NBIM DISCUSSION PAPER

#4 - 2011

This paper was part of the NBIM memo 'On fixed-income investments' (March 2011)

The term premium

18 March 2011

In this section, we review the theory and empirical evidence of the term premium. The term premium is the excess return that an investor obtains in equilibrium from committing to hold a long-term bond instead of a series of shorter-term bonds.

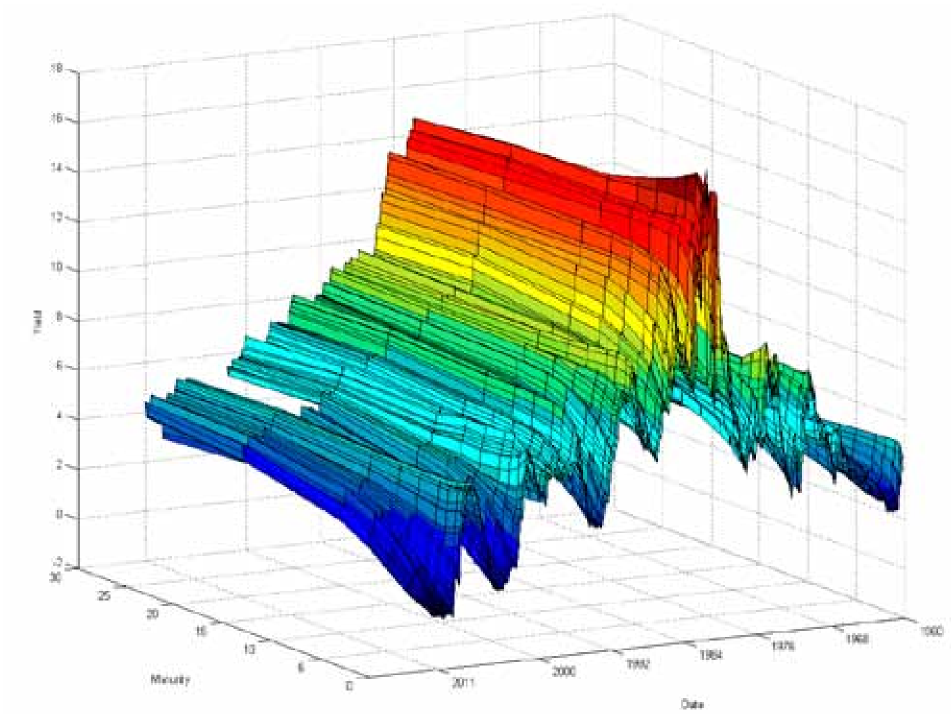
Main findings

- Most of the empirical research has focused on the post World War II period and the US Treasury market, and finds that the term premium is positive on average.
- The presence of excess returns on long-maturity bonds over Treasury bills contradicts the expectations hypothesis of the term structure, but the literature is inconclusive with regard to the economic rationale for the term premium.
- Most academic contributions to the term premium literature (for example, Campbell and Shiller 1991) point to a time-varying term risk premium, and an investor would have to adopt a dynamic approach towards duration exposure in order to best capture this premium.
- Historical approaches to explaining the term premium, such as the liquidity preference and the market segmentation theory, have been followed by a rich empirical literature that can be classified as influenced by financial theory (affine term structure models) or by macroeconomic theory (reduced-form models). While the finance-orientated research identifies uncertainty about the evolution of the short-term interest rate as the primary driver of the term premium, the macro-finance approach emphasises uncertainty about the macroeconomy, i.e. growth and inflation.
- The macro-finance models combine the approaches of macroeconomic literature with the no-arbitrage models from financial literature and tentatively give credence to the notion that a positive term premium is compensation for risk with regard to the evolution of policy interest rates, which in turn is driven by uncertainty about underlying macroeconomic factors.

Theories of the term structure of interest rates

The term structure of interest rates describes the relationship between bond yields and their maturities. The yield curve plots the term structure, and two basic patterns of yields emerge when looking at historical curves (see Figure 1): (1) on average the yield curve is upward sloping, and (2) there is substantial volatility in yields across all maturities.

Figure 1: Term structure in the US Treasury market over time



Source: NBIM calculations, Federal Reserve Bank of St. Louis

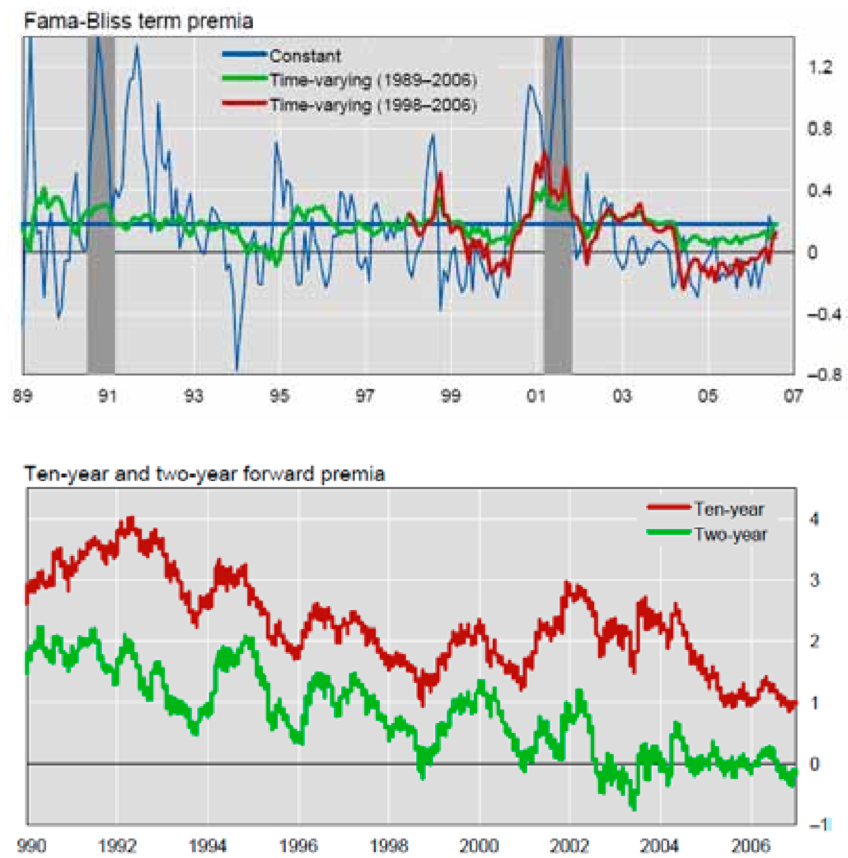
The expectations hypothesis developed by Irving Fisher (see Fisher 1930 and Lutz 1940) is one of the oldest and most widely known theories of the term structure of interest rates. The expectations hypothesis argues that investments in different maturities will generate the same expected return over a given investment horizon, and thus default-free bonds of all maturities are perfect substitutes.[1] This hypothesis does not take into account that future interest rates are uncertain and thus fails to take into account the compensation an investor requires for taking on interest rate risk. A term premium will arise whenever there is a deviation from the expectations hypothesis. The latter also ignores that the real return on nominal bonds is subject to the risk of unexpected inflation, and that uncertainty tends to increase with longer time horizons.

The expectations hypothesis finds little support in empirical studies (for example, Roll 1970, Sargent 1979, Hansen and Sargent 1981, and Campbell and Shiller 1991). In particular, several studies show that a strategy where the investor sells fixed-income securities with a short maturity and invests in securities with a long maturity when this interest rate spread is wide will earn an excess return over time. The return achieved by an investor using such a strategy can be viewed as reaping a term premium. Fama and Bliss (1987) use data from the period 1965-1985 and find a non-zero and time-varying term premium. While they estimate this premium to be almost as large as 6 per cent (close to mid-1980s) during periods of strong business activity, they also find that the premium can turn negative when the business environment turns sour (1973-1974 and 1979-1982). Kim and Orphanides (2007) estimate the Fama and Bliss (1987) regression on a short-term data sample of the

1 Note that while the expectations hypothesis focuses on expected returns, empirical literature such as Fama (1984), Fama (1990) and Fama and Bliss (1987) use term premium to refer to realized, rather than expected, excess returns on long-term bonds.

futures curve from 1989 to 2007. The authors find an average short-term premium of 0.18 percent. However, this volatile measure of the term premium behaves very differently if the sample period starts a decade later in 1998 (see graph below). Moreover, Kim and Orphanides employ an affine term structure model that incorporates forecast three-month T-bill rates and find (mostly) positive and time-varying term premia for both short and long horizons.

Figure 2: Top panel: Fama-Bliss term premia in the US Treasury market (units in %)
Bottom panel: Blue Chip Financial Forecasts term premia (units in %)



Source: Kim and Orphanides (2007)

Similarly, Campbell and Shiller (1991) argue that the expectations hypothesis holds reasonably well in a data sample for 1952-1978, while being strongly rejected for the period 1952-1987. The authors suggest that the deviation from the expectations hypothesis could arise from a time-varying risk premium. Cochrane and Piazzesi (2005) confirm these findings on an updated data sample by pointing out that the difference between forward rates and current spot rates does not forecast a change in the spot rate from this year to the next. Moreover, the estimates obtained by, among others, Kim and Orphanides (2007) and Cochrane and Piazzesi (2005) show that the term premium varies significantly across the term structure and an investor would have to adopt a dynamic approach towards duration exposure in order to best capture this premium.

The question is then: how can we account for this excess return? In particular, what manifestation of risk are investors being compensated for holding? In empirical studies of asset pricing, the term premium is usually viewed as a systematic risk factor (Fama and French 1989 and 1993). The source of this systematic risk factor is still not fully accounted for in academic finance (Campbell, Lo and MacKinlay 1997).

Two of the most cited fundamental theories of the term structure are the liquidity preference hypothesis (Hicks 1946) and the market segmentation hypothesis (Culbertson 1957). While the expectations hypothesis states that the forward rate equals the expected future spot rate, these two theories assume that forward rates can be decomposed into expectations of future short-term interest rates and interest rate risk premia. Moreover, an average of these forward rates is what makes up long-term interest rates. Long-term interest rates also depend on expectations of future short-term interest rates and interest rate risk premia. For this reason, movements in long-term rates can be attributed to movements in either expectations of short-term rates, risk premia or both. The observation that a significant part of long-term interest rates is made up of a time-varying and stochastic risk premium finds support in academic research. The open question that remains, however, is what determines the level and variation of the term premium over time and time-to-maturity.

Models of the term structure of interest rates

Broadly, the literature trying to account for the level and variation of the term premium can be classified into two complementary approaches: the affine structural-model approach and the reduced-form approach.

Affine structural-model approach: This approach, in which the yield curve (and the price of risk) is driven by a set of latent – unobservable – factors, stems from the financial literature and in particular the concept of no-arbitrage. A strict interpretation of the no-arbitrage condition excludes the possibility of achieving a risk-free future profit with a zero net investment.[2] Any existing arbitrage opportunities would be eliminated by instant price adjustments resulting from efficient market activity within this framework.

Reduced-form approach and macro-finance models: This approach stems from the empirical macroeconomic literature and takes the form of factor models based on macroeconomic variables. These reduced-form models provide a way to identify and interpret the underlying drivers behind the unobserved factors from the affine structural models. More recent models, the so-called macro-finance models, combine the approaches of the macroeconomic literature with the no-arbitrage models from the financial literature.

Affine term structure models

Affine term structure models have been defined in a number of different ways. Piazzesi (2010) has written an overview of the class of affine term structure models and defines these models as no-arbitrage models in which bond yields are affine functions – a constant plus a linear function – of some set of (risk) factors. Within a structural framework, these models offer a simple way of interpreting factors that affect the term structure and their impact across different maturities. However, financial literature generally does not specify these factors in detail, and they are therefore treated as latent – unobservable – variables. Duffie and Kan (1996) argue in favour of explaining yields with latent factors. They cannot observe a given variable X directly, but rather infer X by looking at its effect on yields. Most models with latent variables aim at giving the variables intuitive labels. In general, these factors are typically categorized as "level", "slope" or "curvature" depending on the nature of their impact on the yield curve. This approach presents a framework for understanding term structure dynamics. However, it does not offer any insight into what determines the interest level itself, and cannot be used as a tool for forecasting.

In their most basic form, affine term structure models allow short-term interest rates to be the sole determinant of the whole term structure. Vasicek (1977), which is one of the earliest affine term structure models, is such a one-factor model. The Vasicek model is based on a statistical approach where short-term rates are independent of macroeconomic determinants and thus determined only by their own past movements. This implies that expectations of future rates are formed purely on

2 Defined as a portfolio of long and short investments with a net value of zero.

the basis of currently observed interest rates. The only source of risk within this framework is the potential deviation of short-term interest rates from their expected levels.[3]

The basic one-factor approach implies that long-term interest rates are given as the average of expected short-term rates and a time-varying and maturity-dependent risk premium. The magnitude of this risk premium depends on both the variation in the short-term interest rate and the "market price of risk".[4] Moreover, this approach can be described by a linear one-factor relationship, where long-term interest rates are determined by the one-month interest rate. Thus, for a given maturity, the slope can be interpreted as the sensitivity of long-term rates to changes in one-month rates. This sensitivity will differ across maturities and be determined by, among others, the dynamics and volatility of short-term interest rate as well as the market price of risk.

The linear relationship between short- and long-term rates forces interest rates to be perfectly correlated across all maturities. This is a strong assumption with dubious empirical support even though interest rates of different maturities do co-vary to some extent. The fact that rates are not perfectly correlated tells us that short-term rates cannot be the sole determinant of the joint dynamics of interest rates across maturities. A perhaps more important limitation of the Vasicek model is that it allows negative interest rates with near-constant volatility.

In order to overcome these limitations, Cox-Ingersoll and Ross (1985) and Longstaff and Schwarz (1992) extend the Vasicek model to two-factor models that are characterised by time-varying and level-dependent volatility. Duffie and Kan (1996) suggested a multifactor affine term structure model which has been further investigated by, among others, Dai and Singleton (2000) and Duffee (2002). Multifactor models describe yield dynamics by imposing strict linear conditions, which ensures tractability. However, whether or not these models can capture empirical observations is an open question.

A strand of research by, among others, Wachter (2006) and Buraschi and Jiltsov (2007) extends from the multifactor affine term structure models of Duffee (2002) and allows time-varying risk aversion to affect the shape of the term structure while retaining the affine structure. A study by Campbell, Sunderam and Viceira (2010) builds on these models even though they to a great extent depart from the affine framework in order to introduce time-varying covariance into their model. The authors find that the term premium is partly determined by the covariance between bond and equity returns. The authors include a covariance factor in their model and argue that investors will require a positive (negative) term premium for holding bonds whenever this covariance is positive (negative). Their logic states that bond risk is low whenever returns on bonds and equities move in opposite directions, as in the early 2000s. Investors treat bonds as a hedge against equity risk in these scenarios, while the opposite will be the case when bond and equity returns tend to co-move, as in the early 1980s.

A study by Swanson, Rudebusch and Sack (2007) reviews several approaches to measuring the term premium and comes out in favour of the methodology put forward by Kim and Wright (2005). Kim and Wright employ an affine three-factor model based on the work by Duffie and Kan (1996) and Duffee (2002). In their model, interest rates and the term premium are determined by three latent factors that are linear functions of observed bond yields. The model estimates expected future short-term interest rates and defines the term premium as the forward rate less the model-implied expected future short-term rate.

3 As an illustration: the price an investor receives in one month for selling a two-month bond depends solely on the prevailing interest rate one month from now. The risk lies in the fact that this interest rate is unknown at present. Thus, many term structure models, including Vasicek (1977), assume that the fundamental source of uncertainty in the economy is the short rate.

4 The market price of risk can be seen as a representation of the risk aversion of the marginal investor and, ultimately, the premium investors on the margin require as compensation for taking an additional unit of risk, including that associated with holding a long-term bond. The no-arbitrage condition implies that there is no expected excess return on any asset after properly adjusting for risk. It further implies that different returns at different maturities are a result of different risks associated with these maturities. Moreover, Campbell, Lo and MacKinlay (1997) define the market price of interest rate risk as the ratio of the expected bond excess return to the standard deviation of the bond excess return.

Traditional reduced-form macroeconomic models

The purely statistical reduced-form models take the form of factor models based on macroeconomic variables, and are usually specified as a regression of interest rates on various macroeconomic variables. These macroeconomic variables include inflation, GDP (level and growth), government debt and other economic indicators, and can be translated into risks such as risk of real economic activity variability and risk of inflation variability. The approach aims to examine the extent to which macro variables can explain movements in both short-term and long-term interest rates.

The foundations for recent developments in reduced-form models were laid down by a comprehensive strand of literature during the 1960s, 1970s and 1980s. Patinkin (1965) estimates a model where government debt, the monetary base and an income factor together have significant explanatory power over interest rates. Sargent (1969) estimates several regressions in order to examine the impact of various macro variables on interest rates. In particular, the author argues that money supply, gross national product and anticipated inflation have an effect on nominal interest rates. On the other hand, Yohe and Karnosky (1969) find that anticipated inflation is the only systematic influence that can account for most of the movements in interest rates. Feldstein and Eckstein (1970) run a series of regressions and conclude that long-term interest rates are mainly determined by four variables: liquidity, inflation, government debt and expected interest rate changes. Hambor and Weintraub (1974) argue that government debt, base money, risk aversion as well as industrial production and general economic activity have a significant impact on the term structure of interest rates. Cornell (1983) studies the effects of money supply innovations and concludes that these innovations can account for movements across all interest rate maturities. Urich and Wachtel (1984) examine the effects of inflation and money supply announcements on interest rates. In particular, they claim that both these announcements and the actual changes in money supply have an immediate effect on interest rates.

In contrast to the affine structural models, these purely statistical reduced-form models are unable to impose the no-arbitrage condition. However, the models prove useful in identifying the sensitivity of interest rates across maturities to changes in the different macro risk factors and provide a way to identify and interpret the underlying drivers behind the unobserved factors from the affine structural models.

New macro-finance models

More recent literature has come a long way in combining the affine term structure models with the approaches of macroeconomics in order to account for the co-movements of the market prices of risks and the real returns on nominal assets. In particular, Ang and Piazzesi (2003) argue that macro variables can account for 85 percent of the variation in US yields over time. Lildholdt, Panigirtzoglou and Peacock (2007) confirm this result for the UK, and claim that inflation and the GDP gap drive short-term yields, while long-term inflation drives long-term yields. On the other hand, among others, Jorion and Mishkin (1991), Estrella and Hardouvelis (1991) and Estrella and Mishkin (1998) argue that inverted (downward-sloping) yield curves predict recessions (with only one exception since the mid-1960s).

These combined models replace the latent (unobserved) variables with actual macroeconomic variables while retaining the fundamental structure of the affine multifactor models. The macroeconomic variables include inflation rate, GDP growth, exchange rates, government debt, unemployment and other economic indicators, and can be translated into risks such as inflation variability and real economic activity variability. These models, just like the models with latent factors, offer a way to determine the sensitivity of interest rates across maturities to changes in the different risk factors.[5]

The relationship between various macro variables and the yield curve has been studied within a no-arbitrage framework by Ang, Piazzesi and Wei (2006), Wu (2006), Dewachter and Lyrio (2002), Kozicki and Tinsley (2001), Diebold, Rudebusch and Aruoba (2003), Evans and Marshall (2007) and Piazzesi (2001). Ang and Piazzesi (2003) and Hördahl, Tristani and Vestin (2003) model the term structure on

5 As in the latent variable model, the market price of risk determines the compensation an investor receives for being exposed to these risks.

a set of macro variables, but allow for a residual component that remains unexplained. This latent component is not necessarily the same as one of the latent factors from the financial literature. The authors argue that macro variables can account for most of the variability in short- to medium-term yields, but do not find evidence of the same macro-sensitivity in longer term yields. Evans and Marshall (2007) employ the same framework but allow for interest rate smoothing – i.e. current yields are dependent on historical yields – and argue that macro variables have a strong effect on both short- and long-term yields. Cochrane and Piazzesi (2002) isolate monetary policy shocks (changes in the Federal Funds target rate) by investigating daily data for long-term yields, and claim that fiscal shocks have a significant impact on yields. This is in contrast to Evans and Marshall (2007), who argue that fiscal policy shocks play a negligible role in determining interest rate variability.

Gallmeyer, Hollifield, Palomino and Zin (2007) link the dynamics of the term structure to macroeconomic variables by explicitly combining a monetary policy process, which is specified as a Taylor rule (Taylor 1993), and an endogenous inflation process. In this framework, shocks to real growth are transmitted through the central bank policy rule and the inflation process to determine the shape of the yield curve and its evolution over time. The authors argue that these macroeconomic shocks can account for a large part of the time variation in yields, and in particular the (on average) upward-sloping yield curve. The correlation between the inflation process and the market price of risk tells us that the term premium will be affected by the volatility of short-term interest rates and investors' sensitivity to this volatility.

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