

What determines the yields for treasury bills in Pakistan?

Shahid Ali, Muhammad Rafiq and Saleem Gul

Institute of Management Sciences, Peshawar

Treasury bills are financial tools to maintain and control liquidity in economies. Liquidity has implications on business activities and therefore has considerable importance for economic growth. Pricing of financial tools adjust to demand and supply forces. The macroeconomic landscape of Pakistan largely depends on interventions made by the State Bank of Pakistan through its monetary policy. Treasury bills are assumed to perform a dual role of maintaining liquidity while keeping inflation low. The yields on securities primarily depends on the terms of maturity however there could be many other factors that affect the yields of treasury bills in Pakistan. There is little empirical research available that empirically measures the effects of all underlying factors on the yields of treasury bills in the native economy. Term of maturity is an important consideration when it comes to determining the yields on securities. Yields on Treasury Bills in Pakistan may involve other factors apart from term premiums. Term premiums have been studied by notable researchers around the world using sets of macroeconomic factors as independent variables. This paper considers macroeconomic factors more relevant to the Pakistani context that play towards shaping the bid and offer rates of Treasury Bills locally. This paper adopts the Risk-Averse Preferred Habitat Model suggested by (Heuson, 1988) by taking term premiums as explained variable. The set of macroeconomic factors include un-expected changes in stock prices, money supply, consumer price index, and the prime rate. The paper uses a theoretical framework and builds testable hypotheses. Data is taken from State Bank of Pakistan, International Monetary Fund, World Bank, and Karachi Stock Exchange. Formal diagnosis of Durbin-Watson Statistic and Variance Inflation Factors is carried out for checking typical regression problems. Included data does not suffer from serious autocorrelation and multicollinearity and therefore regression estimates could be trusted more. Prime rate (KIBOR) is found to be the most significant determinant of yields on T bills whereas other modeled variables are insignificant though mostly they show expected signs for their coefficients.

Key Words: Treasury bills, liquidity preference, yields, determinants

State Bank of Pakistan (SBP) regularly floats treasury bills of varying maturities that reflect upon the monetary policy to maintain liquidity. These bills are mostly aimed at controlling excess liquidity in the economy and have a two-pronged agenda. In the recent past SBP has been taking a strict monetary stance as it has been trying to control inflation by managing liquidity. Monetary exchange rates are also controlled by monetary interventions. In Pakistan, T bills have maturities of three months, six months, and one year and are issued in accordance with Public Debt Act of 1944. This form of investment is open for both indigenous and foreign nationals and can be purchased from primary or secondary markets. They are only redeemable at maturity and are highly liquid. They are viewed as risk free options of investment as they are backed by Government of Pakistan. The market based financial liberalization policies have added value to economic transactions as they have ensured greater transparency and have minimized transaction costs. The yields of T bills have severe implications on interest spread charged by sellers of money to buyers of money. These spreads affect cost of capital and resultantly affecting consumption and investments. There is considerable literature available on the topic that links the yields of T bills

with different variables of macroeconomy like researchers have attempted to use these yields as determinants of interest rates in Pakistan. (Bain, 1951: Ho & Saunders, 1981: Neumark & Sharpe, 1992: Samuel & Valderrama, 2006) T bills of different denominations are floated fortnightly by SBP and rates are offered to investors who bid and buy them SBP, (2008). Little work seems to have addressed the determination of yields of treasury bills in Pakistan. There could be many plausible factors that determine these yields in the indigenous financial markets.

In the local context the selected macroeconomic variables include changes in stock prices, consumer price index, prime lending rate, and money supply. The market proxy for changes in stock prices is Karachi Stock Exchange's KSE 100 index. The change in this index portrays anticipation of equity investors and would show unexpected rise or fall in the equity market reflecting on the status of the economy as improving or disproving. An improvement or rise should suggest increase in required rate of return on Treasury bills as the cost of acquiring funds is likely to increase. The cost of funds for banks is approximated by prime rate or interbank and is usually termed Karachi Inter-bank Offer Rate (KIBOR). If prime rate increases this should imply that banks interested in investing in T bills would demand higher required yields. Broad money is believed to be another important macroeconomic consideration that is likely to affect the prices of T bills. Increase in money supply in the market is

Correspondence concerning this article should be addressed to Shahid Ali, Assistant Professor at Institute of Management Sciences, Hayatabad Peshawar Email: shahid.ali@imsciences.edu.pk

supposed to lower the yields as excess supply is going to bid up its price. It was noted by Fama & Gibbons (1984) who believed that unanticipated inflation determines security prices.

This paper examines the relationship of yields of one year treasury bills with stock returns, broad money, inflation, KIBOR, and GDP growth by making a theoretical framework and uses standard statistical procedures to conclude findings. In doing so, the paper relies upon most recent data from State Bank of Pakistan, International Monetary Fund, The World Bank, and Karachi Stock Exchange.

Literature Review

Finance theory offers several expectations hypotheses when it comes to predicting the term structure of interest rates. Most of the expectations hypotheses suggest that bond prices are determined on the basis of implied forward rates and expected spot rates. The liquidity preference theory was given by Keynes (1936) which inferred that investors demand high premium on long term maturities as it is less risky to hold cash. Hicks (1946) (Hicks, 1946) extended the liquidity preference theory by putting more weight on the risk preferences of investors on expected spot rates in future. Hicks theoretical assertion was that risk aversion of market participants in terms of increasing maturity amounts should place the expected spots greater than the forward rates. This work implied that maturity of the term of the security was given more weight under the extension of liquidity preference theory. The theoretical paradigm suggested by this work was that for longer term securities some premium had to be added to the return to incite investors for holding long term securities. Term premiums were explained differently by (Culbertson, 1957) and some other researchers in a market segmentation hypothesis. This hypothesis presented a scenario that investors have maturity preferences that differ in markets where bonds of differing maturities are offered. The hypotheses also theorized that bonds' prices are little affected by neighboring bond maturities in different markets. Another theoretical stance was taken by Modigliani & Stuch (1966) in their preferred habitat theory by taking some similar assumptions as market segmentation theory. This work was aimed at rationalizing the term premiums in context of differing maturities by looking at different expectation theories. The theories presented above revolved more around the discussion of the closeness of forward rates with expected spot rates. Determining the term premiums required further investigation which contemporary researchers noted. Realizing this need Roll (1970) tested a mean-variance model by using conditions of market efficiency. A more recent attempt in determining the term premiums is made by (Cox, Ingersoll, & Ross, 1985). This work was pitched in the general equilibrium theory and involved key assumptions of the earlier expectation theories. Due consideration was given in this model to risk preferences of investors, consumption timings, features of alternative investment options, and future events' anticipations. This model permitted the effects

of underlying variables in the term structure of interest rates. The behavior of returns carry due credence and (Fama F. E., Short Term Interest Rates as Predictors on Inflation, 1975) concludes in a hypothesis that this behavior is constant through time. This returns' behavior of US Treasury Bills is also consistent with the market efficiency paradigm that postulates that price-setting of these instruments. The study further adds that autocorrelations of real returns on US T Bills are almost zero as market uses efficient information on past changes while determining their current rates. The hypothesis about constant-behavior of returns was retested by Fama (1976) by studying the relationship between real expected returns and the uncertainty in the real returns and especially the uncertainty traceable due to inflation. The earlier proposed hypotheses was modified to another form which theorized that uncertainties in real returns related to inflation are associated with the risk-type the market reimburses. The study further paves a way for researching determining the prices of treasury bills and proposes the mean-variance portfolio approach by mentioning the limitations that may come up. In the traditional portfolio mean-variance approach each security real returns are linearly associated with the real returns of the market and the risk of the security contributes to the total risk in the market. Fama proposes that expected returns of T bills and its covariance with market expected returns for different maturities could be worked out to see whether there is a correspondence of expected returns of T bills with differences in risk estimates. It is believed that covariances observed would be small in nature as T bills are low risk or risk free instruments. Choosing a proxy of market returns would be difficult to obtain and assumptions have to be made to get a more realistic market portfolio. Risk bearing securities otherwise would not suffer from this limitation. This study by Fama (1976) further reports that returns on long-term T bills are larger than returns realized on short-term bills and in case of long-term bills the risk differences are supposed to be associated with uncertainty in future expectations about inflation rates.

(Khwaja & Din, 2007) conducts a study for determining interest spread in Pakistan and show their skepticism about low effectiveness of bank-borrowing channels. Their study reports that in total bank deposits the share of interest-intense deposits is one major determinant of interest spread in Pakistan. (Hassan & Javed, 2009) establishes a relationship between equity markets and monetary variables in the Pakistani context. Their study uses rigorous econometric procedure in concluding a short-term relationship between returns from equity markets and monetary variables. A study is done by (Thenmozhi & Nair, 2014) in which they have taken treasury bond prices as an explained variable by taking numerous macroeconomic explanatory variables. Their study is done for both developed and emerging markets and the authors confirm that economic fundamentals do affect bond returns.

Method

There is a need to develop a theoretical model that could provide a functional form preferable non-linear which could explain the term premiums of a T bill determined by both macroeconomic factors and its maturity terms. This requirement paves the way to adopt the approach used by (Heuson, 1988). Using this approach a model for this study could be developed.

The term premium is defined as follows

$$R(\theta, t) - R(t) \text{ _____ (i)}$$

Where $R(\theta, t)$ in (i) is yield to maturity of a default-free bond that promises the payment of \$1 in θ periods and is measured at time period t

$R(\theta)$ is yield on similar security that matures at the shortest possible time interval at time period t

Using the term premium the following model could be suggested for bringing the explained and explanatory variables under a statistical relationship using which factors could be identified in pricing of T bills indigenously.

$$\Gamma(\theta, t) = \beta t \ln(\theta) + \epsilon t \text{ _____ (ii)}$$

$$\beta t = \gamma_0 + \sum_{i=1}^m \gamma_i X_{i,t} \text{ _____ (iii)}$$

In the mentioned (ii) and (iii) γ_i 's are constants with $X_{i,t}$ the values from macroeconomic factors in time t . There are random errors assumed in the first model that are believed to be independent of the regression coefficients. The model described in (ii) exhibits γ_0 as non-zero only when term premiums are fully explained by term structure meaning that term premiums should assume a logarithmic curve. This should also suggest that coefficients for term premiums (βt) be positively related in period t to risk aversion of investors in market. The following form of the equation from the above mentioned two equations could be easily obtained

$$R(\theta, t) = R(t) + \gamma_0 \ln(\theta) + \sum_{i=1}^m \gamma_i X_{i,t} \ln(\theta) + \epsilon t \text{ _____ (iv)}$$

We could estimate (iv) equation on a pooled time series dataset where we have different values of θ in time periods t . The macroeconomic variables are represented by $X_{i,t}$ in the equation. In the local context the selected macroeconomic variables include changes in stock prices, consumer price index, prime lending rate, and money supply. The market proxy for changes in stock prices is Karachi Stock Exchange's KSE 100 index. The change in this index portrays anticipation of equity investors and would show unexpected rise or fall in the equity market reflecting on the status of the economy as improving or disproving. An improvement or rise should suggest increase in required rate of return on Treasury bills as the cost of acquiring funds is likely to increase. This should help us build our first hypothesis as follows;

Hypotheses

H₀₁: Unexpected rise in stock prices increases the required rate of return on T bills

Taking the same notion prime lending rate for banks should increase as the cost of acquiring funds increase. The cost of funds for banks is approximated by prime rate or interbank and is usually termed Karachi Inter-bank Offer Rate (KIBOR). If prime rate increases this should imply that banks interested in investing in T bills would demand higher required yields. This should bring us to the second hypothesis in this work.

H₀₂: Rise in prime rate increases the required yield on T bills for banks

We could also associate changes in CPI to yields at maturity of T bills. Theoretically speaking, consumer price index indicates the rise in general price level in the economy. It was noted by (Fama & Gibbons, 1984) who believed that unanticipated inflation determines security prices. To keep real rate constant in short run in case of unanticipated inflation there is additional premium required for compensation. In light of this discussion the following hypothesis could be shaped.

H₀₃: Unanticipated inflation increases the required rate of return on T bills

Broad money is believed to be another important macroeconomic consideration that is likely to affect the prices of T bills. Increase in money supply in the market is supposed to lower the yields as excess supply is going to bid up its price. This discussion leads us to frame the following hypothesis.

H₀₄: Increase in rate of change of money supply decreases the required rate of return on T bills

The presented four hypotheses could be tested using data on all concerned variables where the macroeconomic variables are hypothesized to have the following signs in the regression relationship where real return is a dependent variable.

Variable	Hypothesized Sign Of Coefficient
Increase in stock prices	Positive (+)
Increase in prime rate	Positive (+)
Increase in inflation	Positive (+)
Increase in money supply	Negative (-)

Equation (iv) given above could be further modified in the following form that would enable testing our hypotheses on the basis of available data.

$$R(\theta, t) = \alpha_0 + \gamma_0 \ln(\theta) + \gamma_1 S_t^u \ln(\theta) + \gamma_2 P_t^u \ln(\theta) + \gamma_3 I_t^u \ln(\theta) + \gamma_4 M_t^u \ln(\theta) + \epsilon_t \text{ (vi)}$$

Where $R(\theta, t)$ is average yield of a T bill in year t with 365 days to maturity; S is the rate of change in share prices, P is the change in prime rate, I is the change in inflation, and M is the change in money supply. The yield on maturity with the shortest possible maturity term is deemed constant and is denoted by α_0 in the model. The stated regression model in (vi) may suffer from conventional regression problems. Diagnostics are carried out to identify regression problems and then to pursue regression using standard statistical smoothing. Serial correlations can pose serious threats in giving reliable estimates for the coefficients. Durbin Watson test measures the amount of serial correlation which conventionally is stated as follows;

$$\sum_{t=2}^T (e_t - e_{t-1})^2 / \sum_{t=1}^T e_t^2 \text{ (vi)}$$

When the value of (vi) is equal to 2 there may be no evidence of autocorrelation. A value reasonably lower or greater than 2 indicates negative or positive autocorrelation respectively. Another potential threat to regression coefficients is the presence of multicollinearity which could be detected using a number of diagnostics. Highly correlated predictors lower our confidence in estimated values of the dependent variable. The paper suggests using Variance Inflation Factors (VIF) in measuring serious correlations between predictors. Multicollinearity between predictors would be considered serious if $VIF > 10$.

Data & Findings

Data about treasury bills of different maturities is available from State Bank of Pakistan. The bills are offered in 3-month, 6-month, and 12-month maturities. The average cut-off yield in a spreadsheet form is used from 2004 to 2014. Changes in stock prices in the same period are computed using data from Karachi Stock Exchange. Data about prime rates, inflation rates, and money supply are gathered from different reports of State Bank of Pakistan. Table 1 gives a statistical summary of included variables. In the last eleven years the average t bill yield has been 9.91% with very low variation. Almost similar variation is observed in 12 month KIBOR with an average rate of 10.64%. As expected the highest volatility is observed in equity returns and has given the highest returns to its investors.

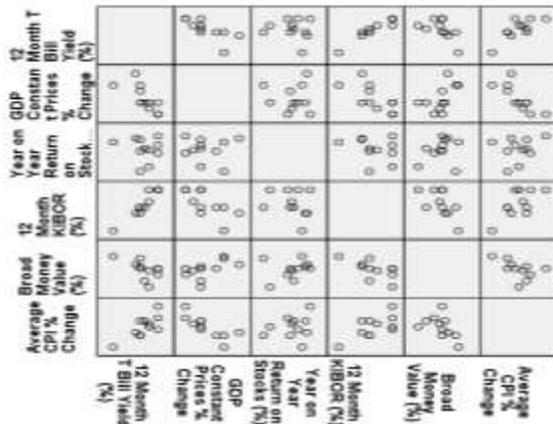
Table 1
Summary Statistics

	Mean	SD
12 Month T Bill Yield (%)	9.91%	.02914
GDP Constant Prices % Change	4.73%	.02240
Year on Year Return on Stocks (%)	11.00%	.44184
12 Month KIBOR (%)	10.64%	.02248

Broad Money Value (%)	14.55%	.04367
Average CPI % Change	10.91%	.03727

Figure 1 gives a summary of scatter plot for possible pairs of variables. It is readily observable from the following matrix of plots that variables are showing different kind of relationships with the dependent variable and also in-between predictors. A positive correlation exists between 12 month T bill yield and 12 Month KIBOR and which makes sense too. Some relationships are not comprehensible like 12 Month KIBOR and Year on Year Return on Stocks do not seem to have any correlation.

Figure 1



In order to detect multicollinearity and autocorrelation the paper relies on Durbin-Watson Statistic (DWS) and Variance Inflation Factors (VIFS). If we notice in Table 2 the DWS is 1.92 which is close enough to 2 and does not pose a real threat to our regression estimates. A higher R-squared value increases our confidence in giving closer estimates for yield of one-year t bill rates. The regression coefficients reported in Table 3 after factoring multicollinearity and autocorrelation are posing a more reliable estimation picture as the F-statistic is found to be significant in finding estimates for 12 Month T Bill Yields. The value computed is 0.003 for F-test which is well below the threshold level of 5%. A higher value of R-Square also suggests that the fitted model has included most of the relevant determinants in predicting the 12 Month T Bill Yields.

Table 2
Model Summary^b

Model	R	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.776 ^a	.602	.01898	1.92

a. Predictors: (Constant), Average CPI % Change, Year on Year Return on Stocks (%), Broad Money Value (%), 12 Month KIBOR (%), GDP Constant Prices % Change
 b. Dependent Variable: 12 Month T Bill Yield (%)

The regression coefficients take a deep effect of these two problems and some smoothing would take place if the problems are intense. Table 3 shows VIF values for all variables below 10, which suggests multicollinearity is not posing any big threat to our regression coefficients.

Table 3
Regression Coefficients^a

Model	B	SD	Beta	t	Sig.	Tol.	VIF
(Constant)	-.047	.035		-1.328	.242		
GDP Constant Prices % Change	.006	.226	.005	.027	.979	.315	3.175
Year on Year Return on Stocks (%)	.001	.008	.019	.155	.883	.606	1.651
12 Month KIBOR (%)	1.094	.220	.844	4.968	.004	.329	3.040
Broad Money Value (%)	.053	.088	.079	.599	.575	.548	1.824
Average CPI % Change	.196	.151	.250	1.298	.251	.255	3.917

a. Dependent Variable: 12 Month T Bill Yield (%)

Table 3 also reports regression coefficients for our developed regression equation earlier in the methodology. Only 12 Month KIBOR is found to be significant in explaining 12 Month T Bill Yields. The other variables are found to be insignificant. All tests are performed at 5% level of significance. The standard error statistics are found to be smaller for all variables despite of the fact that only eleven years data was used in exploring major relationships.

The data analysis carried out for this paper suggests that according to our expectations the coefficient of rise in stock prices does have a positive coefficient which goes in favor of theory; however it is not statistically significant. Stock returns does seem to have implications on T-bill yields as it fits in the overall regression sense of producing changes in them. Though we cannot accept H_{01} but have reason to believe that with rising stock prices T-bill yields also go up. The second hypothesis which was conjectured earlier is accepted as not only the sign of the coefficient for prime rates is positive but is also significant. This is again a sense making acceptance as measuring returns on assets and portfolios are benchmarked and in Pakistan KIBOR is a widely used benchmark in computing interest rates. The third hypotheses about inflation could not be accepted as the coefficient is not found significant in explaining T-Bill yields. The sign of the coefficient for inflation does meet expectations and contributes to the theoretical standpoint in conventional finance. While working towards the fourth hypotheses about money supply, the sign of the coefficient is positive and is against the theoretical conviction. The coefficient is found insignificant as well. Since the study suffers from limitation of fewer data value which may be a potential reason for this finding. However, in future research could unfold determinants for T-Bill yields of other maturities like monthly, six monthly, and nine monthly yields etc with longer panel sets.

Conclusions

Little work seems to have addressed the determination of yields of treasury bills in Pakistan. There could be many plausible factors that determine these yields in the indigenous financial markets. In the local context the selected macroeconomic variables include changes in stock prices, consumer price index, prime lending rate, and money supply. The market proxy for changes in stock prices is Karachi Stock Exchange's KSE 100 index. The change in this index portrays anticipation of equity investors and would show unexpected rise or fall in the equity market reflecting on the status of the economy as improving or disproving. An improvement or rise should suggest increase in required rate of return on Treasury bills as the cost of acquiring funds is likely to increase. The cost of funds for banks is approximated by prime rate or interbank and is usually termed Karachi Inter-bank Offer Rate (KIBOR). If prime rate increases this should imply that banks interested in investing in T bills would demand higher required yields. Broad money is believed to be another important macroeconomic consideration that is likely to affect the prices of T bills. Increase in money supply in the market is supposed to lower the yields as excess supply is going to bid up its price. It was noted by (Fama & Gibbons, 1984) who believed that unanticipated inflation determines security prices. This paper considers macroeconomic factors more relevant to the Pakistani context that play towards shaping the bid and offer rates of Treasury Bills locally. This paper adopts the Risk-Averse Preferred Habitat Model suggested by Heuson (1988) by taking term premiums as explained variable. The set of macroeconomic factors include unexpected changes in stock prices, money supply, consumer price index, and the prime rate. The paper uses a theoretical framework and builds testable hypotheses. Data is taken from State Bank of Pakistan, The International Monetary Fund, The World Bank, and Karachi Stock Exchange. Formal diagnosis of Durbin-Watson Statistic and Variance Inflation Factors is carried out for checking typical regression problems. Included data does not suffer from serious autocorrelation and multicollinearity and therefore regression estimates could be trusted more. Prime rate (KIBOR) is found to be the most significant determinant of yields on T bills whereas other modeled variables are insignificant though mostly they show expected signs for their coefficients.

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Received: May, 14th, 2014

Revisions Received: Jan, 1st, 2015