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Monetary policy regimes: Implications for the yield curve and bond pricing ☆

Kameliya Filipova *, Francesco Audrino, Enrico De Giorgi

Department of Economics, School of Economics and Political Science, University of St. Gallen, Bodanstrasse 6, CH-9000 St. Gallen, Switzerland

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ABSTRACT

We develop a multivariate dynamic term structure model, which takes into account the nonlinear (time-varying) relation between interest rates and the state of the economy. In contrast to the classical term structure literature, in which nonlinearities are captured by increasing the number of latent state variables or by latent regime shifts, in our no-arbitrage framework the regimes are governed by thresholds and are directly linked to economic fundamentals. Specifically, starting from a simple monetary policy model for the short rate, we introduce a parsimonious and tractable model for the yield curve, which takes into account the possibility of regime shifts in the behavior of the Federal Reserve. In our empirical analysis, we show the merit of our approach three dimensions: interpretable bond dynamics, accurate short end yield curve pricing, and yield curve implications.

1. Introduction

Over the last 40 years researchers, have actively studied the dynamics of the term structure of interest rates and its relation with the states of the economy. Most of the recent attention has been devoted to jointly modeling yield and macroeconomic variables within a no-arbitrage framework. While it is well known that the response of the short rate to the state of the economy changes over time, it is surprising that the macro-finance literature typically ignores this stylized fact, capturing nonlinearities by increasing the number of latent state variables. This leaves the link between the state of the economy and interest rates a puzzle. In a seminal paper, Ang and Piazzesi (2003, p. 156) note, for example, that "coefficients are highly sensitive to the sample period selected, as structural changes cause the coefficients in the short rate model to be time-varying." Ignoring nonlinearities in the short rate dynamics can give misleading results about the impact of

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* Corresponding author. Tel.: +41 71 2242468.
E-mail addresses: kameliya.filipova@gmail.com (K. Filipova), francesco.audrino@unisg.ch (F. Audrino), enrico.degiorgi@unisg.ch (E. De Giorgi).

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the different macroeconomic fundamentals on the term structure of interest rates. It also blurs understanding of bond risk premia.

In this paper, we propose a new approach to model and analyze yields and their relation to the economy. We argue that the linkage between the term structure of interest rates and the state of the economy is complex and goes beyond simple business cycle variations. A simple but crucial assumption is that the short end of the yield curve is subject to regime shifts. We focus on smooth threshold-type shifts, in which the regimes are directly linked to macroeconomic fundamentals. Due to the directly observable regime shifts, we are able to derive iterative, closed-form solutions for the whole yield curve. More specifically, starting from a common Taylor rule-type short rate representation, we introduce a model for the yield curve, which takes into account the possibility of regime switches in the behavior of the Federal Reserve. We study the merit of our approach along the following dimensions: interpretability and accuracy of the estimated short rate dynamics, design and implications of a no-arbitrage dynamic term structure model, yield curve implications, and accuracy of short-end yield curve pricing.

The paper makes two main contributions to the term structure literature. First, the paper sheds new light on the forces driving the US short rate over the last 60 years. We show the impact of nonlinearities on the policy function itself. We consider a simple monetary policy model in which the Taylor rule parameters are allowed to change over time. These changes are modeled as smooth threshold-type regime shifts, which are directly linked to macroeconomic fundamentals. The optimal regime structure and the number of regimes are endogenously determined by the data. In the model, agents are aware of the possibility of regime changes. They observe the state of the economy today and, based on the current relevant macroeconomic information and the optimal threshold structure only, they infer the future state. Thus, the short rate dynamics not only depends on the local mean parameters but also on the beliefs around alternative regimes.

Due to the flexible econometric technique for selecting the optimal number of regimes and the corresponding threshold structure, we contribute new evidence to the debate about the changes in US monetary policy over the last 60 years. We find that the behavior of the Fed is closely related to that of the levels of (expected) inflation and unemployment growth.

The second and most important contribution of the paper is the development of a new multivariate dynamic term structure model. Motivated by the results for the short rate, we design a modeling framework suitable for pricing bonds and other financial derivatives. Our approach combines the no-arbitrage restrictions on the cross section of bonds together with macroeconomic factors that drive bond yields. in addition, it accommodates nonlinearities (regime shifts) in the conditional mean of the short rate and bond risk premia and, therefore, carries over to the entire term structure. While the classical Markovian regime-switching models rely on log-linear approximation for bond prices, in our model, due to the directly observable threshold structure, we are able to obtain iterative closed-form solutions for yields without resorting to bond prices linearization. In our framework, the resulting term structure model is quadratic and arises naturally as a by-product of the regime-switching short rate dynamics. In this way, we can identify the most important realized second order moments of macroeconomic fundamentals, avoiding the full quadratic model specification, which typically leads to overparametrization. Without resorting to purely latent factors, our framework allows us to establish a tight link between yields and directly interpretable economic quantities. This enables us to assess the direct impact of the macroeconomic fundamentals on the term structure of interest rates.

To estimate the model we use a nonlinear filtering technique, unscented Kalman filter, proposed by Julier and Uhlmann (1997) and recently used in finance by Campbell, Sunderam, and Viceira (2013). We assess the goodness of fit of our regime-switching modeling framework by studying a series of model implications. First, we show that, depending on the level of inflation, the model has significant differences in monetary policy conduction. In particular, depending on the regime, the yield curve and bond excess returns react differently to shocks in the macroeconomic fundamentals. Second, we show that our model produces accurate short end bond pricing results over different time horizons. Third, our model is able to reproduce the Cochrane and Piazzesi (2005) tent-shape bond risk premia factor. Importantly, we show our model's ability to accommodate unspanning and to generate the various yield curve shapes.

The remainder of the paper is organized as follows. Section 2 gives a brief summary of the related literature. Section 3 presents the description of the model for the short rate. Section 4 discusses the design of a pricing framework and studies its implications. Section 5 describes the estimation strategy and the empirical results for the short rate, the yield curve, and the bond excess returns. Finally, Section 6 proposes several generalizations and possible applications.

2. Related literature

This paper is closely related to two strands of the term structure literature: macro-finance models and models with regime shifts.

2.1. Macro-finance models

An important part of the term structure literature has focused on studying the relation between the term structure of interest rates and the economy. Ang and Piazzesi (2003) have drawn attention to this question by showing that the inclusion of macroeconomic factors in addition to latent components improves predictability and sheds some light on the economic nature of the underlying forces that drive changes in interest rates. Other closely related papers, which focus on the linkage between macro variables and the yield curve using little or no macroeconomic structure are, for example, Kozicki and Tinsley (2005), Ang, Piazzesi, and Wei (2006), Dewachter and Lyrio (2006), and Joslin, Priebsch, and Singleton (2010).

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