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China's official rates and bond yields

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ABSTRACT

Recent research shows that bond yields are influenced by monetary policy decisions. To learn how this works in a bond market that differs significantly from those in the US and Europe, we model Chinese bond yields using the one-year deposit interest rate as a state variable. We also include the spread between the one-year market interest rate and the one-year deposit interest rate as another factor. The model is developed in an affine framework and closed-form solutions are obtained. We then test the model empirically with a Markov Chain Monte Carlo simulation procedure. The results show that the new model that incorporates the official rate in China characterizes the changing shape of the yield curve well.

1. Introduction

Early yield curve models focus on modeling the short-term interest rate as a stochastic process. Having specified the short-term interest rate, the medium- and long-term interest rates can then be seen as functions of the short rate. One-factor models such as the Vasicek (1977) model, the Ho and Lee (1986) model, the Cox et al. (1985) model, and the Hull and White (1990) model all define interest rate movements in terms of the dynamics of the short rate. Later models include other factors that may influence the yield curve. For instance, the Brennan and Schwartz (1979) model uses both the short- and long-term interest rates to define the yield curve. Heath et al. (1992) also show that it is possible to use the information contained in the whole yield curve to model the evolution of interest rates. Besides parametric models such as those mentioned above, there are also studies that model the term structure using nonparametric approaches (e.g. Gómez-Valle and Martínez-Rodríguez, 2009).

There is a growing literature that uses economic variables to model the yield curve (e.g. Ang and Piazzesi, 2003; Gallmeyer et al., 2005; Duffee, 2006; Ang et al., 2008; Spencer and Liu, 2009). Recently, a number of studies have focused on the relationship between monetary policy and the yield curve (e.g. Piazzesi, 2005). In the US and Europe, monetary policy is carried out either through a specific interest rate, such as the federal funds rate, or by adjusting money supply. Monetary policy in this framework focuses on the short-term interest rate, while the medium- and long-term interest rates are set by the market. It is thus natural to assume that monetary policy directly influences the short-term interest rate and thereby affects the whole yield curve. Different approaches to yield curve modeling have therefore been developed based on this standard monetary policy framework.

The new literature that brings macroeconomic and finance perspectives together is of significant interest to researchers, policy makers, and market participants. However, so far, studies that take monetary policy into consideration when modeling the yield curve have almost exclusively focused on the US and, to some extent, Europe. Even though these studies help us understand the underlying processes in the US and European bond markets, they are difficult to apply to countries with monetary systems that differ significantly from those of the US and Europe. For example, while the US central bank uses the target interest rate to set monetary policy, China's central bank, the People's Bank of China (PBC), uses a set of official interest rates among which the one-year deposit interest rate is arguably the most commonly used benchmark.

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One of the main novelties of this paper is that it takes the institutional features in China into account when modeling domestic bond yields. We apply a multi-factor model that incorporates the one-year deposit interest rate to bond yields with maturities ranging from one to five years. The deposit rate is directly specified by the central bank and has a direct impact on Chinese market rates (Fan and Johansson, 2009). The market interest rates are assumed to be influenced by the one-year deposit rate and the spread between the one-year market rate and the one-year deposit rate. The deposit rate is specified with a stochastic jump process. This paper thus differs from related studies in that it includes the one-year deposit rate and the spread between the market rate and the official rate as state variables rather than a typical target rate. The jump process for the deposit rate also differs from those of earlier studies (e.g. Piazzesi, 2005). We assume that the jump size follows a stochastic process. This approach allows us to capture some of the unique features in China's monetary policy conducted through official rates. To model the bond yields, we use an affine approach (see Duffie and Kan, 1996). Then, we derive a closed-form solution for the model and use a Markov Chain Monte Carlo (MCMC) procedure to estimate its parameters. It is shown that the model captures the movements in yields with different maturities well.

The rest of the paper is organized as follows: Section 2 discusses related literature on the relationship between monetary policy and bond yields. It also brings up some of the unique features in China's monetary policy and their effects on bond yields. Section 3 introduces the new model. Section 4 briefly explains the estimation procedure and then discusses the data and the empirical results from the estimation. Finally, Section 5 concludes the paper.

2. Monetary policy and bond yields

Most studies on yield curves use latent state variables that are estimated using market data (e.g. Dai and Singleton, 2000). While valuable in the sense that they help us understand the behavior of yield curves, those models do not explicitly take macroeconomic factors into account and thus limit our understanding of how macroeconomic factors influence the yield curve. However, and as mentioned earlier, there is a growing literature on the relationship between the yield curve and macroeconomic and monetary policy variables. In this section, we focus the discussion on related studies that analyze the relationship between monetary policy and the yield curve.[1] We also introduce some of the unique features in China's government bond market and how monetary policy affects bond yields in China.

Balduzzi et al. (1997) analyze the Federal Reserve's short-term target rate and its effect on the yield curve. They find that the spread between the short-term interest rate and the overnight federal funds rate is mainly influenced by the expectation of changes in the target rate. Balduzzi et al. (1998) develop a term structure model that incorporates the infrequent but predictable changes of the interest rate target. Farnsworth and Bass (2003) use a model in which the short-term market interest rate is subject to a control that keeps it close to the target rate. Ellingsen and Söderström (2001) propose a model that incorporates different theories of the behavior of the yield curve after a change in monetary policy. Their approach allows for a variety of market reactions to monetary policy. There are also studies on monetary policy that focus on the short rate only (e.g. Das, 2002; Johannes, 2004; Jiang and Yan, 2009). Some of these studies relate to this paper in that they allow for jumps to influence the interest rate. For example, Das (2002) incorporates jumps in a generalized Vasicek model and identifies significant jumps in the federal funds rate. His results show that the jumps are more pronounced when the Federal Open Market Committee is conducting its meetings. There are a number of reasons why jumps may occur in interest rates, including central bank interventions, macroeconomic surprises, shocks in the exchange rate, and extreme market events. Johannes (2004) shows that monetary policy is one of the major factors behind jumps in the short rate. Piazzesi (2005) focuses on how monetary policy decisions are linked to bond yields. Her results show the value of incorporating monetary policy, in this case in the form of the target rate, when modeling the yield curve. The target rate data improves the fit of the yield curve compared to alternative three-factor models such as Dai and Singleton (2000) and she concludes the paper by advocating additional studies on other markets. Moreover, Andersson et al. (2006) analyze how different monetary policy signals influence interest rates. Using signals such as repo rate changes, inflation reports, public speeches and reports from meetings, they show that monetary policy signals have significant effects on the Swedish yield curve.

While many of the above studies show the important relationship between monetary policy and interest rates, few of them actually develop models for the yield curve that take monetary policy into account and take them to the data. One important exception is that of Piazzesi (2005), which is fairly close to our study. However, we focus on monetary policy and its impact on the yield curve in China, a country with significantly different institutional features as compared to the US or Europe. Only a small number of studies have tried to model China's bond yields and, to our knowledge, no previous study has developed a model for China's yield curve that incorporates the effect of monetary policy.[2]

The PBC uses a number of different tools to conduct its monetary policy. Money supply was initially controlled through a system of national bank credit quota. This way, the central bank directly controlled the amount of money that each of the banks could use. In October 1998, a major reform resulted in the move to open market operations when the central bank introduced cash bond trading. In 2003, the central bank finally began issuing its own bills through regular auctions. China's central bank also conducts monetary policy through the fine-tuning of reserve requirements and a general guidance of credit orientation. Even though there is a functioning short-term money market in which the central bank theoretically can control money supply by using repos, this is not an effective channel for monetary policy. During numerous periods of excess liquidity in the Chinese banking system, banks have not been responding to changes in money market rates. Up until now, outstanding bonds are still limited when compared to the size of the economy. With a constant excess demand for bonds, Chinese banks usually have to deposit their excess funds with the central bank. The PBC pays an interest on such excess cash. The fact that the money market in China is not functioning as it does in developed countries means that money market rates are typically not used as benchmark rates.

The so-called CHIBOR (China Interbank Offered Rate) came into operation in 1996 to allow for banks to fix interest rates for interbank lending and borrowing. However, the CHIBOR has not turned out to be a good benchmark tool, mainly because the trading volume of interbank funding activities has been so small. In an attempt to improve the situation, the so-called SHIBOR (Shanghai Interbank Offered Rate) was launched in January 2007. The SHIBOR is generally seen as a more market-sensitive benchmark since it is based on quoted rates from large financial institutions, mainly

[1] For a more detailed overview of this literature, see Diebold et al. (2005).

[2] There is still only a limited number of studies that focus on the Chinese bond market (e.g. Fan and Zhang, 2007; Li and Zou, 2008). The very few existing studies that attempt to model China's yield curve are primarily published in Chinese journals.