



Forecasting the term structure of government bond yields

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Abstract

Despite powerful advances in yield curve modeling in the last 20 years, comparatively little attention has been paid to the key practical problem of forecasting the yield curve. In this paper we do so. We use neither the no-arbitrage approach nor the equilibrium approach. Instead, we use variations on the Nelson–Siegel exponential components framework to model the entire yield curve, period-by-period, as a three-dimensional parameter evolving dynamically. We show that the three time-varying parameters may be interpreted as factors corresponding to level, slope and curvature, and that they may be estimated with high efficiency. We propose and estimate autoregressive models for the factors, and we show that our models are consistent with a variety of stylized facts regarding the yield curve. We use our models to produce term-structure forecasts at both short and long horizons, with encouraging results. In particular, our forecasts appear much more accurate at long horizons than various standard benchmark forecasts.

Introduction

The last 25 years have produced major advances in theoretical models of the term structure as well as their econometric estimation. Two popular approaches to term structure modeling are no-arbitrage models and equilibrium models. The no-arbitrage tradition focuses on perfectly fitting the term structure at a point in time to ensure that no arbitrage possibilities exist, which is important for pricing derivatives. The equilibrium tradition focuses on modeling the dynamics of the instantaneous rate, typically using affine models, after which yields at other maturities can be derived under various assumptions about the risk premium.¹ Prominent contributions in the no-arbitrage vein include Hull and White (1990) and Heath et al. (1992), and prominent contributions in the affine equilibrium tradition include Vasicek (1977), Cox et al. (1985), and Duffie and Kan (1996).

Interest rate point forecasting is crucial for bond portfolio management, and interest rate density forecasting is important for both derivatives pricing and risk management.² Hence one wonders what the modern models have to say about interest rate forecasting. It turns out that, despite the impressive theoretical

advances in the financial economics of the yield curve, surprisingly little attention has been paid to the key practical problem of yield curve forecasting. The arbitrage-free term structure literature has little to say about dynamics or forecasting, as it is concerned primarily with fitting the term structure at a point in time. The affine equilibrium term structure literature is concerned with dynamics driven by the short rate, and so is potentially linked to forecasting, but most papers in that tradition, such as de Jong (2000) and Dai and Singleton (2000), focus only on in-sample fit as opposed to out-of-sample forecasting. Moreover, those that *do* focus on out-of-sample forecasting, notably Duffee (2002), conclude that the models forecast poorly.

In this paper we take an explicitly out-of-sample forecasting perspective, and we use neither the no-arbitrage approach nor the equilibrium approach. Instead, we use the Nelson and Siegel (1987) exponential components framework to distill the entire yield curve, period-by-period, into a three-dimensional parameter that evolves dynamically. We show that the three time-varying parameters may be interpreted as factors. Unlike factor analysis, however, in which one estimates both the unobserved factors and the factor loadings, the Nelson–Siegel framework imposes structure on the factor loadings.³ Doing so not only facilitates highly precise estimation of the factors, but, as we show, it also lets us interpret the factors as level, slope and curvature. We propose and estimate autoregressive models for the factors, and then we forecast the yield curve by forecasting the factors. Our results are encouraging; in particular, our models produce one-year-ahead forecasts that are noticeably more accurate than standard benchmarks.

Related work includes the factor models of Litzenberger et al. (1995), Bliss, 1997a, Bliss, 1997b, Dai and Singleton (2000), de Jong and Santa-Clara (1999), de Jong (2000), Brandt and Yaron (2001) and Duffee (2002). Particularly relevant are the three-factor models of Balduzzi et al. (1996), Chen (1996), and especially the Andersen and Lund (1997) model with stochastic mean and volatility, whose three factors are interpreted in terms of level, slope and curvature. We will subsequently discuss related work in greater detail; for now, suffice it to say that little of it considers forecasting directly, and that our approach, although related, is indeed very different.

We proceed as follows. In Section 2 we provide a detailed description of our modeling framework, which interprets and extends earlier work in ways linked to recent developments in multifactor term structure modeling, and we also show how it can replicate a variety of stylized facts about the yield curve. In Section 3 we proceed to an empirical analysis, describing the data, estimating the models, and examining out-of-sample forecasting performance. In Section 4 we offer interpretive concluding remarks.

Section snippets

Modeling and forecasting the term structure I: methods

Here we introduce the framework that we use for fitting and forecasting the yield curve. We argue that the well-known Nelson and Siegel (1987) curve is well-suited to our ultimate forecasting purposes, and we introduce a novel twist of interpretation, showing that the three coefficients in the Nelson–Siegel curve may be interpreted as latent level, slope and curvature factors. We also argue that the nature of the factors and factor loadings implicit in the Nelson–Siegel model facilitate...

Modeling and forecasting the term structure II: empirics

In this section, we estimate and assess the fit of the three-factor model in a time series of cross sections, after which we model and forecast the extracted level, slope and curvature components. We begin by introducing the data....

Concluding remarks

We have re-interpreted the Nelson–Siegel yield curve as a dynamic model that achieves dimensionality reduction via factor structure (level, slope and curvature), and we have explored the model's performance in out-of-sample yield curve forecasting. Although the 1-month-ahead forecasting results are no better than those of random walk and other leading competitors, the 1-year-ahead results are much superior.

A number of authors have proposed extensions to Nelson–Siegel to enhance flexibility,...

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