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The expected real yield and inflation components of the nominal yield curve

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ABSTRACT

The term structure of real yields and expected inflation are two unobserved components of the nominal yield curve. The primary objectives of this study are to decompose nominal yields into their expected real yield and inflation components and to examine their behaviour using state-space and regime-switching frameworks. The dynamic yield-curve models capture three well-known latent factors – level, slope, and curvature – that accurately aggregate the information for the nominal yields and the expected real and inflation components for all maturities. The nominal yield curve is found to increase slightly with a slope of about 120 basis points, while the real yield curve slopes upward by about 20 basis points, and the expected inflation curve is virtually flat at slightly above 2 per cent. The regime-switching estimations reveal that the nominal yield, real yield and expected inflation curves have shifted down significantly since 1999.

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1. Introduction

Generally, real yields are expected to be a more important determinant for the short-end of the nominal yield curve because of the influence of monetary policy shocks, while inflation expectations are expected to be relatively more important for the longer end because of the influence of shocks to inflation expectations. Although the nominal yield curve is widely used for pricing bonds, as well as for forecasting output and inflation, there has been little research on these two key determinants of the yield curve largely because they are unobservable. The real yield curve is particularly important for monetary policy since real yields affect all intertemporal savings and investment decisions in the economy. Real yields are also important because they are often used to gauge the stance of monetary policy relative to the neutral or natural real rate of interest in a Taylor-type rule. In addition, real yields are of interest to investors that focus on the cost of capital. The term structure of inflation expectations is very important for monetary policy in a country like Canada that has adopted explicit targets for inflation. Inflation expectations also play a crucial role in hedging strategies of portfolio investors. Consequently, both policy makers and market participants have an interest in the central roles that expected real rates and inflation play in the dynamics of asset prices over time.

This study attempts to fill this gap in the literature by capturing some stylized facts about these two important unobservable components of the nominal yield curve in Canada. A previous study by Ang, Bekaert, and Wei (2008) uses an affine

term-structure model to identify the structure of real rates and inflation risk premia to fill this gap for the U.S. In general, the affine term-structure models tend to be restricted in the range of term structure yields that they can handle in order to obtain closed form solutions. Some previous studies also rely on survey data for inflation expectations to derive expected real yields and risk premia. For example, Joyce, Lildholdt, and Sorensen (2010) use survey data on long-term inflation expectations for the U.K. Similarly, Chernov and Mueller (2012) use information in the term structure of survey-based forecasts of inflation to estimate a factor hidden in the nominal term structure of yields. However, survey data on inflation expectations differ considerably in their breadth of coverage, the frequency and time span over which they are accessible, and the extent to which they may be distorted by certain biases due to the heterogeneity of agents surveyed. This study on Canada contributes to the literature by overcoming some of the limitations of these previous studies by first decomposing the nominal yield curve into its expected real rate and inflation components using structural VAR techniques instead of relying on survey data. Secondly, the study uses a state-space methodology that estimates dynamic latent factors for the level, slope and curvature of the three term-structure curves. These yield curve factors are able to quite accurately aggregate information from a relatively larger set of term structure data than that restricted by the affine term-structure models in the finance literature.

The empirical methodology in this study proceeds in four steps. First, the nominal yield curve is decomposed into the term structure of theoretical yields that are consistent with the expectations hypothesis plus a rolling term premia using the stationary vector-stochastic process in Campbell and Shiller (1987, 1991). Second, the longer term theoretical yields are then decomposed into *ex ante* real yields and expected inflation using the structural VAR methodology developed by Blanchard and Quah (1989), where structural shocks are identified by the long-run restriction that inflation expectation shocks have a permanent effect on longer term yields, while *ex ante* real rate shocks have only a temporary effect. Third, the nominal yields and the real and inflation components are estimated using the dynamic Nelson and Siegel (1987) model in a state-space framework to capture three latent factors – level, slope and curvature – that can accurately capture the three term-structure curves. Finally, a Markov-switching VAR framework is used to capture regime shifts in the variances and in the contemporaneous responses of the level, slope and curvature factors to innovations in inflation and the monetary policy rate, the primary nominal and real sources of the regime switches.

To preview the conclusions, the yield curve decompositions capture credible stylized facts about *ex ante* real yields, expected inflation, and the term premium. The dynamic yield-curve models identify a nominal yield curve that increase from about 5 per cent to slightly over 6 per cent with a slope of over 120 basis points, an *ex ante* real yield curve that slopes upward by about 20 basis points to plateau at slightly less than 3 per cent, and an expected inflation curve that is virtually flat at slightly above 2 per cent. The regime-switching estimations stochastically divide the sample period into high- and low-variance regimes in about 1999 for all three curves. The dynamic yield-curve models for the two regimes indicate that the nominal yield curve has shifted down by almost 4.5 percentage points to about 3.50 per cent in the current regime, while the real yield curve has shifted down by almost 3.5 percentage points to about 1.25 per cent and the expected inflation curve has shifted down by over 1.0 percentage points to about 1.60 per cent.

The following section briefly discusses some recent research on the state-space representation of the dynamic factor model for the nominal term-structure of interest rates and on the regime-switching behaviour of interest rates, including attempts to extract real yields from nominal interest rates. Section 3 outlines the methodology for the decomposition of the nominal yields and presents the results for nominal yields and the *ex ante* real yield and expected inflation components. Section 4 outlines the dynamic yield-curve methodology and discusses the results for the nominal yield curve and its components. The regime-switching approach used in this study and the results are presented in Section 5. The final section briefly discusses the implications of the empirical results for monetary policy and market practitioners and outlines some directions for further research.

2. Some previous research

2.1. Dynamic yield curve model

he dynamic factor or yield-curve model can traced to Diebold and Li (2006), who provide essentially a time-series extension of the exponential components framework by Nelson and Seigel (1997) that assumes the term structure of interest rates to be a function of three unobservable components. They extend the framework by computing the values of the exponential factor loadings and using ordinary least squares to obtain three time-varying parameters that are interpreted as factors corresponding to the level, slope, and curvature of the yield curve. Diebold, Rudebusch, and Aruoba (2006) extend the model in a state-space form with the Kalman filter and a VAR transition equation. The extension allows for a simultaneous fit of the yield curve at each maturity and maximum-likelihood estimates, as well as optimal filtered and smoothed estimates of the underlying factors. They find that the three time-varying parameters in the state-space form of the Nelson-Seigel model can be estimated efficiently for the United States. However, they do not find evidence of strong own-dynamics of the term structure factors.

Diebold et al. (2006) also extend the dynamic latent-factor framework further by complementing the empirical Nelson-Seigel model with a nonstructural VAR model for real activity, inflation, and the monetary policy instrument. Overall, they find that causality from macroeconomic variables to the yield curve is much stronger than from the yield curve to the