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Dynamic asset allocation with ambiguous return predictability ☆

Hui Chen [a], Nengjiu Ju [b], Jianjun Miao [c,d,e]

[a] MIT Sloan School of Management, 77 Massachusetts Ave, Cambridge, MA 02139, United States
[b] Shanghai Advanced Institute of Finance (SAIF), Shanghai Jiaotong University, Shanghai, 200030, China
[c] Department of Economics, Boston University, 270 Bay State Road, Boston, MA 02215, USA
[d] CEMA, Central University of Finance and Economics, Beijing, China
[e] AFR, Zhejiang University, Hangzhou, China

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ABSTRACT

We study an investor's optimal consumption and portfolio choice problem when he is confronted with two possibly misspecified submodels of stock returns: one with IID returns and the other with predictability. We adopt a generalized recursive ambiguity model to accommodate the investor's aversion to model uncertainty. The investor deals with specification doubts by slanting his beliefs about submodels of returns pessimistically, causing his investment strategy to be more conservative than the Bayesian strategy. Unlike in the Bayesian framework, the hedging demand against model uncertainty may cause the investor's stock allocation to decrease sharply given a small doubt of return predictability, even though the expected return according to the VAR model is large. Over much of the parameter space, the robust strategy is very close to the Bayesian strategy with Epstein–Zin preferences and risk aversion chosen to match the same average portfolio holdings. This is true in particular when the IID model is unlikely and the dividend yield is low, as in recent years. However, differences in strategies can be substantial if the IID model is unlikely and the dividend yield is high.

1. Introduction

One of the most debated questions in recent financial research is whether asset returns or equity premia are predictable.[1] This question is of significant importance for portfolio choice. If asset returns are independently and identically distributed (IID) over time, then the optimal asset allocation is constant over time (Merton, 1969 and Samuelson, 1969). However, if asset returns are predictable, then the optimal asset allocation depends on the investment horizon and the predictive variables (Brennan et al., 1997; Campbell and Viceira, 1999 and Kim and Omberg, 1996). Economists have different views on whether asset returns are predictable. Welch and Goyal (2008) argue that the existing empirical models of predicting asset returns do not outperform the simple IID model both in sample and out of sample, and thus are not useful for investment

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E-mail addresses: huichen@mit.edu (H. Chen), njju@saif.sjtu.edu.cn (N. Ju), miaoj@bu.edu (J. Miao).

[1] For an example, see the July 2008 issue of the *Review of Financial Studies*.

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advice. Campbell and Thompson (2008) argue that the empirical models of predictability can yield useful out-of-sample forecasts if one restricts parameters in economically justified ways. Cochrane (2008) points out that poor out-of-sample performance is not a test against the predictability of asset returns.

While many estimation models deliver significant variations in expected returns, the predictive relation is statistically weak and unstable. The estimated predictability coefficient is typically not quite significant and R^2 is generally low. In addition, the sample period and predictive variables are important for regression performance. This suggests that the estimation models may be misspecified. The contrast between the economic significance of various return predictability models and their marginal statistical significance presents a dilemma for investors. The significant variation in expected returns predicted by these models implies aggressive market timing strategies, which can be very costly if they turn out to be wrong.

How should a long-term investor make consumption and portfolio choice decisions when facing alternative possibly misspecified models of asset returns? To address this question, we build a dynamic model in which an investor is concerned about model misspecification and averse to model uncertainty.[2] Following most papers in the portfolio choice literature, we consider a simple environment in which the investor allocates his wealth between a risky stock and a risk-free bond with a constant real interest rate. We depart from this literature and the rational expectations hypothesis by assuming that there are two submodels of the stock return process: an IID model and a vector autoregressive (VAR) model. For simplicity, we adopt the (demeaned) dividend yield as the single predictive variable in the VAR estimation and abstract away from parameter uncertainty. The investor is unsure which one is the true model of the stock return, and thus faces a model selection problem. The investor can learn about the asset return model by observing past data.

The standard Bayesian approach to this learning problem is to impose a prior over the possible stock return submodels. The posteriors and likelihoods are derived by Bayesian updating. They can be reduced to a single predictive distribution by Bayesian averaging. One can then solve the investor's decision problem using this predictive distribution in the standard expected utility framework (see Barberis, 2000; Pastor and Stambaugh, 2012; Wachter and Warusawitharana, 2009 and Xia, 2001). We depart from this Bayesian approach in that we assume that posteriors and likelihoods cannot be reduced to a predictive distribution in the investor's utility function. This irreducibility of compound distributions captures attitudes towards model uncertainty or ambiguity, as discussed by Segal (1987), Klibanoff et al. (2005, 2009), Hansen (2007), Seo (2009), Hayashi and Miao (2011) and Ju and Miao (2012). The standard Bayesian approach implies ambiguity neutrality.

To accommodate model ambiguity and ambiguity aversion, we adopt a recursive ambiguity utility model recently proposed by Hayashi and Miao (2011) and Ju and Miao (2012), who generalize the model of Klibanoff et al., (2005, 2009). This generalized recursive ambiguity model is tractable in that it is smooth and allows for flexible parametric specifications, e.g., a homothetic functional form, as in Epstein and Zin (1989). We may alternatively interpret this utility model as a model of robustness in that the investor is averse to model misspecification and seeks robust decision making. We find that an ambiguity-averse investor slants his beliefs towards the submodel of stock returns that delivers the lowest continuation value. The endogenous evolution of these pessimistic beliefs has important consequences in the consumption and portfolio choice decision and welfare implications.

We calibrate the ambiguity aversion parameter using thought experiments related to the Ellsberg Paradox (see Halevy, 2007 and the references cited therein). Our calibrated value is consistent with the experimental finding reported by Camerer (1999), which suggests that the ambiguity premium is typically about 10 to 20 percent of the expected value of bets. We use our calibrated value of the ambiguity aversion parameter, the standard value of risk aversion parameter, and econometric estimates of the stock return process to solve an ambiguity-averse investor's decision problem numerically. We refer to the optimal stock allocation rule for an ambiguity-averse investor as the robust strategy. We compare this robust strategy with three other investment strategies widely studied in the literature: the IID strategy, the VAR strategy, and the Bayesian strategy. The IID and VAR strategies refer to the optimal investment strategies when the investor knows for sure that the stock return follows an IID model and a VAR model, respectively. The Bayesian strategy refers to the optimal investment strategy under Epstein–Zin utility in the Bayesian framework.[3]

We show that the robust stock allocation depends on the investment horizon, the beliefs about the model of stock returns, and the predictive variable. Compared to the Bayesian strategy with identical values of the intertemporal elasticity of substitution and the risk aversion parameter, the robust strategy is more conservative in that it recommends an ambiguity-averse investor to hold less stocks than a Bayesian investor, inducing more nonparticipation in the stock market. To understand the differences between the Bayesian and the robust strategies, we first review the portfolio rule under the Bayesian strategy studied by Xia (2001) for the case of parameter uncertainty. The Bayesian stock demand can be decomposed into a myopic demand and an intertemporal hedging demand. The myopic demand depends on the expected return, which is the weighted average of the expected returns from the two submodels of stock returns. The hedging demand can be further decomposed into two components. The first component is the hedging demand associated with the predictive variable. This component is analyzed by Campbell and Viceira (1999) and Kim and Omberg (1996) in settings without model uncertainty. The second component is the hedging demand against model uncertainty. High realized returns

[2] Our notion of model uncertainty is in the sense of Knightian uncertainty or ambiguity in that no known probabilities are available to guide choices. A classical example to illustrate ambiguity and ambiguity aversion is the Ellsberg Paradox (Ellsberg, 1961).

[3] Assuming that the investor maximizes expected utility from next-period wealth, Kandel and Stambaugh (1996) study myopic strategy in a Bayesian framework.