A Joint Factor Model of the Treasury Yields and the Economy
to Forecast Economic Growth

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Abstract
This paper proposes an econometric model of the joint dynamic relationship between the yield curve and the economy. In contrast to previous literature, we examine the predictive power of the yield curve – in a unified framework – with respect to linear predictions of future economic growth as well as the beginning and end of economic recessions at the monthly frequency. In addition, the proposed bivariate dynamic factor model takes into account not only the popular term spread but also information extracted from the entire yield curve. The nonlinear model is used to investigate the relationship between the phases of the bond market and of the business cycle. The results indicate a strong interrelation between these two sectors. The proposed joint model of the yield curve and the economy displays a much improved ability to anticipate economic recessions compared to alternative frameworks that use only the term spread, or the yield level and curvature separately. In particular, the yield factor predicts all recessions with no false peaks and no missed turns producing a perfect forecast score. The model also displays a better linear forecasting performance compared to similar alternative specifications. This result holds using revised or real time unrevised data.

Keywords: Business Cycles, Yield Curve, Dynamic Factor Models, Markov Switching.
JEL Classification: C32, E32, E44

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I. Introduction

The yield curve, which relates bond yields to their time to maturity, has become one of the most popular leading indicators of the economy, as there is substantial evidence of systematic association between changes in its shape and future recessions. The slope of the yield curve (i.e. the term spread) is the difference between long term and short term interest rates. Generally, the yield curve is upward sloping since longer maturity is associated with higher yield. This is especially the case in the early stages of economic expansions, when the market expects a rise in the short term interest rates. Under the arbitrage pricing and liquidity preference theories, investors require a term and a risk premium, respectively, for acquiring long maturity bonds rather than the risk free short term rate. On the other hand, the slope of the curve tends to become flat or inverted towards the end of expansions. One of the possible reasons is that tight monetary policy generally precedes a recession. As short rates rise above long rates, the yield curve becomes inverted. In addition, according to the expectation theory, long-term rates reflect market expectation for future short-term rates. Hence, a flat or inverted curve indicates that the market expects a fall in future real interest rates given the prospect of future weak economic activity.

There is a large literature that investigates prediction of future economic activity using the term structure of interest rates. In general, linear regression models are used to forecast the growth rate of economic activity (e.g. Ang et al. 2006, Hamilton and Kim 2002) and discrete choice models such as probit or logit specifications to predict the probability of a recession (e.g Estrella and Hardouvelis 1991, Estrella and Mishkin 1998, Chauvet and Potter 2002, 2005, Wright 2006). While the term structure is predominantly used in these models, recently literature has shown that information across the whole yield curve can result in more efficient and accurate forecasts (see, e.g. Ang, Piazzesi, Wei 2006).

This paper proposes an econometric model of the joint dynamic relationship between the yield curve and the economy. In contrast with previous literature, we

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examine the predictive value of the yield curve to forecast – in a unified framework – both future economic growth as well as the beginning and end of economic recessions at the monthly frequency. In addition, we specify a dynamic latent bivariate factor model that takes into account not only the term spread but also the information extracted from the entire yield curve.

Related asset pricing literature models the yield curve using some unobserved factors generally called the level, slope, and curvature as, for example, Litterman and Scheinkman (1991), Knez, Litterman, and Scheinkman (1994), Duffie and Kan (1996), Dai and Singleton (2000), Ang and Piazzesi (2003), Diebold and Li (2006) or Diebold, Rudebusch and Aruoba (2006). These papers show that these three factors can explain most of the time variation of the yield curve. In our paper we use empirical proxies to measure the level, slope, and the curvature of the yield curve, from which we extract a latent yield factor that summarizes the information common to these three variables. The proposed framework uses comprehensive information on the yield from several variables in a parsimonious way and connects it with the economy without incurring in potential multicollinearity problems as in linear regressions. We also extract an unobservable economic factor from monthly industrial production. The model is cast on state space form and lagged values of the latent yield factor are linked to the economic factor in a vector autoregressive transition equation system. The two factors are then simultaneously estimated from their relationship with the observable variables and from their relationship with each other.

Since changes in the yield curve are cyclical and potentially related to future economic expansions and recessions, we allow the yield and economic latent factors to follow two-state Markov switching processes. The Markov states for the yield curve factor represent the phases of bond market cycles. The Markov states for the economic factor correspond to business cycle phases. These cyclical phases of the bond market and the economy are linked through the dependence structure of the factors in the transition equations.

The nonlinearities in the form of switching states can capture changes in the stochastic structure of the economy such as the possibility of recurrent breaks. Several recent papers have shown that the predictive power of the yield curve is not stable over
time. For example, Chauvet and Potter (2002, 2005) find strong evidence of breaks in the relationship between the yield curve and economic activity, and conclude that models that do not take into account these evolving dynamics may lead to poor real time forecasts.

We investigate the in-sample and out-of-sample forecasting performance of the yield factor from our proposed framework to future economic activity both in form of linear projections, as well as in terms of event timing – the beginning and end of business cycle phases. The analysis is performed using revised data and real time unrevised data. Our results show a strong correlation between the real economy and the bonds market. The yield factor has a much improved ability to anticipate economic recessions compared to alternative frameworks that use only the term spread, or the yield level and curvature separately. In particular, the yield factor predicts all recessions with no false peaks and no missed turns – a perfect forecast score. In addition, the lead time of the yield factor to recessions is more stable than the alternative models. Finally, both the univariate term spread specification and our yield factor model predicts the onset of the current recession. However, only our model already predicts the end of this recession.

The model also displays a better linear forecasting performance compared to an alternative specification that uses only the term spread as well as compared to a specification that uses the information on the yield curve, slope, and spread. That is, our model reduces the dimensionality of the information on the yield curve down to one state variable whose dynamics is superior in forecasting the economy compared to a specification that uses all three factors in a linear regression. This result holds in-sample, out-of-sample, and in a real time exercise.

The paper is organized as follows. In Section 2 we introduce univariate dynamic factor models for the yield curve and for industrial production. We construct the joint model of the bond market and the economy that allows for the interrelations between these sectors in Section 3. The empirical results from our model and the alternative specifications are discussed and real time forecasting results are presented in Section 4. Section 5 concludes.