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Maximizing equity market sector predictability in a Bayesian time-varying parameter model☆

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Abstract

The Kalman filter methodology is employed to develop a dynamic sector allocation model for US equities. Bayesian parameter estimation and model selection criteria result in significantly improved sector return predictability over static or rolling parameter specifications. A simple trading strategy illustrates how widely tested financial and economic variables can be used as inputs in for a potentially profitable investment strategy.

Keywords: Asset pricing; Gibbs sampling; Markov switching; Behavioral finance; Kalman filter

1. Introduction

As the field of finance has struggled to find a successor model to the benchmark Capital Asset Pricing Model (CAPM) specification, the role conditional macroeconomic factors play in determining investor risk premia and ultimately equity return predictability has come into greater focus. In this paper we develop a robust dynamic trading model for economic sectors using factors identified as significant in the relevant literature. Further, the model we develop assumes time variation in factor sensitivities to capture changing risk premia over time. Time variation in factor betas is approached using dynamic updating in the Kalman filter. The result is a highly responsive model that significantly outperforms comparable static and rolling parameter specifications. Employing this methodology, we would like a model that is particularly prescient at business cycle turning points. Such a model may provide an important hedge against more passive models optimized over the most recent economic regime or long term samples. The model developed here also appears to have important risk pricing properties when contrasted with the benchmark CAPM.

One of the earliest and most straightforward investigations on the role macroeconomic factors play in determining equity returns is that of Chen et al. (1986). Using cross-sectional analysis, Chen et al. find that a number of macroeconomic risk factors are significantly priced in the stock market. In another application, Lo and MacKinlay (1997) derive predictive portfolios based on lagged macroeconomic variables that lend themselves to dynamic trading strategies. A further indication of the importance of lagged macroeconomic variables is presented in Ferson and Harvery (1999), where conditional lagged fundamental information included in a risk pricing model renders sorted portfolio attributes in the popular Fama and French (1992, 1993, 1996) three factor model insignificant.

☆ The opinions expressed in this paper are those of the authors and do not necessarily reflect those of Numeric Investors.

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In addition to the available empirical tests suggesting an important role for conditional macroeconomic information in asset pricing, a pricing model based strictly on prior macroeconomic information has intuitive and theoretical appeal. As pointed out by Roll (1977), any empirical examination of the standard CAPM is theoretically suspect if the chosen proxy for the market portfolio is not truly representative of the entire market. Even providing for a reasonable proxy for the market portfolio, Cochrane (1996) notes that explanations of changes in returns over the business cycle based on expected market returns are hardly useful in establishing what risk factors cause returns of individual portfolios to vary. What is surely of greater interest over the business cycle are what particular macroeconomic forces drive expected returns.

The other obvious advantage of a factor model incorporating strictly lagged information is the potential application to return predictability. In one such exercise, Lo and MacKinlay (1997) find that up to 50% of the variation in returns can be explained by lagged economic factors introduced through what they term a Maximally Predictable Portfolio. Any evidence of systematic predictability naturally lends itself to questions of market efficiency, however, a model based on return reaction to fundamental information is much easier to reconcile with a future cash flow model than much of what is currently in the anomaly literature. A broad competing class in the predictability literature has focused on non-fundamental momentum effects that provide some predictability over sorted portfolios. Jegadeesh and Titman (1993) and Lee and Swaminathan (2000) report to find consistent profit opportunities on the order of 1% per month employing a basic strategy of buying past winners and selling past losers.

Another question of interest in testing a factor model based on fundamental information is the extent to which tangible fundamentals actually drive the stock market. The late 1990s is a notable period in which the valuation of broad classes of equities de-coupled from traditional pricing measures. The classic dividend discount model of Gordon (1962) extended by Campbell and Shiller (1989) posits that the value of an individual equity or broad market index is a function of future anticipated cash payments. Changes in price should move in tandem with growth in dividends and expectations of higher dividends in the future. Pairing this model with the experience of the late 1990s required extraordinary future dividend income growth to explain the rapid increase in equity valuations. Even an extension of the Campbell and Shiller model using earnings as a proxy for dividends struggles to account for the run up in equity valuations without allowing for substantial future earnings growth significantly greater than trend GDP growth. Despite record 7.5% real earnings growth in the 1990s, as documented in Fama and French (2002), the non-fundamental equity premium, calculated here as real capital gains net of real earnings growth, was a substantial 5.22% per year. The dividend yield by the end of the 1990s fell to as low as 1.1%, indicating a very high level of expected dividend growth in the future or a new regime of near zero discount rates. Therefore, a further question of interest is the degree to which observable fundamentals even matter in determining equity returns over different stages of the business cycle, or in the case of the late 1990s, during a possible speculative boom.

One of the primary motivating factors in the development of the conditional pricing models of Ferson and Harvery (1999), Wu (2002) and Cochrane (1996) is the strong empirical evidence that equity market risk premia are time varying. Each of these conditional beta representations use lagged macroeconomic factors to capture time variation. Another approach to addressing time variation in risk factors is to allow the evolution of risk sensitivities to evolve in a Bayesian manner. Such an approach is made available through application of the Kalman filter with a time-varying parameter specification. An example of a time-varying parameter model using the Kalman filter can be found in Kim and Nelson (1989).

The balance of this paper is organized as follows: In Section 2 a time-varying parameter factor model (TVPFM) using lagged economic factors and industry sectors as portfolios is motivated and developed. Section 3 describes the full Bayesian estimation and model selection criteria employed for evaluating the model. Some preliminary indications from the model output are also discussed. Section 4 investigates the behavior of out of sample risk premia on the predicted model sector returns. In Section 5, the potential profitability of a simple trading strategy using the predicted returns of the TVPFM is investigated and discussed. Section 6 concludes.

2. A time-varying parameter factor model

2.1. General model specification

We begin with a time series factor model of equity returns. The factors are assumed to be lagged fundamental macroeconomic variables. The model is a hybrid of a time-varying parameter model and a Markov-switching model