Journal of Financial Economics 106 (2012) 367–394

Contents lists available at SciVerse ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

The term structure of inflation expectations ☆

Mikhail Chernov [a,b], Philippe Mueller [a,*]

[a] London School of Economics, London, UK
[b] CEPR, UK

ARTICLE INFO

Article history:
Received 21 April 2008
Received in revised form
3 August 2011
Accepted 1 September 2011
Available online 15 June 2012

JEL classification:
G12
G17
E43
C58

Keywords:
Affine term structure models
Macro factors
Hidden factors
Survey forecasts

ABSTRACT

We use information in the term structure of survey-based forecasts of inflation to estimate a factor hidden in the nominal yield curve. We construct a model that accommodates forecasts over multiple horizons from multiple surveys and Treasury real and nominal yields by allowing for differences between risk-neutral, subjective, and objective probability measures. We establish that model-based inflation expectations are driven by inflation, output, and one latent factor. We find that this factor affects inflation expectations at all horizons but has almost no effect on the nominal yields; that is, the latent factor is hidden. We show that this hidden factor is not related to either current and past inflation or the standard set of macro variables studied in the literature. Consistent with the theoretical property of a hidden factor, our model outperforms a standard macro-finance model in its forecasting of inflation and yields.

1. Introduction

Inflation expectations play an important role in policy making and in research on asset pricing. The generalized Fisher equation expresses a nominal yield via a sum of the real yield, the expectation about inflation, and the premium on inflation risk. Therefore, when policy makers attempt to determine how monetary policy affects the real economy, they need to break down the nominal yield into its components. This task prompts them to consider the break-even inflation rate (the difference between the nominal and real yields) and survey-based inflation expectations. Likewise, most theories of asset pricing make predictions about the real economy, while, with few exceptions, researchers observe nominal asset prices. Therefore, it is desirable to have a reliable estimate of expected inflation and the premium on inflation risk to be able to test the real theories on nominal data.

Herein, we highlight another reason why academics and practitioners should be interested in inflation expectations

☆ We are grateful to the editor, Bill Schwert, and the anonymous referee for the exceptional feedback. We would also like to thank Dave Backus, Andrea Buraschi, Stephen Cecchetti, Albert Lee Chun, Pierre Collin-Dufresne, Valentina Corradi, Darrell Duffie, Eric Ghysels, Marc Giannoni, Francisco Gomes, Refet Gürkaynak, Scott Joslin, Don Kim, Sharon Kozicki, Lars Lochstoer, Igor Makarov, Stephen Schaefer, Antoinette Schoar, James Stock, Raman Uppal, Andrea Vedolin, Jonathan Wright, Stephen Zeldes, Stan Zin, and participants at the Bank of England, Barclays Global Investors, College of Queen Mary, Columbia Macro and Finance workshops, Copenhagen Business School, the European Central Bank, the 2007 Financial Econometrics Conference at Imperial College, Goethe University Frankfurt, the London Business School Finance workshop, McGill University, MIT Sloan School of Management, the 2007 National Bureau of Economic Research Summer Institute, PIMCO, the 2007 SAFE Conference on New Directions in Term Structure Modeling in Verona, State Street Global Advisors, and Wharton School of the University of Pennsylvania. We are especially grateful to Ruslan Bikbov for many insights into term structure modeling.

* Corresponding author at: London School of Economics, Department of Finance, Houghton Street, London WC2A 2AE, UK.
Tel.: +44 20 7955 7012.
E-mail addresses: m.chernov@lse.ac.uk (M. Chernov), p.mueller@lse.ac.uk (P. Mueller).

0304-405X/$ - see front matter
http://dx.doi.org/10.1016/j.jfineco.2012.06.004

and their role in asset pricing. The recent research on bond predictability points to the importance of considering hidden factors when modeling bond yields (Duffee, 2011; Joslin, Priebsch and Singleton, 2010). A hidden factor does not itself affect the cross section of yields. However, it predicts factors that do. As a result, this hidden factor helps in forecasting bond-related quantities, such as yields or excess returns. It is important to understand the economic intuition behind these hidden factors. Using macro data in conjunction with yields is one way to achieve this. Moreover, such an approach is likely to lead to better statistical properties of the estimated hidden factor than the entirely yields-based approach of Duffee. We argue that survey-based inflation expectations are the macro variables that are helpful in developing our understanding of hidden factors.

The Duffee (2011) intuition is that a factor is hidden in the nominal yield curve if risk premia vary with the level of this factor in the amount equivalent but opposite to the variation in the expected future short nominal rates. Using this intuition as a basis, the Fisher equation shows us that, if a factor is hidden, the joint variation in inflation risk premia and real risk premia associated with this factor offset the joint variation in the expected future short real rates and the expected inflation that is associated with the same factor. Hence, expected future inflation and expected future short real rates should depend on the hidden factor. Therefore, it should be possible to extract the hidden factor from the cross section of expected future short real rates or of expected inflation. Whereas the former is not readily available, the latter can be inferred from survey-based forecasts of inflation.

If the hidden factor is inflation itself, as in Joslin, Priebsch and Singleton (2010), one need not worry about inflation expectations because it is trivial to retrieve the hidden factor from inflation. Nonetheless, the view that inflation is the hidden factor has exactly the same implications for expectations about future inflation as for other possible hidden factors. Therefore, using inflation expectations to learn about the hidden factor constitutes a more general approach. Moreover, such an approach allows for the possibility that information sets of survey forecasters are richer than allowed for by common term structure models.

These observations highlight a role for survey-based expectations that is complementary to the one pointed out by Kim and Orphanides (2012). These authors argue that incorporating survey data into term structure models alleviates the difficulty of statistical inference about persistent variables in short samples. If there is a hidden factor that is not related to observable macro variables, even an infinite data set consisting of yields and macro variables is not going to help a researcher extract the hidden factor. Adding surveys would help in solving this problem.

The challenge that one faces in implementing this idea is that it is not clear whether information about inflation expectations that is embedded in yields is identical to or in conflict with that derived from surveys. That these two possibilities are a real concern is indicated by the fact that the mechanisms that generate these expectations are different. In contrast to consensus survey forecasts, which average the opinions of up to only about 50 participants, the expectations embedded in bond prices are formed by thousands of traders who invest hundreds of millions of dollars. To date, the literature has been concerned with the comparison of different methods of forecasting inflation, but, to the best of our knowledge, no one has reported whether observed yields and survey forecasts could be rationalized within a single model. A joint model of surveys and yields would help to establish whether the two sources of inflation expectations are compatible by detecting whether a common set of factors explains both.

We specify a no-arbitrage macro-finance model that is sufficiently flexible to accommodate inflation, output, real and nominal yields, and survey-based inflation expectations. The yields and forecasts are driven by two observed macro variables (output and inflation) and by latent variables. The joint dynamics of these variables determine inflation expectations for any horizon under the objective probability measure, i.e., a measure determined by the actual factor dynamics of a model. The yields reflect inflation expectations under the risk-neutral probability measure. We connect the behavior of the real and nominal interest rates via inflation, by relying on the transition from the real to the nominal economy. As a result, we obtain the Fisher equation of the nominal interest rate.

Inflation expectations are available from various surveys and at various horizons (see Fig. 1). However, no two surveys are the same in terms of the composition of forecasters, the frequency of the observations, or the forecast horizons. Our model incorporates these characteristics. The key feature of this model is that forecasts from different surveys and at different horizons enter the model in an internally consistent fashion, taking into account, in a reduced form, potentially different information sets or the different objective functions for forecasting. We model the respective expectations as those of heterogeneous agents. This implies that, for each survey, the expectations are computed using a subjective measure, which reflects an individual's perception of the factor dynamics of a model. We allow that the subjective measure might differ from both objective and risk-neutral measures. The flexibility inherent in this modeling approach allows for state-dependent deviations of the subjective measure-based expectations from the objective measure-based expectations.

For our empirical analysis, we use a panel of eight yields ranging from three months to ten years, with inflation and gross domestic product (GDP) observed quarterly from 1971 to 2008. We combine these with a total of 19 inflation forecasts from the three surveys depicted in Fig. 1. As a robustness check, we also use our model with added data on Treasury Inflation-Protected Securities (TIPS) yields (from 2003 to 2008).

We need three latent factors (five in total) in the model to accommodate the joint behavior of yields and survey-based expectations. Allowing for the difference between subjective and objective probability measures, we show a rich pattern of term disagreements, i.e., the differences between model-based subjective and objective inflation