The expected utility theory philosophy essay

An essential ingredient of any model trying to understand asset prices or trading behavior is an assumption about investor preferences, or about how investors evaluate risky gambles. The vast majority of models assume that investors evaluate gambles according to the expected utility framework, EU henceforth. The theoretical motivation for this goes back to Von Neumann and Morgenstern (1944), VNM henceforth, who show that if preferences satisfy a number of plausible axioms – completeness, transitivity, continuity, and independence – then they can be represented by the expectation of a utility function. Unfortunately, experimental work in the decades after VNM has shown that people systematically violate EU theory when choosing among risky gambles. In fact, empirical studies dating from the early 1950s have revealed a variety of patterns in choice behavior that appear inconsistent with EUT.

Violations of EUT fall under two broad headings: those which have possible explanations in terms of some " conventional" theory of preferences and those which apparently do not. The former category consists primarily of a series of observed violations of the independence axiom of EUT; the latter of evidence that seems to challenge the assumption that choices derive from well-defined preferences. Let us begin with the former. There is now a large body of evidence indicating that actual choice behavior may systematically violate the independence axiom. Two examples of such phenomena, first discovered by Maurice Allais (1953), have played a particularly important role in stimulating and shaping theoretical developments in non-EU theory. Allais believed that EUT was not an adequate characterization of individual risk preferences and he designed the following problems as a counterexample.

Experiment 1

Experiment 2

Gamble 1A

Gamble 1B

Gamble 2A

Gamble 2B

Winnings

Chance

Winnings

Chance

Winnings

Chance

Winnings

Chance

â‚£1 million

100%

â‚£1 million

89%

Nothing

89%

Nothing

90%

Nothing

1%

â‚£1 million

11%

â‚£5 million

10%

â‚£5 million

10%

Allais expected that people faced with these choices might opt for Gamble 1A in the first problem, lured by the certainty of becoming a millionaire, and select 2B in the second choice where the odds of winning seem very similar, but the prizes very different. Evidence quickly emerged that many people did respond to these problems as Allais had predicted. This is the famous “ Allais paradox” and it is one example of the more general common consequence effect.

Other Theories

In response to this, there has been an explosion of work on so-called non-EU theories, all of them trying to do a better job of matching the experimental evidence. Some of the better known models include weighted-utility theory [Chew and MacCrimmon (1979), Chew (1983)], implicit EU [Chew (1989), Dekel (1986)], disappointment aversion [Gul (1991)], regret theory [Bell (1982), Loomes and Sugden (1982)], rank-dependent utility theories [Quiggin (1982), Segal (1987, 1989), Yaari (1987)], and prospect theory [Kahneman and Tversky (1979), Tversky and Kahneman (1992)].

While still trying to better explain the empirical evidence, the two brilliant psychologists, Amos Tversky and Daniel Kahneman, described three heuristics that are employed when making judgments under uncertainty (Tversky and Kahneman 1974):

Representativeness: When people are asked to judge the probability that an object or event A belongs to class or process B, probabilities are evaluated by the degree to which A is representative of B, that is, by the degree to which A resembles B.

Availability: When people are asked to assess the frequency of a class or the probability of an event, they do so by the ease with which instances or occurrences can be brought to mind.

Anchoring and adjustment: In numerical prediction, when a relevant value (an anchor) is available, people make estimates by starting from an initial value (the anchor) that is adjusted to yield the rational answer. The anchor may be suggested by the formulation of the problem, or it may be the result of a partial computation. In either case, adjustments are typically insufficient. For instance, when people were asked if the Mississippi was longer or shorter than 2000 miles they gave a lower estimate than those who were asked whether the river is longer or shorter than 5000 miles. It has been found that once people make an initial pass at a problem their initial judgment may prove to be remarkably resistant to revision. (Nisbett & Ross)

But, should financial economists be interested in any of these alternatives to expected utility? It may be that EU theory is a good approximation to how people evaluate a risky gamble like the stock market, even if it does not explain attitudes to the kinds of gambles studied in experimental settings. On the other hand, the difficulty the EU approach has encountered in trying to explain basic facts about the stock market suggests that it may be worth taking a closer look at the experimental evidence. Indeed, recent work in behavioral finance has argued that some of the lessons we learn from violations of EU are central to understanding a number of financial phenomena.

Prospect Theory

Of all the non-EU theories, prospect theory may be the most promising for financial applications, and we discuss it in detail. The reason we focus on this theory is, quite simply, that it is the most successful at capturing the experimental results. In a way, this is not surprising. Most of the other non-EU models are what might be called quasinormative, in that they try to capture some of the anomalous experimental evidence by slightly weakening the VNM axioms. The difficulty with such models is that in trying to achieve two goals – normative and descriptive – they end up doing an unsatisfactory job at both. In contrast, prospect theory has no aspirations as a normative theory: it simply tries to capture people's attitudes to risky gambles as parsimoniously as possible. Indeed, Tversky and Kahneman (1986) argue convincingly that normative approaches are doomed to failure, because people routinely make choices that are simply impossible to justify on normative grounds, in that they violate dominance or invariance.

Prospect theory (PI hereafter) was proposed first by Kahneman and Tversky (1979) (KT hereafter). KT (1979) argued that the choices that individuals make in risky situations exhibit several characteristics that are inconsistent with the basic principles of the Von Neuman-Morgenstem theory of utility (VMUT hereafter). They argued, for example, that individuals underweight probable outcomes in comparison with outcomes that are certain. They called this phenomenon the certainty effect. KT also pointed out that the certainty effect brings about risk-aversion in choices involving certain gains and risk-seeking in choices involving certain losses (KT, 1979, p. 265).

KT (1979) also found that individuals facing a choice among different prospects disregard components that are common to all prospects under consideration. They termed this commonality the isolation effect. The isolation effect, they argued, will cause the framing of a prospect to change the choice that the individual decision-maker makes (ibid., p. 271).

A third element of the decision-making process that KT discovered was the reflection effect, which is the equivalence of choice involving negative prospects and positive prospects (ibid., p. 268); that is, that choices among negative prospects are a mirror image of choices among positive prospects.

In order to compensate for these characteristics of individual behavior which are unexplained by the VMUT, KT developed a new choice model and called it PT. Whereas in VMUT, decisions in risky situations are made based on final wealth and probabilities, in PT, these decisions are made based on values assigned to gains and losses with respect to a reference point and decision weights (ibid., p. 277). KT found that the decision weights of PT are lower than the corresponding probabilities of the VMUT except in cases of very low probabilities. KT pointed out that this overweighting of low probabilities may explain why individuals choose to accept insurance and gambling at the same time.

KT (1979) developed a two-phase model for simple prospects with monetary outcomes1. The first phase of PT is the editing phase and the second is the evaluation phase.

1The function of the editing phase is to organize and reformulate the options so as to simplify subsequent evaluation and choice. Editing consists of the application of several operations that transform the outcomes and probabilities associated with the offered prospects (ibid., p. 274).

During the editing phase, four major sequential operations occur:

Coding;

Combination;

Segregation and;

Cancellation.

Coding involves the setting of a reference point by the decision- maker by which all gains and/or losses are measured. Combination consists of the aggregation of probabilities associated with identical outcomes. Segregation involves separating the risky components of a prospect from the riskless components of the prospect. Cancellation involves discarding the components of choices that are common to all prospects.

In the evaluation phase, the decision-maker evaluates the prospects that are attainable to him or her after the conclusion of the editing phase. The decision-maker then chooses the prospect with the highest value. KT denoted the overall value of an edited prospect with a V which is defined in terms of two scales, Ï€ and v. Accordingly, " the first scale, Ï€, associates with each probability p a decision weight n(p), which reflects the impact of p on the overall value of the prospect. The second scale, v, assigns to each outcome x a number v(x), which reflects the subjective value of that outcome" (ibid., 275). These scales are combined to form the basic equation of the theory which determines the overall value of a regular prospect: a prospect that is neither strictly positive nor strictly negative. Following is the equation that KT used for simple regular prospects with the form (x, p; y, q) which have at most two nonzero outcomes:

V(x, p; y, q) = Ï€ (p)v(x) + Ï€(q)v(y) (1)

This equation generalizes the VMUT by eliminating the expectation principle. If the prospect is either strictly positive or strictly negative, the prospects are separated into a riskless component and a risky component during the segregation operation of the editing phase. Thus, if p+q= 1 and either x> y> 0 or x V(x, p; y, q) = v(Y)+ Ï€ (P)[v(x)- v(y)] (2)

One of the essential features of PT is the one described in the Coding process, that the overall value of a prospect is based on changes in a decision-maker’s wealth reference point rather than on final states of wealth, as in the case of the VMUT.

The value function is one of the most widely used components of PT. KT proposed that PT’s value function has three main characteristics:

Defined on deviations from the reference point;

Generally concave for gains and commonly convex for losses; and

Steeper for losses than for gains” (ibid., p. 279) (See Figure 2).

Decision to commit further resources framed as a choice between gainsIn comparing PT’s value function with VMUT’s utility function, the latter is shallow in the referencpoint region and the former is at its steepest at this point.

Source: Kahneman and Tversky (1979): “ Prospect Theory: An Analysis of Decision Under Risk.” Econometrica 47(2): 279.

Another important element of PT is the weighting function. KT (1979) describe this function as:

In Prospect Theory, the value of each outcome is multiplied by a decision weight. Decision weights are inferred from choices between prospects much as subjective probabilities are inferred from preferences in the Ramsey-Savage approach. However, decision weights are not probabilities: they do not obey the probability axioms and they should not be interpreted as measures of degree or belief (ibid., p. 280).

KT also defined the properties of the weighting function, Ï€, which relates decision weights to stated probabilities:

Naturally, Ï€ is an increasing function of p, with Ï€ (0) = 0 and Ï€ (1) = 1. That is, outcomes contingent on an impossible event are ignored, and the scale is normalized so that Ï€ (p) is the ratio of the weight associated with the probability p to the weight associated with the certain event (ibid., p. 280).

Empirical work in the field of Prospect Theory

Verifications of PT

Karmarkar (1979) uses PT to explain observed behavior in the Allais Paradox. 3 He points out that, in PT,

…probabilities are modified by a weighting function which can be more general than that used here. However, the weights enter the decision criterion linearly and are not normalized. Thus for a given gamble, the weights need not be ‘ coherent.’ Furthermore, the weighting function in the Prospect Theory is required to have certain specific additional properties” (Karmarkar, 1979, p. 69).

Karmarkar also pointed out that some other complications, such as the subcertainty of weight requirements and the question of how and when equivalent payoffs are aggregated, arise when one uses PT to explain the Allais Paradox.

In his paper entitled “ Toward a Positive Theory of Consumer Choice,” Journal of Economic Behavior & Organization in 1980, Thaler argues that there are circumstances when consumers act in a manner that is inconsistent with economic theory and he proposes that Kahneman and Tversky’s prospect theory be used as the basis for an alternative descriptive theory. Topics discussed are: underweighting of opportunity costs, failure to ignore sunk costs, search behaviour, choosing not to choose and regret, and precommitment and self-control. The paper introduced the notion of `mental accounting.’

Newman (1980) explains how academicians, practitioners, and policymakers are impacted by PT. He contends that, whereas VMUT is deductive, or based on an explicit set of axioms, PT is inductive, or based on observations of behavior [italics added].

He implements a simple accounting information systems example to demonstrate that the following four claims are true.

Expected utility theory and prospect theory predict different values for information structures.

“ More” information is not necessarily preferred to “ less” information by an agent who behaves according to PT.

If the information evaluator and the decision-maker are separate, the evaluator will normatively (from an expected utility theory perspective) be made better off if he or she uses the descriptive model of the decision-maker, whether that model is represented by expected utility theory or prospect theory (or some competing altemative).

If the information evaluator a priori assumes that the decision maker maximizes expected utility, he or she may systematically select an inappropriate information system and may never learn the true model of the decision maker (Newman, 1980, 218-19).

He points out, " Prospect theory represents one tractable method of incorporating descriptive theory into analytical models. To the extent that PT proves viable, we have demonstrated several useful results through a simple numerical example" (ibid., p. 228).

He does not believe, however, that PT is a completely viable theory. He points out that, in spite of what KT claims, it is not easy to incorporate complex gambles into the model, but admits that the Allais Paradox could be resolved by PT, but not by VMUT, a point that was missed by Karmarkar (1979).

In another important paper Tversky and Kahneman (1981) introduced framing. They showed that the psychological principles that govern the perception of decision problems and the evaluation of probabilities and outcomes produce predictable shifts of preference when the same problem is framed in different ways.

Arkes and Blumer (1985) apply PT to examine the irrational behavior of individuals who continue with a losing prospect simply because they have already invested money in that project. They argue that the concept of individuals' " throwing good money after bad' is appropriately described by PT. They present a total of 10 experiments involving a decision prospect to a group of college students. Each student is presented with only one experiment, each containing some sunk cost decision that must be made. The experiments range from deciding whether to go along with a $10 million investment project to choosing between two ski trips.

The authors find that two characteristics of PT are important in explaining sunk cost reactions: the value function, which " represents the relation between objectively defined gains and losses and the subjective value a person places on such gains and losses" (Arkes and Blumer, 1985, p. 130- 13 1); and the certainty effect, which implies that a sure gain is overvalued and a sure loss is undervalued. The point out, however, that " prospect theory does not specify the psychological basis for the findings that sure losses are so aversive and sunk costs are so difficult to ignore" (ibid., p. 132).

Chang, Nichols, and Schultz (1987) examine the usual assumption that individuals are riskaverse with respect to tax evasion. They present 56 middle-income MBA students with six tax lottery cases. They conclude that PT better describes taxpayers' attitudes than does VMUT. They find that, although taxpayers generally exhibit risk-averse behavior, a large group will sometimes exhibit risk-seeking behavior. It is this group of risk-seeking individuals whose attitudes are consistent with PT. The authors acknowledge the following contribution of PT to their study:

Depending on the reference point, tax payments may be perceived as a reduced gain or as a loss. This means that income may not be the only argument in the taxpayer’s utility function. The taxpayer’s utility function may be different for gains compared to losses. Viewed from a Prospect Theory perspective, we would hypothesize that if a tax payment is perceived as a reduced gain, the taxpayer’s utility function will assume a concave shape. In contrast, if a tax payment is perceived as a loss, the taxpayer’s utility function will assume a convex shape. Finally, from a prospect theory perspective, the taxpayer may not conform to the expected utility axioms. For example, high probabilities or low probabilities may often be overweighted in the prospect theory view of behavior compared to the Von Nuemann-Morgenstem view of behavior (Chang, Nichols, and Schulz, 1987, p. 300).

Plan:

What is Expected Utility Theory (EUT)?

Violation of EUT – Allais Paradox

Discovery of Prospect Theory

Various aspects of prospect theory:

Editing Phase

Coding Phase

Value function

Verification and Rejection of PT

Various Literature thereafter

Empirical Evidence supporting my work