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Predicting Inflation and Output in Pakistan: The Role of Yield Spread

Fida Hussain[*] and Asif Mahmood[#]

Abstract

This paper presents the empirical evidences on the predictability of yield spread, particularly with respect to inflation and output growth in Pakistan. To our knowledge, this study is the first of its kind in case of Pakistan. We also test the role of foreign interest rates such as of the US in influencing the domestic interest rates in Pakistan and their contribution towards predicting inflation and output growth as well. Our results indicate that the yield spread in Pakistan do contain information about future changes in output growth but not for inflation. Both in-sample and out-of-sample forecasts for output growth show that the predictive content span from 6 to 24 months in future across the yield spreads. Use of the US yield spread further increases the predictability of domestic yield spread for output growth. In case of inflation, the results are found to be insignificant across different horizons and measures of yield spreads.

JEL Classification: E43, O47, E31, C53
Keywords: Yield curve, inflation, output, forecasting

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Non-technical Summary

The slope of the yield curve, i.e. the yield spread, is often used by financial market analysts and policy makers as an indicator of future economic activity and inflation. There is a consensus in literature that short-term interest rates are normally influenced by monetary policy stance of the central bank, while long-term interest rates are believed to reflect market views on evolving macroeconomic conditions, particularly its expectations about output growth, inflation expectations, credit risks and expected real yields. The rationale is that financial variables are inherently forward looking as they rapidly assimilate developments in various sectors of the economy, which are usually not observable on real time basis.

The researchers in recent years have shown immense interest in using term structure of interest rates to assess private sector's expectations about future inflation and economic conditions. A number of studies provide empirical evidence concerning predictive power of the term structure of interest rates. Nevertheless, most work related to predictive power of the yield spread has mainly focused on advanced countries. In case of emerging economies, however, the empirical literature related to ability of yield spread to predict both inflation and output can be considered as scarce.

Recently in Pakistan too, policy makers and financial analysts in Pakistan often refer to changes in term structure of interest rates as reflecting changes in market expectations about future inflation, economic activity, and thus the monetary policy stance. This is particularly true in the context of significant changes in the financial markets witnessed in the last two decades. These changes have gradually increased the role of market interest rates in making future financial decisions.

In this backdrop, we attempted to explore the leading indicator qualities of the yield spread in Pakistan, particularly in the context of predicting inflation and output growth. We applied standard methodologies which are extensively used for answering this kind of empirical question in economic literature. We also attempted to capture the influence of international financial linkages using the changes in US interest rates. Our findings show that the yield spread in Pakistan is a good indicator of future output growth in Pakistan, particularly for horizons beyond 6 months and up to 2 years. These results are confirmed by both in-sample and out-of-sample forecast performance. We also found that the use of the US yield spread increases the predictive power of domestic yield spread. Unlike output growth, however, we could not find any significant role of yield spread in predicting future inflation in Pakistan.

1. Introduction

The yield curve or term structure of interest rates contains useful information in respect of future movement in inflation, economic activity, and short term interest rates (Wheelock and Wohar, 2009)[1]. There is a consensus in literature that short-term interest rates in the economy are normally influenced by the monetary policy stance of the central bank, while long-term interest rates are believed to reflect market views on evolving macroeconomic conditions, particularly its expectations about output growth, inflation expectations, credit risks and expected real yields. The rationale is that financial variables are inherently forward looking as they rapidly assimilate developments in various sectors of the economy, which are usually not observable on real time basis[2].

Researchers have recently shown immense interest in using term structure of interest rates to assess private sector's expectations about future inflation and economic conditions. A number of studies provide empirical evidence concerning predictive power of the term structure of interest rates. Fama (1975) found the nominal interest rates leading the movements in US inflation during 1953-71. These findings were also found consistent with the actual data observed subsequently. Fama (1977) came up with more assertive conclusion that "interest rate remains the best single predictor of inflation". Mishkin (1988 and 1990) showed that term structure of nominal interest rates contain substantial information about inflation, i.e., the term structure of real interest rates. He also found that the yield spread is not very accurate in predicting short-term inflation but forecasts do get slightly better as the forecasting horizon increases. Fama (1990) also reached similar conclusions.

According to Fisher hypothesis, the yield curve should contain information mainly about future path of inflation[3]. However, a number of recent studies have shown that slope of the yield curve has a significant predictive power for changes in economic activity. The pioneer work demonstrating predictive power of the yield spread for real activity includes Stock and Watson (1989), Harvey (1991) and Estrella and Hardouvelis (1991) [4]. Most of these studies also show that yield spread performs quite well in predicting recessions[5]. Findings of a survey of recent research on usefulness of the information content of term structure by Wheelock and Wohar (2009) show that most of the studies have found the term spread as useful indicator for predicting output growth and recessions 6 to 12 month in advance. The survey also

[1] Yield curve or term structure of interest rates represents the relationship between the maturities and the yields of government securities. See appendix A for typical shapes of the yield curve and their possible economic interpretations.

[2] Ang and Piazzesi (2003) found that about 85 percent of the variations in bond yields at shorter end are explained by innovations in macro factors and the movements in longer-end bond yields are mostly influenced by unobservable factors. According to Evans and Marshal (2007), movements in long-term interest rates of almost all maturities are driven by developments in major sectors of the economy and changing path of key macroeconomic variables. This implies that the level and slope of the yield curve strongly responds to the changes in macroeconomic conditions. Fama (1975) argued that market uses all available information likely to have effects on future inflation while setting the nominal interest rates of one month to six months. This means that market incorporates its assessment about changes in purchasing power over the one month to 6 month period. Also see Bernanke and Blinder (1992) for details.

[3] According to Fisher (1930), the nominal interest rates could be decomposed into real interest rate and expected inflation, adjusted for risk premium.

[4] For more details, see Dotsey (1998), Hu (1993), Haubrich and Dombrosky (1996), Tse (1998), and Estrella (2005).

[5] Estrella (2005) in particular argued "*the yield curve has predicted essentially every US recession since 1950 with only one "false" signal, which preceded the credit crunch and slowdown in production in 1967."*

shows that term spread provides more reliable predictions for recessions than the forecasts for output growth.

Besides having explanatory power for predicting inflation and economic activity, the literature shows that term structure of interest rates is often taken as an indicator of likely monetary policy stance[6]. After the seminal work by Irving Fisher in 1930, Fama (1984a and 1984b) and Fama and Bliss (1987) provide empirical evidence that longer maturity forward interest rates help in forecasting distant future spot rates. Mishkin (1988) finds term structure helpful in predicting future short-term interest rates several months in advance. Mishkin's later studies show that term structure of nominal interest rates of up to 6-month maturities does provide information about the term structure of the real interest rates.

Nevertheless, most work related to predictive power of the yield spread has mainly focused on advanced countries. In case of emerging economies, however, the empirical literature related to ability of yield spread to predict both inflation and output can be considered as scarce with a few exceptions including a study by Mehl (2006)[7]. The study used a sample of 14 emerging economies to explore the usefulness of sample country's slope of the yield curve to forecast inflation and growth both for short and long run horizons. The findings shows that the yield curve has information content in almost all countries in the sample while predicting output growth up to 2 years. However, yield spread could also predict inflation for half of countries. The study also found the significant role of the US interest rates in influencing the yield spread in selected emerging economies.

To our knowledge, the empirical work exploring the predictive power of yield spread in case of Pakistan is non-existent. Moreover, policy makers and analysts in Pakistan often refer to changes in term structure of interest rates as reflecting changes in market expectations about future inflation, economic activity and thus the monetary policy stance[8]. In this context, it would be interesting to see the empirical support, particularly when financial markets in Pakistan have undergone significant changes during the last two decade.

In this backdrop, the objective of this paper is to explore if yield spread in Pakistan could provide useful information about future inflation path and the direction of economic activity. For this purpose, we use standard methodologies surveyed by Stock and Watson (2003) and Mishkin (1990) for predicting both inflation and output growth up to 2 years. Given the importance and impact of changes in the US interest rates for emerging economies, we also attempt to explore this angle through empirical analysis. We perform both in-sample and out-of-sample forecasts to check the predictive power of yield spread while predicting output growth and inflation. To check the predictive power of yield spread in out-of-sample forecasts, we compare our results with simple Autoregressive (AR) model.

Our findings show that the yield spread is a good predictor of output growth in Pakistan, particularly for horizons beyond 6 months and up to 2 years. These results are supported by both in-sample and out-of-

[6] According to Frankel and Lown (1994), the steepening of the yield curve also suggests that the current monetary policy stance is expansionary and hint at plausible monetary tightening in the medium term to rein in inflation expectations. Moreno (2006) notes that nominal bond yields reflect market's views on future course of monetary policy.

[7] Elshareif and Tan (2009) examined the ability of term structure to predict inflation in Malaysia, Philippines and Thailand and found it useful indicator of inflation in case of Malaysia.

[8] SBP Monetary Policy Statement, July 2014

sample forecasts. Our findings also show that changes in the US interest rates (or yield spread) have significant impact on domestic interest rates in Pakistan, and its inclusion improves the predictive power of yield spread to forecast output growth. This latter finding is in line with empirical results of Caceres et. al (2016)[9]. Unlike growth, however, we do not find the significant results for predicting future inflation in Pakistan. When compared to other emerging economies, inflation volatility and thus uncertainty in Pakistan appears to be high which may have confounded the results in case of inflation prediction.

The rest of the paper is organized as follows. Section 2 presents the stylized facts on bond market in Pakistan. We also discuss the trends in the yield spread and other macroeconomic indicators during last decade. Section 3 details the empirical framework for testing the predictive power of yield spread for inflation and output growth in Pakistan. Section 4 describes the data issues. Section 5 discusses the results and caveats while last section makes the concluding remarks.

2. Stylized Facts

In Pakistan, the process of financial liberalization was started in the early 1990s. The beginning of auction based system for government securities paved the way for development of bond market. First auction of both short-term T-bills and longer term bonds were conducted in March 1991. After remaining successful in the earlier years, however, the Federal Investment Bonds (FIBs) lost their attractiveness[10]. Participation of financial institutions in bond auctions almost came to a standstill during fiscal year (FY) 1997-98 and bond auctions were subsequently suspended in June 1998[11].

Government resumed the auctions of bonds in December 2000 with the introduction of Pakistan Investment Bonds (PIBs) to replace FIBs. Investors were found keen to invest in the new long term bonds. However, increased external inflows reduced government's financing needs from the domestic sources[12]. Resultantly, government issued bonds worth Rs12 billion only during FY2004-05 and FY2005-06. Although, issuance was increased gradually from FY2006-07 onwards, the average share of bonds in total outstanding government securities remained around 38.0 percent. The relatively higher dependence on short-term T-bills overtime did not allow the development of long-term liquid secondary market in Pakistan[13]. Likewise, beginning from 1991 the government issued 6-month T-bills only. Afterwards, it also started issuing 3 and 12 month T-bills (from 1998 to date).

Figure 1 plots the trend in the yield spread – calculated as a difference between yield on 10-year bond and 3-month T-bills in the secondary market[14]. It could be observed that during the period from January 2003 to June 2004, the yield spread is positively sloped[15]. During July 2004 to December 2007, SBP increased

[9] Caceres et. al (2016) found significant pass-through impact of changes in the US interest rates in 43 selected emerging and advanced economies, including Pakistan. Specifically for Pakistan, their results showed that a 100 basis points unanticipated increase in the US interest rates could increase the domestic interest rates in Pakistan by 45 basis points in one year.

[10] For further details see Pakistan: Financial Sector Assessment 1990-2000.

[11] Fiscal year in Pakistan starts from 1st July and ends on 30th June.

[12] During FY2004-05 and 06, 66 percent of the total budget financing was met through external resources.

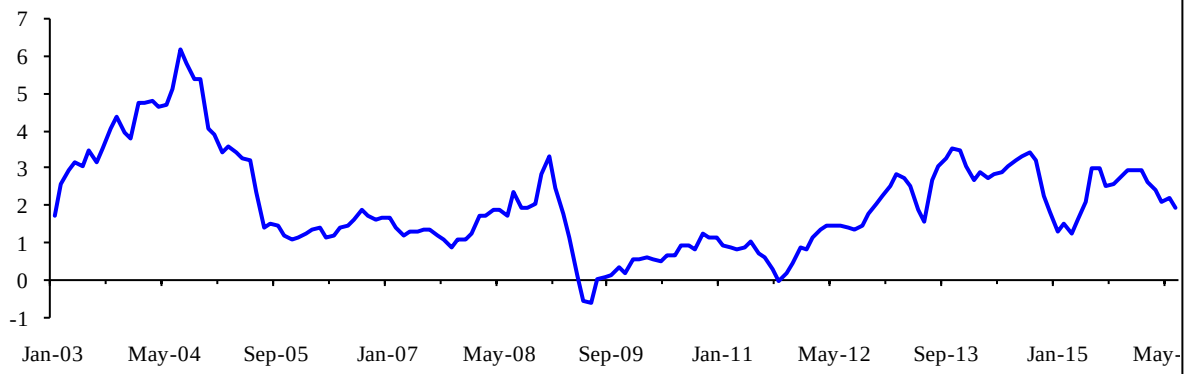
[13] The existence of National Saving Scheme (NSS) instruments - with normally attractive rates than the PIB rates - is another obstacle in the development of longer end of the yield curve in Pakistan.

[14] See figure B1 in appendix B for 3D presentation of the yield curve in Pakistan in the last decade.

[15] This was the time when private sector activities were booming and economy was witnessing considerable foreign capital inflows in the financial system. Inflationary pressures started to build up from October 2003, however, SBP

its market intervention rate in its regular open market operations (OMOs). This put upward pressure on short-term market interest rates, which resulted into a negatively sloped yield curve. Moreover, due to unprecedented increase in oil prices and subsequent pressure on Pak rupee-US dollar parity, the inflationary pressures emerged from December 2007 onwards. Subsequently, SBP geared up its policy tightening and increased the policy rate by 500 basis points in 2008 to 15 percent.

Figure 1: Trend in Yield Spread in Pakistan
(*Spread between yields on 10-year bond and 3-month treasury bill, in percentage points)*



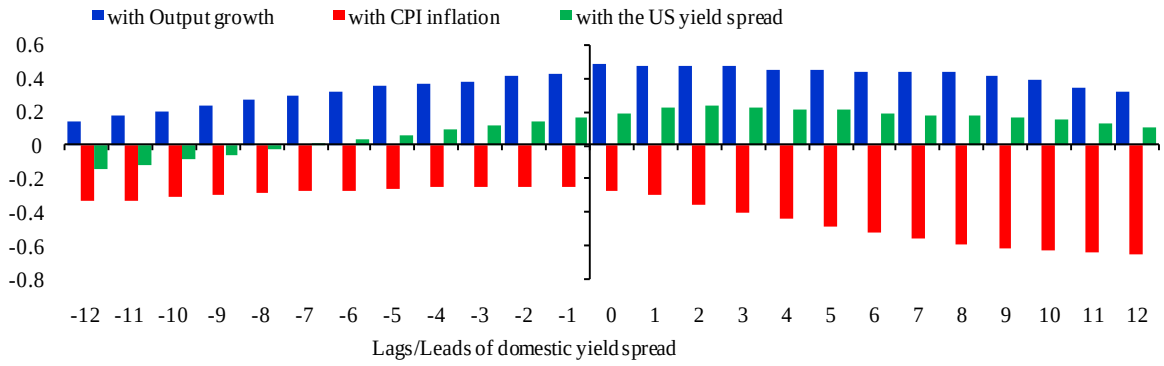
Source: Authors' estiimates

In August 2009, after abrupt movements in overnight repo rate, SBP adopted the interest rate corridor framework for monetary policy implementation. The focus to control short-term market interest rate i.e. overnight repo rate increased. Following this, market had adjusted their expectations about interest rate levels as slight upward trajectory could be observed in the yield spread in the earlier months. In FY16 yield spread increased despite decline in inflation. Such behavior, to some extent, could also be explained by the significant increase in PIB issuance from Rs522 billion at the end of December 2011 to Rs4,925 billion as of end June 2016.

Figure 2 exhibits the dynamic correlations of yield spread with year-on-year changes in headline inflation, which is calculated from the Consumer Price Index (CPI), and output growth [proxy by changes in Large-scale Manufacturing (LSM) index] in the last decade. Moreover, as discussed in previous section, correlation between the US and Pakistan yield spreads is also plotted. It could be seen that the yield spread in time '*t'* is positively correlated with output growth up to t+12 horizons. After peaking at t+3 months, the correlation starts moderating though with a lesser pace. Similarly, the US yield spread in time '*t'* is found positively correlated with the yield spread in Pakistan up to t+12 horizons. Similar as in case of output growth, the correlation increases up to 3 months in future after which it starts to decline gradually. However, in contrast to what theory says, the dynamic correlation with inflation is found negative in both lags and leads.

kept its policy rate unchanged at 7.5 percent. Subsequently, banks' participation in both short and long term debt auctions declined as they were already getting attractive returns from the private lending.

Figure 2: Dynamic Correlations between Yield Spread and Macroeconomic Variables



Note: The selected variables are used here as a base in time t while domestic yield spread having lags/leads Source: Authors' estimates

3. Estimation Methodology

To investigate the usefulness of the slope of the yield curve in Pakistan as a predictor of domestic inflation and growth, we follow the standard methodology used by Estrella and Mishkin (1997), Hamilton and Kim (2002) and Stock and Watson (2003). The slope of the yield curve, denoted as X_t, is defined as the difference in period t between the yield on the long-term domestic government bond, denoted i_t^l, and that on the short-term domestic T-bills, denoted i_t^s.

$$X_t = i_t^l - i_t^s$$

In case of output growth, the forecasting begins from next one-month up to k-month ahead in order to see the predictive power of yield curve along various time horizons. The basic model is estimated as;

$$Y_{t+k}^k = \beta_0 + \beta_1 X_t + \varepsilon_{t+k}^k \qquad (1)$$

where Y_{t+k}^k represents output growth over next *k* months, X_t represents term spread at time *t*, and ε_{t+k} represents error term. We use Large-scale Manufacturing (LSM) Index to proxy the output growth. LSM is transformed such that,

$$Y_{t+k}^k = \left({}^{1200}/_{k}\right) \times \ln\left(\frac{LSM_{t+k}}{LSM_t}\right)$$

The ${}^{1200}/_{k}$ is multiplied to standardize LSM growth in annualized form. Based on theoretical underpinnings discussed in the first section, the value of β_1 is expected to be positive in equation (1). Since the lagged output may be useful in forecasting the output growth, we estimate the model including those lags in (1) where the number of lags is chosen by AIC and SIC. The criterion suggests inclusion of first lag in case of Pakistan.

For testing the predictive power of yield spread in case of headline CPI inflation (π) in Pakistan, the basic model is similar to that of output growth model as;

$$\pi_{t+k}^{k} = \beta_0 + \beta_1 X_t + \varepsilon_{t+k}^{k} \quad (2)$$

Likewise LSM growth, we transform the π_t^k as;

$$\pi_{t+k}^{k} = \left({}^{1200}/_{k}\right) \times \ln\left(\frac{\pi_{t+k}}{\pi_t}\right)$$

Equation (2) is considered as 'inflation equation' where we want to see the predictive content of yield spread on inflation over the next *k* periods.

We also estimated 'change in inflation equation' as suggested by Mishkin (1990) and further refined and tested by Fama (1990), Mishkin (1991), Jorion and Mishkin (1991). Basically, we investigate whether the current spread between m-period and n-period interest rates includes information about the change of inflation between periods m and n. It stems from the Fisher equation that the nominal interest rate in time *t* with maturity in period m ($i_{t,m}$) may be decomposed into an ex-ante real interest rate ($rr_{t,m}$) in time *t* maturing in m and expected inflation (E_t) over the next m-periods in time *t*;

$$i_{t,m} = E_t\pi_{t,m} + rr_{t,m} \quad (3)$$

The expected inflation over the next *m*-periods equals actual inflation (perfect foresight assumption) in the period plus the forecast error of inflation ($\varepsilon_{t,m}$);

$$E_t\pi_{t,m} = \pi_{t,m} + \varepsilon_{t,m} \quad (4)$$

By combining equations (3) and (4) we obtain;

$$\pi_{t,m} = i_{t,m} - rr_{t,m} + \varepsilon_{t,m} \quad (5)$$

Since the objective of this study is to extract information about the future path of inflation embodied in the term structure, a similar equation for *n*-periods (*m* > *n*) must be subtracted from equation (5), which gives;

$$\pi_{t,m} - \pi_{t,n} = i_{t,m} - i_{t,n} - rr_{t,m} + rr_{t,n} + \varepsilon_{t,m} - \varepsilon_{t,n} \quad (6)$$

After rewriting the equation (6) into a regression form that will be used for empirical testing we obtain;

$$\pi_{t,m} - \pi_{t,n} = \alpha_{m,n} + \beta_{m,n}\left(i_{t,m} - i_{t,n}\right) + \mu_{t,m,n} \quad (7)$$

Equation (7) is considered as 'change in inflation equation.' If the null hypothesis $\beta_{m,n} = 0$ is rejected, the slope of the nominal yield spread ($i_{t,m} - i_{t,n}$) contains information about the change in the future inflation rate between periods *n* and *m*, and, at the same time, the slope of the nominal and the real yield spread do not move one for one in time. Moreover, if the null hypothesis $\beta_{m,n} = 1$ is rejected then the slope of the real yield spread is not constant over time and the slope of the nominal yield spread contains information about the real yield spread.

Furthermore, as discussed in literature review, to capture the effects of international financial linkages on movement of yield spread in Pakistan, we use the US yield spread data based on corresponding tenor rates. For this, we followed Mehl (2006) and tried to instrument the slope of the yield curve in Pakistan by using the US yield spread as an explanatory variable[16]. We then add the fitted series and residual from first stage regression as explanatory variable while predicting output growth and/or inflation in Pakistan. Specifically, we model the foreign linkage part for output growth prediction as;

$$Y_{t+k}^{k} = \beta_0 + \beta_1 \widehat{X}_t + \beta_2 \varepsilon_t + \mu_{t+k}^{k} \quad (8)$$

where $\widehat{X}_t$ and ε_t represents the fitted and residual from first stage regression when yield spread from Pakistan is instrumented by the US yield spread. As suggested by Mehl (2006), with $\beta_2 = 0$ suggesting that movements in the yield spread of Pakistan have no residual information content for future inflation and output growth beyond that was predicted by movements in the US yield spread. Otherwise, if $\beta_2 \neq 0$, this indicates that the yield spread in Pakistan do contain some information about future inflation and output growth.

4. Data

All the data series cover the period from January 2003 to June 2016[17]. While inflation is calculated through headline consumer price index (CPI), the inflation for different tenors is annualized. Similar treatment is also carried out for LSM growth. Monthly average of Pak rupee revaluation rates (PKRV) are used for all interest rates series. US interest rates are used as foreign interest rates[18]. See Table B2 in appendix B for further data descriptions.

5. Results and Discussion

Based on the empirical framework for this study, for both output growth and inflation, we divide our findings into three broad categories; results obtain from in-sample forecasts, results from pseudo out-of-sample forecasts and outcomes from the estimation capturing international financial linkages.

5.1. In-sample Forecast Results

5.1.1. Output Growth

Table 1 reports the results from estimation of equation (1). It could be observed from the table that beyond 3-month horizon, yield spread measured through different interest rate tenors tend to predict output (LSM) growth in case of Pakistan. The estimates suggest that 1 percent steepening of yield spread – measured from 3-year and 3-month tenors – is expected to increase the LSM growth by 1.6 percent in the next 6 months. Similarly, a 1 percent steepening of a yield spread which is made up of 10-year and 12-month interest rate tenors is expected to increase the LSM growth by 0.66 percent in the next 2 years. Importantly, it appears that predictive power of yield spread decrease with increase in forecasting horizon.

[16] See Table B1 in appendix B for results obtained from Granger causality tests applied at yield spreads of the US and Pakistan.
[17] For selected tenors, no consistent interest rates series is available before 2003 for interbank market in Pakistan. Due to this, the data sample used in this study is relatively small when compared to other studies on the same topic.
[18] See Table B2 in appendix B for further data descriptions

Also, across the yield spreads, spread between 10-year bond and 3-month T-bills rates is found to be significant in all horizons beyond 3 months. These results are in line with findings from the other emerging economies (Mehal 2006).

Table 1: One-Step Ahead In-Sample Forecast for Output Growth

(From equation (1), β_1 coefficients based on respective yield spread and output (LSM) growth horizon)

Horizon / Spread	k = 1 month	k = 3 months	k = 6 months	k = 12 months	k = 18 months	k = 24 months
3 year – 3 month	-0.002	1.053	1.617 **	1.544 ***	0.941 ***	0.860 ***
3 year – 6 month	0.615	1.293	1.889 **	1.713 ***	1.050 ***	0.998 ***
3 year – 12 month	0.239	1.247	1.715 *	1.611 ***	0.925 **	0.795 ***
5 year – 3 month	1.078	1.119	1.377 **	1.409 ***	0.872 ***	0.766 ***
5 year – 6 month	1.479	1.247	1.505 **	1.493 ***	0.933 ***	0.835 ***
5 year – 12 month	1.361	1.241	1.413 **	1.442 ***	0.864 ***	0.793 ***
10 year – 3 month	1.291	1.078	1.178 **	1.056 ***	0.725 ***	0.630 ***
10 year – 6 month	1.507	1.144	1.240 ***	1.090 ***	0.759 ***	0.668 ***
10 year – 12 month	1.480	1.162	1.076 ***	0.736 ***	0.736 ***	0.658 ***
No. of observations	160	158	155	149	143	137

Note: ***, ** and * denote statistically significant at the 1%, 5% and 10% level of confidence.

5.1.2. Inflation

Table 2 reports the results from equation (2) the 'inflation equation.' Unlike the findings in case of output growth, the results indicate that the yield spread is not a good predictor of inflation in Pakistan. Besides being statistically insignificance at almost each horizon, the sign of the estimated coefficients is negative, which is not in line with theoretical underpinnings about the information content of term structure about future inflation. Similar observations in case of inflation are also reported by Mehl (2006) for most of the other emerging economies. It also identified inflation volatility, variations in risk premia, permanent and positive productivity shocks, and the lack of liquidity of the domestic debt market as main reasons which distort the information signals embodied in securities prices in these emerging economies.

Table 2: One-Step Ahead In-Sample Forecast for CPI Headline Inflation

(From equation (2), β_1 coefficients based on respective yield spread and inflation horizon)

Horizon / Spread	k = 1 month	k = 3 months	k = 6 months	k = 12 months	k = 18 months	k = 24 months
3 year – 3 month	-1.385	-0.785	-0.402	-0.176	-0.026	-0.015
3 year – 6 month	-1.770	-0.918	-0.443	-0.199	-0.042	-0.018
3 year – 12 month	-1.959	-1.046	-0.503	-0.242	-0.067	-0.065
5 year – 3 month	-1.286	-0.569	-0.329	-0.115	-0.010	-0.023
5 year – 6 month	-1.487	-0.625	-0.345	-0.123	-0.017	-0.025
5 year – 12 month	-1.595	-0.684	-0.378	-0.144	-0.028	-0.049
10 year – 3 month	-0.982	-0.309	-0.134	-0.039	0.011	-0.006
10 year – 6 month	-1.079	-0.330	-0.135	-0.040	0.009	-0.006
10 year – 12 month	-1.142	-0.355	-0.145	-0.047	0.005	-0.016
No. of observations	160	158	155	149	143	137

Note: ***, ** and * denote statistically significant at the 1%, 5% and 10% level of confidence.

Furthermore, to check the predictive power of yield spread for inflation, Table 3 presents the estimation results for 'change in inflation' based on equation (7). Unlike findings from equation (2) where yield spread was found statistically significant in some cases, here it is found to be insignificant across all measures of spread and horizons. Moreover, except for change in inflation between 18 and 3 months in future, the coefficient has negative sign, which is inconsistent with the theory.

Table 3: One-Step Ahead In-Sample Forecast for Change in CPI Headline Inflation

(From equation (7), $\beta_{m,n}$ coefficients based on respective yield spread and change (Δ) in inflation horizon)

Horizon / Spread	ΔCPI = 6 – 1 months	ΔCPI = 12 – 1 months	ΔCPI = 18 – 3 months	ΔCPI = 24 – 3 months	ΔCPI = 24 – 6 months
3 year – 3 month	-0.602	-0.333	0.313	0.067	0.096
3 year – 6 month	-0.568	-0.269	0.364	0.085	0.081
3 year – 12 month	-0.693	-0.424	0.413	0.047	0.052
5 year – 3 month	-0.420	-0.230	0.184	0.024	0.077
5 year – 6 month	-0.388	-0.189	0.206	0.031	0.068
5 year – 12 month	-0.450	-0.271	0.229	0.009	0.055
10 year – 3 month	-0.118	-0.075	0.072	-0.025	-0.012
10 year – 6 month	-0.093	-0.049	0.082	-0.023	-0.019
10 year – 12 month	-0.115	-0.088	0.091	-0.038	-0.031
No. of observations	155	149	143	137	137

Note: ***, ** and * denote statistically significant at the 1%, 5% and 10% level of confidence.

5.2. Out of Sample Forecast Results

To check the predictive power of yield spread, we perform out-of-sample forecasts across different tenors for one year ahead. However, we perform this analysis for output growth only as yield spread is not found to be a good predictor of future inflation in Pakistan. As suggested by Stock and Watson (2003), the predictive power of yield spread forecasting model would be examined by comparing root mean square error (RMSE) of spread models against the simple Autoregressive (AR) models which includes only lagged value of the dependent variable. The relative RMSE ratio is calculated as;

$$\text{Relative RMSE ratio} = \frac{\text{RMSE of yield spread forecasting model}}{\text{RMSE of AR model}}$$

The lower value of RMSE indicates the more accurate forecasting performance. The value of relative RMSE ratio below 1 would indicate that the spread forecasting model outperforms simple AR model.

Table 4 reports the relative RMSEs of out-of-sample forecasts results for output growth and of simple AR models. For this exercise, we only select those horizons which were found to be significant based on Table 1 results. Only 5 observations, out of 36 calculations for relative RMSEs, have ratio below unity, indicating better performance of yield spread model than AR model. Also, all these relatively lower RMSEs found while forecasting output growth for the next 12 months.

Table 4: Out-Of-Sample Forecast Results for Output Growth

(Relative RMSE ratio)

Horizon / Spread	k = 6 months	k = 12 months	k = 18 months	k = 24 months
3 year – 3 month	1.095	**0.922**	1.506	2.562
3 year – 6 month	1.136	1.033	1.682	3.095
3 year – 12 month	1.173	1.171	1.775	3.483
5 year – 3 month	1.161	**0.891**	1.370	2.259
5 year – 6 month	1.199	**0.966**	1.474	2.511
5 year – 12 month	1.237	1.073	1.562	2.704
10 year – 3 month	1.223	**0.919**	1.255	1.686
10 year – 6 month	1.261	**0.984**	1.324	1.797
10 year – 12 month	1.305	1.074	1.404	1.915

Note: Bold figure represents best model specification

5.3. Impact of International Financial Linkages in Predicting Output Growth in Pakistan[19]

Based on equation (8), Table 5 presents the results about the influence of international integration of domestic financial markets in Pakistan. As discussed above, we use the yield spread calculated using interest rates on US bonds and T-bills to proxy the impact of international financial linkages. It could be observed from Table 5 that when yield spreads in Pakistan is instrumented by the US yield spreads, the results for 6 to 24 months forecasting horizons is not only found to be statistically significant but also explains most variations in LSM growth, i.e. $\beta_2 = 0$ based on Wald test.

Specifically, the results indicate that when yield spread in Pakistan is instrument by the US yield spread, its predictive power increases while predicting out growth in Pakistan, particularly when compared to results provided in Table 1. For instance, when predicting output growth for next 6 month, using an instrumented yield spreads shows that a 1 percent increase in spread is expected to increase the output growth in the range of 1.5 percent to 2.5 percent across different tenors. However, using the same tenors but without incorporating the impact of US interest rates, Table 1 showed that a 1 percent increase in yield spreads is expected to increase the output growth in Pakistan in range of 1.2 percent to 1.6 percent at next 6 months horizon. Similar results are found at longer horizons as well.

Table 5: Impact of International Financial Linkages in Predicting Output Growth in Pakistan

(From equation (8), coefficients values)

Horizon / Spread	k = 6 months		k = 12 months		k = 18 months		k = 24 months	
	B_1	B_2	B_1	B_2	B_1	B_2	B_1	B_2
3 year – 3 month	2.522 ***	-3.012	2.147 ***	-1.058	1.235 **	-0.368	1.169 ***	-0.335
5 year – 3 month	1.915 ***	-2.295	1.813 ***	-0.766	1.075 ***	-0.308	0.952 ***	-0.194
10 year – 3 month	1.518 ***	-2.511	1.306 ***	-1.091	0.837 ***	-0.317	0.741 ***	-0.280
Wald test (B_2=0)	Yes		Yes		Yes		Yes	

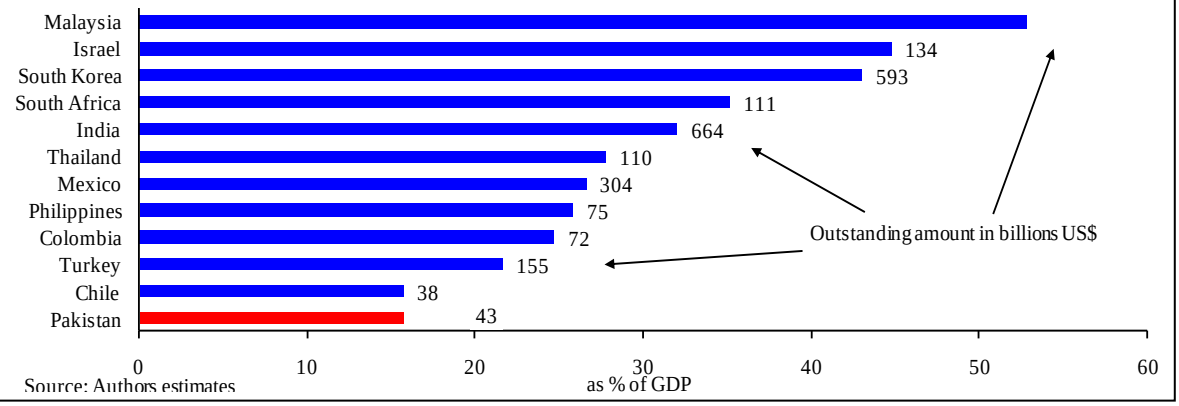
Note: ***, ** and * denote statistically significant at the 1%, 5% and 10% level of confidence

[19] We dropped the inflation prediction due to insignificant results.

Overall, while our empirical results do support the hypotheses that yield spread is a good indicator of predicting output growth in Pakistan over next two years, the results for inflation, however, remained insignificant throughout the study for different specifications. As highlighted, in general, similar observations are also found by Mehl (2006) in most of the emerging economies. Two reasons are usually identified for this diverging behavior for the yield spread prediction in case of emerging economies; shallow bond markets and volatility in inflation.

During the last ten years, the average turnover ratios for short-term T-bills and longer term bonds are 0.88 and 0.20 in Pakistan, respectively[20]. The relatively illiquid bond market indicates the existence of high liquidity premium in Pakistan. In fact, when compared to most other emerging and regional economies, the bond market size in Pakistan is quite small (Figure 3). McCauley and Remolona (2000) suggests that the outstanding government bonds must exceed around US$100–200 billion in order to sustain a liquid government bond market. According to this criterion, it can be observed that Pakistan is far behind than most other emerging markets.

Figure 3: Long-term Government Domestic Bonds
(At original maturity of greater than one year, outstanding position as of end Q2-2016)

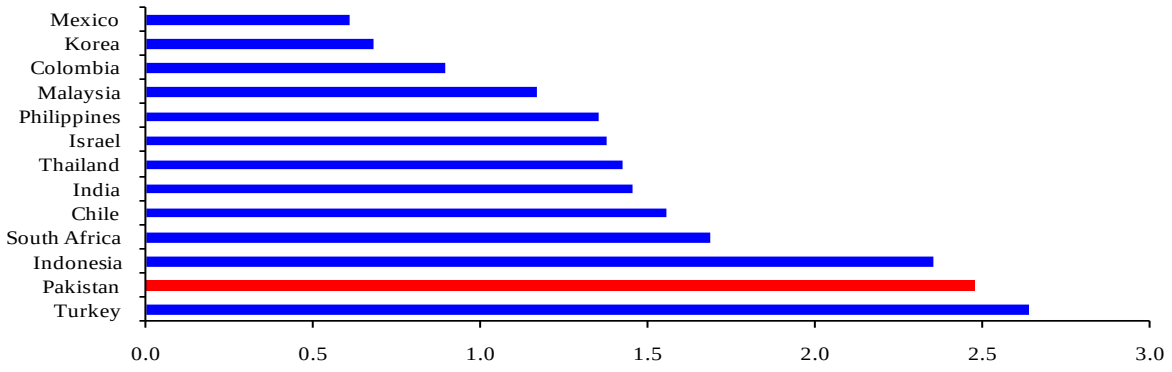


Source: Authors estimates

Besides the shallow bond market, there are also certain demand-side factors affecting predictive power of yield spread in case of inflation. Inflation uncertainty (or volatility) is one of these prime factors. The empirical evidences indicate that lower inflation uncertainty decreases the term premium while higher inflation uncertainty leads to higher term premiums (Wright 2011). Figure 4 depicts that inflation has been relatively more volatile in Pakistan in the last decade compared to most of the other emerging economies.

[20] $\text{Turnover ratio} = \frac{\text{Traded volume of bonds/bills}}{\text{Average outstanding volume of bonds/bills}}$

Figure 4: Inflation Uncertainty
(Average standard deviation calculated using 2-year rolling window, January 2003 – June 2016, in percent)



Source: Authors estimates

6. Concluding Remarks

The slope of the yield curve, i.e. the yield spread, is often used by financial market analysts and policy makers as an indicator of future economic activity and inflation. While empirical analysis generally confirm this attribute of yield spread, however, the research is largely done for advanced economies with very little focus on emerging countries. Financial markets in Pakistan have undergone significant changes in the last two decades. Their integration with global markets has also increased both in terms of volumes and transactions in recent years. These developments have gradually increased the role of market interest rates in making future financial decisions. Now, policy makers and financial analysts in Pakistan often refer to changes in term structure of interest rates as reflecting changes in market expectations about future inflation, economic activity, and thus the monetary policy stance.

In this backdrop, we attempted to explore the leading indicator attributes of the yield spread in Pakistan, particularly in the context of predicting inflation and output growth. We applied standard methodologies, extensively used in economic literature for investigating this kind of empirical question. We also attempted to capture the influence of international financial linkages using the changes in US interest rates. Our findings show that the yield spread in Pakistan is a good indicator of future output growth in Pakistan, particularly for horizons beyond 6 months and up to 2 years. These results are confirmed by both in-sample and out-of-sample forecast performance. We also found that the use of the US yield spread increases the predictive power of domestic yield spread. Unlike output growth, however, we could not find any significant role of yield spread in predicting future inflation in Pakistan.

This finding about inflation particularly deserves attention. Due to high and volatile inflation, the market participants might have been giving more weigh to liquidity than their inflation expectations. Moreover, the argument of shallow market cannot be ruled out in this regard. This suggests that, apart from expectations, term premium in Pakistan is also influenced by day-to-day movement in liquidity. Another observation worth recording is absence of inflation indexed bonds and lack of inflation expectation surveys that limit market's capacity to form expectation over a longer horizon. Therefore, market expectations seems to not vary significantly for the longer horizon compared to those in shorter horizon, which seems to be based on contemporaneous inflation numbers. Nevertheless, its implication for

monetary policy implementation is that monetary policy decisions are transmitted across the term structure of interest rate in a smooth and stable manner.

Overall, like any empirical analysis, this study also carries some caveats and limitations which provide room for further empirical investigation and research. Particularly, in the context of emerging economies, the theoretical identification of financial markets behavior and why yield curve predict (or not predict) future economic activity and inflation will be a good contribution. Moreover, the role of central bank's operations and its monetary policy stance is another area of further exploration.

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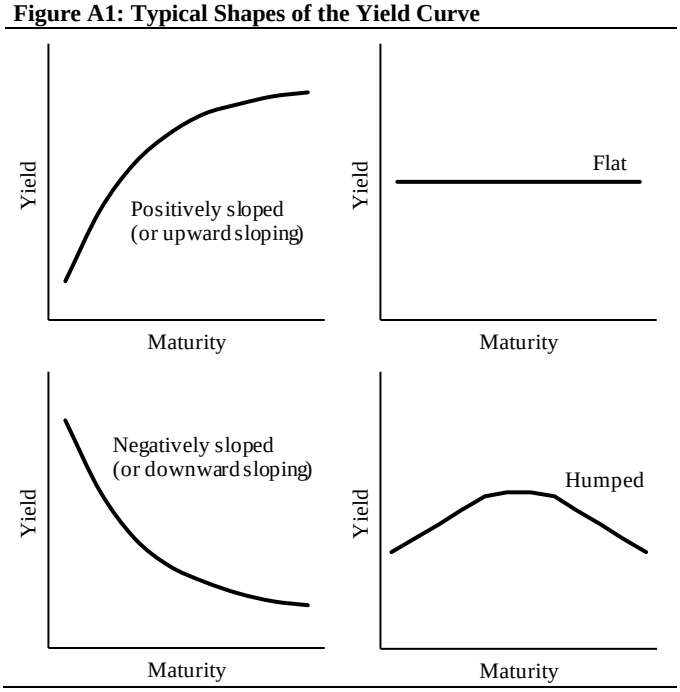
Appendix A

Shapes of the Yield Curve and Their Economic Interpretations

Yield curve or term structure of interest rates represents the relationship between the maturities and the yields of government securities. As represented in figure A1, there are three main types of yield curve shapes: normal, inverted and flat (or humped). A normal yield curve is one in which longer maturity bonds have a higher yield compared to shorter-term bonds. An inverted yield curve is one in which the shorter-term yields are higher than the longer-term yields. In a flat or humped yield curve, the shorter- and longer-term yields are very close to each other.

Figure A1: Typical Shapes of the Yield Curve



A *positively (or upward) sloping* yield curve is considered to be a signal of expansion of economic activities and rising inflation expectations in the economy in near term. A *negatively (or downward) sloping* yield curve suggests lower inflation expectations and slowdown in economic activity in the medium to long-run. A *flattening of the yield curve*, which means short-term rates are almost same as the long-term interest rates, indicates uncertainty about economic conditions. A *humped yield curve* means the yields on medium-term bonds is relatively higher than the short- and long-term bonds. While higher yields on medium tenor bonds relative to shorter tenor bonds indicates increase in inflation and better prospects for economic activity over the medium term, flat yields on longer-tenor bonds shows the inflation to fall without any significant change in economic activity in the long run.

From the theories establishing the relationship between short and long term bond yields, which give the yield curve a particular shape, long-term interest rate or long term bond yield is thought to contain useful information concerning future inflation and economic activity. The liquidity preference theory states that

investor demand higher return on longer term bonds due to being less liquid relative to shorter term bonds which could easily be converted into transactions balances. Thus yields on longer term bonds is usually higher than on the shorter term bonds as investors tend to charge a liquidity premium for holding long-term bonds. This liquidity premium is thought to be influenced by investors' expectations about uncertainties surrounding future path of macroeconomic fundamentals having bearing on liquidity of the bonds. According to the expectation theory, also known as the Fisher Hypotheses Fisher decomposition, long term interest rates are the average of current and expected short term interest (at the time of maturity of the bond or investment) plus a term premium. These suggest the positively slopped yield curve under the normal economic conditions[21].

Any change in the slope, which means disproportionate change in short and long term yields, and position of the yield curve, that is proportionate change in short and long term yield, reflects the changing market's perception about future short-term interest rates and uncertainty surrounding their investment. These are, in turn, influenced by investor's changing expectations about future inflation and economic activity. For instance, increase in long-term bond yields might be due to investors' expectation of higher future short-term interest rate and thus inflation. Similarly, investors' changing perception about the risk premium could reflect future path of economic activity influencing liquidity of the bond or financial conditions of the debtor.

Steepening of the yield curve, increase in long-term rates relative to short-term rates or people's preferences for holding shorter tenor bonds and charging a premium for holding relatively less liquid longer tenor bonds, appears to suggest that inflation is expected to rise in the future[22]. This means that future short-term rates to be higher than the current rates or central bank to adopt tight monetary policy in future. Alternative Current lower short-term rates relative to long-term rates also suggests that monetary policy is expansionary at the moment, which is perceived to provide boost to economic activity over the medium term. In other words, the real interest rates, current interest rate adjusted for expected inflation, are low or negative, which encourage households and businesses to spend more and thus provides boost to economic activity. Given that market participants expect the future economic activity to pick up and Philips relationship to hold, then inflation would also be expected to increase.

As an alternative explanation of yield curve steepening, Ang et al (2003) note that risk premium is counter cyclical and tends to increase on longer tenor bonds in periods of slowdown in economic activity. This is because demand for longer tenor bonds usually decreases during recession, resulting in higher price. Therefore, steepening of the yield curve Nevertheless, increase in very long-term rates relative to short-term rates might be purely due to increase in risk premium, reflecting market's concerns about a possible slowdown in economic activities in future. These could also incorporate the likely fiscal position

[21] There at least four major theories – expectations, liquidity preference, market segmentation and preferred habitat theory – explaining the term structure of interest rate.

[22] The interpretation is consistent whether steepening is due to fall in short-term interest rates or increase in long-term interest rates.

of the government, in particular the overall debt levels and its financing. In such case, steepening of the yield curve might indicate recession in the long-term.

Against this, a negatively sloped or "inverted" yield curve suggests lower inflation expectations and slowdown in economic activity in the medium to long-run. The intuitive argument is that higher short-term rates relative to long term suggests that monetary policy is currently tight in real terms, i.e. real interest rates are positive or relatively high at the moment, which is likely to bring inflation down in future. It also means that current high (real) interest rates encourage households to postpone current consumption for higher consumption in future and businesses to hold their expansion plans, which is likely to affect the real economic activity negatively.

In the same vein, a flattening of the yield curve, which means short-term rates are almost same as the long-term interest rates, indicates uncertainty about economic conditions. It also suggests a likely transition in economy from high inflation expectations – recovery in economic activity to low inflation expectations – slowdown in economic activity, and vice versa. Interpreting a humped yield curve, which means the yields on medium-term bonds is relatively higher than the short- and long-term bonds, is quite difficult. While higher yields on medium tenor (3 to 5 years) bonds relative to shorter tenor bonds indicates increase in inflation and better prospects for economic activity over the medium term, flat yields on longer-tenor bonds shows the inflation to fall without any significant change in economic activity in h long run.

Appendix B

Table B1: Granger Causality Tests between the Slope of the Yield Curve: US and Pakistan

Null Hypothesis	H_0: US's yield does not Granger Cause Pakistan's yield spread			H_0: Pakistan's yield does not Granger Cause US's yield spread		
Lags / Spread	2	4	6	2	4	6
3 year – 3 month	0.003 ***	0.003 ***	0.004 ***	0.274	0.523	0.675
3 year – 6 month	0.000 ***	0.001 ***	0.001 ***	0.267	0.332	0.489
5 year – 3 month	0.000 ***	0.001 ***	0.002 ***	0.164	0.358	0.445
5 year – 6 month	0.002 ***	0.003 ***	0.005 ***	0.332	0.4588	0.546
10 year – 3 month	0.003 ***	0.004 ***	0.004 ***	0.259	0.470	0.569
10 year – 6 month	0.006 ***	0.005 ***	0.004 ***	0.379	0.602	0.760

Note: ***, ** and * denote statistically significant at the 1%, 5% and 10% level of confidence (and rejection of null hypothesis).

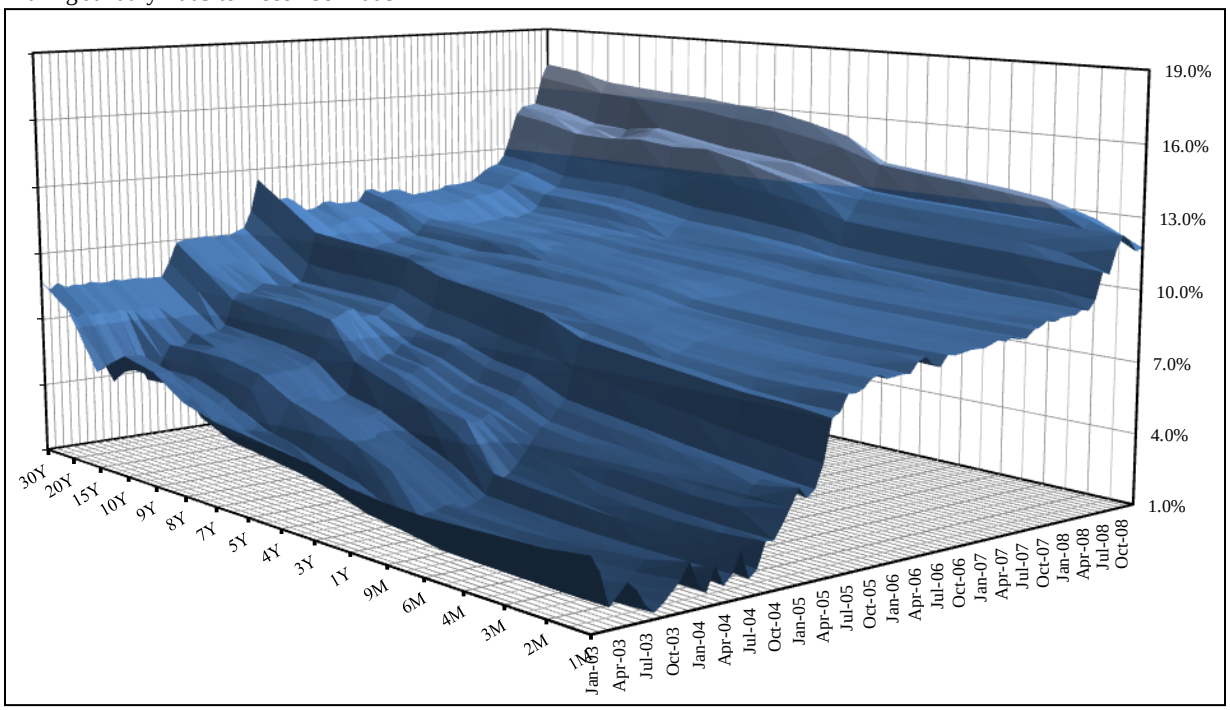
Table B2: Descriptive Statistics of the Selected Variables

	Mean	Median	Maximum	Minimum	Std. Dev.	Source
Interest rates – Pakistan, in percent per annum						
3-month	8.75	9.23	13.45	1.10	3.44	FMA, SBP
6-month	8.86	9.27	13.73	1.12	3.46	
12-month	9.02	9.39	14.06	1.37	3.41	
3-year	9.77	10.12	15.52	2.55	3.17	
5-year	10.20	10.40	16.01	3.61	2.94	
10-year	10.79	11.21	16.56	4.60	2.59	
Yield spreads – Pakistan, in percentage points						
3 year - 3 month	1.02	0.83	3.58	-0.81	0.75	FMA, SBP
3 year - 6 month	0.92	0.71	3.11	-0.83	0.71	
3 year - 12 month	0.75	0.55	2.70	-0.83	0.67	
5 year - 3 month	1.45	1.15	4.69	-0.75	0.98	
5 year - 6 month	1.35	1.07	4.23	-0.77	0.95	
5 year - 12 month	1.18	0.94	3.81	-0.77	0.91	
10 year - 3 month	2.04	1.73	6.17	-0.63	1.31	
10 year - 6 month	1.94	1.66	5.71	-0.61	1.30	
10 year - 12 month	1.77	1.49	5.29	-0.61	1.25	
Yield spreads – US, in percentage points						
3 year - 3 month	0.72	0.82	2.06	-0.57	0.52	Federal Reserve Bank
5 year - 3 month	1.24	1.39	2.81	-0.60	0.77	
10 year - 3 month	2.05	2.22	3.69	-0.52	1.09	
Inflation and output growth, in percent						
Headline CPI inflation - yoy	8.95	8.51	24.86	1.32	4.86	PBS
LSM growth - yoy	6.11	4.50	44.62	-19.71	8.90	

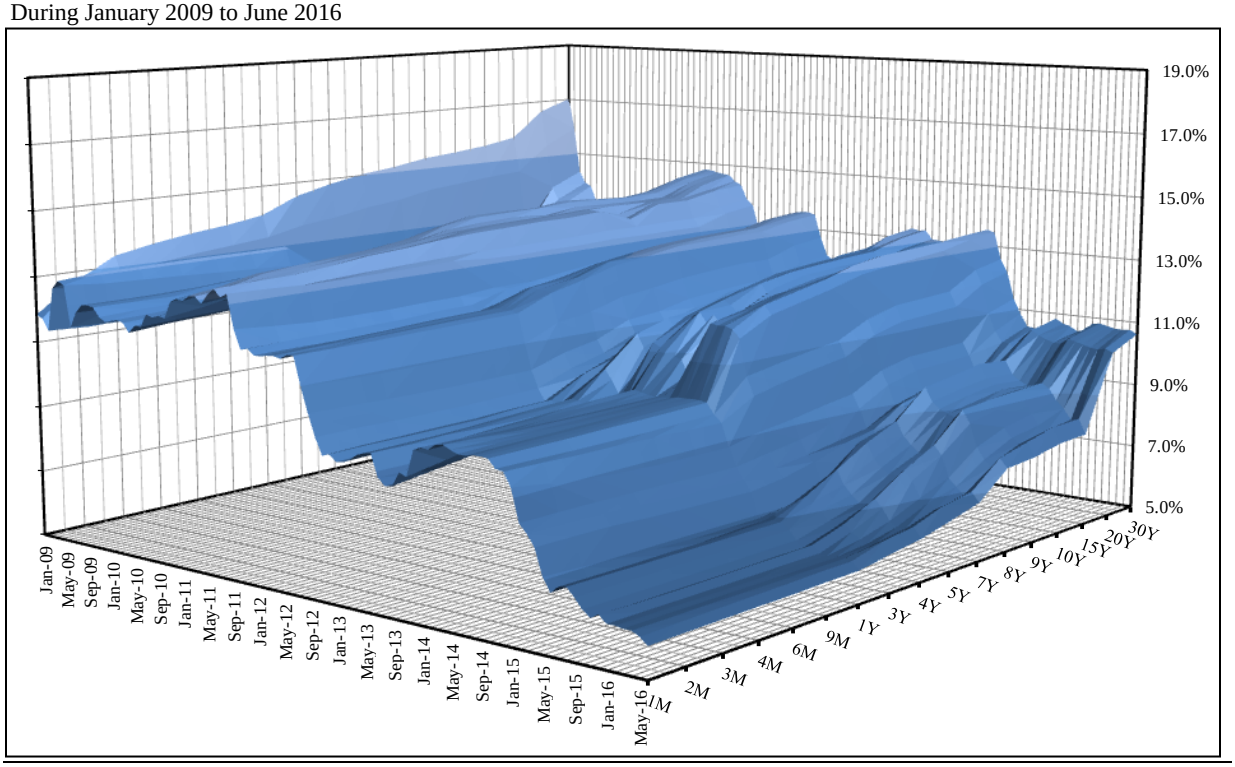
Note: Data period starts from January 2003 to June 2016, 162 observations.

Figure B1: 3D Presentation of the Yield Curve in Pakistan

During January 2003 to December 2008



During January 2009 to June 2016



Source: Authors' calculations