A NOTE ON TERM STRUCTURE AND INFLATIONARY EXPECTATIONS IN KENYA

BY

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Abstract

This paper analyses the relationship between the term structure and future changes in inflation in Kenya, using the 91 and 182-days Treasury bill rates spreads. The paper's findings are consistent with those obtained for other countries indicating that the slope of the term structure is a good predictor of expected inflation. The paper shows that the slope of the yield curve provides some information on changes in inflation over periods less than six months. This empirical result is not without some qualifications. Foremost amongst these is the relatively short period over which the analysis is done (TBR182 minus TBR91). Doing the analysis for TBR364 versus TBR91 gives non-significant results with only 10 observations involved. The paper therefore provides a case for investigating further the relationship between term structure and expected inflation utilizing a wider spectrum of government securities as a longer history of data becomes available.

1. Introduction

In many situations, economists are interested in not just short-term interest but also in long-run rates. Changes in the short-run rates that serve as the operational targets for implementing monetary policy will affect aggregate spending decisions only if longer rates are affected (Walsh 2010). Understanding how monetary policy affects the long-run rates therefore requires a consideration of the relationship between short-term and long-run rates. This relationship between interest rates over different horizons is the so-called term structure of interest rates which captures the relationship between default-free interest rates that only differ in the length of their maturity (Cox et al. 1985). By offering a schedule of interest rates over time, the term structure incorporates the market's expectations of future events and therefore provides a means to extract this information.

The conventional view is that short-term interest rates will be affected by money supply and other instruments of monetary policy such as the Central Bank Rate. The short term rates are in turn linked to long-term rates through the term structure of interest rates. This implies that the shape and characteristics of the yield curve is important for policy analysis and implementation. Shifts in the yield curve can therefore alert policymakers to changes in market expectations (Anand et al. 2011).

The term structure of interest rates is also important for monetary policy and its transmission mechanisms which run from short-term interest rates that the central banks try to influence to the long-run rates, through to real economic activities. By providing information on expected inflation, the term structure is important in achieving the desired rate of inflation. This is because nominal interest rates are a reflection of inflation rates over the term of the loan. In this case a gap between two or more interest rates of differing maturities should be useful as a predictor of inflation over that horizon. The bond rate should be seen to contain a premium for expected inflation and serve as an indicator of a central bank's commitment to a low level of inflation.

The slope of the yield curve has received considerable attention in the literature for its ability to forecast both real and nominal macroeconomic variables. Mishkin (1990a, 1990b) for example demonstrate that the slope of the curve is a relatively good predictor of the change in the rate of inflation. The empirical evidence in this paper shows that the 182-days - 91-days Treasury bills yield spread provides significant information about changes in inflation. Yield spreads between shorter dated securities are therefore found to contain significant information concerning future changes in inflation.

The term structure of interest rates is important for several other reasons. First, a critical problem in developing countries is managing the domestic debt to enhance its maturity profile. How successfully this can be done depends on the shape of the yield curve. Second, for those investors wishing to raise funds through the various debt instruments available in the market, the term structure provides information on minimizing future interest payments. Third, understanding the structure of the yield curve is important to financial institutions that take short-term deposits but provide long-term loans, since the yield curve predicts the behavior of the latter.

The objective of this paper is to analyze the term structure of interest rates in Kenya to tease out its implications for inflationary expectations in the country. It examines the ability of the slope of the yield curve to predict inflation in Kenya. The rest of the paper is organized as follows. Section 2 provides an overview of the theories of the term structure of interest rates; Section 3 discusses the analytical framework utilized in the paper; and Section 4 discusses the data, estimation procedure and results. The paper is concluded in Section 5.

2. Overview of the Theories of the Term Structure of Interest Rates

Economists are interested in the term structure theoeries for a number of reasons (Rusell 1992). First, since the actual term structure of interest rates are easy to observe, the accurancy of the predictions of the various theories would be easy to evaluate. Second, these theories help explain ways in which short-term interest rates impact on long-terms rates which is important for understanding the effectiveness of monetary policy. Lastly, the term structure may provide expectations of participants in the securities market.

In standard textbook analyses, there are basically four theories of the terms structure (Kettell 2001). The expectations hypothesis postulate that securities are priced such that the implied forward rates are equal to the the expected spot rates. This implies that the return from holding a long-term bond to maturity is equal to the expected returns on repeated investment in a series of short-term securities. Under this hypothesis, the long-term interest rates are a function of the current short-term rates given the investors' expectations about the future. In other words, the interest rate on the long-run bond must average the interest rates on short-term bonds over its own life time (Romer 2006). Hence the term structure is determined by the time path of the expected short-term rates. Since these future short-term rates are functions of monetary policy, expectations about future policy play an important role in determining the shape of the term structure.

On the other hand, the liquidity premium theory argues that the long-run rate is a function of current and expected future short-term rates plus a liquidity premium. Bondholders for example care about the purchasing power of the real return they receive from bonds, not just the nominal value of the coupon payments. Uncertainty about inflation creates uncertainty about a bond’s real return, making the bond a risky investment. The further the future, the greater the uncertainly about the level of inflation, which implies that a bond’s inflation risk increases with its time to maturity.

Similarly, interest-rate risk arises from a mismatch between investor’s investment horizon and a bond’s time to maturity. If a bondholder plans to sell a bond prior to maturity, changes in the interest rate generate capital gains or losses. The longer the term of the bond, the greater the price changes for a given change in interest rates and the larger the potential for capital losses. As in case of inflation, the risk increases with the term to maturity, so the compensation must increase with it. The liquidity premium theory therefore views bonds of different maturities as substitutes, but not perfect substitutes. The liquidity premium is an incentive to investors to induce them to commit their resources to greater risk. The liquidity hypothesis therefore places more weight on the effects of the risk preferences of market preferences of market participants (Cox et al. 1985). It asserts that risk aversion will cause forward rates to be systematically greater than expected spot rates, usually by an amount increasing with maturity. This term premium is the increment required to induce investors to hold long-term 'riskier' securities.

The segmented markets hypothesis postulates that individuals have strong maturity preferences and that bonds of different maturities trade in separate and distinct markets. This theory therefore assumes that markets for different maturity bonds are completely segmented. As a result, returns on bonds with differing maturities are determined in the markets via demand and supply of bonds with differing terms. In other words, longer bonds that have associated with them inflation and interest rate risks are completely different assets than the shorter bonds. Thus, the bonds of different maturities are not substitutes at all, so the expected returns from a bond of one maturity has no effect on the demand for a bond of another maturity. The yield curve is therefore unable to explain the direction of future interest rates.

Finally, the related preferred habitat theory postulates that individual investors have a preferred range of bond maturity lengths, and will only go outside of this range if a higher yield is promised. Besides interest rate expectations, investors have distinct investment horizons and require a meaningful premium to buy bonds with maturities outside their "preferred" maturity, or habitat. The theory argues that the long-term interest rate is dependent upon investor expectations regarding short-term rates, a term premium, and the demand and supply conditions of bonds of differing maturity profiles traded in the market.

The term structure literature has been mainly pre-occupied with testing one or the other of these theories. Anticipation of future events is important as are risk preferences and the characteristics of other market alternatives, while investors can have specific preferences about the timing of their consumption, and hence preferred habitat (Cox et al. 1985). Determining the term structure therefore requires to be done in a general equilibrium framework that takes into account expectations, investment alternatives and preferences about the timing of consumption in the future.

3. The Analytical Framework

The literature on the ability of the yield curve to predict changes in inflation typically begins with the standard Fisher equation (Mishkin 1990a, 1990b):

$$E_t\pi^m_t = i^m_t - r^m_t \qquad (1)$$

where E_t denotes the expectation at time t, π^m_t is the inflation rate between time t and t+m, i^m_t is the nominal m period interest rate and r^m_t the real m period interest rate.

Assuming rational expectations, the observed rate of inflation (π^m_t) equals the expected rate plus a forecast error:

$$\pi^m_t = E_t\pi^m_t + \varepsilon^m_t \quad (2)$$

Substituting Equation (1) into (2):

$$\pi^m_t = i^m_t - r^m_t + \varepsilon^m_t \quad (3)$$

To obtain a relationship between the slope of the yield curve and the change in the inflation rate, the n period inflation rate is subtracted to yield:

$$\pi^m_t - \pi^n_t = (i^m_t - i^n_t) + (r^m_t - r^n_t) + (\varepsilon^m_t - \varepsilon^n_t) \quad (4)$$

Analysts typically assume that the slope of the real yield curve is constant through time so that $(r^m_t - r^n_t)$ is a constant. The dual assumptions of a constant real term structure and rational expectations underpin the following equation which forms the basis of the tests:

$$\pi^m_t - \pi^n_t = \alpha + \beta(i^m_t - i^n_t) + v^{m,n}_t \quad (5)$$

If prices are fully flexible and rapidly adjust to changes in monetary policy, the assumption of a constant real rate spread is appropriate and β should equal to one and α equal to zero. Otherwise β is less than one and α not necessarily equal to zero if these conditions do not hold. Tests of the statistical significance of β coefficient and whether it differs from one reveal how much information is in the slope of the term structure about future changes in inflation.

4. Data, Estimation Procedure and Results

Estimation of equation (5) requires continuous and regular data over a sufficiently long period to permit robust econometric results. Many of the empirical studies focus on the United States and other developed countries that have yield curves data that go back for decades (Anand et al. 2011). This is not the case in Kenya. The country has only been implementing measures to promote the bond market since at least 2003, with the goals of (a) raising money more easily for the Treasury; and (b) encouraging the issuance of corporate bonds. Data on interest rates on government bills and bonds are therefore generally of short duration. Data on the 91-days and 182-days Treasury bills are available fairly continuously since February 1994, while those on the 364-days Treasury bill are available from August 2009 severely limiting degrees of freedom in the last case. We therefore focus our analysis to the information content of the 91-days and the 182-days Treasury bills rates using quarterly data.

Figure 1 shows the evolution of the term structure of the 91-days and 182-days Treasury bills as well as changes in inflation over 1994Q1 - 2012Q4. The figure shows that changes in inflation are quite noisy compared to the term structure of 91- and 182-days Treasury bills, but they track one another quite well. Unit root tests (Table 2) show that INFL and INFL(+1) as well as the Treasury bill rates are I(0) at least at the 5% level, implying that their differentials are also I(0). Table 2 also shows insignificant Granger-causality (at two lags each) between term structure and changes in inflation at the 10% level, indicating that the series are fairly independent of one another[1].

Table 3 gives the OLS regression results for Equation (5) (that is, those using interest rate maturities which match the period over which the change in inflation is being forecast) after control for both serial correlation and heteroskedasticity as suggested by the OLS equation diagnostics.

The results in Tables 3 show that the slope of the yield curve provides significant information about the change in inflation in the case for the 6-3 months spread. The term structure however explains only about 34% of the anticipated inflation, so that the nominal term structure does not fully explain future inflation changes. It is nevertheless possible to reject the hypothesis that the coefficient on the yield spread equals zero. In the short run, this spread is useful in predicting inflation because a significant impact of expansionary monetary policy falls on prices rather than output. An increase in term structure leads to a lower forecast inflation, as the monetary authorities are expected to pursue a tight monetary policy. A policy induced rise in short rates would be interpreted as meaning that a tight monetary policy is expected to lower future inflation, thereby lowering long-term interest rates and future short-term rates (Walsh 2010).

Similar other studies find diverse results. In a study of the US term structure for maturities less than 12 months, Mishkin (1990a) finds that for maturities of 6 months or less the term structure provides no information on inflation while for maturities of 9 to 12 months the term structure does provide some information. In a more comprehensive study of the "less than 12 months"

[1] At 5 lags, the Granger causality from anticipated changes in inflation to term structure becomes significant at the 5% level, consistent with the structural results.

term structure for a number of OECD countries, Mishkin (1991b) finds little evidence that the term structure provides information about future changes in inflation. Browne and Manasse (1990), however, present conflicting evidence arguing that the inflation forecasting ability declines as the maturity lengthens. In a study of G-7 countries, Schich (1999) also found substantial variation of results across countries and over time, with significant information content identified for the US, the UK, Germany and Canada. In one of the few studies on developing countries, Mehl (2009) finds that the predictive power of changes in the slope of the yield curve holds in a sample of fourteen different emerging countries between 1995 and 2005.

5. Conclusions

The evidence presented in this paper suggests that the slope at the short-end of nominal yield curve is useful in predicting the future path of inflation. The slope of the yield curve provides some information on changes in inflation over periods less than six months. This empirical result is not without some qualifications. Foremost amongst these is the relatively short period over which the analysis is done (TBR182 minus TBR91). Doing the analysis for TBR364 versus TBR91 gives non-significant results with only 10 observations involved (Table 4).

The paper provides a case for investigating further the relationship between term structure and expected inflation utilizing a wider spectrum of government securities as a longer history of data becomes available. A tentative analysis by Anand et al (2011), based on NSE secondary market data on government bond trades since 2008, show the Treasury bills and bonds yields increased sharply in 2008 and 2009 and then declined in 2010, reflecting relaxation of monetary policy by CBK. They interpret this as partly a reflection of the decline in inflation over 2009 and 2010 which the economic agents interpreted as relatively permanent[2].

At a more abstract level, the above tests are predicated on the assumption that both the authorities and other agents in the economy did not change their behaviour with respect to the yield curve over the sample period. Any such changes could alter the relationship between the slope of the yield curve and the future path of the rate of inflation. Notwithstanding this qualification, this paper provides some support for using at least the short-end slope of the yield

[2] We were subsequently provided with monthly NSE yield curve data for between January 20, 2008 and April 2013 at least for 2 to 15-years bonds. Analysis did not show significant inflation content of term structure perhaps because of the short period involved.

curve as an indicator of the future paths of inflation. Figure 2 shows the OLS coefficients were quite stable over the study period as they are within two standard errors, except for 2004 following a sharp decline in the cash reserves ratio.

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Appendix

Figure 1: Term Structure and Changes in Inflation in Kenya

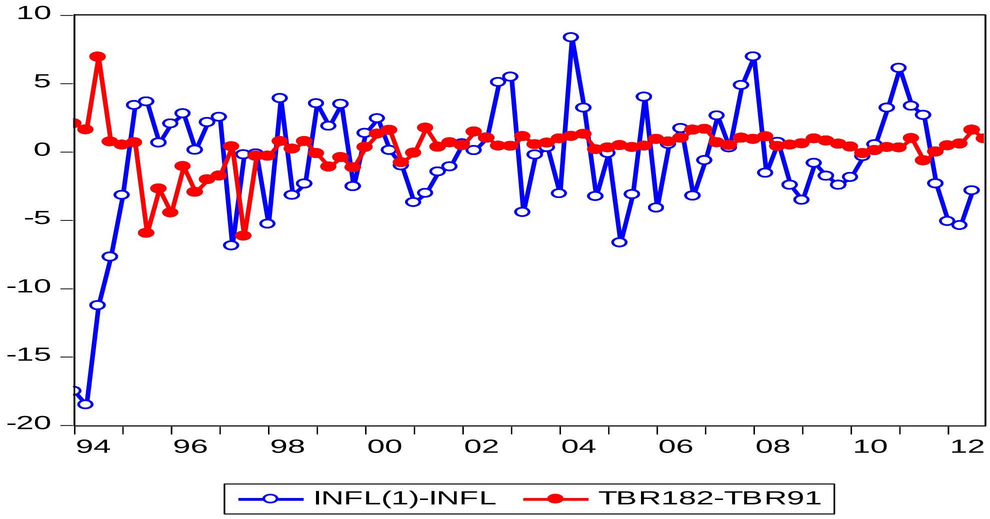

Table 1: Unit Root Tests: INFL, INFL(+1), TBR91 and TBR182

Null Hypothesis: INFL has a unit root				
Exogenous: Constant				
Lag Length: 5 (Automatic based on SIC, MAXLAG=11)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.289157	0.0010
Test critical values:	1% level		-3.527045	
	5% level		-2.903566	
	10% level		-2.589227	
*MacKinnon (1996) one-sided p-values.				

Null Hypothesis: INFL(+1) has a unit root				
Exogenous: Constant				
Lag Length: 5 (Automatic based on SIC, MAXLAG=11)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.289157	0.0010
Test critical values:	1% level		-3.527045	
	5% level		-2.903566	
	10% level		-2.589227	
*MacKinnon (1996) one-sided p-values.				

Null Hypothesis: TBR91 has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic based on SIC, MAXLAG=11)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.168883	0.0259
Test critical values:	1% level		-3.521579	
	5% level		-2.901217	
	10% level		-2.587981	
*MacKinnon (1996) one-sided p-values.				

Null Hypothesis: TBR182 has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic based on SIC, MAXLAG=11)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.902390	0.0032
Test critical values:	1% level		-3.521579	
	5% level		-2.901217	
	10% level		-2.587981	
*MacKinnon (1996) one-sided p-values.				

Table 2: Pairwise Granger Causality Tests

Sample: 1994Q1 2012Q4			
Lags: 2			
Null Hypothesis:	Observations	F-Statistic	Prob.
TBR182-TBR91 does not Granger Cause INFL(+1)-INFL	73	0.29098	0.7485
INFL(+1)-INFL does not Granger Cause TBR182-TBR91		1.56912	0.2157

Table 3: Regression Results - (INFL(+1)-INFL) ON (TBR182-TBR91)

Dependent Variable: INFL(+1)-INFL				
Method: Least Squares				
Sample (adjusted): 1994Q2 2012Q3				
Included observations: 74 after adjustments				
Convergence achieved after 6 iterations				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.244506	0.733753	-0.333226	0.7399
TBR182-TBR91	-0.342233	0.141122	-2.425082	0.0179
R-squared	0.294447	Mean dependent variable		-0.477308
Adjusted R-squared	0.274573	S.D. dependent variable		4.174875
S.E. of regression	3.555825	Akaike info criterion		5.414747
Sum squared residual	897.7164	Schwarz criterion		5.508155
Log likelihood	-197.3457	Hannan-Quinn criterion		5.452009
F-statistic	14.81518	Durbin-Watson stat		2.246220
Prob(F-statistic)	0.000004			
Inverted AR Roots	.45			

Figure 2: Stability of the Model Coefficients

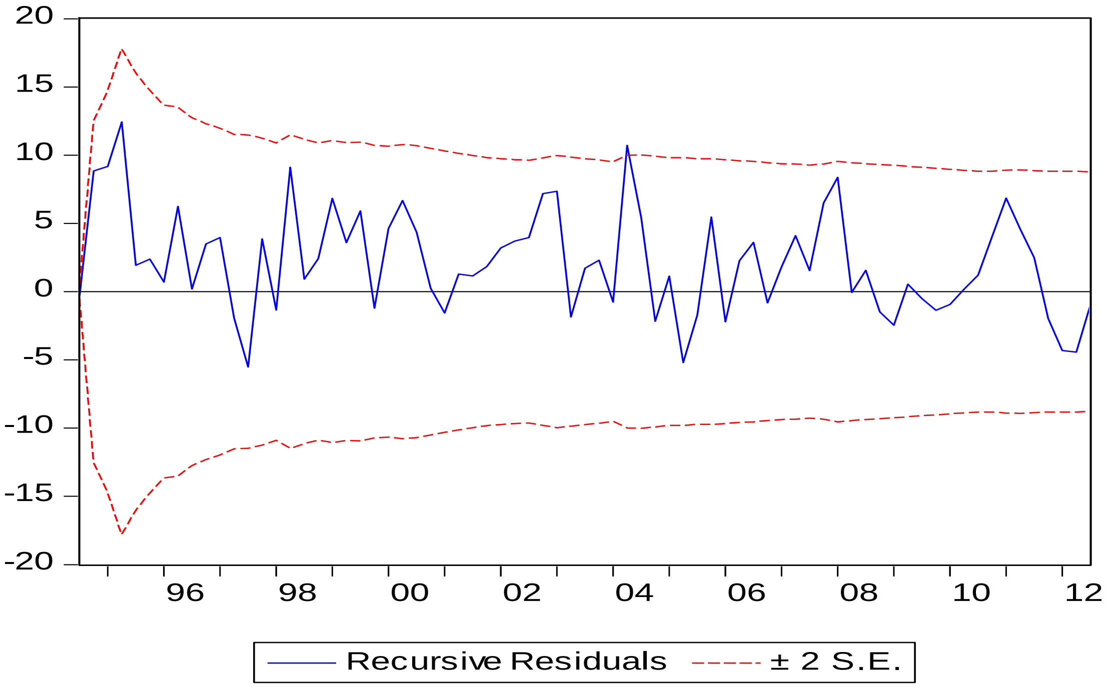

Table 4: Regression Results - (INFL(+4)-INFL) ON (TBR364-TBR91)

Dependent Variable: INFL(+4)-INFL				
Method: Least Squares				
Sample (adjusted): 2010Q1 2011Q4				
Included observations: 8 after adjustments				
Convergence achieved after 10 iterations				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-36.44647	416.4958	-0.087507	0.9337
TBR364-TBR91	0.153750	3.168954	0.048518	0.9632
R-squared	0.595109	Mean dependent variable		2.767409
Adjusted R-squared	0.433152	S.D. dependent variable		11.25374
S.E. of regression	8.472861	Akaike info criterion		7.391610
Sum squared residual	358.9469	Schwarz criterion		7.421401
Log likelihood	-26.56644	Hannan-Quinn criterion.		7.190685
F-statistic	3.674497	Durbin-Watson stat		0.341553
Prob(F-statistic)	0.104315			
Inverted AR Roots	.96			