.45	14.82	18.70
24	3.50	13.27	25.41	3.47	15.23	27.12	3.45	15.02	18.65

the difference between long term and short term yield of financial assets, i.e. the term spread, possesses valuable information about the path of output growth. The stylized pattern that yield curve inverts prior to economic downturn and becoming steep before economic boom attracted researchers to investigate this issue. We analyzed the predictive power of Malaysian T bills term spread in predicting annual output growth in Malaysia. We perform single equation as well as multi-equation system of analysis based on vector autoregression (VAR). Our results support the positive association between term spread and output growth. Term spread is shown to convey valuable information up to about six months ahead. We also show that the information derived from the term-spread is unique and not affected by changes in monetary policy. Nevertheless, the predictive power of term spread is only limited for the near term output growth (about six months). Over the long run, the effect of money growth is superior. These findings indicate the usefulness of term spread in predicting near term output pattern. Thus, incorporation of term spread in economic forecasting models are supported.

ENDNOTES

1. Expressions in brackets are added by author for relevant interpretation.

2. Tests for the liquidity-premium theory include Startz (1982) and Shiller (1979) among others.

3. Other models of term structure include multifactor and lattice-type or branching process models. Tests concerning these more recent works include Brown and Dybvig (1986), Heath et.al (1990) and Longstaff and Schwartz (1992) among others. Cox-Ingersoll-Ross (1985) provide explanation for the term structure based on real economic variables in a general equilibrium framework.

4. Our definition of term spread refers to the difference in yields of securities which are default free issued by the government. The use of government securities eliminates the influence of default risk, liquidity, tax treatment, etc. in the determination of yields. The term spread can also be represented by the slope of yield curve which depicts yields of different maturities at a given moment.

5. The insignificance of term spread in predicting inflation is supported by Koedijk and Kool (1995). The view that term spread provides valuable forecast about future inflation is supported by Fama(1990) and Mishkin (1990).

6. The probability of recession is calculated based on a time series probit model. Similar analyses are performed by Estrella and Mishkin (1998) and Dueker (1997) using various other measures of term spread and economic activity. Both conclude on the superiority of term spread. The yield curve slope remains the single best recession predictor compared to other measures of leading indicators. Dotsey (1998) and Haubrich and Dombrosky (1996), however, note the weakening forecasting power of the spread particularly in recent years. Term spread significantly predicts GDP growth when samples include long data period beginning in the 50s or 60s. However, the significance disappears when the data set is restricted to post-1985. Dotsey also notes

that the information content of the spread is reduced once other variables such as lagged output and lagged level of short term rates are included. The root mean square errors (RMSE) of out of sample output forecast with or without the term spread are not significantly different cautioning the usefulness of term spread in predicting output.

7. Strongin (1990) proposes three different models that link term spread with economic activity, i.e. Constant Real Rate Model, Real Business Cycle Model/ Technology Shock Model and Monetary Distortion Model. It is argued that the first two models do not fit the stylized fact identified by empirical evidence. The Monetary Distortion Model that associates term spread with monetary policy is shown to be consistent with the identified pattern. Nevertheless, Strongin shows that spread's ability to predict economic activity is not dependent on monetary variables.

8. See Christiano and Eichenbaum (1992), Leeper and Gordon (1992) and Kim and Ghazali (1998, 1999) for discussion and evidence of liquidity effect in developed and developing nations. Ghazali (1997) discusses the transmission mechanism of monetary policy with respect to the Malaysian economy. It is argued that changes in monetary aggregate affect real output in the short run. However, the effect dissipates in the long run as prices adjust to increase in money supply.

9. Previous studies on the term spread generally use the spread between yield on long term bonds and short term instruments. However, the development of a long term bond market particularly government bonds in Malaysia is still in its developing stage with less trading activities recorded. We therefore, choose to use the T bills rates. Our preleminary analysis shows that the discount rates for T bills closely move with the Kuala Lumpur Interbank Offer Rates (KLIBOR) which are frequently quoted to measure liquidity in Malaysia. It is also being sold on auction basis. Ghazali (1993) show that expectation hypothesis can be supported for the T Bills rates, thus, justifying the use of T bills rates for our study.

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