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Does ambiguity matter? Estimating asset pricing models with a multiple-priors recursive utility ☆

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ABSTRACT

This paper considers asset pricing models with stochastic differential utility incorporating decision makers' concern with ambiguity on true probability measure. Under a representative agent setting, we empirically evaluate alternative preference specifications including a multiple-priors recursive utility. We find that relative risk aversion is estimated around 1–8 with ambiguity aversion and 7.4–15 without ambiguity aversion. Estimated ambiguity aversion is both economically and statistically significant and can explain up to 45% of the average equity premium. The elasticity of intertemporal substitution is higher than one, but its identification appears to be weak, as observed by previous authors.

1. Introduction

Asset market participants often make decisions when their knowledge about the underlying probability distribution is incomplete. This type of ambiguity on the stochastic nature of economic environment can make market investors request uncertainty premiums in addition to those from conventional risks. Considering the fact that current and future utilities describe the dynamic behaviors of the market investor, we ask the following question: Is it possible to quantify the extent to which financial markets price ambiguity by identifying and estimating an appropriately specified intertemporal utility

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that disentangles risk aversion, intertemporal substitutability, and ambiguity aversion? To answer, this paper examines continuous time asset pricing models with recursive preferences of the representative agent, incorporating the decision maker's concern with ambiguity on true probability measure. Our measure of ambiguity aversion is derived using properties of continuous time diffusion processes, and conditional volatilities of asset returns play an important role in measuring premiums driven by ambiguity aversion.

Since the seminal papers by Hansen and Singleton (1982) and Mehra and Prescott (1985), a large body of work has sought after relevant forms of economic agents' preferences to explain asset market behaviors. The main reason for this direction of research is because time-separable expected utility functions equipped with a constant relative risk aversion (CRRA) impose a potentially restrictive relation between risk aversion and intertemporal substitution. Under the power utility models, the elasticity of intertemporal substitution (EIS) is given by the reciprocal of the coefficient of relative risk aversion and this model results in various complications such as equity premium, volatility and interest rate puzzles. Epstein and Zin (1989, 1991) investigate an important generalization of the standard power utility model by considering a class of recursive utility functions. The basic structure of recursive utility is due to Koopmans (1960) and Lucas and Stokey (1984), which decompose a utility function into current consumption and future utility in a nonlinear fashion. Epstein and Zin (1989) provide a theoretical framework in which the agent can have distinct attitudes toward intertemporal substitution and risk. This flexibility can offer a possible solution for various asset price anomalies because a high (low) risk aversion does not necessarily imply a low (high) elasticity of intertemporal substitution.

In addition, the Ellsberg paradox suggests that decision makers prefer an unambiguous situation, other things being equal. In response to this, Gilboa and Schmeidler (1989) build a multiple-priors model to incorporate ambiguity aversion in an atemporal setting.[1] Epstein and Wang (1994) develop a dynamic version of Gilboa and Schmeidler in a discrete-time framework and Epstein and Schneider (2003) provide axiomatic foundations for recursive multiple-priors utility. Chen and Epstein (2002) focus on the formulation of utility in continuous time that allows a distinction between risk aversion and ambiguity aversion, as well as the distinction from the EIS. In particular, they extend the continuous time version of the recursive utility (stochastic differential utility) proposed by Duffie and Epstein (1992b) such that the model includes a set of priors instead of a single prior. According to Chen and Epstein (2002), the economic agents have multiple prior beliefs on the state of the nature and they form a set of expectations based on their beliefs. Because fundamental shock processes are generated by Brownian motions, the degree of ambiguity is described by an additional term distorting the conditional mean component of the implied asset return processes and the decision maker chooses a probability measure using the maxmin principle.[2]

Despite the appealing features of the multiple-priors utility model, little econometric work exists on estimating the model compared with other utility specifications. To the best of our knowledge, this paper is the first to empirically tackle the issue under the framework of consumption-based models. The multiple-priors recursive utility model has a multifactor beta representation of asset returns, consisting of covariance between returns and consumption growth, covariance between returns and aggregate wealth return, and covariance between returns and ambiguity. However, this structure makes identification of the model difficult because aggregate wealth and volatility of returns are unobservable, more notably, a lack of econometric methodology exists for estimating continuous time models.

With regard to the unobservability of aggregate wealth, several approaches have been suggested. The baseline approach would be to use a broad-based index as a proxy for the aggregate wealth (e.g., Epstein and Zin, 1991; Bakshi and Naka, 1997; Normandin and St-Amour, 1998). However, the aggregate wealth portfolio should be a broader measure than the financial market portfolio because the former includes human capital as well as the financial wealth. Therefore, the financial market return covers only a subset of the aggregate wealth returns. Another approach is to use a specific structure for the unobservable wealth by incorporating the dynamics of consumption growth and utility continuation value. Given the imposed structure, the aggregate wealth is implicitly given by consumption and utility continuation value. Chen, Favilukis, and Ludvigson (2013) exploit the Euler equation to estimate future continuation utility in a nonparametric way.

Although this method is attractive, it is difficult to use in our continuous-time framework involving mixed frequencies of data. Instead, we consider a different approach to overcome the difficulties from the unobservable aggregate wealth. The aggregate wealth can be regarded as an asset that pays a stream of future consumption as dividends. That is, periodic consumption is financed by aggregate wealth return. We can think of aggregate wealth as the sum of financial wealth and human capital, the two largest sources of the income in an economy. The unobservability falls mostly on the human wealth. Following Campbell (1993), we assume that the proportion of the financial wealth to the human wealth is stationary and moreover, the labor income is homogeneous of degree one with respect to the human wealth. In this case, the

[1] Simply put, they assume that economic agents have a class of probability distributions, say $\mathcal{P}$ on some events in a measurable space $(\Omega, \mathcal{F})$. Then the agents make decisions following a max–min rule. For instance, the agent decides consumption c to maximize utility $u(c)$ by solving $\max_c \min_{Q \in \mathcal{P}} E^Q[u(c)]$, where E^Q denotes the expectation under Q-measure.

[2] There exists a related line of work on robust decision making. Hansen and Sargent (2001) and their co-authors emphasize model uncertainty and the concern on the misspecification, which is similar in spirit to ambiguity aversion à la Gilboa and Schmeidler. Related, another line of literature is based on smooth ambiguity aversion (e.g., Klibanoff, Marinacci, and Mukerji, 2005) by embedding a smooth functional to adjust subjective probabilities.