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Theories of choice under risk: Insights from financial markets

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ABSTRACT

To date, the plausibility of theories of choice under risk hinges are mainly on experimental evidence. This paper devises and implements an approach amenable of assessing the performance of three families of models (expected utility, rank-dependent expected utility, and the cumulative prospect theory) using information from *financial asset markets*. Our findings unequivocally support reference-point dependence, diminishing marginal sensitivity, loss aversion, and nonlinear weighting of (gain and loss) physical probabilities. The empirical observations are found to be robust to, inter alia, the parameterization of the utility and probability weighting functions, "day-of-the-week effects", the choice of a reference point, and the introduction of possible, low-probability market crashes (peso component).

1. Introduction

Expected Utility Theory (EUT, Von Neumann and Morgenstern, 1944) has been a main building block in economic modelling of choice under risk. The vast theoretical and empirical research in that area has brought up some violations of EUT and motivated alternative, non-expected utility, modelling approaches for the decision-making process.

To date, models of decision-making under risk have been tested mainly in experimental setups, apart from the market environment (Camerer, 1995 and Starmer, 2000 provide comprehensive surveys). Nevertheless, "large gamble" evidence on the relative merits of expected and non-expected utility theories is still scarce. The purpose of our work is to fill this gap by estimating the parameters characterizing agents' behavior using *real, financial market data*.

Implementing the proposed approach, we are successful in estimating three families of models – EUT, Rank-Dependent Expected Utility (RDEU, Quiggin, 1982; Yaari, 1987), and Cumulative Prospect Theory (CPT, Tversky and Kahneman, 1992[1]) – using information on asset prices in US markets. Moreover, we are able to compete the alternative theories by measuring their overall compliance with the data.

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[1] Note also Prospect Theory, Kahneman and Tversky (1979b).

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Rejecting EUT in favor of non-expected utility models of investor behavior would corroborate the viewpoint that security markets are affected by investor psychology and advocate the inclusion of behavioral variables in asset pricing models. Moreover, empirical support to behavioral models would cast doubt on the efficient market hypothesis asserting that market prices reflect only economic-relevant information.

As aforementioned, one alternative approach to EUT has been provided by RDEU. It generalizes EUT by allowing the weights assigned to possible outcomes to differ from their probabilities. In particular, physical (objective) probabilities are nonlinearly transformed into decision weights via a Probability Weighting Function (PWF).

CPT has further generalized EUT. In a nutshell, CPT characterizes risk attitudes by PWFs and a value function. The PWF advocated by CPT differs from that of RDEU in being defined separately for losses and gains. The value function characterized by CPT has three distinctive features: (i) it is defined on wealth changes, rather than on levels, relative to a reference point such as current wealth (the "status-quo" point); (ii) it is S-shaped: concave for gains and convex for losses, such that the marginal sensitivity to a lottery's outcome diminishes when moving away from the reference point; and (iii) it manifests loss aversion, by having a kink at the reference point and being steeper for losses than for gains, so losses are more painful than equal-size gains are pleasurable.[3]

Accumulated laboratory evidence (e.g., Tversky and Kahneman, 1992; Camerer and Ho, 1994; Tversky and Fox, 1995; Wu and Gonzalez, 1996; Gonzalez and Wu, 1999; Abdellaoui, 2000; Bleichrodt and Pinto, 2000; Donkers et al., 2001) indicates that the PWF displays the following features: (i) it is regressive, overweighting small probabilities and underweighting large probabilities; (ii) it is inverse-S shaped (first concave then convex), describing individuals' higher sensitivity to probability changes near the distribution's endpoints; and (iii) it is asymmetric, having a fixed point (where it intersects the diagonal) at a probability level of approximately one-third.

The scarcity of real-data based empirical analysis of non-expected utility models stands in sharp contrast to the abundant experimental literature on decision making. Presumably, the reason for the imbalance between laboratory and market data applications lies in the complexity inherent in the construction of the latter. To illustrate, Jullien and Salanie (2000) take the U.K. betting market for horse races as a venue for investigating bettors' risk attitudes. Inter alia, they rest their study on a representative agent assumption applied to bettors with identical initial wealth and risk attitudes.[4]

Indeed, different elements of the CPT may reconcile observed regularities in various domains (Camerer, 2000), such as labor supply (Camerer et al., 1997), saving and consumption (Bowman et al., 1999), state lotteries (Cook and Clotfelter, 1993), insurance (Cicchetti and Dubin, 1994), and seller behavior in the housing market (Genesove and Mayer, 2001).

The finance literature has also documented such regularities. For example, Benartzi and Thaler (1995) offered a possible explanation to the equity premium puzzle (Mehra and Prescott, 1985) by combining loss aversion and mental accounting into a concept they dub Myopic Loss Aversion (MLA), and Odean (1998) examined markets in which the behavior of overconfident market participants increases trading volume and decreases traders' expected utility. Barber and Odean (2001) tested the prediction that overconfident investors would trade excessively by partitioning the investors on gender, under the psychologically based presumption that men are more overconfident than women.

Additional related finance literature consists of Barberis and Huang (2001), shedding light on empirical phenomena, such as high mean stock returns and excess volatility, by studying economies populated by loss averse investors, and Barberis et al. (2001), providing an explanation to the high mean, excessively volatile, stock returns in an economy populated by loss averse investors whose degree of loss aversion depends on their prior investment performance.

RDEU and CPT differ from EUT by allowing a distortion of probabilities according to nonlinear PWFs. Are the attributes of decision making captured in the PWFs supported by market data? Does the fact that EUT is oblivious of probability distortions mirrors in an overall fit improvement of these alternative models? According to CPT, preferences are reference-based and the PWF is different in the loss and gain domains. How supportive are the data of such reference-based preferences? This paper provides clear-cut answers to these questions.

The rest of the paper is organized as follows. Section 2 delineates our proposed approach. Basically, it builds on the link between agents' marginal utility and the Stochastic Discount Factor (SDF).[5] One prominent advantage of this setup is that *both* marginal utilities and subjective probabilities can be *s* imultaneously estimated. Hence, we circumvent the need to isolate preferences and beliefs, a practice usually found in controlled laboratory settings.

Section 3 starts with a brief description of the dataset and the econometric procedure. Our paper advocates the use of index option prices. In particular, it exploits the preference information inherent in the prices of one-month-to-expiration, European call options written on the *S*&*P*500 index. In the sequel, we hopefully make translucent the significance of such an empirical practice, in light of existing established results from option pricing theory on the potential of these prices to recover valuable decision-making-related information on a *state-by-state basis*. The Section proceeds with a presentation of "base-case" results. Consistent with the paper's objectives, we are interested in: (i) estimating the parameters of EUT, RDEU, and CPT and (ii) ranking the models' goodness-of-fit.

Section 4 portrays an assortment of alterations to the reported "base-case". Specifically, we deal there with the following cases: (i) parameterization of the utility function; (ii) parameterization of the PWF; (iii) definition of the reference point;

[3] Clearly, RDEU takes no notice in any of these features, since it stipulates that agents value future absolute wealth levels, rather than changes.

[4] Jullien and Salanie (2000) are unable to reject expected utility in their analysis.

[5] The SDF is the ratio of state prices (prices of hypothetical Arrow-Debreu contingent claims) and decision weights assigned by the agents.