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The Relationship among the Nominal Rates of Interest, the Real Rates of Interest and the Inflation Rates: An Empirical Study of the Fisher Effect on the Malaysian T Bill Market

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ABSTRAK

Hipotesis Fisher menyatakan bahawa jika kadar faedah benar dijangka adalah malar dan oleh itu bebas daripada kadar inflasi dijangka, maka setiap satu peratus kenaikan dalam kadar inflasi dijangka akan menghasilkan satu peratus kenaikan dalam kadar faedah nominal. Kajian ini menguji kesahihan hipotesis Fisher dalam pasaran bil perbendaharaan Malaysia. Selaras dengan itu hubungan di antara tiga pembolehubah iaitu kadar nominal, kadar benar dan paras harga cuba dikenalpasti. Kajian ini menunjukkan bahawa tindakbalas positif oleh kadar nominal terhadap kenaikan kadar inflasi dijangka adalah meningkat apabila kematangan bertambah. Bertentangan dengan kesan Fisher, kadar inflasi dijangka didapati merupakan faktor yang utama dalam penentuan kadar faedah benar dijangka dan bukannya kadar faedah nominal. Oleh itu sifat malar kadar faedah benar adalah ditolak. Selain daripada itu, paras harga bagi masa-masa yang lalu didapati tidak memiliki maklumat yang berharga dalam meramalkan kadar faedah nominal atau pun kadar benar. Ketidakcekapan pasaran juga wujud kerana kadar nominal didapati tidak berjaya untuk mengambilkira semua maklumat yang terdapat pada paras harga yang lepas.

ABSTRACT

The Fisherian hypothesis asserts that, if the expected real rate of interest is constant and therefore independent of expected inflation, each percentage point rise in the expected inflation results in a percentage point rise in the nominal rate of interest. This paper tests the validity of the hypothesis on the Malaysian T Bill market. In conjunction to that, the interactions of the three variables, namely, nominal rate of interest, real rate of interest and the price level were explored. This study found that the positive response of nominal rate toward the expected inflation increases gradually as maturity increases. In contradiction to the Fisher effect, the expected rate of inflation was found to be a major determinant

factor or the expected real rate, instead of the nominal rate. Thus, a non-variant character of the real rate is rejected. In addition, past inflation rates do not possess any valuable information in forecasting future nominal or real rates. The sign of inefficiency in the market exists since the nominal rate is unable to summarize all information from previous price levels.

INTRODUCTION

The effect of inflation on the returns of financial assets has been an important theoretical issue for many years. Many studies employing different sets of data and methodologies were performed in search of the true relationship and in identifying the major determinant factors for the three variables, namely, the nominal rate, the real rate, and the inflation rate. Knowing the exact interactions of these variables will assist not only the monetary authority in setting their policies but also the general investors (lenders and borrowers) in various economics decisions such as portfolio adjustment, setting charges on loans, balancing money and real investment.

According to Fisher, the nominal rate of interest can be defined as a sum of two major variables, namely, the expected real rate of interest and the expected rate of inflation. This can be shown as

$$i_{n(t)} = r_{n(t)} + P'_{n(t)}$$

where,

$i_{n(t)}$ is the nominal rate of interest for n period starting from time t,

$r_{n(t)}$ is the expected real rate of interest for n period starting from time t, and

$P'_{n(t)}$ is the expected inflation rate over n period starting from time t.

The above hypothesis known as Fisher Effect rests on two major assumptions. First, one percentage point increase in the expected inflation will cause a one percentage point increase in the nominal rate. Second, expected real rate is constant. Thus, for us to accept the Fisherian hypothesis the two ssumptions must be valid.

Previous studies on the Fisher effect ended with mixed results. Basically, the studies can be grouped into three classes based on their arguments on how the nominal rate adjusts to the changes in the price level. The first group argued that the relationship between the nominal and expected inflation is less than one to one due to the variant of expected real rate. Mundell (1963) and Tobin (1965) both argued the validity of the first assumption based on the Pigou's Real Balance Effect. Mundell stated that the higher price level predicted will make an individual to feel poorer due to the reduction in the real cash balance, and therefore he will increase his saving. Collectively, this will shift the saving curve to the right and lower the real rate. Tobin on the other hand proposed the Keynesian view that higher expected inflation will reduce the marginal product of capital and thus the expected real rate. The variant character reduces the effect of expected inflation on the nominal rate to less than one to one. Tanzi (1980), using the alternatives time series of expected inflation, found a less than one to one relationship. He conducted the regression analysis between the nominal rate and expected inflation and obtained a coefficient of about 0.6. In a recent study Kama 1981) suggested a less than unity response. He found that the rate on call money in Japan increased by 0.24 percentage point in response to a 1 percent increase in the consumer price index. The effect on bond rate was even lower. In addition, Huizinga and Mishkin (1984) conducted a comprehensive study of reaction of the real rates toward inflation for 7 types of financial assets differing in length of maturity and risk level. They employed 4 sets of price indices in their study. Regardless of the price indices used they found a significant negative relationship on all the seven assets. The coefficient ranges from -0.24 to -2.085. They identified that as maturity increases the drop in real rate due to the anticipated rate of inflation is getting larger. This support Tobin's theoretical explanation who argued that higher expected inflation will dampen the marginal product of capital and thus the real rate. Summers (1982) also identified a non-constant character of the real rate. He showed that the real rate of interest fluctuates significantly from 19.8 percent in 1870 to -4.9 percent in 1940. Thus, it is not suprising that the R^2 between the nominal rate and expected inflation is low. Jaffe and Mandelker (1976) stated that the expected real return on the stock seems to be negatively related to the anticipated rates of inflation, rather than invariant as suggested by the generalized Fisher Effect. They found a 3% drop in the real rate as inflation is predicted to increase by 1%.

The second group claimed a more than one to one response between the nominal rate and expected inflation after taking into consideration the tax factor. Darby (1975) was the first to point that in the world of taxes investors are more concerned with the after tax real rate. To compensate the tax charges on interest earned, investors will adjust the nominal return by more than a proportional increase in the price level. This modification of the Fisher Effect is now known as the Darby Effect. Feldstein (1976) and Gandolfi (1982) were also in agreement with Darby. They found that the nature of response is largely determined by the tax rates, investment and saving attitudes. Leiderman (1979) obtained a larger than unity response in the Argentina market over the period of 1964-79. Levi and Makin (1978, 1979) suggested that in a world of taxes, the impact of inflation on the nominal interest rate is in the range of 0.857 to 1.333. Thus supporting the modified Darby Effect.

The third group consists of those who confirmed the Fisher Effect. Their findings indicated that a one to one relationship exists between the two variables.In investigating the efficiency of the US T Bills market, Fama (1975) found that the one month nominal rate increases proportionately with the increase in the expected changes in purchasing power. He showed that the nominal rate adjusts by about 0.98 percent for a one percentage increase in expected inflation. In addition, he supported the idea of the nonvariant character of real rate by showing that the sample autocorrelations of the expected real rate were close to 0 over the period of study. Mandelker and Tandom (1981) extended Fama's approach in testing the efficiency over a period of 1966-79. They concluded that the coefficients of response were in the order of unity and the short term rates can be used as proxy for changes in price level. The results of both studies indicated that the real rate is independent of the changes in price level. Others such as Feldstein and Eckstein (1970) concluded that a permanent one percent increase in the annual rate of inflation would increase the interest rate by 0.97 percent. The differing results explained earlier may be due to differences in methodology and the data used. It is important to note that one major problem surrounding studies of the Fisher Effect is in the determination of the ex ante or expected variables which are unobservable.

One of the major issue pointed by Fama (1975) was the ability of the nominal rate to be used as predictor of inflation. Fama argued that if the Fisher Effect is valid then the nominal rate should be an unbiased estimator of subsequently observed inflation rate. Furthermore he claimed that the current nominal rates should have summarized all relevant information consist in the past inflation rates, thus changes in the purchasing power can be attributed to the current nominal rate. He tested the following two regression to support his argument.

1. $P_t = a + b_{it}$

2. $P_t = a + b_{it} + cP_{t-1}$

The coefficient b was found to be close to 1 and c was close to zero. Thus Fama concluded that the nominal rate is a good predictor of inflation rate and the market is efficient since past information of price level is no longer valuable in improving the predictive power of the first equation in forcasting future inflation rate. Leiderman (1979) and Mandelker and Tandon (1981) studies also agree with Fama on the predictive power of the nominal rates. In contrast to that, Carlson (1977) rejected Fama's view by showing that in a period of little variation in expected inflation the nominal rate is not a good predictor of inflation rates.

DATA AND METHODOLOGY

This study examines the interactions of the three rates (nominal, real, and inflation) over a 15 year period, from January 1974 to December 1988. The monthly Consumer Price Index (CPI) reported in the Quarterly Bulletin issued by the Bank Negara Malaysia was used as the measurement of price level. The average annualized discount rates on Malaysian T Bills reported monthly in the same bulletin were taken as a base to generate the nominal rates.

The tests were conducted on three maturity categories, i.e., 3 months, 6 months and 12 months. January 1974 was selected as the starting date because only since August 1973 the Malaysian T Bills have been sold on an auction basis. Before this date, the bills were issued through an on tapp basis, thus preclude the effect of market competitiveness on the T Bills discount rates.

The discount rates for the T Bills published in the bulletin were in the form of annual discount yield. Thus, to correctly use the data it must be converted into bond equivalent return over the holding period. The issuing price was calculated as

$$V_t = \frac{FV * 365}{365 + (d * T)}$$

where,

V_t is the issuing price of T Bill at time t,

FV is the face value of T Bill,

d is the annualized discount rate reported in the bulletin, and

T is the time remaining to maturity.

The nominal rate of return over n period starting from time t was calculated as

$$i_{n(t)} = \frac{100 - V_t}{V_t} * 100\%.$$

Formation of the expectation of price level was based on the monthly CPI. As noted earlier, finding a proxy for the ex ante variable is a major problem faced by researchers in this topic. To overcome this, three methods to form the expected inflation were chosen based on the previous studies by Lahiri (1976) and Tanzi (1980). Thus, each holding period has three time series of expected inflation. The three methods are as the following:

1. Distributed Lag: $P'_{n(t)} = w_0 + w_1 * P_{n(t-i)}$

2. Adaptive: $P'_{n(t)} = w_o + w_1 P'_{n(t-1)} + w_2 P_{n(t-1)}$

3. Exptrapolative: $P'_{n(t)} = w_0 + w_1 P_{n(t-1)} + w_2(P_{n(t-1)} - P_{n(t-2)})$

where,

$P_{n(t)}$ = actual inflation rate over n period starting from time t,

$P_{n(t-i)}$ = actual inflation rate over n period beginning from time t-i (i = 1,2,3,.....),

$P'_{n(t)}$ = expected inflation rate at time t over next n period, and

$P'_{n(t-i)}$ = expected inflation rate at time t-i over next n period (i = 1,2,3,.....).

Substracting the expected inflation rate from the nominal rate of interest will generate the expected real rate,

$$r_{n(t)} = i_{n(t)} - P'_{n(t)}.$$

Two null hypotheses which verify the assumptions made by Fisher can be stated as:

1. There is a one to one relationship between the nominal interest rate and the expected inflation.
2. There is no relationship between the expected real rate and the expected inflation.

The first hypothesis determines the degree of response of the nominal rate toward changes in expected inflation. If it is rèjected at a high significance level, it means that the nominal rate does not adjust in a one to one fashion toward expected inflation as suggested by Fisher Effect. Rejection of the second hypothesis implies a nonconstant character of the expected real rate, which means that the Fisher hypothesis is not valid.

RESULTS AND DISCUSSIONS

THE NOMINAL RATE OF INTEREST AND EXPECTED INFLATION

The critical issue of the Fisher hypothesis is the response of nominal rate towards the expectation of price level. Tables 1 through 3 show the summary statistics of the regression analysis between the nominal rates and the expected inflation for the Malaysian T Bills, according to the maturity. From these tables, it is clear that the nominal rates do response positively toward the expected inflation. However, the level of response and its significance levels vary according to the maturity of the bills. The longer the maturity of the T Bill the higher is the response of the nominal rate towards the expected inflation. The average coefficients for 3, 6 and 12 months T Bills are 0.15, 0.88 and 1.68, respectively. The response co-effient for 6 months maturity length shows consistency with the Fisher effect. The coefficients of determination, R^2, indicate that the expected inflation alone does not play an important role in determining the Malaysian T Bills rates. The R^2 ranging from 0.0003 to 0.1 are very low which indicate that there are several other important variables which might explain the behavior of the nominal return. The preceeding results indicate that the Fisher effect is only valid for the 6 months maturity assets. The 3 months maturity bills response by less than unity, while the 12 months bills show greater than unity relationship toward the anticipated inflation.

THE EXPECTED REAL RATE OF INTEREST AND EXPECTED INFLATION

Analysis of the behaviour of the expected real rate will assist us in examining the validity of the Fisher's second assumption. Most studies beside Fama's concluded that the expected real rate is not independent of the expected inflation rate. Tables 4 through 6 show the regression statistics between expected real rates and expected inflation rates. Consistent with previous studies, a significant negative relationship between the two variables is also true in Malaysia. Interestingly, the expected real rate decreases by about the same proportion as the increase in the expected inflation rate. A one percent increase in the expected inflation reduces the expected real rate for 3, 6 and 12 months by 0.97, 0.99, and 1.0 percent, respectively. This enables us to reject the second hypothesis at a high significance level (P-Prob equals 0.000). The expected real rate is not independent of the changes in the price level, and thus, the Fisher Effect is rejected. In addion, the expected inflation does play an important role in determining the expected real rate and this can be justified by a high coefficient of determination for the three maturity categories. This means that the movement in the price level can explain a high portion of the variation in the expected real rate.

TABLE 1. Summary statistics of regression between the nominal rate of interest and the expected inflation rate using distributed lag formation

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	Correlation Coefficient r	Significance Level P-Prob
3 months	0.7876	0.23936 (0.40806)	0.587	0.00193	0.04392	0.5582
6 months	0.2377	0.84267 (0.36907)	2.283	0.02893	0.17008	0.0236
12 months	−2.8351	1.5841 (0.40525)	3.909	0.08292	0.28795	0.0001

Note: Standard errors of estimates for beta are shown in the parentheses.

TABLE 2. Summary statistics of regression between the nominal rate of interest and the expected inflation rate using adaptive formation.

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	Correlation Coefficient r	Significance Level P-Prob
3 months	0.94898	0.09428 (0.37344)	0.252	0.00036	0.01892	0.801
6 months	0.0868	0.90969 (0.36427)	2.497	0.03441	0.1855	0.0134
12 months	−3.6059	1.74947 (0.40273)	4.344	0.10044	0.31693	0.0000

Note: Standard errors of estimates for beta are shown in parentheses

TABLE 3. Summary statistics of regression between the nominal rate of interest and the expected inflation rate using extrapolative formation

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	Correlation Coefficient r	Significance Level P-Prob
3 months	0.9336	0.11244 (0.3786)	0.297	0.0005	0.02225	0.7668
6 months	0.14297	0.885 (0.36426)	2.43	0.03263	0.18064	0.0161
12 months	−3.4126	1.70789 (0.40339)	4.234	0.0959	0.30967	0.0000

Note· Standard errors of estimates for beta are shown in parentheses.

TABLE 4. Summary statistics of regression between the expected real rate of interest and the expected inflation rate using distributed lag formation

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	Correlation Coefficient r	Significance Level P-Prob
3 months	1.05685	−0.97482 (0.013)	−74.99	0.96697	-0.98335	0.0000
6 months	2.2574	−0.9934 (0.01547)	−64.21	0.9593	-0.97944	0.0000
12 months	4.70057	−1.02077 (0.1442)	−7.079	0.96736	−0.98354	0.0000

Note Standard errors of estimates for beta are shown in the parentheses

TABLE 5. Summary statistics of regression between the expected real rate of interest and the expected inflation rate using adaptive formation

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	Correlation Coefficient r	Significance Level P-Prob
3 months	1.05697	−0.96466 (0.01456)	66.25	0.96103	−0.98032	0.0000
6 months	2.25775	−0.99611 (0.01568)	−63.53	0.95843	−0.97899	0.0000
12 months	4.70083	−1.02677 (0.144)	− 7.13	0.96784	−0.98379	0.0000

Note: Standard errors of estimates for beta are shown the parentheses.

TABLE 6. Summary statistics of regression between the expected real rate of interest and the expected inflation rate using extrapolative formation

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	Correlation Coefficient r	Significance Level P-Prob
3 months	1.05705	-0.96628 (0.01439)	-67.15	0.962	-0.98082	0.0000
6 months	2.2576	-0.995 (0.01568)	-63.46	0.95837	-0.97896	0.0000
12 months	4.70083	-1.02526 (0.0144)	-71.2	0.96772	-0.98373	0.0000

Note Standard errors of estimates for beta are shown in the parentheses.

NOMINAL RATE, REAL RATE AND LAGS OF INFLATION

In order to determine the relative impact of different lagged values of inflation rates on the nominal and the real rates, the following multiple regressions were performed:

1. $i_t = a + w_j P_{t-j}$

2. $r_t = a + w_j P_{t-j}$

Tables 7 and 8 presented the lagged coefficients of the nominal and real rates for the past 12 months. As can be seen, the results indicate that there are no consistent relationships between lags of inflation and the nominal or the real rate. The coefficients are not significantly different from zero . This is against the Jaffe and Mandelker (1979) findings which identified a strong negative relationship of current nominal return and the past values of inflation rate. However, the coefficient of determination for the nominal rates is larger compared to the coefficient of determination when the expected inflation was used as the independent variable. This suggests that the current nominal rate was influenced more by the previous inflation rates. However, overall, the portion explained is still low (the highest R^2 is 0.69 for the 3 months maturity). The coefficient of determination for the real rate is smaller when compared to R^2 when the expected inflaon was used as the independent variable. This indicates that investors are more concerned with the anticipated price level rather than the previous experience in setting their investment decisions. The insignificant coefficients and the lack of consistent relationship suggest that previous price levels cannot be used to provide an accurate prediction of the nominal or the real rate.

PREDICTIVE POWER OF THE NOMINAL AND REAL RATE OF INTEREST

The two regressions test used by Fama were conducted on the Malaysian T Bills market and the results are shown in Tables 9 and 10. Table 9 indicates a positive value for b in all maturity categories and the coefficient gets larger as maturity increases. Even though the reaction of subsequent inflation toward the current nominal rate is quite high but their explanatory power is low with the highest R^2 of 0.07 for the 12 months holding period. Current nominal rate is not a good predictor of subsequent inflation. This is supported by the coefficients in Table 10. The coefficients c are close to 1 for the three maturities length. As we can see, the inclusion of past inflation rate improves the predictive power indicated by the high coefficient of determination, R^2, ranging from 0.5 to 0.96. Moreover, the

TABLE 7. Coefficients of multiple regression of the nominal rate of interest and the lagged inflation rates

	3 months		6 months		12 months	
Lag j	Coefficient w	t-value t	Coefficient w	t-value t	Coefficient w	t-value t
1	0.05	0.68	−0.01	−0.13	0.04	0.67
2	−0.04	−0.46	0.01	0.13	0.01	0.13
3	0.10	1.25	0.00	0.05	0.00	−0.25
4	−0.02	−0.20	0.00	−0.06	−0.02	−0.23
5	−0.06	−0.88	−0.01	−0.23	0.14	0.19
6	0.11	1.33	0.03	0.68	−0.02	−0.23
7	0.27	2.97	0.01	0.02	0.01	0.14
8	0.54	6.03	−0.01	−0.14	−0.02	−0.30
9	−0.03	−0.36	0.00	−0.08	−0.01	−0.14
10	0.11	1.59	−0.01	−0.12	0.00	−0.03
11	−0.04	−0.55	−0.01	−0.17	−0.01	−0.14
12	−0.06	−0.95	0.08	2.42	0.12	2.36
a	0.13	1.29	2.05	51.47	4.13	51.69
R^2	0.69		0.27		0.36	
F	30.57		5.17		7.34	

Notes: 1 a is the constant value of the regression
2 R^2 is the coefficient of determination.
3. F is the F statistic value.

TABLE 8. Coefficients of multiple regression of the real rate of interest and lagged inflation rates

	3 months		6 months		12 months	
Lag j	Coefficient w	t-value t	Coefficient w	t-value t	Coefficient w	t-value t
1	0 08	1.25	−0.14	−0.91	−0.41	−1.85
2	−0.05	−0.67	−0.09	−0.42	−0.04	−0.13
3	0.02	−0.28	−0.02	−0.07	0.01	0.03
4	−0.00	0 04	0.01	0.05	−0.11	0.36
5	0.04	0.68	−0 09	−0 41	−0.01	−0.03
6	−0.11	−1.41	0.11	0.54	0.00	0.01
7	−0.01	−0.13	−0.08	−0.36	0.02	0.05
8	0.47	5.76	−0 11	−0.49	0.06	0.19
9	0 47	6.88	−0.04	−0.20	0.17	0.56
10	0.04	0.61	0.10	0.47	0.04	0.13
11	0.04	0 52	−0.02	−0.09	0.11	0.37
12	−0.02	−0.29	0.17	1.20	−0.16	−0.77
a	0.09	1.02	0.76	4.46	1.27	3.80
R^2	0 74		0.22		0.20	
F	38.55		3.78		3.25	

Notes 1 a is the constant value of the regression
2 R^2 is the coefficient of determination.
3. F is the F statistic value.

TABLE 9. Summary statistics of regression between the inflation rate and the nominal rate of interest

Maturity	Constant a	Beta b	Calculated t-value t(b)	Coefficient of Determination R^2	F statistic F
3 months	0.92	0.224	3.04	0.05	9.22
6 months	0.337	0.858	1.88	0.02	3.52
12 months	−2.969	1.672	3.62	0.07	13.13

TABLE 10. Summary statistics of multiple regression between the inflation rate, nominal rate of interest and one lagging period of inflation

Maturity	Constant a	Beta	Calculated t-value $b_1 t(b_1)$	Beta b_2	Calculated t-value $t(b_2)$	Coefficient of Determination R^2	F statistic F
3 months	0.451	−0.136	−2.24	0.755	12.59	0.50	88.12
6 months	0.607	−0.202	−1.22	0.916	34.65	0.88	614.12
12 months	0 925	−0.182	−1.76	0.968	59.45	0.96	911.1

coefficient c is significantly different from 0 for all categories. Thus, past inflation rates do carry valuable information in forecasting future price level and the nominal rate fails to summarize all relevant information available. The result shows a sign of inefficiency in the Malaysian T Bills market.

CONCLUSIONS AND IMPLICATIONS

This study examines the validity of the Fisher effect in the Malaysian T Bills market by exploring the interactions among the three variables, namely, the nominal rate of interest, the real rate of interest and the expected inflation rate. Positive association exists between the nominal rate of interest and the expected inflation. An increase in the latter will cause the former to move in the same direction. However, the proportion of increase is robust with respect to the length of the holding period. Nominal return on longer maturity assets is affected more as compared to the shorter maturity assets when the public expects the price level to increase in the future. Assets with maturity of 3 months respond by less than unity while 12 months assets respond by greater than unity to an increase in the expected inflation. Nominal return on the 6 months asset is consistent with the Fisher hypothesis since the return increases in approximately the same proportion with the increase in the price level. However, the test indicated that expected inflation plays a minor role in determining the nominal return on the T Bills.

In contrast to the Fisher Effect, the expected real rate was found to be negatively related to the expected inflation. The strong negative relationship is significant at all maturity levels. Thus, the nonvariant character proposed by Fisher is rejected. In addition, the price level appears to be a major factor which determine the expected real rate. Based on this, the Fisher effect is rejected.

Past inflation rates provide a weak explanatory power towards the determination of the nominal or real rates. However, nominal rates on shorter maturity assets were influenced more by the past inflation rates. No clear relationship exists between the past inflation rates and the current nominal rates of the bills. Past information of price levels is not valuable in forecasting the nominal rates. The same is true for the real rate of interest.

The nominal rate of interest is not a good predictor of future inflation rate. It fails to incorporate all relevant information from previous price levels. Historical rates of inflation do provide a meaningful information in forecasting future price level. This implies inefficiency in the Malaysian T Bills market.

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