The Journal of Behavioral Finance
2003, Vol. 4, No. 2, 54–58

EDITORIAL COMMENTARY

The Contributions of Daniel Kahneman and Amos Tversky

The Royal Swedish Academy of Science awarded the 2002 Nobel Prize in Economics to Daniel Kahneman "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty." Kahneman shares the prize with Vernon Smith.[1] Kahneman did much of his Nobel Prize winning work with Amos Tversky, a fellow psychologist, starting when both were at the Hebrew University of Jerusalem. Tversky was not eligible for the Nobel Prize since its rules prohibit posthumous awards. He was 59 when he died in 1996.

The concepts of risk and return lie at the heart of finance; Kahneman and Tversky's work provides fundamental insights into the psychology associated with both. Their work is composed of two strands, prospect theory, and heuristics and biases. Prospect theory describes how people make decisions when facing risky (or risk-free) alternatives, while heuristics and biases describe, among other things, how people assess risk. Prospect theory provides the major psychological underpinnings for the behavioral approaches to portfolio selection, while heuristics and biases provide the major psychological underpinnings for the behavioral approach to asset pricing. We describe each strand and its applications to finance.

Prospect Theory and Portfolio Construction

Prospect theory, developed by Kahneman and Tversky [1979] and published in *Econometrica,* was singled out for praise by the Royal Swedish Academy of Science. Prospect theory is an alternative to mean-variance theory, the theory that underlies modern portfolio theory [Markowitz, 1959]. Prospect theory, like its mean-variance theory counterpart, focuses on the way people choose among alternatives. But the theories are different. People who conform to prospect theory tend to violate the principles that underlie mean-variance theory.

Several features distinguish prospect theory from mean-variance theory. First, people in mean-variance theory choose among alternatives based on the effect of the outcomes on the *levels* of their wealth. In contrast, people in prospect theory choose based on the effect of outcomes on *changes* in their wealth, relative to their reference point.

Second, people in mean-variance theory are risk averse in all of their choices. In contrast, people in prospect theory are generally risk averse when all changes in wealth are perceived as gains, but they are risk seeking when all changes in wealth are perceived as losses. Moreover, people in prospect theory perceive losses more severely than they perceive gains of equal amounts. Kahneman and Tversky use the term "loss aversion" to describe this asymmetry between the perception of gains and losses.

Third, people in mean-variance theory treat risk objectively, by its probabilities. In contrast, people in prospect theory overweight small probabilities. Overweighting may lead people to be risk-seeking in the domain of gains (ex. purchasing lottery tickets), and it may lead people to be risk-averse in the domain of losses (ex. purchasing insurance against outcomes with small probabilities).

Fourth, mean-variance theory implicitly assumes that the framing of alternatives does not affect choice. In contrast, prospect theory emphasizes that frames affect choices.

Kahneman and Tversky have influenced financial economists through many experiments. Consider an experiment that illuminates the features of prospect theory. Imagine that you face a concurrent choice within two pairs (A vs. B and C vs. D), where:

A = a sure gain of $24,000
B = a 25% chance to gain $100,000 and a 75% chance to gain nothing.
C = a sure loss of $75,000
D = 75% chance to lose $100,000 and 25% chance to lose nothing.

Kahneman and Tversky found that more people chose A than B and more people chose D than C. This common choice is a puzzle within standard finance, since mean-variance theory, the mainstay of standard finance, assumes that investors are always risk-averse, never risk-seeking. While the choice of A over B is consistent with risk aversion, the choice of D over C is

not. Instead it is consistent with risk-seeking. Note that the $25,000 expected gain of B (25% of a $100,000 gain), is greater than the sure $24,000 gain of A, so the common choice of A over B is consistent with risk-aversion. However, the common choice of D over C indicates that most people make some choices as if they are risk-seeking. Note that the expected $75,000 loss of D (75% of a $100,000 loss) is equal to the sure $75,000 loss of C, but D is riskier than C since it can impose a $100,000 loss. Kahneman refers to the choice of D over C as "aversion to a sure loss," since C imposes a sure loss while D does not.

Kahneman and Tversky emphasized that choices often depend on the manner in which alternatives are framed. For example, in the example described above, the common choice of the A & D combination is stochastically dominated by the less frequently chosen B & C combination. Note that A & D offers a 25% chance to win $24,000 and a 75% chance to lose $76,000, while B & C offers a 25% chance to win $1,000 more and a 75% chance to lose $1,000 less. Even though the instructions indicate that the choice among A, B, C and D is concurrent, people tend to frame the choice into one from A and B and one from C or D, overlooking the link between the two choices and its relationship to the final level of their wealth. Indeed, Kahneman and Tversky found that when people are asked directly whether they would prefer the possibility of winning $25,000 instead of $24,000, and losing $75,000 instead of $76,000, all chose the more favorable amounts, the amounts associated with the stochastically dominating B & C.

In the context of portfolio construction, Kahneman and Tversky's findings imply that people do not choose well-diversified portfolios. In particular, people ignore covariance among security returns and therefore, choose stochastically dominated portfolios that lie below the efficient frontier.

Shefrin and Statman [1985] applied the prospect theory concepts of "aversion to a sure loss" and "purchase price as reference point" to finance in their study of the "disposition effect," a term they coined for the disposition of investors to sell winners too early and ride losers too long. The disposition hypothesis states that the reluctance of investors to realize losses reflects a combination of prospect theory elements: regret (another Kahneman–Tversky concept), self-control, and tax incentives to realize losses. These elements combine to predict that investors realize gains more often than they realize losses in all months other than December. However, in December when the tax benefits of realizing losses become salient, investors realize losses more often than they realize gains.

The stream of research on the disposition effect continues to this day. Heisler [1994] documented the disposition effect among futures traders, while Odean [1998] provided the most compelling evidence for the disposition effect among individual investors. Odean analyzed the trades of many thousands of individual investors at a large brokerage firm and found that investors realize gains more frequently than they realize losses in all months other than December but they realize losses more frequently than they do gains in December. Grinblatt and Keloharju [2000] documented the disposition effect among Finnish individual investors, while Shapira and Venezia [2001] documented the disposition effect among Israeli individual and institutional investors.

Benartzi and Thaler [1995] applied prospect theory to the equity premium puzzle. The puzzle involves a difference between the historical returns of stocks and bonds that is too high to be consistent with standard finance. They concluded that the equity premium reflects what they call "myopic loss aversion." Olsen [1997] surveyed professional money managers and found that they displayed myopic loss aversion. Barberis, Huang, Ming and Santos [2001] used prospect theory to explain why stock prices are so volatile and why returns have predictable components.

Prospect theory also has implications for the construction of portfolios. Shefrin and Statman [2000] proposed a behavioral portfolio theory in which investors construct portfolios as pyramids, with a lottery-like upside potential layer designed to make them rich and an insurance-like downside protection layer designed to prevent them from being poor. Investors buy bonds, stock mutual funds and insurance policies as if they are risk-averse but they also buy options, individual stocks and lottery tickets as if they are risk-seeking.

The principles of behavioral portfolio theory differ from those of Markowitz's mean-variance theory. Yet in 1952, when Markowitz published his paper on mean-variance theory, he also published an article that explained why people buy both insurance policies and lottery tickets. Kahneman and Tversky developed prospect theory, in part, on the foundation of Markowitz's analysis of that common tendency to buy both insurance policies and lottery tickets.

Heuristics, Biases and Asset Pricing

The behavioral approach to asset pricing applies Kahneman and Tversky's work on heuristics and biases. The behavioral finance approach to asset pricing is the counterpart to the standard finance approach to market efficiency, just as prospect theory is the counterpart to mean-variance theory. Standard finance proponents of market efficiency argue that prices of assets equal the fundamental values of assets since people consider only fundamental values when they choose assets, and because prices properly aggregate the collective information of investors about fundamental values. As a result, investors find it impossible to beat the

market by earning abnormal returns (except by luck). Standard finance proponents of market efficiency concede that individuals have biases but they argue that these biases are not systematic or large enough to prevent prices from equaling fundamental values.

The behavioral approach to asset pricing postulates that people use rules of thumb, known as heuristics, to assess assets. By their nature, heuristics are imperfect, and therefore give rise to biases. Unsystematic biases would average to zero across people but the behavioral approach to asset pricing postulates that heuristics and biases are systematic and they move prices away from fundamental values.

After the announcement of his Nobel Prize, Daniel Kahneman was interviewed on CNBC. When asked what advice he would give to individual investors, he responded "buy and hold." This advice may surprise some, in that it is the typical market efficiency advice offered by the proponents of standard finance. The advice is indeed the same, but the underlying reasons are different. Standard finance proponents of market efficiency argue that it is impossible to earn abnormal returns (except by luck) because prices fully reflect all fundamental information. Behavioralists argue that although prices deviate from fundamental values, most investors are hampered by their biases as they attempt to exploit market inefficiencies.

In their influential article, "on the psychology of prediction," Kahneman and Tversky [1973] described the common tendency to rely on a heuristic they called representativeness. In effect, representativeness is overreliance on stereotypes, basing judgments on "the degree to which the outcomes represent the essential features of the evidence" [p. 237]. Kahneman and Tversky argued that people underweight base rate information when they rely on representativeness, so they make predictions that violate Bayes' rule.

To understand why reliance on representativeness can lead to underweighting of base rate information, consider one of the experiments that Kahneman and Tversky described in their 1973 article. Subjects in the experiment were presented with the following task:

> A panel of psychologists have interviewed and administered personality tests to 30 engineers and 70 lawyers, all successful in their respective fields. On the basis of this information, thumbnail descriptions of the 30 engineers and 70 lawyers have been written. ... For each description, please indicate the probability that the person described is an engineer, on a scale of 0 to 100.

The same task has been performed by a panel of experts, who were highly accurate in assigning probabilities to the various descriptions. You will be paid a bonus to the extent that your estimates come close to those of the expert panel.

One of the descriptions follows:

> Jack is a 45-year old man. He is married and has four children. He is generally conservative, careful, and ambitious. He shows no interest in political and social issues and spends most of his free time on his many hobbies, which include home carpentry, sailing, and mathematical puzzles.

At the end of the description of Jack, subjects were asked to fill in a probability: "The probability that Jack is one of the 30 engineers in the sample of 100 is ___%."

Next, Kahneman and Tversky made one small but important change in the experiment and conducted it with a second group of subjects. The change involved reversing the proportions of engineers and lawyers. While the first group was told that there were 30 engineers and 70 lawyers, the second group was told that there were 70 engineers and 30 lawyers.

In the experiment just described, the "base rate," or Bayesian prior, corresponds to the relative proportions of engineers to lawyers. The description of Jack corresponds to "singular information." Bayes' rule requires that base rate information and singular information be properly combined when judging the probability that Jack is an engineer, but Kahneman and Tversky found that most people focused on singular information, severely underweighting base rate information. In other words, people formed their assessment of probabilities that Jack is an engineer or lawyer by overweighting the extent to which the description of Jack is representative of their stereotype of an engineer or lawyer and underweighting the information about the proportions of engineers and lawyers in the population.

In the same article, Kahneman and Tversky described another experiment where subjects were asked to predict college students' grade point average (GPA) at the end of the freshman year based on descriptions that included GPA percentile during the early part of the year, the results of a test on mental concentration and a variable that measures sense of humor. Kahneman and Tversky found that people tend to base GPA predictions on representativeness, so they overestimated the GPAs of students whose prior values of GPA percentile were high, with positive descriptions and underestimate the GPAs of students with negative descriptions.

Motivated by the Kahneman–Tversky [1973] findings, Werner DeBondt and Richard Thaler [1985] analyzed whether the GPA experiment might apply to stocks such that investors might make extremely positive predictions for "winner" stocks that gained much in the past and extremely negative predictions for "loser" stocks that lost much in the past. They found evidence consistent with their hypothesis. DeBondt and Thaler's finding is a direct challenge to the weak

form of the efficient market hypothesis since the abnormal returns they documented were based on the history of prices alone.

David Dreman [1982] suggested, along similar lines, that low P/E stocks would outperform high P/E stocks because investors overreact to earnings and DeBondt and Thaler [1985] suggested that such overreaction originates in Kahneman–Tversky's representativeness heuristic. Specifically, investors overweight information about recent earnings performance (the singular information) and underweight information about the tendency of past winners and losers to revert to the mean (the base rate information).

DeBondt and Thaler's work on the winner–loser effect has been followed by others. Chopra, Lakonishok and Ritter [1992] documented the relationship between the winner–loser effect and firm size; Lakonishok, Shleifer, and Vishny [1994] found that investors inappropriately extrapolate past earnings and sales growth. While the winner–loser effect is about long-term return reversals, Jegadeesh and Titman [1993] found continuations in short-term returns. Subsequent work by Barberis, Shleifer, and Vishny [1997], and Daniel, Hirshleifer, and Subrahmanyam [1998] drew on the psychology literature to reconcile short-term continuations and long-term reversals.

Kahneman and Tversky were joined in their contributions to psychology by many other psychologists. The collection of articles by psychologists, edited by Kahneman, Slovic, and Tversky [1982], has served financial economists for years as the major source for information about heuristics and biases.

Conclusion

To appreciate the importance of Kahneman and Tversky's contributions to finance, consider the assumptions that underlie standard finance. Standard finance theories of choice and asset pricing are grounded in neoclassical assumptions of rationality. People in standard finance are assumed to be rational, and prices are assumed to be set as if all people are rational. Proponents of standard finance acknowledge that the rationality assumption does not apply to all people. However, their common view is that deviations from rationality are unsystematic or minor (see Miller [1986]). According to this view, these deviations may be pertinent when studying a family business or a single investor, but only serve as distractions when seeking to identify the fundamental forces of finance.

The power of Kahneman and Tversky's work is in the identification of choices and cognitive biases that are systematic and significant. Their theories provide a structured approach to financial behavior and their ideas illuminate how individual investors form portfolios, how managers make corporate financial decisions, and how prices reflect systematic biases.

Note

1. The contributions of Vernon Smith were described in the previous issue of the journal.

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