

# “Predictive Power of Forward Rates: Evidence From Malaysian Government Securities (MGS) Market”

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## Predictive Power of Forward Rates: Evidence from Malaysian Government Securities (MGS) Market

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### Abstract

Prior study of developing economies such as the Malaysian Government Securities (MGS) market in Malaysia indicates that the Expectations Hypothesis is equally applicable as for developed financial markets of Europe and the United States. Extending from such study, this paper concentrates on the predictive power of implied forward rates for future spot rates. Past studies, notably from Fama (1976, 1984), show that the predictive power of implied forward rates for future spot rates is weak over long sample periods and tends to vary across different sub-periods. The study on the MGS market is consistent with Fama's result. The forecasting power is weak both over the shorter end and the longer end of the investment horizon. Bonds with remaining years to maturity between 2 years to 5½ years are able to predict future spot rates with accuracy of between 57% to 72%, and the forecast power increases with maturity.

**Key words:** Expectation Hypothesis, Term structure of interest rates, Implied forward rates, Malaysian Government Securities.

### 1. Introduction

A new approach in the studies of the term structure of interest rates is to determine whether the forward rates can predict future spot rates. The pure Expectations Hypothesis of the finance theory explains that the forward rates provide unbiased information about future spot rates. Macaulay (1938) was among the first to test the Expectations Hypothesis where he found no evidence to support it. Many studies by Hickman (1942), Culbertson (1957), Shiller (1979), Shiller, Campbell and Schoenholtz (1983), Mankiw and Summers (1984), Fama (1984), Mankiw and Miron (1986), Mankiw (1986), Fama and Bliss (1987), Campbell and Shiller (1991), Hardouvelis (1994) and Bekaert, Hodrick and Marshall (1995) all supported Macaulay's finding, that is, rejecting the Expectations Hypothesis. All the above researches were based on test using US Treasuries data. This rejection of the Expectations Hypothesis is believed to be caused by the term premia which were not controlled in those studies. Campbell and Shiller (1991) explained that the rejection of the theory using US data is due to the term premia causing long rates to over-react to expectation of future short rates or alternatively, to under-react to current short rates.

However, the rejection of the Expectations Hypothesis provides further interests in this subject matter which eventually lead to some conclusive studies reporting varying degree of support for weaker forms of the Expectation Hypothesis.

Fama (1984) examines a new approach to measure the information in forward rates about premia and future spot rates. In his paper, he concluded that forward rates contain variation in expected returns on multi-period bills. Forward rates also have information about future spot rates. From data of U.S. Treasury bills taken between the period of 1959-1982, Fama (1984) found that the one-month forward rate always has power as a predictor of the spot rate one-month ahead. For periods preceding 1974, forward rates had power as predictors but it seemed to decay over the time horizon. Following this, Fama and Bliss (1987) used the *forward premia*, which are linear combinations of two different yields spreads, and concluded that the forecasting power of the term structure of interest rates improves as the horizon increases from 2 years to 5 years. This improvement is attributed to a slowly mean-reverting interest rate process, which is more easily forecast over long time periods than over short time periods.

Campbell and Shiller (1991) confirm the results of Fama and Bliss (1987). Their studies show that for US securities with maturity below 1 year, the forecast power deteriorates with the horizon. The forecast power reaches its minimum at 9 to 12 months, and then starts to improve. Mankiw and Miron (1986) find large variation in forecast power across different sub-periods, for

sub-period from 1890 to 1914, there was strong forecast power, from 1914 to 1933, the forecast power was weaker and from 1933 to 1984, forward rates were totally unable to predict the future spot rates. Hardouvelis (1988) finds that prior to October 1979, the forward rates show predictive power up to six weeks ahead, but such forecast power diminishes substantially after the October 1979 period up to August 1982. Similarly, Mishkin (1988) finds that the forecast power of forward rates is generally higher after the August 1982 period.

This paper examines the forecast power of the forward rates of the Malaysian Government Securities (MGS) grouped into different portfolio according to their maturity. Data were taken from March 1976 to December 2002, on a quarterly basis. Omitting the term premia and employing the pure Expectations Hypothesis, the simple regression Model was used to regress the changes of future spot rates on the changes in the forward rates.

Section 2 provides an insight into the Malaysian Bond Market and its development. The theory and methodology are explained in Section 3, followed by the explanation of the data in Section 4. Finally, the findings are discussed in Section 5 along with the conclusions in Section 6.

## 2. Bond Market in Malaysia.

The government of Malaysia issues default-free securities called Malaysia Government Securities (MGS) ranging from one to slightly over twenty years maturity to raise funds to meet its financial obligations. However, due to the tight financial regulations, MGS forms a very captive market with financial institutions normally holding the scripts until full maturity. Financial institutions, pension fund managers and insurance companies are compelled by law and by liquidity considerations to hold MGS under the mandatory liquid asset requirements set by the central bank, BNM. Trading of MGS in the secondary market is therefore very lukewarm. The government over the years recognises that perhaps lack of attention to the importance of this market for low-income investors has somewhat restricted and suppressed the growth and development of this financial sector. Hence, in early 1989, it took the bold move to introduce new and prudent reform policies with the intention to give this market the opportunity for growth without too much control or interferences from BNM by returning the market to be formed by private sector incentives.

The history of the Malaysian bond market dates back to post independence of the 1950s. It can therefore be consider as a developing market. In contrast to the capital market, the trading of stock and shares through the Kuala Lumpur Stock Exchange (KLSE) has far out-spaced the trading of bonds. This is because the secondary market for bond is rather inactive. For the year 2002, MGS issuance total RM 16.3 billion compared with RM 13.3 billion raised through equities. The Malaysian Bond Market comprises securities issued by the government of Malaysia, quasi-government bonds issued by government affiliated agencies, Cagamas bonds issued by the national mortgage corporation, Cagamas Berhad and bonds issued by corporations known as private debt securities (PDS).

The securities issued by the government of Malaysia include Malaysian Treasury Bills (MTBs) and Bank Negara Bills (BNBs) which are short-term government securities, usually less than 1 year maturity. Longer-term securities, usually with maturity exceeding 1 year include Government Investment Issues (GIIs), Malaysia Saving Bonds and the more popular Malaysia Government Securities (MGS).

Quasi-government bonds offered to the public are Khazanah bonds, Danaharta and Danamodal Bonds. Khazanah bonds are issued by Khazanah Nasional Berhad, a wholly-owned company of the Ministry of Finance (MOF), acting as an investment arm for the government. Pengurusan Danaharta Nasional Berhad (Danaharta) was incorporated as a statutory company on June 20, 1998 to address the issue of non-performing loans (NPLs) arising from the 1997 Asian Financial Crisis. Therefore, Danaharta issues government-guaranteed, zero coupon bonds to purchase NPLs. These bonds have a maturity period of 5 years with the option to extend the maturity term for an additional period of 1, 3 or 5 years. Under this specially arranged program, Danaharta will issue Danaharta bonds up to RM 15 billion (nominal value), the bonds to be issued progressively in 4 issues per year.

Danamodal Nasional Berhad (Danamodal) was incorporated on August 10, 1998 as one of the national asset management companies. Danamodal has issued Danamodal bonds of RM 11 billion in nominal value to finance the banking institution re-capitalisation program. These bonds have very similar features as the Danaharta bonds, except that they do not have the guarantee of the government, but are given special status which qualifies them as liquid assets.

Cagamas Bonds are issued by Cagamas Berhad, which is the national mortgage corporation incorporated on December 2, 1986. It was formed with the main purpose to purchase mortgage loans from banks which were cautious and reluctant to lend due to the tight liquidity in the economy during the tail-end of the 1980s recessions. Today, Cagamas extends its activities to purchase hire purchase and leasing debts from these financial institutions. As at December 31<sup>st</sup>, 2002, Cagamas bonds outstanding in the market amounted to a total nominal value of RM 26.194 billion.

Prior to the mid-eighties, the PDS market was almost non-existent. Private corporations were raising funds from the conventional practice through bank borrowings or issuance of company shares. The issuance of bonds to raise funds was untested and therefore many corporations were cautious and tend not to consider this option. However, with the success of the Cagamas securities, many business corporations resorted to PDS as a means of financing. This option was again proven to be more popular particularly after the 1997 Asian Financial Crisis. This debt instrument becomes favourable because many banks were burdened with large volume of NPLs which inevitably resulted in their reluctance to provide loans. At the same time, the share market has suffered tremendously with the CI index falling to an all time low of 262.70 points on September 1, 1997, as compared with the highest index of 1,271.57 points in February 1997, prior to the financial crisis. Therefore, the normal practice of raising funds from the public through shares in this period of time is no longer viable.

The growth of the PDS market has been very impressive over the years. In 1987 funds raised by the private sector through PDS were a mere RM0.295 billion. By 1997, funds raised through the issuance of PDS increased to RM 14.43 billion. For the year 2002, this amount reached a figure of RM 36.2 billion. The total outstanding PDS in 1988 was RM 0.976 billion. In 2002, this has increased to RM 114.195 billion.

Malaysian Government Securities (MGS) are debt instruments issued by Bank Negara Malaysia (BNM), the Central Bank of Malaysia, on behalf of the Government of Malaysia. These bonds are guaranteed by the Malaysian government and therefore they are considered to be default free and risk-free. MGS are issued to meet long-term domestic borrowings, particularly to finance public sector projects to meet the country's development agenda to achieve developed country status by the year 2020. Due to this requirement, the country's public expenditure increased tremendously in the seventies and early eighties, thereby increasing the amount of MGS issues. In 1970, the MGS market size was only RM 3.48 billion. This reached a peak of RM 66.643 billion by 1992. As at December 2002, the total outstanding MGS stands at RM 109.55 billion.

The development of the MGS market over the years have seen several changes, particularly as from January 1989, a financial reform was introduced. This was necessary to encourage a more active secondary market, which prior to 1989 was hardly in existence. Coupon rates for MGS were predetermined by the government prior to 1989. Now, the pricing of these bonds are market driven where appointed principal dealers (PDs) are required to bid for a minimum of 10% of the primary issue size. The coupon rate is calculated by the weighted average yield of the successful bids of the auction. Other changes to reflect transparency in the Malaysian bond market include a pre-announced auction calendar for MGS issuance. This was introduced by BNM in March 2000. This is an improvement over the past practice of announcing MGS auction at very short notice, usually only one or two weeks in advance.

The MGS market has been a very much captive one due to the stringent financial regulations imposed by BNM on financial institutions. Such financial institutions are compelled to hold MGS under the mandatory liquid asset requirement. The result of such regulations means that these bonds are usually locked away and hence preventing any transactions in between. This eventually created a weak and illiquid secondary market. However the financial reform of 1989 reduced the liquid asset requirement from the 20% minimum to 17%, hence paving way for a more active secondary market.

Recently, on March 29, 2002, the Malaysian Government Securities Futures was first introduced. A Five-Year Malaysian Government Securities (FMG5) was offered and traded through the Malaysia Derivatives Exchange Berhad (MDEX). Later, on September 19, 2003, MDEX launched the Three-Year (FMG3) and the Ten-Year (FMGA) MGS Futures. These MGS Futures are contracts to make or to take delivery of the MGS at a future date. Upon maturity, the buyers and sellers of the MGS futures contracts will be settled in cash based on a final settlement value. The bond futures are normally used by financial institutions, insurance companies, bond portfolio managers, provident funds and asset managers as a hedging instrument against medium to long term interest rates risk. The MGS futures are introduced to help to provide liquidity in the bond market. As mentioned earlier, most MGS are closely held until maturity. Therefore, investors will have difficulty to buy the desired MGS from the secondary market. As an alternative to holding the physical MGS, these investors may choose to invest in MGS futures contract.

### 3. Theory and Methodology

The theory of the term structure of interest rates is about the relationship between debt instrument yields and the time to maturity. There are four established theories, namely the Expectations Theory, Liquidity Preference Theory, Market Segmentation Theory and the Preferred Habitat Theory. However, this paper employs the Expectations Theory in its evaluation of the bond yields.

#### 3.1. The Expectations Hypothesis (EH)

The most widely followed explanation of the term structure is the Expectation Hypothesis. This theory was first mentioned by Fisher (1930). He developed early ideas about the relationship between short-term and long-term rates of interest. That body of work has later become the basis for the Expectations Hypothesis of the term structure. This states that the long-term rate is equal to the product of all the expected short-term rates. Accordingly, the long-term rates are given by the current and expected short-term rates. The spread between long rates and short rates reflects the market forecast of changes in short rates.

The Expectations Hypothesis can be expressed as:

$$(1 + r_{1,t})^t = (1 + r_1)(1 + r_2) \dots (1 + r_t), \quad (3.1)$$

where,  $r_1, r_2 \dots r_t$  – short-term rates at period 1, 2, ...,  $t$ ,

$r_{1,t}$  – long-term rate beginning at current time and maturity in period  $t$ ,

$t$  – maturity period.

There are several very important assumptions which provide the basis of this theory. These assumptions are as follows: there is no transaction costs; the investor has similar expectations regarding future interest rate and is therefore indifferent to the investment horizon, regardless of the maturity strategy.

The main assumption, which provides the most accepted interpretation of theory, suggests that investors do not prefer bonds of one maturity to bonds of another maturity. That is, the investors expect the return for any investment to be the same, regardless of the maturity period. This would mean that if an investor has say, an investment horizon of five years, he would expect his return in the next five years would be the same if five one-year-term bonds were held in sequence. However, in reality, this assumption does not hold as the expected returns from those five very different bonds with different maturities should differ in significant ways (Refer Cox, Ingersoll and Ross (1981)). This discrepancy is caused by the presence of price risk associated with investing in bonds with maturity greater than the investment horizon. This uncertainty about the price of the bond at the end of the investment horizon is greater if the maturity period is longer.

### 3.2. Predictive Power of the Implied Forward Rate

Fama and Bliss (1987) use simple regression tests in order to prove that forward rates do contain information about current expected returns and future interest rates. The return on an  $x$ -year discount bond with  $y$  years remaining to maturity, is defined as:

$$h(x, y : t + x - y) = \ln p(y : t + x - y) - \ln p(x : t), \quad (3.2)$$

where,  $t$  is the time of purchase and  $t + x - y$  is the time the bond is sold.  $P(x:t)$  is the price of the bond at time  $t$  and  $p(y : t + x - y)$  is the price of the same bond but with  $y$  years remaining to maturity at time  $t + x - y$ .

The yield  $r(x:t)$  on a discount bond with \$1 face value and  $x$  years to maturity at  $t$  is given by:

$$r(x : t) = -\ln p(x : t). \quad (3.3)$$

The 1-year forward rate at time  $t$ , for the year from  $t+x-1$  to  $t+x$  is

$$\begin{aligned} f(x, x-1 : t) &= \ln p(x-1 : t) - \ln p(x : t) \\ &= r(x : t) - r(x-1 : t) \end{aligned} \quad (3.4)$$

The price of a  $x$ -year discount bond at time  $t$  that pays \$1 at maturity is the present value of the \$1 payoff discounted at the time  $t$  expected values ( $E_t$ ) of the future 1-year returns on the bond. Mathematically, it is represented by

$$p(x : t) = \exp \left[ \begin{array}{l} -E_t h(x, x-1 : t+1) - E_t h(x-1, x-2 : t+2) \\ -\dots - E_t r(1 : t+x-1) \end{array} \right]. \quad (3.5)$$

Equation 3.5 implies that the price of the discount bond contains rational forecasts of equilibrium expected returns. The forward rate is the rate at the current time on a contract to purchase a  $n$ -year bond at some time in the future. Therefore, for example, the forward rate  $f(x, x-1:t)$  is the rate at time  $t$  on a contract to purchase a 1-year bond at  $t+x-1$  in the future. In Equation 3.5, adding the first  $x-1$  expected returns will give:

$$p(x : t) = \exp \left[ -E_t h(x, 1 : t+x-1) - E_t r(1 : t+x-1) \right]. \quad (3.6)$$

Substituting (3.6) into (3.4) and subtracting the 1-year spot rate  $r(1:t)$  give

$$\begin{aligned} f(x, x-1 : t) - r(1 : t) &= \left[ E_t r(1 : t+x-1) - r(1 : t) \right] \\ &\quad + \left[ E_t h(x, 1 : t+x-1) - r(x-1 : t) \right] \end{aligned} \quad (3.7)$$

The right hand side of Equation 3.7 is the forward-spot spread from which we obtain the following regression:

$$r(1 : t+x-1) - r(1 : t) = a_1 + b_1 [f(x, x-1 : t) - r(1 : t)] + u_1(t+x-1). \quad (3.8)$$

Equation 3.6 is also applicable to realised returns. Therefore,

$$\begin{aligned} f(x, x-1 : t) - r(1 : t) &= \left[ r(1 : t+x-1) - r(1 : t) \right] \\ &\quad + \left[ h(x, 1 : t+x-1) - r(x-1 : t) \right] \end{aligned} \quad (3.9)$$

Similarly as in Equation 3.8, we obtain the regression

$$\begin{aligned} h(x, 1 : t+x-1) - r(x-1 : t) &= -a_1 + (1-b_1) [f(x, x-1 : t) - r(1 : t)] \\ &\quad - u_1(t+x-1) \end{aligned} \quad (3.10)$$

In equation 3.5, adding the last  $x-1$  expected returns, the price of the  $x$ -year bond is given:

$$p(x : t) = \exp \left[ -E_t h(x, x-1 : t+1) - E_t r(x-1 : t+1) \right]. \quad (3.11)$$

Substituting (3.11) into (3.4) and subtracting the spot rate  $r(1:t)$  gives

$$f(x, x-1:t) - r(1:t) = \left[ E_t h(x, x-1:t+1) - r(1:t) \right] + \left[ E_t r(x-1:t+1) - r(x-1:t) \right] \quad (3.12)$$

where  $h(x, x-1:t+1) - r(1:t)$  is the term premium in the 1-year return on a  $x$ -year bond. From Equation (3.12) we obtain the regression:

$$h(x, x-1:t+1) - r(x-1:t) = a_2 + b_2 [f(x, x-1:t) - r(1:t)] + u_2(t+1) \quad (3.13)$$

and its complementary regression is given by:

$$r(x-1:t+1) - r(x-1:t) = -a_2 + (1-b_2) [f(x, x-1:t) - r(1:t)] - u_2(t+1) \quad (3.14)$$

### 3.3. Regression Of Spot Rate And Forward Rate

To test the validity of the Expectation Hypothesis, the model compares the implied forward rate with the actual spot rate. By using the linear regression analysis method, the following equation and hypothesis are tested.

$${}_t SR_n = \alpha + \beta {}_t FR_n + e, \quad (3.15)$$

where  ${}_t SR_n$  – Actual spot rate at time  $t$  for  $n$  years to maturity.

${}_t FR_n$  – Implied forward rate at time  $t$  for  $n$  years to maturity.

$e$  – Residual errors.

The two hypotheses are

$$H_0 : \alpha = 0, \quad \beta = 1$$

$$H_1 : \alpha \neq 0, \quad \beta = 0$$

The null hypothesis where  $\alpha = 0$  and  $\beta = 1$  implied that the expectation hypothesis is valid. The ability of the implied forward rate to forecast the spot rate is indicated by the value of  $\beta$ , the closer the  $\beta$  to 1 indicates the better forecasting power. The alternative hypothesis where  $\alpha \neq 0$  and  $\beta = 0$  means that the expectation hypothesis is rejected.

The above Equation 3.15 will be the basis to test the validity of the Expectation Hypothesis for all the different bond portfolios.

However, initial regression test of the spot rate on the forward rate shows the presence of high auto-correlation. To remove this problem, the first difference method is employed and hence Equation 3.15 is modified to:

$$\Delta {}_t SR_n = \alpha + \beta \Delta {}_t FR_n + e. \quad (3.16)$$

The test hypothesis remains the same as stated above.

## 4. Data

The data were abstracted from the Ph.D. Thesis (May 2004) submitted by Neoh (2004) to Universiti Putra Malaysia. In this thesis, quarterly MGS data were compiled from the monthly issues of the Investor Digest. The period of analysis is from March 1976 (1976:3) to December 2002 (2002:12) spanning a total of 27 years. Altogether this gives a total 108 quarterly data.

Each quarterly set of data consists of between 40 to 110 individual MGS raised at various time and with different term to maturity, ranging from more than one year to twenty years. In the thesis, Neoh (2004) firstly employs the Fama bootstrapping method to obtain zero-coupon or spot rate for the MGS, which are coupon bearing bonds. Next, the forward rates are computed from the spot rates assuming that the pricing process follows the Expectation Theory.

For the purpose of this study, these bonds are grouped into portfolios according to their maturity. For bonds with maturities from one year up to seven years, the grouping is in interval of

six months, hence twelve bond portfolios. From seven years to ten years, there is one group with three year intervals. Finally, from ten to twenty years, the grouping is in interval of five years. Therefore, this arrangement of data set produces fifteen sub-groups of different portfolios.

## 5. Results

The empirical evidence on the first difference of the spot rates from the forward rates for each of these bond portfolios is summarised in Table 5.1.  $R^2$  value for each of the bond portfolios is plotted in Figure 5.1, clearly demonstrating that seven of the bond portfolios with maturity periods ranging from 24 months to 66 months (2 years to 5½ years) indicate very close relationship between the observed spot rates and the forward rates. The  $R^2$  value range from 0.7559 to 0.9901, with an average of 0.9282. This means that, on average, the regression model fits the data very well, up to an average of 93%. The  $R^2$  for the bond portfolio with maturity ranging from 12 months to 24 months and from 66 months to 120 months falls below this high and generally acceptable level of 0.6 and therefore not in supporting the Expectation Hypothesis. The other two bond portfolios with maturity ranging from 120 months to 240 months (10 years to 20 years) indicate an average  $R^2$  value of 0.8443. This means that the regression model is able to predict 84% of the variation in movements in the dependent variable, the spot rates.

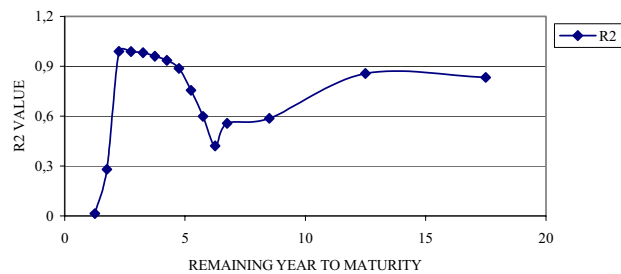


Fig. 5.1.  $R^2$  distribution for different bond portfolios

Table 5.1

$R^2$ , Estimated Coefficients ( $\alpha$ ,  $\beta$ ), t-ratios and D-W statistics for bond portfolios

Portfolio Number	Maturity Range (months)	Number of Data N	$R^2$	Estimated Coefficients	t-ratio	D-W
1	2	3	4	5	6	7
1	12≤M<18	369	0.0147	FR 0.01283 Const 0.03717	2.336 13.76	1.4330
2	18≤M<24	397	0.2809	FR 0.14289 Const 0.02661	12.42 12.24	1.5110
3	24≤M<30	389	0.9901	FR 0.57408 Const -0.00189	197 -6.371	1.6201
4	30≤M<36	375	0.9888	FR 0.60314 Const -0.00226	181.8 -6.791	1.6010
5	36≤M<42	342	0.9813	FR 0.63615 Const -0.00290	133.7 -6.521	1.6712
6	42≤M<48	337	0.9602	FR 0.67012 Const -0.00347	89.93 -5.431	1.8289
7	48≤M<54	326	0.9349	FR 0.69935 Const -0.00322	68.20 -3.981	1.6944



Table 5.1 (continuous)

1	2	3	4	5	6	7
8	54≤M<60	318	0.8863	FR 0.71444 Const -0.00248	49.62 -2.33	1.6246
9	60≤M<66	272	0.7559	FR 0.71727 Const -0.000754	28.92 - 0.4191	1.3216
10	66≤M<72	265	0.5986	FR 0.63503 Const 0.004129	19.8 2.024	1.2866
11	72≤M<78	262	0.4216	FR 0.47939 Const 0.011534	13.77 5.281	1.4203
12	78≤M<84	262	0.5572	FR 0.38984 Const 0.015388	18.09 8.284	1.2925
13	84≤M<120	1430	0.5871	FR 0.36730 Const 0.017135	45.06 15.79	1.7463
14	120≤M<180	1536	0.8562	FR 0.01679 Const 0.02061	95.57 13.42	1.953
15	180≤M<240	800	0.8324	FR 0.09042 Const 0.03408	62.94 11.84	1.935

The D-W statistics are plotted in Figure 5.2 for each of the bond portfolios. With the exception of the bond portfolio with maturity from 12 months to 18 months and from 60 months to 84 month, all D-W statistics are well above 1.5 indicating that serial correlation is not a problem.

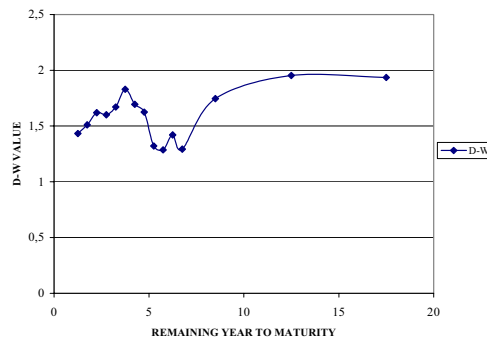


Fig. 5.2. Durbin Watson distribution for different bond portfolios

The estimated coefficients for the explanatory variable and for the constant are plotted for the different bond portfolios as illustrated in Figure 5.3 to provide a visual means of verifying the instability of the parameters.

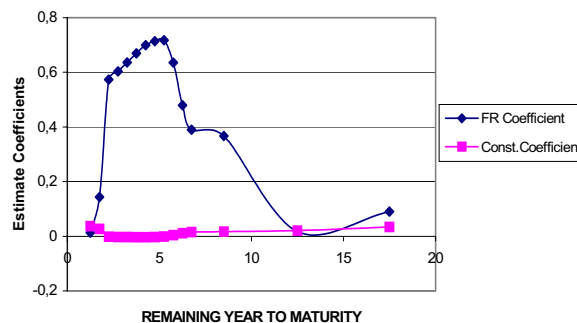


Fig. 5.3. Estimate coefficients for different bond portfolios

Table 5.1 also shows the values of these coefficients for the 15 different bond portfolios. According to the linear regression Equation 3.16, the constant term  $\alpha$  should be zero and the forward rate coefficients should be equal to one.  $\alpha$  for all the different bond portfolios is close to zero. Of particular interest are the 7 bond portfolios with maturity from 24 months to 66 months, whose average  $\alpha$  equals  $-0.002426$  which is very close to zero and may be considered to be zero. The  $\beta$  term ranges from 0.00549 to 0.71727. The empirical results appear to suggest a rejection that these bond portfolios with  $\beta$  values less than 0.04 (acceptable level set earlier) are not anywhere near one. Therefore, bond portfolio numbers 1, 12, 13 and 14 appear to provide no support for the hypothesis. Consideration of  $R^2$  value (and D-W statistics) of bond portfolios numbers 2, 9, 10, 11 and 12 also lead to the rejection of the hypothesis. Hence, bond portfolios numbers 3 to 8 are the only one that behave consistent with theory and thus provide support to the Expectation Hypothesis. The t-ratios of 6 out of 17 portfolios show significance at the 0.01 probability (99% confidence) level. Returning to the  $\beta$  values of these same portfolios in Table 5.1,  $\beta$  value may be noted as ranging from 0.57408 to 0.71727 which means that the forward rates can predict the spot rate with some accuracy from 57% to 72%. It's important to note, it is obvious to an observer that the predictive power increases across the portfolio maturities, from 2 years up to 5½ years investment horizon. This is consistent with the results obtained by Fama and Bliss (1987) in the US study. In their study of U.S. Treasury bonds, the results for the 1-year forward rates supported forecasts of changes in the 1-year interest rate 2- to 4-year ahead and that the forecasting power increases with the forecast horizon.

The  $\beta$  coefficient for the bond portfolio with maturity ranging from 60 months to 66 months (5 years to 5½ years) has the highest value at 0.71727. This is an increase of almost 25% higher than the  $\beta$  value for the bond portfolio with maturity ranging from 24 months to 30 months.

The predictive power for the first two bond portfolio at the short end of the yield curve with maturity ranges of 12 months to 18 months and from 18 months to 24 months is weak. Early literature up to about the early 1960s, showed evidence at the very short end of the maturity spectrum of the forward rates is not accurate predictor of the future spot rates. The main cause of this deviation is due to term premia and other suspected factors such as taxes and transaction costs. Macaulay (1938), focusing on the accuracy of forward rates as predictors of subsequent spot rate, finds that there is little evidence of successful forecasting. In fact, the forward rate derived from the term structure of very short-term securities has been confirmed to be useless in predicting the change in the spot rates. Kessel (1965), also using very short-term data, confirmed Macaulay's findings. The forward rates gave very poor and misleading predictions about the change in the spot rate. However, when the forward rate is adjusted with the term premium, the forecast of the change in the spot rate improved substantially. At the long end of the yield curve, immediately after 5½ years, the predictive power decreases drastically.

## 6. Conclusions

Although the regression results show that the Malaysian term structure behaves consistently with the Expectations Hypothesis and also behaves consistently with similar tests in other developed economies, it would be necessary to explore further the predictive power of the term structure and how far into the time horizon can the forecast power be maintained. To search for these answers, the bond data were separated into fifteen groups of bond portfolios, each group clearly distinguished by their range of maturity periods.

For the period under study from 1976 to 2002, the findings indicate that the Malaysian data are useful to predict future spot rates from the implied forward rates only for those bonds with 2 year to 5½ year remaining time to maturity. Bonds with maturity of below 2 years have no forecast power at all. Similarly, bonds with maturity greater than 5½ years yield results that led to rejection of the Expectation Hypothesis. It is worthwhile to note that the forecast power ranges from 57% to 72% accuracy and the forecast power increases with maturity, but only up to the 5½ years range.

### 6.1. Limitation of This Study

The empirical result from this study has provided sufficient understanding of the behaviour of the term structure of interest rate in Malaysia. However, as a first analysis and for simplicity in analysis, the study has adopted the Fama-Bliss (1987) Bootstrapping methodology, which obviously has its own assumption and limitations. Other factors contributing to the limitations of this study are discussed below:

- i) The study has accepted the pure Expectation Hypothesis as a measure of the bond market efficiency. In doing so, it has totally ignored the term premia factor.
- ii) The forward rate curve is very sensitive to slight variations or errors in prices. Errors in price are caused by round-off errors in quotes of bid-ask prices.
- iii) The selection of a suitable discount function to represent the term structure is equally an important factor for improved results. For example, the cubic spline method by McCulloch (1975) is able to provide a smooth forward yield curve. Advancing from this, the exponential polynomial functions as adopted by Nelson-Siegel (1987) using 4 parameters and by Svensson (1994) using 6 parameters are able to cope with any shapes of the yield curve, be it upward sloping, downward sloping or humped.
- iv) Insufficient bond data due to lack of issues have forced interpolation errors. This is particularly prominent from 1992 to 1966 where the number of bond issues with remaining years to maturity from 13 years to 20 years is very few.

### 6.2. Suggestion for Further Studies

This investigation into the Malaysian bond market for the first time has enlightened us of the powerful theory in its application under any conditions. In the course of analysing the results, it has opened more questions and answered some. Below some suggestions are presented for further work in the same area of interest:

- i) Following similar work by Fama (1984) and Campbell and Schiller (1991), one could use future premium and the change in spot rate to regress on the current forward-spot differential (also known as forward-spot spread). This will control the effect of term premia.
- ii) Due to the existence of term premium in the forward rates, adjusted forward rates are used to predict future spot rates as demonstrated by Buser, Karolyi and Sanders (1996).
- iii) It is widely recognized that the bond rate contains useful information about long-term expected inflation. This can be tested using the data available from this study. This relationship between the term structure and inflation can be further investigated by running a regression of the inflation rate against the real interest rate. Such information can serve as a useful financial tool for monetary policy maker.

We have persevered to develop a methodology by selecting a process to study term structure in an emerging market. It would be very desirable if future researchers could apply this process to study more markets among the 67 emerging economies. Such efforts, limited as these are because of the data availability problem (recall that this study had to secure the data set for the first time), may lead to verification of these preliminary results conjectured and shown in this thesis for one emerging market.

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