READING

7

The Behavioral Finance Perspective

by Michael M. Pompian, CFA

Michael M. Pompian, CFA, is at Sunpointe Investments (USA)

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** contrast traditional and behavioral finance perspectives on investor decision making;
☐	**b.** contrast expected utility and prospect theories of investment decision making;
☐	**c.** discuss the effect that cognitive limitations and bounded rationality may have on investment decision making;
☐	**d.** compare traditional and behavioral finance perspectives on portfolio construction and the behavior of capital markets.

INTRODUCTION

1

Behavioral finance attempts to understand and explain observed investor and market behaviors. This differs from traditional (standard) finance, which is based on hypotheses about how investors and markets should behave. In other words, behavioral finance differs from traditional finance in that it focuses on how investors and markets behave in practice rather than in theory. By focusing on actual behavior, behavioral researchers have observed that individuals make investment decisions in ways and with outcomes that differ from the approaches and outcomes of traditional finance. As Meir Statman so succinctly puts it, "Standard finance people are modeled as "rational," whereas behavioral finance people are modeled as "normal."[1] Normal people behave in a manner and with outcomes that may appear irrational or suboptimal from a traditional finance perspective. As a result of identified divergence between observed and theoretically optimal decision making, the global investment community has begun to realize that it cannot rely entirely on scientific, mathematical, or economic models to explain individual investor and market behavior.

1 Statman (1999).

As behavioral finance gains acceptance, efforts to understand what drives individual investor and market behavior will increase. Complete understanding will never be possible, however, because human behavior cannot be predicted with scientific precision or fully explained by a simple "unifying theory." In fact, trying to predict economic behavior, and by extension market behavior, has been likened to trying to predict the weather.

> Like weather forecasters, economic forecasters must deal with a system that is extraordinarily complex, that is subject to random shocks, and about which our data and understanding will always be imperfect. In some ways, predicting the economy is even more difficult than forecasting the weather, because the economy is not made up of molecules whose behavior is subject to the laws of physics, but rather of human beings who are themselves thinking about the future and whose behavior may be influenced by the forecasts that they or others make. To be sure, historical relationships and regularities can help economists, as well as weather forecasters, gain some insight into the future, but these must be used with considerable caution and healthy skepticism.
>
> US Federal Reserve Chairman Ben Bernanke[2]

At its core, behavioral finance is about understanding how people make decisions, both individually and collectively. By understanding how investors and markets behave, it may be possible to modify or adapt to their behaviors in order to improve economic outcomes. In many instances, this may entail identifying a behavior and then modifying the behavior so it more closely matches that assumed under the traditional finance models. In other instances, it may be necessary to adapt to an identified behavior and to make decisions that adjust for the behavior. The integration of behavioral and traditional finance has the potential to produce a superior economic outcome; the resulting financial decision may produce an economic outcome closer to the optimal outcome of traditional finance, while being easier for an investor to adhere to in practice.

To provide a framework for understanding the implications of the decision-making process for financial market practitioners, throughout this reading we will use an approach developed by decision theorist, Howard Raiffa. Raiffa (1997) discusses three approaches to the analysis of decisions that provide a more accurate view of a "real" person's thought process. He uses the terms normative analysis, descriptive analysis, and prescriptive analysis. Normative analysis is concerned with the rational solution to the problem at hand. It defines an ideal that actual decisions should strive to approximate. Descriptive analysis is concerned with the manner in which real people actually make decisions. Prescriptive analysis is concerned with practical advice and tools that might help people achieve results more closely approximating those of normative analysis. We can think of the traditional finance assumptions about behavior as normative, behavioral finance explanations of behaviors as descriptive, and efforts to use behavioral finance in practice as prescriptive.

In order to use behavioral finance in practice, it is important to understand how behavioral finance differs from traditional finance and some of the theoretical perspectives that are relevant to the understanding of the differences. Section 2 compares and contrasts behavioral and traditional perspectives of investor behaviors. Section 3 discusses theories that relax the assumptions about investor behavior that are inherent

---

2 Bernanke (2009).

in traditional finance. Section 4 compares and contrasts traditional and behavioral finance perspectives of market behaviors and portfolio construction. A summary and practice problems conclude the reading.

BEHAVIORAL VERSUS TRADITIONAL PERSPECTIVES

2

Traditional finance is grounded in neoclassical economics. Within traditional finance, individuals are assumed to be risk-averse, self-interested utility maximizers. Investors who behave in a manner consistent with these assumptions are referred to as rational. Traditional finance further hypothesizes that, at the market level, prices incorporate and reflect all available and relevant information. Markets that behave in a manner consistent with this hypothesis are described as efficient.

Behavioral finance is largely grounded in psychology. The term behavioral finance—generally defined as the application of psychology to finance—appears regularly in books, magazine articles, and investment papers; however, a common understanding of what is meant by behavioral finance is lacking. This may be because of a proliferation of topics resembling behavioral finance that examine investor behavior: These include behavioral economics, investor psychology, behavioral science, experimental economics, and cognitive psychology. Such emerging subjects as neuro-economics and adaptive finance (also known as evolutionary finance) are making their way into the conversation and provide another perspective on investor behavior. The variety of approaches taken to examine investor behavior adds to the confusion about what is meant by behavioral finance.

Behavioral finance attempts to understand and explain observed investor and market behaviors and bases its assumptions on observed financial behavior rather than on idealized financial behavior. Behavioral finance neither assumes that people act rationally and consider all available information in decision making nor that markets are efficient. To make behavioral finance easier to understand—and to differentiate the study of individual investor behavior from collective market behavior—behavioral finance in this reading is classified as either behavioral finance micro (BFMI) or behavioral finance macro (BFMA). Behavioral finance micro examines behaviors or biases that distinguish individual investors from the rational actors envisioned in neoclassical economic theory. Behavioral finance macro considers market anomalies that distinguish markets from the efficient markets of traditional finance. Whether BFMI or BFMA is of greater interest to practitioners depends on many factors, including the job held. For example, the primary focus of wealth managers and investment advisers to individual clients is BFMI (i.e., the behavior of individuals), while the primary focus of fund managers and economists is BFMA (i.e., the behavior of markets).

Regardless of whether BFMI or BFMA is of primary interest, it is critical to understand that much of traditional financial theory is based on the assumptions that individuals act rationally and consider all available information in the decision-making process and that markets are efficient. Behavioral finance challenges these assumptions. BFMI questions the perfect rationality and decision-making process of individual investors, and BFMA questions the efficiency of markets.

BFMI suggests that behavioral biases impact the financial decisions of individual investors. Behavioral biases can be categorized as cognitive errors or emotional biases. Cognitive errors stem from basic statistical, information-processing, or memory errors; cognitive errors may be considered to result from reasoning based on faulty thinking. Emotional biases stem from impulse or intuition; emotional biases may be considered to result from reasoning influenced by feelings. Behavioral biases, cognitive or emotional, may cause decisions to deviate from the rational decisions of traditional finance. BFMA suggests that markets are subject to behavioral effects. These behavioral effects may cause markets to deviate from the efficient markets of traditional finance.

Meir Statman, a prolific contributor to behavioral finance research, states comprehensively, "Standard finance is the body of knowledge built on the pillars of the arbitrage principles of Miller and Modigliani, the portfolio principles of Markowitz, the capital asset pricing theory of Sharpe, Lintner, and Black, and the option pricing theory of Black, Scholes, and Merton."[3] Statman's point is that traditional (standard) finance theory is designed to provide mathematically elegant explanations for financial questions that, when posed in real life, are often complicated by imprecise conditions. The traditional finance approach relies on assumptions that tend to oversimplify reality and are challenged by behavioral finance.

Sections 2.1, 2.2, and 2.3 focus on assumptions about investor behavior (BFMI). Section 2.1 provides an overview of the traditional finance perspective of individual behavior; section 2.2 discusses the behavioral finance challenges to the traditional finance perspective of individual behavior; and section 2.3 briefly introduces neuro-economics and its potential role in explaining individual investor behavior. Following section 2 and its discussions of traditional finance and behavioral finance perspectives, section 3 primarily addresses theories developed in response to apparent deviations from the assumptions of traditional finance regarding decision making.

2.1 Traditional Finance Perspectives on Individual Behavior

Traditional finance concepts may be thought of as normative, indicating how people and markets should behave. Investors are assumed to be rational; investors make decisions consistent with utility theory and revise expectations (update beliefs) consistent with Bayes' formula. They are further assumed to be self-interested and risk-averse, to have access to perfect information, and to process all available information in an unbiased way. Each of these underlying assumptions will be discussed further in the following subsections.

2.1.1 *Utility Theory and Bayes' Formula*

In **utility theory**, people maximize the present value of utility subject to a present value budget constraint.[4] **Utility** may be thought of as the level of relative satisfaction received from the consumption of goods and services. Decision makers choose between risky or uncertain prospects by comparing their expected utility values. They maximize their expected utility—the weighted sum of the utility values of outcomes multiplied by their respective probabilities—subject to their budget constraints. It is important to note that the determination of the value of an item is not based on its price, but rather on the utility it yields. The price of an item is dependent only on the characteristics of the item and is equal for everyone; the utility, however, is dependent on the particular circumstances and preferences of the person making the estimate of utility.

For our purposes, it is not important to understand fully the mathematical aspects of the expected utility model, which assumes that it is possible to quantify exactly how much utility an individual will derive based on the uncertain outcome of an economic decision and that the individual can and will choose between various options to arrive at an optimal decision that maximizes the individual's expected utility. Normatively, this is how people *should* make economic decisions; it is important to understand expected utility theory conceptually.

---

3 Statman (1999).
4 See, for example, Samuelson (1937).

There are some basic axioms of utility theory.[5] It is assumed that a rational decision maker follows rules of preference consistent with the axioms and that the utility function of a rational decision maker reflects the axioms. From any set of alternatives, a *rational* decision maker makes decisions consistent with the axioms of utility theory and chooses the combination of decisions that maximizes expected utility. The basic axioms of utility theory are completeness, transitivity, independence, and continuity.

- *Completeness* assumes that an individual has well-defined preferences and can decide between any two alternatives.

  Axiom (Completeness): Given choices A and B, the individual either prefers A to B, prefers B to A, or is indifferent between A and B.

- *Transitivity* assumes that, as an individual decides according to the completeness axiom, an individual decides consistently.

  Axiom (Transitivity): Transitivity is illustrated by the following examples. Given choices A, B, and C, if an individual prefers A to B and prefers B to C, then the individual prefers A to C; if an individual prefers A to B and is indifferent between B and C, then the individual prefers A to C; or, if an individual is indifferent between A and B and prefers A to C, then the individual prefers B to C.

- *Independence* also pertains to well-defined preferences and assumes that the preference order of two choices combined in the same proportion with a third choice maintains the same preference order as the original preference order of the two choices.

  Axiom (Independence): Let A and B be two mutually exclusive choices, and let C be a third choice that can be combined with A or B. If A is preferred to B and some amount, x, of C is added to A and B, then A plus xC is preferred to B plus xC. This assumption allows for additive utilities. If the utility of A is dependent on how much of C is available, the utilities are not additive.

- *Continuity* assumes there are continuous (unbroken) indifference curves such that an individual is indifferent between all points, representing combinations of choices, on a single indifference curve.

  Axiom (Continuity): When there are three lotteries (A, B, and C) and the individual prefers A to B and B to C, then there should be a possible combination of A and C such that the individual is indifferent between this combination and the lottery B. The end result is continuous indifference curves.

If the individual's decision making satisfies the four axioms, the individual is said to be rational. Put another way, if an individual is to maximize utility, he or she will choose one alternative over another if and only if the expected utility of one alternative exceeds the expected utility of the other alternative. The utility of any choice may be expressed as a function of the utility of the possible outcomes of the choice and their respective probabilities. If an individual believes a choice has possible outcomes, x_i, each with a utility of $u(x_i)$ and a subjective probability of $P(x_i)$, then the individual's subjective expected utility is $\Sigma u(x_i)P(x_i)$.[6] The completely rational individual makes decisions based on the axioms of utility theory in order to maximize expected utility.

The rational decision maker, given new information, is assumed to update beliefs about probabilities according to Bayes' formula. **Bayes' formula** is a mathematical rule explaining how existing probability beliefs should be changed given new information. In other words, Bayes' formula expects people to update old beliefs in a certain manner when given new information. Bayes' formula is essentially an application of conditional

5 See von Neumann and Morgenstern (1944).
6 See Savage (1954).

probabilities. This formula is valid in all common probability interpretations. In order to develop the calculation, all possible events must be mutually exclusive and exhaustive events with known probabilities.

Bayes' formula shows how one conditional probability is inversely related to the probability of another mutually exclusive outcome. The formula is:

$$P(A|B) = [P(B|A)/P(B)]\ P(A)$$

where:

$P(A|B)$ = conditional probability of event A given B. It is the updated probability of A given the new information B.

$P(B|A)$ = conditional probability of B given A. It is the probability of the new information B given event A.

$P(B)$ = prior (unconditional) probability of information B.

$P(A)$ = prior probability of event A, without new information B. This is the base rate or base probability of event A.

EXAMPLE 1

Example of Bayes' Formula

You have two identical urns, U1 and U2. U1 has 2 red balls (R) and 3 white balls (W). U2 has 4 red balls and 1 white ball. You randomly choose one of the urns to pick out a ball. A red ball is pulled out first. What is the probability that you picked U1, based on the fact that a red ball was pulled out first, P(U1|R)?

Solution:

P(R|U1) is the conditional probability of a red ball being pulled out, given U1 is picked:

2 red balls/5 balls = 40%

P(U1) is the probability of picking U1:

1 urn/2 urns = 50%

P(R) is the probability of a red ball being picked regardless of which urn is picked:

2 red balls in U1 + 4 red balls in U2 = 6 red balls

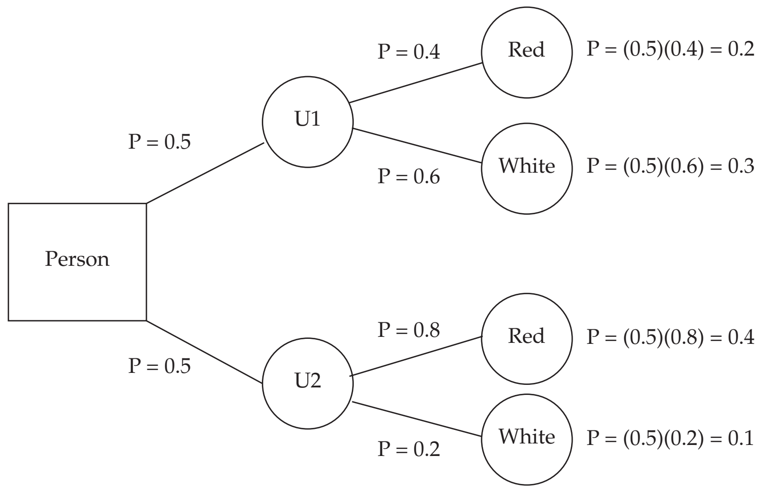
6 red balls/10 balls = 60%

P(U1|R) is the objective of the exercise. Based on the above formula, we calculate:

$$P(U1|R) = [P(R|U1)/P(R)]\ P(U1) = [40\%/60\%]50\% = 33.3\%$$

This solution can also be shown using a probability tree. In Exhibit 1, we can see that the probability of U1 being picked and a red ball being chosen is P(U1) × P(R|U1) = (0.5 × 0.4) = 0.20. The probability of picking a red ball if either urn is picked is P(R) = (0.20 + 0.40) = 0.60. Therefore, because we know that a red ball was picked, we can find the probability of having chosen U1 by dividing the probability of choosing both U1 and a red ball by the probability of choosing a red ball. This gives us 0.333 or 33.3% [= 0.20/0.60].

Exhibit 1 Probability Tree



Different people may make different decisions because they may have different utility functions or different beliefs about the probabilities of different outcomes.

In a perfect world, when people make decisions under uncertainty, they are assumed to do the following:

1. Adhere to the axioms of utility theory.
2. Behave in such a way as to assign a probability measure to possible events.
3. Incorporate new information by conditioning probability measures according to Bayes' formula.
4. Choose an action that maximizes the utility function subject to budget constraints (consistently across different decision problems) with respect to this conditional probability measure.

Is it reasonable, however, to think that ordinary people perform Bayesian updating on a consistent basis or make decisions as if they perform Bayesian updating? Bayesian updating requires the ability to perform complicated statistical calculations. People have cognitive limitations not accounted for in expected utility theory. Behavioral finance proponents argue that it seems highly unlikely that people actually take each of these steps as a matter of procedure every time they make a decision or that the decisions of people are consistent with those that would be made on the basis of Bayesian updating.

2.1.2 *Rational Economic Man*

Traditional finance assumes that after gathering information and analyzing it according to Bayes' formula, individuals will make decisions consistent with the decisions of homo economicus or **rational economic man** (REM). REM will try to obtain the highest possible economic well-being or utility given budget constraints and the available information about opportunities, and he will base his choices only on the consideration of his own personal utility, not considering the well-being of others except to the extent this impacts REM's utility. Using indifference curve analysis, rational economic man will determine the choices that will combine to give him the highest utility. REM will construct curves of consumption bundles amongst which he is indifferent because each bundle gives the same utility. The curve that is within budget constraints and furthest from the origin gives the highest utility. Choices made by REM will fall on that curve.

The notion of rational economic man was developed in the late 19th century as a simple model of human economic behavior. The model assumes that humans make perfectly rational economic decisions at all times. REM is a rational, self-interested, labor-averse individual who has the ability to make judgments about his subjectively defined ends. REM also strives to maximize economic well-being by selecting strategies contingent on predetermined, utility-optimizing goals on the information that he possesses as well as on any other postulated constraints. REM tries to achieve discretely specified goals to the most comprehensive, consistent extent possible while minimizing economic costs.

The amount of utility that REM associates with any given outcome is represented by the output of his algebraic utility function. Predicting how REM will negotiate complex trade-offs, such as the pursuit of wages versus leisure, entails the use of mathematical models using calculus. REM ignores social values unless adhering to them will give him pleasure (i.e., provide utility) or failing to adhere to them will cause him pain (i.e., create disutility). Principles of perfect rationality, perfect self-interest, and perfect information govern REM's economic decisions.

2.1.3 *Perfect Rationality, Self-Interest, and Information*

REM is assumed to maximize utility and make complex deductions toward that end. He is capable of thinking through all possible outcomes and choosing the course of action that will result in the best possible outcome. Perfect rationality assumes that REM is a perfectly rational thinker and has the ability to reason and make beneficial judgments at all times. In reality, however, rationality is not the sole driver of human behavior. At times, it is observed that the human intellect is subservient to such human emotions as fear, love, hate, pleasure, and pain. Moreover, people often use their intellects to achieve or avoid these emotional outcomes.

Perfect self-interest is the idea that humans are perfectly selfish. For every economic decision, REM ensures that he is getting the highest possible utility and will never concede anything to his opponent in a transaction. Many studies have shown that people are not perfectly self-interested. If they were, philanthropy would not exist. Religions prizing selflessness, sacrifice, and kindness to strangers would also be unlikely to thrive as they have over millennia. Perfect self-interest would preclude people from performing unselfish deeds, such as volunteering, helping the needy, or serving in the military. If behaving in an apparently altruistic manner generates utility for the giver, however, then such behavior is consistent with self- interest and may be viewed as rational.

Some people may possess perfect or near-perfect information on certain subjects. A doctor or dentist, for example, should be impeccably versed in her field. It is impossible, however, for every person to enjoy perfect knowledge of every subject. In the world of investing, there is nearly an infinite amount to learn and know, and even the most successful investors don't master all disciplines. In microeconomics, a state of perfect information is assumed in some models of perfect competition. That is, assuming all agents are rational and have perfect information, they will choose the best products; the market will then reward those who make the best products with higher sales accordingly. Perfect information would mean that all consumers know all things about all products at all times; therefore, they would always make the best decision regarding purchases. In competitive markets, unlike in game-theory models, perfect competition does not require that agents have complete knowledge about the actions of others. Rather, in competitive markets, it is assumed that all relevant information is reflected in prices.

2.1.4 *Risk Aversion*

Expected utility theory generally assumes that individuals are risk-averse. This means that an individual may refuse a fair wager (a wager with an expected value of zero), and also implies that his utility functions are concave and show diminishing marginal utility of wealth. Given two choices—investing to receive an expected value with certainty or investing in an uncertain alternative that generates the same expected value—someone who prefers to invest to receive an expected value with certainty rather than invest in the uncertain alternative that generates the same expected value is called risk-averse. Someone who is indifferent between the two investments is called risk-neutral. Someone who prefers to invest in the uncertain alternative is called risk-seeking. In traditional finance, individuals are assumed to be risk-averse.

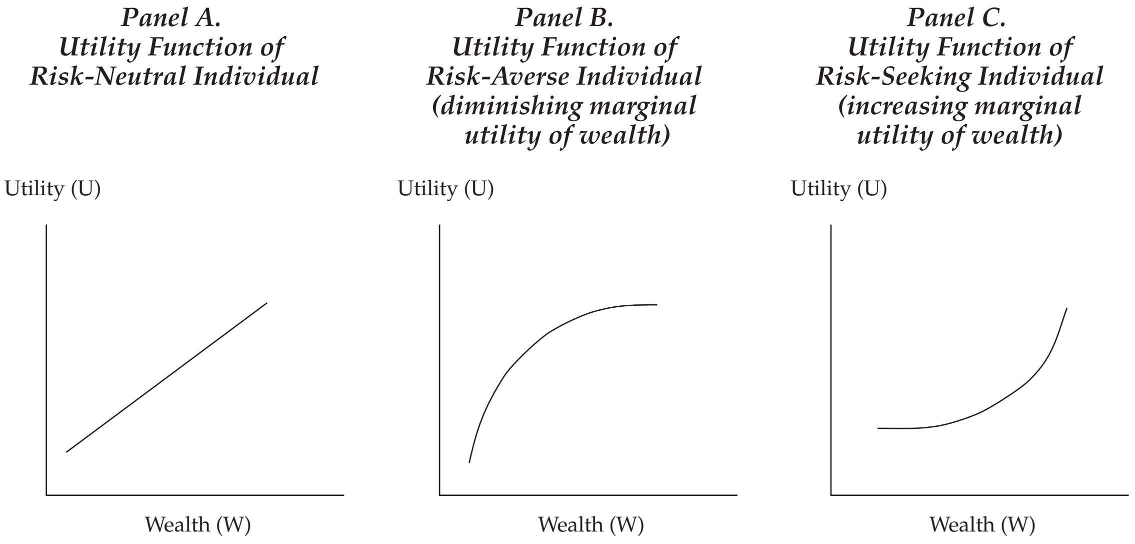
Following is an example that demonstrates risk neutrality, risk aversion, and risk-seeking. Let's assume a person is given the choice between two scenarios. In the guaranteed scenario, the person receives $100. In the uncertain scenario, a coin is flipped to decide whether the person receives $200 or nothing. The expected payoff for both scenarios is $100. A person who is insensitive to risk or risk-neutral will be indifferent between the guaranteed payment and the coin flip. A person is risk-averse if he or she would accept a payoff of less than $100 with certainty rather than take the coin flip. A person is risk-seeking (or risk-loving) if the guaranteed payment has to be more than $100 to induce him to take the guaranteed option rather than the coin flip, where he could possibly win $200.

An alternative example to demonstrate risk aversion, risk neutrality, and risk-seeking involves determining how much a person is willing to pay to participate in the uncertain scenario. If the person is willing to pay $100 (the expected payoff), the person is risk-neutral. If the person is willing to pay less than $100, the person is risk-averse. If the person is willing to pay more than $100, the person is risk-seeking.

Given an opportunity to participate or to forgo to participate in an event for which the outcome, and therefore his or her receipt of a reward, is uncertain, the **certainty equivalent** is the maximum sum of money a person would pay to participate or the minimum sum of money a person would accept to not participate in the opportunity. The difference between the certainty equivalent and the expected value is called the risk premium. Certainty equivalents are used in evaluating attitudes toward risk.

Risk attitudes toward wealth are reflected in the curvature of the individual's utility function of wealth. As shown in Exhibit 2, risk-neutral individuals have linear utility functions; risk-averse individuals have concave utility functions; and risk-seeking individuals have convex utility functions. A linear utility function means that utility increases at a constant rate with increases in wealth; the risk-neutral individual has a constant marginal utility of wealth. A concave utility function means that utility increases at a decreasing rate with increases in wealth; the risk-averse individual has a diminishing marginal utility of wealth. A convex utility function means that utility increases at an increasing rate with increases in wealth; the risk-seeking individual has an increasing marginal utility of wealth. The degree of risk aversion can be measured by the curvature of the utility function.

Exhibit 2 Utility Function of Wealth



As stated previously, expected utility theory generally assumes that individuals are risk-averse. This implies that utility functions are concave and exhibit diminishing marginal utility. A commonly cited example to demonstrate diminishing marginal utility is a favorite food or beverage. The first taste may give great pleasure (high utility), but each subsequent taste may generate less pleasure; in fact, excessive consumption may lead to discomfort (disutility). Although there may be no discomfort associated with increasing wealth, one can imagine a situation in which an incremental increase to wealth generates less increased utility than a previous increase to incremental wealth. For example, sufficient wealth to pay for housing has a very positive utility, but the extra wealth to pay for a third or fourth home may have a much smaller positive impact on utility. Thus, assuming that individuals are risk-averse and that utility curves are concave and exhibit diminishing marginal utility seems reasonable.

2.2 Behavioral Finance Perspectives on Individual Behavior

Behavioral finance challenges the assumptions of traditional finance based on observed behaviors. The assumptions of traditional finance with respect to the behaviors of individuals are not universally observed to hold true. Investors do not necessarily make decisions consistent with utility theory and revise expectations (update beliefs) consistent with Bayes' formula. They may exhibit behavior that is not self-interested or risk-averse. They do not have access to perfect information and may not process all available information.

In contrast to ideas of perfect rationality or utility maximization, behavioral finance attempts to identify and learn from human psychological phenomena at work within individual market participants. The impact of psychological phenomena on individual market participants may then, in turn, impact financial markets. Behavioral finance, like traditional finance, is guided by basic precepts and assumptions. However, behavioral finance grounds its assumptions in observed financial behavior rather than in idealized financial behavior. For example, behavioral finance examines mental processes, such as the fear of loss or the human tendency to overestimate low-probability events. Some of the behavioral challenges to the assumptions of traditional finance are discussed in the following sections.

2.2.1 *Challenges to Rational Economic Man*

The validity of rational economic man (REM) has been the subject of much debate since the model's introduction. Those who challenge REM do so by attacking the basic assumptions of perfect information, perfect rationality, and perfect self-interest. Keynes (1936) contends that no human can be fully informed of "all circumstances and maximize his expected utility by determining his complete, reflexive, transitive, and continuous preferences over alternative bundles of consumption goods at all times." Keynes acknowledges the inherent limitations of people in making decisions.

Bounded rationality (discussed further in section 3.2) is proposed as an alternative to the assumptions of perfect information and perfect rationality. It relaxes the assumptions of expected utility theory and perfect information to more realistically represent human economic decision making. Bounded rationality assumes that individuals' choices are rational but are subject to limitations of knowledge and cognitive capacity. Bounded rationality is concerned with ways in which final decisions are shaped by the decision-making process itself.

A shortcoming of the theory of rational economic man is that it disregards the inner conflicts that real people face. For instance, rational economic man does not account for the fact that people can have difficulty prioritizing short-term versus long-term goals (e.g., spending versus saving) and do not behave with perfect self-interest. People instead seem to try to reconcile short-term and long-term goals with individual goals and societal values. This may result in inner conflicts, and these conflicts may lead to behavior that is not rational as defined in traditional finance.

Perhaps the strongest criticisms of REM challenge the underlying assumption of perfect information. It is intuitively obvious that many economic decisions are made in the absence of perfect information. For example, some economic theories assume that people adjust their buying habits based on the monetary policy of central banks. Although some people may know how to find the central bank data, interpret it, and apply it, many do not even know the roles of central banks. This one example demonstrates the implausibility of the idea that all participants in financial markets possess or act as if they possess perfect information.

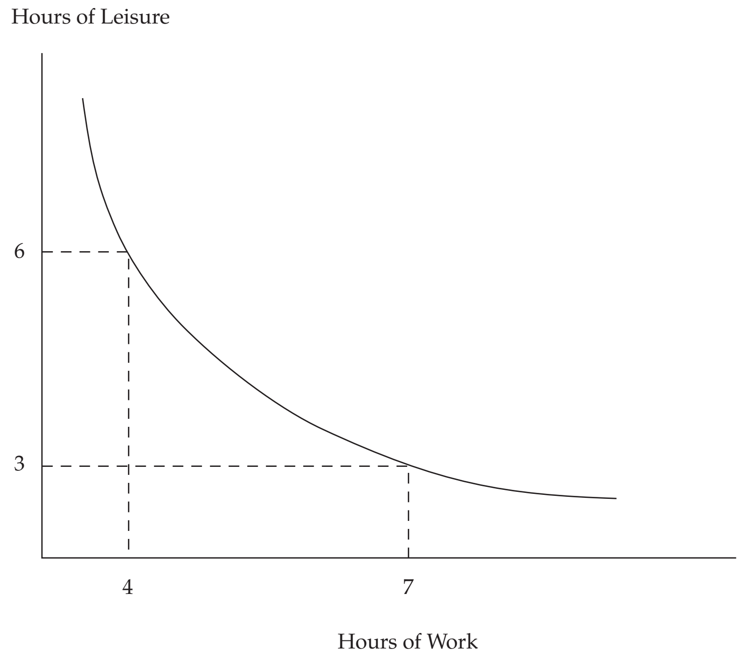
The concept of rational economic man is appealing to financial theorists for two primary reasons. First, assuming decision making by REM simplifies economic models and analysis, because it is easier to model human behavior given this assumption. Second, this allows economists to quantify their findings, making their work easier to understand. If humans are perfectly rational and self-interested and possess perfect information, then quantifying their behavior may be feasible. However, human rationality covers a spectrum from that which appears perfectly rational to that which appears irrational. Individuals are neither perfectly rational nor perfectly irrational; instead, they possess diverse combinations of rational and irrational characteristics and benefit from different degrees of knowledge. The extent to which any one individual appears to be behaving rationally can vary between decisions depending on a variety of factors, including the type of decision, the extent of the individual's knowledge, and the particular circumstances. Even if individuals do not behave rationally, the idea of REM is useful because it is normative and helps define an optimal outcome.

2.2.2 *Utility Maximization and Counterpoint*

A useful way to assess the validity of rational economic theory is to use indifference curves. The aim of indifference curve analysis is to demonstrate, mathematically and graphically, the basis on which a rational consumer substitutes certain quantities of one good for another. For example, it is possible to model the effects of a wage adjustment on a worker's allocation of hours to work versus leisure. **Indifference curve analysis** may incorporate budget lines or constraints, which represent restrictions on consumption that stem from resource scarcity. In the work-versus-leisure model, for example, workers may not allocate any sum exceeding 24 hours per day. The number of hours available for work and leisure may be lower than 24 hours depending on other demands on their time.

An indifference curve, as shown in Exhibit 3, depicts all of the possible combinations of two goods amongst which an individual is indifferent.[7] This individual appears to have a constraint of 10 hours available for work and leisure. Consuming any bundle on the curve shown yields the same level of utility for the individual. In Exhibit 3, the individual would achieve equal satisfaction with four hours of work and six hours of leisure or with seven hours of work and three hours of leisure. The indifference curve shows the marginal rate of substitution, or the rate at which a person is willing to give up one good for another, at any point. If the two items are perfect substitutes, then the individual is willing to trade one for the other in a fixed ratio; then, the indifference curve is a line with a constant slope reflecting the marginal rate of substitution. If the two items are perfect complements, then the curve would be L-shaped. An additional amount of either good adds no extra utility because the goods are only used in combination.

Exhibit 3 Trade-Off between Work and Leisure



Utility theory should also consider such other factors as risk aversion, probability, size of the payout, and the different utility yielded from the payout based on the individual's circumstances. For example, in a period of high unemployment, an individual may be competing with many others for a job. Under these circumstances, the individual may be willing to work 10 hours a day with no leisure. The trade-off between work and leisure hours is impacted by exogenous factors.

Although indifference curve analysis is theoretically sound, is an individual likely to calculate and perform mathematical equations to determine the trade-off between work and leisure on an ongoing basis? Some might, but many would not. The failure to consider exogenous factors in rational utility analysis is also problematic. Furthermore,

7 Note that the intercept of the axes as shown (the origin) is not (0, 0).

risk needs to be accounted for. What is this individual's risk of job loss if he or she does not work eight hours a day? Risk plays an important part in making utility-maximizing decisions. Risk aversion is an assumption underlying actions taken by REM.

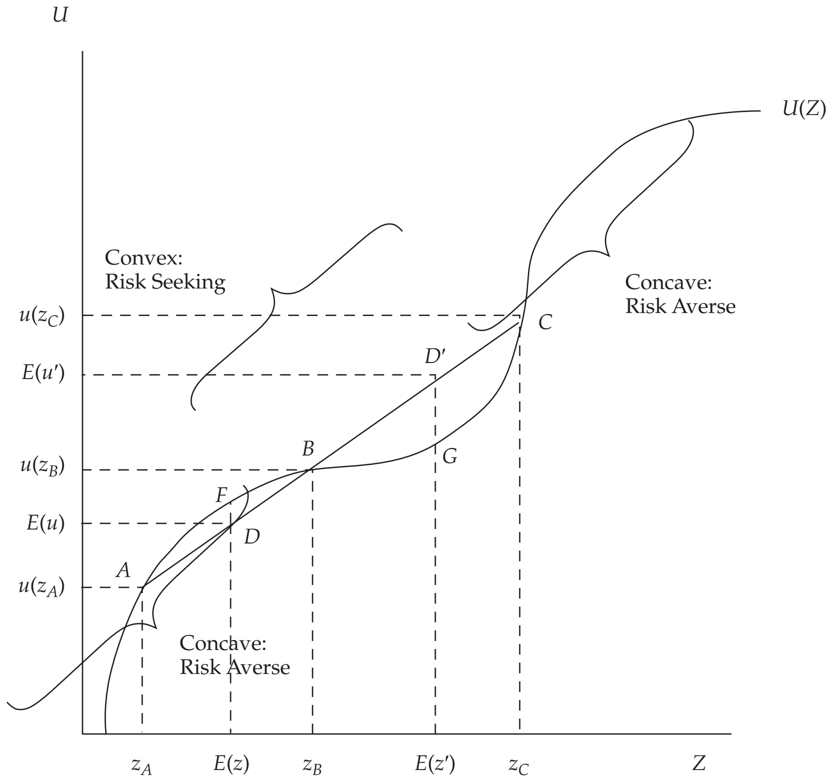
2.2.3 *Attitudes Toward Risk*

Assuming that individuals are risk-averse and that utility curves are concave and exhibit diminishing marginal utility seems reasonable, but observed behaviors are not always consistent with the assumption of an individual who is constantly risk-averse. For example, anyone who has ever purchased a lottery ticket has displayed risk-seeking behavior that is inconsistent with the rational risk-averse behavior assumed in traditional finance. Friedman and Savage (1948) discuss behaviors that seem to contradict the traditional finance beliefs that individuals always seek to maximize the utility of their money and are risk-averse. They cite examples, such as buying lottery tickets and buying insurance, in which expected utility is low but people (even with low incomes) participate in the purchase. The authors find that generally people must be paid a premium to be induced to take moderate risks. However, if an investment offers a few extremely large prizes, its attractiveness is increased far beyond the aggregate value of the prizes. They also find a difference between individuals at different income levels. Those with less income prefer either certainty or a risk that offers a small chance of a large gain to a risk that is moderate. Middle-income people are more likely to be attracted by small, fair gambles.

Perhaps the most important concept we can learn here is that risk evaluation is reference-dependent, meaning risk evaluation depends in part on the wealth level and circumstances of the decision maker. Friedman and Savage indicate that it is not necessarily true that an individual's utility function has the same curvature consistently: There may be levels of wealth, for instance, at which an investor is a risk-seeker and levels of wealth where the investor is risk-neutral. Also, circumstances may vary. As shown in Exhibit 4, the Friedman–Savage **double inflection utility function**, $u(z)$, is concave up to inflection point B, then becomes convex until inflection point C, after which it becomes concave again. Thus, at low income levels (between the origin and z_B), agents exhibit risk-averse behavior; they are also risk-averse at high income levels (above z_C). However, between the inflection points B and C, agents are risk-loving.

Double Inflection Utility Function—A utility function that changes based on levels of wealth.

Exhibit 4 Friedman–Savage Double-Inflection Utility Function



Friedman and Savage try to explain why people may take low-probability, high-payoff risks (e.g., lottery tickets), while at the same time insuring against low risks with low payoffs (e.g., flight insurance). To see this, presume one is at inflection point *B* between risk-averse and risk-seeking. Suppose one faces two lotteries, one yielding *A* or *B*, another yielding *B* or *C*. These lotteries are captured by the solid line segments between the respective payoffs *AB* and *BC*. Expected utility of the first gamble is notated as $E(u)$ and is depicted in Exhibit 4 at point *D*—where, obviously, $E(u)$ is less than the utility of the expected outcome of the first gamble, $u[E(z)]$, depicted at point *F*. Consequently, a risk-averse agent would pay a premium to avoid it. The second gamble yields expected utility $E(u')$ at point D' on the *BC* segment, which is greater than the utility of the expected outcome $u[E(z')]$, depicted at point *G*. A risk-seeking agent would *pay* a premium to undertake this gamble. Thus, we can view risk-averse behavior with regard to *AB* as a case of insurance against small losses and the risk-seeking behavior with regard to *BC* as a case of purchasing lottery tickets.

Prospect theory (discussed further in section 3.3) has been proposed as an alternative to expected utility theory.[8] Prospect theory assigns value to gains and losses (changes in wealth) rather than to final wealth, and probabilities are replaced by decision weights. In prospect theory, the shape of a decision maker's value function is assumed to differ between the domain of gains and the domain of losses. The value function is defined by deviations from a reference point and is normally concave for gains (implying risk aversion), convex for losses (risk-seeking), and steeper for losses than for gains (loss aversion). Decision weights are generally lower than the corresponding probabilities, except in the range of low probabilities.

8 See Kahneman and Tversky (1979).

It appears that the assumptions of traditional finance with respect to the behaviors of individuals are not universally observed to hold true. Investors do not necessarily make decisions consistent with utility theory and revise expectations (update beliefs) consistent with Bayes' formula. They may exhibit behavior that is not self-interested or risk-averse. They may not have access to perfect information and may not process all available information.

2.3 Neuro-economics

Behavioral finance, drawing on psychology, observes behaviors in an attempt to understand and explain how investors and markets behave. Neuro-economics combines neuroscience, psychology, and economics in attempting to explain how humans make economic decisions. Neuro-economics is an emerging field of study relevant to understanding how people make economic decisions under uncertainty. Neuro-economics attempts to explain investor behavior based on the functioning of the brain.

Neuro-economics uses imaging of brain activity and other techniques in combination with experimental economics to study the neural basis of economic decision making. By comparing the blood flow to and activity in different parts of the brain before, during, and after a task, it is possible to associate certain regions of the brain with performance of the task. In addition, chemical levels in the brain are studied to gain insights into responses to events and activities. Neuro-economics attempts to bridge the gap between research on decision behavior and economic theory by understanding the brain activity of judgment and making choices.

Glimcher (2003) described the goal of his research as follows: "The long-term goal of my research is to describe the neural events that underlie behavioral decision making. Our approach to this problem consolidates mathematical economic approaches to decision making with traditional neurobiological tools. By using these tools in our physiological analyses of the brainstem, cortex, and the basal ganglia, we hope to develop a coherent view of how the brain makes decisions."[9]

By observing brain activity, neuro-economics attempts to answer such questions as, "How do emotions affect judgment and decision making? How do people perceive uncertainty? How does risk affect human decision making?" Traditional finance attempts to answer similar questions by making simplifying assumptions. Behavioral finance attempts to answer similar questions by observing behaviors and inferring the basis for the behavior. These approaches each potentially provide insights into financial decision making and should not be viewed as mutually exclusive.

Critics of neuro-economics claim that, although the results of neuro-economics may be interesting, there have been few insights from neurobiological studies that constrain economic theory. Gul and Pesendorfer (2008) argue that neurobiological measurements, per se, are entirely outside the scope of economics. Economic theory makes predictions about behavior, and the actual functioning of the brain during decision making is irrelevant. In short, they argue that insights into biological mechanisms, such as brain activity or chemical levels in the brain, are unlikely to have an impact on economic theory.

Perhaps some of the more interesting insights result from examining chemical levels in the brain. Dopamine and serotonin are chemicals naturally produced in the body. Dopamine functions as a neurotransmitter and is commonly associated with the pleasure system, providing feelings of enjoyment and reinforcement to motivate people to do or continue certain activities. A reduction in serotonin in the body is often linked to such emotional and behavioral problems as anxiety, depression, impulsiveness, and irritability.

---

9 Glimcher (2003).

Dopamine is released in response to both a reward and the expectation of a reward. The release of dopamine after an expected or unexpected reward and the desire for dopamine release may explain risk-taking behavior. The prospect of a euphoric effect may inhibit people from focusing on the more logical thought of how small the odds of a reward (positive outcome) actually are. In this context, it is not difficult to imagine that dopamine may explain such behavioral biases as overconfidence and may also play a role in market overreaction to short-term results.

If an expected reward fails to arrive, dopamine is not released and dopamine levels decline, which may result in a depressed state. Further, unfulfilled expectations depress brain serotonin levels. The resulting emotional state may impact investors in a variety of ways: It may prevent the investors from taking further actions that involve assuming risk or it may cause investors to become impulsive and attempt to recoup losses by employing high-risk investing strategies (usually resulting in excessive trading).

Research focusing on the roles played by areas of the brain also provides insights into human behavior. For example, the amygdala plays a key role in emotions, such as fear and pleasure. It is the amygdala that creates a "fight or flight" response during a sudden event or trauma. For investors, the amygdala may be responsible for a panicked response rather than an analytical response to a dropping market. Although neuroeconomics research is interesting and may provide further insights into individual economic decision making, its effect on economic theory remains to be seen.

3 DECISION MAKING

This section examines behavioral theories developed in response to the relaxing of particular assumptions about individual behavior with respect to decision making. Prospect theory relaxes the assumptions of expected utility theory and risk aversion. Bounded rationality relaxes the assumption that all available information is used to arrive at a wealth-maximizing decision. Before discussing prospect theory and bounded rationality, which are based on observations of how people actually do seem to make decisions, we will discuss theories of how people should make decisions. Prospect theory and bounded rationality are descriptive, describing how people *do* behave and make decisions. Expected utility and decision theories are normative, describing how people *should* behave and make decisions.

3.1 Decision Theory

Decision theory is concerned with identifying values, probabilities, and other uncertainties relevant to a given decision and using that information to arrive at a theoretically optimal decision. Decision theory is normative, meaning that it is concerned with identifying the ideal decision. As such, it assumes that the decision maker is fully informed, is able to make quantitative calculations with accuracy, and is perfectly rational. The practical application of decision theory is prescriptive. It analyzes decisions and attempts to provide tools and methods to help people make better decisions.

From a historical perspective, the initial focus of decision theory was on expected value. The first person to record explorations of expected value was Blaise Pascal, a French mathematician and philosopher in the 1600s who is also known for his wager on the existence of God.[10] In 1670, Pascal discussed expected value and choice in this way: "When faced with a number of actions, each of which could give rise to more than one possible outcome with different probabilities, the rational procedure is to identify all possible outcomes, determine their values (positive or negative) and the probabilities that will result from each course of action, and multiply the two to give an expected value. The action to be chosen should be the one that gives rise to the highest total expected value."[11]

Bernoulli (1954) describes the difference between expected utility and expected value.[12] Expected value of an item is based on its price, which is the same for everyone because the price depends only on the item itself. Expected utility of an item is based on the worth assigned to it by the person making the estimate; as a result, it may vary from person to person because it depends on each person's circumstances. Bernoulli's theory of expected utility, which includes the premise that utility increases at a decreasing rate with increases in wealth, is one of the theories that supports traditional finance perspectives.

Frank Knight (1921) makes important distinctions between risk and uncertainty. He defines risk as randomness with knowable probabilities and uncertainty as randomness with unknowable probabilities. Knight argues that situations with risk, such as decision making with unknown outcomes but known ex-ante probability distributions, differ from situations with uncertainty, such as decision making with unknown outcomes and probabilities. He contends that situations in which decision-making rules, such as maximizing expected utility, can be applied differ in a substantial way from those in which they cannot, such as when the probability distribution of a random outcome is unknown. Risk is measurable, but uncertainty is not.

von Neumann and Morgenstern (1944) posit that a rational decision maker makes decisions consistent with the axioms of utility theory and chooses the combination of decisions that maximize expected utility. Savage (1954) introduces subjective expected utility (SEU). The theories of von Neumann and Morgenstern and Savage extend the scope of expected utility theory to situations in which only subjective probabilities are available. SEU theory extends the conditions of perfect utility-maximizing rationality to a world in which the probability distributions of all relevant variables can be provided by the decision makers.

In order to take SEU theory and apply it to actual decision making, prescriptive theories of choice should consider the empirical evidence as to how people actually make decisions. Prescriptive approaches based on SEU theory consider empirical evidence as to the limits on human rationality. These limitations are imposed by the complexity of the world we live in, the incompleteness and inadequacy of human knowledge, the computational inadequacy of people, the inconsistencies of individual preference and beliefs, and the conflicts of value among individuals and groups.

Descriptive analysis of problem solving and decision making are centrally concerned with how people manage to reduce complicated problems to a cognitively manageable size, with how they approximate and heuristically handle complexity. Descriptive analyses make it possible to develop theories and practices that account for the unrealistic parts of SEU theory. These theories illustrate how people respond

---

10 "Pascal's wager" is a classic example of a choice under uncertainty. The uncertainty is whether God exists. Belief or non-belief in God is the choice to be made. Pascal argues that the reward for belief in God if God actually does exist is infinite, while the cost of believing in God if God actually does not exist is low. Therefore, the expected value of belief exceeds that of non-belief, so Pascal contends that it is prudent to believe in God.

11 Pascal's Pensées by Blaise Pascal (1670).

12 Bernoulli's article was originally published in 1738. The 1954 version is a re-publication.

to complexity and limitations, while striving to achieve results that approximate the ideal (i.e., the results of normative theories). Bounded rationality and prospect theory are examples of such theories.

Bounded rationality theory relaxes the assumptions that perfect information is available and that all available information is processed according to expected utility theory. Bounded rationality acknowledges that individuals are limited in their abilities to gather and process information. Prospect theory relaxes the assumptions that individuals are risk-averse and make decisions consistent with expected utility theory. Prospect theory assumes that individuals are loss-averse.

3.2 Bounded Rationality

Simon (1957) proposed the notion of **bounded rationality**, recognizing that people are not fully rational when making decisions and do not necessarily optimize but rather satisfice (defined below) when arriving at their decisions. People have informational, intellectual, and computational limitations. Even supplementing the capabilities of individuals with computers, humans may not be able to make fully informed and rational decisions. Simon introduced the terms *bounded rationality* and *satisfice* to describe the phenomenon where people gather some (but not all) available information, use heuristics[13] to make the process of analyzing the information tractable, and stop when they have arrived at a satisfactory, not necessarily optimal, decision. In contrast to rational economic man making decisions according to expected utility theory, Simon describes individuals who are satisfied to gather what they deem to be enough information, who will process the information in ways they deem adequate, who are prone to identify with sub-goals and limited objectives rather than try to achieve an optimum, and who will stop when they have a decision that fits within parameters they deem satisfactory.[14]

Bounded rationality sets parameters on how much will be done in making a decision and within which decisions will be deemed as satisfactory. The term **satisfice** combines "satisfy" and "suffice" and describes decisions, actions, and outcomes that may not be optimal, but they are adequate.[15] To satisfice is to find a solution in a decision-making situation that meets the needs of the situation and achieves the goals of the decision maker. Satisficing is finding an acceptable solution as opposed to optimizing, which is finding the best (optimal) solution. The optimal solution is the one that maximizes the utility realizable from the situation. Individuals lack the cognitive resources to arrive at optimal solutions. For example, individuals typically do not know the relevant probabilities of the potential outcomes, can rarely identify or evaluate all outcomes, and have weak and unreliable memories.

Decision makers may choose to satisfice rather than optimize because the cost and time of finding the optimal solution can be very high. In these circumstances, satisficing creates a stop rule to the decision process and allows the cost incurred and time taken to be limited. Another reason for decision makers to use satisficing is that even when people can continue evaluating exhaustive alternatives and cost is not a factor, they still need to find new alternatives and their expected outcomes. This search for an optimum will often become so complicated and time consuming that it is eventually infeasible. The empirical evidence in Simon's studies suggests that consumers, employees, and business people typically satisfice rather than optimize.

13 Heuristics are mental shortcuts based on experience and knowledge that simplify decision making. They are sometimes called "rules of thumb."
14 See Simon (1991).
15 See Simon (1996).

The reason behind this is bounded rationality. It is infeasible to generate all possible alternatives, estimate the probability of each possible outcome of each alternative, and define consistent utility functions for every alternative prior to making a decision.

Instead of looking at every alternative, people set constraints as to what will satisfy their needs. These constraints indicate what is aspired to. This is not a minimum acceptable outcome but a satisfactory acceptable outcome. Simon refers to these constraints as aspiration levels. Aspiration levels are set based on experiences and on comparisons with what other individuals have achieved. People tend to aspire for a future that is better than the past. When aspirations are reached, people tend to adjust the aspirations upward; when aspirations are not reached, people tend to adjust downward.

When searching for alternative solutions to an issue or problem, decision makers may use heuristics to guide their search. Although using heuristics may simplify the search for alternatives, they also may result in alternatives being missed (not identified). Rather than taking a holistic approach, heuristics may use more of an incremental approach. An example of heuristics is means-ends analysis, where the problem solver is at a current state and decides on the goal state. Rather than looking for alternatives to achieve the goal, the decision maker moves toward the goal in stages. Decisions are made progressively until the goal state is achieved: The first decision is made to get one step closer to the goal state, the next decision results in getting still closer to the goal, and decisions continue to be made until the goal state is met. Another example is the divide-and-conquer procedure, where a problem or issue is divided into components. In this case, rather than attempt to find alternatives to solve the issue or problem, the decision makers attempt to find satisfactory solutions for each sub-problem.

An accepted principle of decision making is to attend to only the most important aspects of the situation. When evaluating alternatives, an investor needs to be aware of the surrounding economic and political environment. An investor needs to have an in-depth understanding of the aspiration levels and satisficing heuristics of business people, government officials, and other investors. One is rarely able to use optimization to determine what is best for a portfolio. Alternatives are almost infinite, and accurately estimating an outcome for each alternative is extremely difficult and both cost and time prohibitive. Because investors have only a limited capacity to assess alternatives and outcomes, they act within the constraints of bounded rationality. Thus, portfolio decisions are based on a limited set of factors, such as economic indicators, deemed most important to the end goal. When the alternatives are limited, a person can dedicate more time to evaluating the most likely outcomes to help make decisions that will satisfice the investment goals.

A decision maker is said to exhibit bounded rationality when he violates some commonly accepted precept of rational behavior but nevertheless acts in a manner consistent with the pursuit of an appropriate set of goals or objectives. Although this definition specifies neither the precept being violated nor conditions under which a set of goals may be considered appropriate, it is still usable.

EXAMPLE 2

Bounded Rationality

Harry Timmons has cash that he wishes to earn interest on, have accessible, and protect against loss. He is aware that the amount of cash to be deposited will be fully insured by a corporation backed by the government if it is deposited in an eligible account at an insured member institution. He has decided to deposit the funds in a checking account at the bank down the street. The bank clearly posts on its door that it is a member institution and only offers eligible accounts. The account will pay 0.25 percent.

Explain how this decision has violated rational behavior but is consistent with bounded rationality.

Solution:

Timmons did not behave totally rationally because he did not gather full information to identify a listing of insured members and what types of accounts are eligible. There may be other institutions that offer eligible accounts that pay higher interest. Further, he did not search for alternatives to depositing in an eligible account with a member institution that met his criteria.

Timmons' behavior is boundedly rational because his decision meets the criteria specified but is not necessarily optimal. Although the decision is undoubtedly suboptimal because higher returns may have been possible, it satisfices within the totality of the investor's decision-making environment. Timmons may have decided he had neither the time nor the resources to research all alternatives. Given the investor's apparently limited knowledge of alternatives, and considering time constraints and the three criteria (interest, accessibility, and loss protection), depositing in a fully insured checking account at 0.25 percent may be reasonable.

3.3 Prospect Theory

Kahneman and Tversky (1979) introduce prospect theory as an alternative to expected utility theory. Prospect theory describes how individuals make choices in situations in which they have to decide between alternatives that involve risk (e.g., financial decisions) and how individuals evaluate potential losses and gains. Prospect theory considers how prospects (alternatives) are perceived based on their framing, how gains and losses are evaluated, and how uncertain outcomes are weighted.

In prospect theory, based on descriptive analysis of how choices are made, there are two phases to making a choice: an early phase in which prospects are framed (or edited) and a subsequent phase in which prospects are evaluated and chosen. The framing (editing phase) consists of using heuristics to do a preliminary analysis of the prospects, often yielding a simpler representation of these prospects. More specifically, people decide which outcomes they see as economically identical and then establish a reference point to consider where these prospects rate. Outcomes below the reference point are viewed as losses, and those above the reference point are gains. In the second phase, the edited prospects are evaluated and the prospect of highest perceived value is chosen.

During the editing or framing stage, alternatives are ranked according to a basic heuristic that was identified and chosen by the decision maker. This contrasts with the elaborate algorithms of expected utility theory. Framing refers to the way a choice option or prospect can be affected by the way in which it is presented. Understanding that how choices are presented or framed impacts the final choice is a critical aspect of prospect theory. In many situations, a decision maker does not know all the options available. Depending on the number of prospects, there may be up to six operations in the editing process: codification, combination, segregation, cancellation, simplification, and detection of dominance. In the process, individuals identify their options, and choice can be affected by how that identification is done. The ultimate purpose behind editing is to simplify the evaluation of choices available by reducing the choices to be more thoroughly evaluated. People use editing when making choices because of cognitive constraints.

The following are examples of six operations in the editing process.[16] Some editing operations will permit or prevent others from being carried out. The sequence of editing operations is likely to vary with the offered set and the format of the display. In the editing phase, a decision maker organizes and reformulates the available options to simplify the choice.

- *Codification*: People perceive outcomes as gains and losses rather than final states of wealth or welfare. A gain or loss is, of course, defined with respect to some reference point. The location of the reference point affects whether the outcomes are coded as gains or losses. Prospects are coded as (gain or loss, probability; gain or loss, probability; …) such that the probabilities initially add to 100 percent or 1.0.
- *Combination*: Prospects are simplified by combining the probabilities associated with identical gains or losses. For example, a prospect initially coded as (250, 0.20; 200, 0.25; 200, 0.15; 150, 0.40) will be simplified to (250, 0.20; 200, 0.40; 150, 0.40).
- *Segregation*: The riskless component of any prospect is separated from its risky component. For example, a prospect initially coded as (300, 0.8; 200, 0.2) is decomposed into a sure gain of (200, 1.0) and a risky prospect of (100, 0.8; 0, 0.20). The same process is applied for losses.

The above operations are applied to each prospect separately. The following operations are applied to two or more prospects:

- *Cancellation*: Cancellation involves discarding common outcome probability pairs between choices. For example, the pairs (200, 0.2; 100, 0.5; 20, 0.3) and (200, 0.2; 300, 0.4; –50, 0.4) are reduced to (100, 0.5; 20, 0.3) and (300, 0.4; –50, 0.4).
- *Simplification*: Prospects are likely to be rounded off. A prospect of (51, 0.49) is likely to be seen as an even chance to win 50. Also, extremely unlikely outcomes are likely to be discarded or assigned a probability of zero.
- *Detection of Dominance*: Outcomes that are strictly dominated are scanned and rejected without further evaluation.

Preference anomalies may arise from the act of editing. An example of a preference anomaly is the isolation effect. This results from the tendency of people to disregard or discard outcome probability pairs that the alternatives share (cancellation) and to focus on those which distinguish them. Because different choice problems can be decomposed in different ways, this can lead to inconsistent preferences.

The following is an example of the isolation effect.[17] Experimental subjects were given the choice of Gambles A and B.

- Gamble A: A 25 percent chance of receiving $3,000 and a 75 percent chance of receiving nothing.
- Gamble B: A 20 percent chance of receiving $4,000 and an 80 percent chance of receiving nothing.

Sixty-five percent of the experimental subjects chose Gamble B. The expected value of Gamble B is $800 compared to an expected value of $750 for Gamble A, so it is not surprising that the majority of subjects chose Gamble B.

---

16 Readers should note that there is ongoing work in the area of prospect theory. There have been many papers written on this theory that include examples of the editing and evaluation phases. The examples here are merely presented as an overview.

17 This example comes from the Experimental Economics Center at Georgia State University in Atlanta.

Next, the experimental subjects were given a two-stage gamble. The first stage involves a 0.75 probability of ending the game without winning or losing anything and a 0.25 probability of moving to the second stage. The second stage involves a choice between Gambles C and D. The choice of Gamble C or D had to be made prior to the first stage.

- Gamble C: A 100 percent chance of receiving $3,000.
- Gamble D: An 80 percent chance of receiving $4,000 and a 20 percent chance of receiving nothing.

Seventy-eight percent of the experimental subjects chose C.

The fact that 65 percent of the subjects chose B in the first gamble and 78 percent chose C in the second gamble is viewed as surprising. It is surprising because the true probabilities and expected values of Gambles C and D in the two-stage gamble are respectively the same as those of Gambles A and B in the first gamble. In the two-stage gamble, the majority of subjects chose the gamble with the lower expected value.

- Gamble C: 0.25 × 1.0 = 25 percent chance of receiving $3,000 and a 75 percent chance of receiving nothing.
- Gamble D: 0.25 × 0.8 = 20 percent chance of receiving $4,000 and an 80 percent chance of receiving nothing.

Clearly, how the prospects were framed had an effect on the choice. Kahneman and Tversky interpret this finding in the following manner: To simplify the choice between alternatives, people frequently disregard components that the alternatives share and instead focus on those that distinguish them. Because different choice problems can be decomposed in different ways, inconsistent preferences can result, as above. They call this phenomenon the isolation effect.

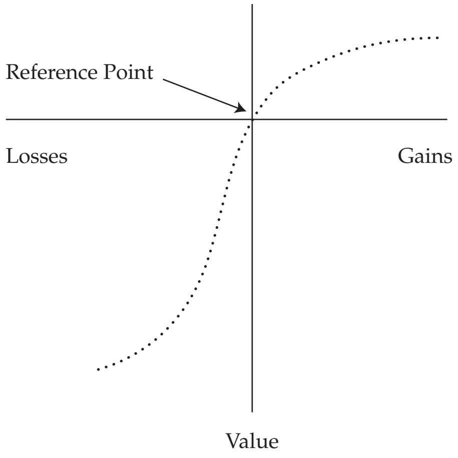
3.3.1 *The Evaluation Phase*

In the evaluation phase of prospect theory, people behave as if they compute a value (utility) function based on the potential outcomes and their respective probabilities and then choose the alternative that has a higher utility. For this evaluation process, Kahneman and Tversky assume the following formula:

$$U = w(p_1)v(x_1) + w(p_2)v(x_2) + \ldots$$

where x_1, x_2 … are the potential outcomes and p_1, p_2 … their respective probabilities; v is a function that assigns a value to an outcome; and w is a probability-weighting function. The probability-weighting function expresses the fact that people tend to overreact to small probability events but underreact to mid-sized and large probabilities. The value function (see Exhibit 5), which passes through the reference point, is s-shaped; moreover, as its asymmetry implies, given the same variation in absolute value there is a bigger impact of losses than of gains (loss aversion). People are not risk-averse but rather are loss-averse.

Exhibit 5 Value Function



A quantitative illustration of the evaluation process is complex and not necessary to review here. What is important to know is that the quantitative elements resemble those of expected utility theory, although there are some important differences. Values are attached to changes rather than final states, and the decision weights need not coincide with probabilities. Experimental evidence shows that most people reject a gamble with even chances to win and lose, unless the amount of the possible win is at least twice the amount of the possible loss. In contrast to expected utility theory, the prospect theory value function measures gains and losses but not absolute wealth and is reference-dependent. Reference dependence is incompatible with the standard interpretation of expected utility theory. Reference dependence is a feature of prospect theory and is central to prospect theory's perspective on how people make decisions under uncertainty.

Kahneman and Tversky illustrate reference dependence with an example. People are presented with the following two situations and asked to make choices.

Situation 1 Given a 50 percent probability of winning $150 and a 50 percent probability of losing $100, is an individual likely to take this gamble? Is the individual's choice likely to change if overall wealth was lower by $100?

There will be few takers of the gamble because experimental evidence shows that most people reject a gamble with even chances to win and lose, unless the possible win is at least twice the size of the possible loss. In this case, the answer to the second question is negative.

Situation 2 Given the choice of losing $100 with certainty and a gamble with a 50 percent probability of winning $50 and a 50 percent probability of losing $200, which is an individual likely to choose? Would the individual's choice change if overall wealth were higher by $100?

In situation 2, the gamble may appear more attractive than the sure loss. Experimental results indicate that risk-seeking preferences are held by a large majority of respondents in choices of this kind. Here again, a change of $100 in total wealth is unlikely to alter preferences. Situations 1 and 2 evoke different preferences, but the difference is caused by a framing effect. In both cases, the gamble compared to the certain position provides an expected net gain of $25 {Situation 1 = E[gain of gamble] – E[certainty] = $25 – $0 = $25; Situation 2 = –$75 – (–$100) = $25}. The situations differ only in that all values are lower by $100 in situation 2. This should be an inconsequential variation.

Kahneman and Tversky examined many choice pairs of this type early in their explorations of risky choice, and they concluded that the abrupt transition from being risk-averse to risk-seeking could not plausibly be explained by a utility function for wealth. Preferences appear to be determined by attitudes toward gains and losses, which are defined relative to a reference point that frames the situation. The discarding of components that are common to all prospects (outcomes) may lead to inconsistent preferences depending on the framing of the choice.

Kahneman and Tversky's prospect theory explains apparent deviations in decision making from the rational decisions of traditional finance. These deviations result from overweighting low probability outcomes, underweighting moderate and high probability outcomes, and having a value function for changes in wealth (gains and losses) that is in general concave for gains, convex for losses, and steeper for losses than for gains. As a result, people are risk-averse when there is a moderate to high probability of gains or a low probability of losses; they are risk-seeking when there is a low probability of gains or a high probability of losses. This is consistent with people simultaneously buying lottery tickets and insurance while investing money conservatively.

4 PERSPECTIVES ON MARKET BEHAVIOR AND PORTFOLIO CONSTRUCTION

Traditional finance assumes that, at the market level, prices incorporate and reflect all available and relevant information. Markets that behave in a manner consistent with this assumption are referred to as efficient. Portfolios constructed in accordance with traditional finance assumptions are referred to as optimal. Section 4.1 provides an overview of the traditional finance perspectives of market behavior. Section 4.2 provides a brief overview of the traditional finance perspectives on portfolio construction. Section 4.3 discusses behavioral finance alternatives to the traditional finance perspective of market behavior and portfolio construction.

4.1 Traditional Perspectives on Market Behavior

Much of modern investment theory and practice is predicated on the efficient market hypothesis:

> Markets fully, accurately, and instantaneously incorporate all available information into market prices.

However, the efficient market hypothesis (EMH) is not universally accepted. In this section, we will discuss the EMH and explore some of the evidence supporting and opposing it.

Writing in the *Financial Times*, Thaler (2009) comments on two aspects of the EMH. He terms these "The Price is Right" and "No Free Lunch." The *price is right* assumes that asset prices fully reflect available information and that securities' prices can be used as a means to allocate resources. Accepting the EMH as fact, and noting the random nature (unpredictability) of prices, some economists infer that prices are indeed right. Robert Shiller calls this inference "one of the most remarkable errors in the history of economic thought."[18] The price is right is a fallacy because mere randomness does not ensure that the prices are not wrong.[19]

No free lunch assumes that it is difficult for any investor to consistently outperform the market after taking risk into account given the inherent unpredictability of prices. Thaler notes that a myriad of studies over several decades have resulted in the same basic conclusion: There is no free lunch. With the exception of some apparent anomalies, the market is hard to beat. In fact, many of the investment strategies that seemed to beat the market did not do so once risk was more accurately measured.

Thaler concludes that the risks of investments are more correlated than previously thought, that high returns based on high leverage may be transitory and an illusion, and that revealed price distortions challenge the assumption of the price is right. Further, the acceptance of the price is right has led to significant misallocations of resources. However, Thaler leaves us with a quandary: If we abandon the efficient market hypothesis and its assumption that the price is right, how do we allocate resources? Thaler suggests that regulation may serve a useful function in the process of allocating resources.

4.1.1 *Review of the Efficient Market Hypothesis*

An efficient market is a market wherein prices fully reflect available information because of the actions of a large number of rational investors (the population of investors). Underlying market efficiency is the assumption that market participants are rational economic beings, always acting in their own self-interest and making optimal decisions by trading off costs and benefits weighted by statistically correct probabilities and marginal utilities. The efficient market hypothesis requires that agents have rational expectations. This means that, in aggregate, the population is correct, even if no one person is. Also, whenever new relevant information appears, the population updates its expectations. Another key assumption is that relevant information is freely available to all participants. Competition among participants results in a market wherein prices of individual investments always reflect the total effect of all information—including information about events that have already happened and events that the market expects to happen in the future. In sum, at any given time in an efficient market, the price of a security will match that security's intrinsic value. If markets are efficient, then no market participant should be able to consistently earn excess returns.

Grossman and Stiglitz (1980) argue that prices must offer a return to information acquisition, otherwise information will not be gathered and processed. If information is not gathered and processed, the market cannot be efficient. This is known as the Grossman–Stiglitz paradox. They conclude that in equilibrium, if markets are to be efficient, a return should accrue to information acquisition. A market is inefficient if, after deducting such costs, active investing can earn excess returns. An investor or researcher should consider transaction costs and information acquisition costs when evaluating the efficiency of a market.

Fama (1970) proposes three forms of market efficiency: the weak form, the semi-strong form, and the strong form. Weak-form market efficiency assumes that all past market price and volume data are fully reflected in securities' prices. Thus, if a market is weak-form efficient, technical analysis will not generate excess returns. Semi-strong-form market efficiency assumes that all publicly available information, past and present, is fully reflected in securities' prices. Thus, if a market is semi-strong-form efficient, technical and fundamental analyses will not generate excess returns. Strong-form

18 Quoted in Fox (2009).
19 See Lamont and Thaler (2003).

market efficiency assumes that all information, public and private, is fully reflected in securities' prices. Thus, if a market is strong-form efficient, even insider information will not generate excess returns.

4.1.2 *Studies in Support of the EMH*

The idea of efficient markets goes back to the turn of the 20th century. In 1900, a French mathematician named Louis Bachelier submitted a PhD dissertation to the Sorbonne titled "The Theory of Speculation" which describes market movements as random. The opening paragraphs show his early insights: "Past, present, and even discounted future events are reflected in market price, but often show no apparent relation to price changes….if the market, in effect, does not predict its fluctuations, it does assess them … mathematically." Many studies have been conducted that support the EMH. Typically, a study tests either the weak form or semi-strong form of efficiency with respect to a particular market. It is more difficult to test the strong form of efficiency. Extensive support for the weak-form and semi-strong forms of market efficiency has been published.

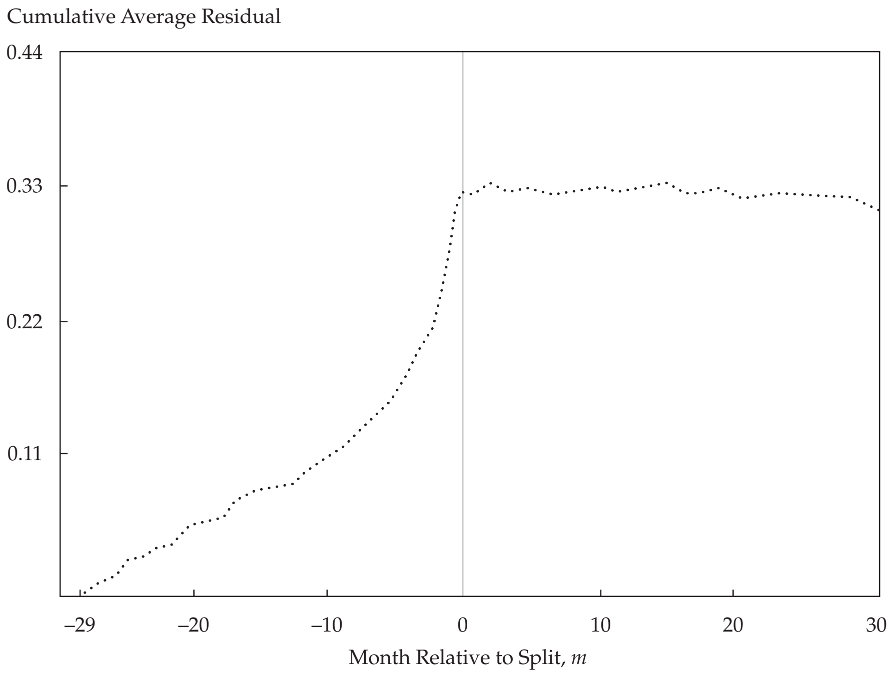
4.1.2.1 Support for the Weak Form of the EMH Initially, most statistical research of the stock market focused on the weak form of market efficiency and tested whether security prices are serially correlated (i.e., whether trends exist in stock prices) or whether they are random (i.e., whether prices of securities, on any given day, are as likely to go up as they are to go down). A number of studies conclude that the path of securities' prices cannot be predicted based on past prices. For example, Roberts (1959) plots the results of a series of randomly generated numbers to see whether any patterns identified by technical analysts are visible. Roberts notes that it is virtually impossible to tell whether his plots are generated using random numbers or actual stock market data. Roberts writes: "If the stock market behaved like a mechanically imperfect roulette wheel, people would notice the imperfections and, by acting on them, remove them."

Several other researchers have studied stock price movements. Fama (1965) concludes that daily changes in stock prices had nearly zero positive correlation. He proposes that the stock market works in a way that allows all information contained in past prices to be incorporated into the current price. In other words, markets efficiently process the information contained in past prices. Samuelson (1965) emphasizes the randomness of stock prices. Like Roberts, he finds that market prices follow random patterns and that future stock prices are unpredictable. Samuelson begins with the observation that "in competitive markets there is a buyer for every seller. If one could be sure that a price would rise, it would have already risen." Samuelson asserts that "we would expect people in the marketplace, in pursuit of avid and intelligent self-interest, to take account of those elements of future events that in a probability sense may be discerned to be casting their shadows before them." By presenting his proof in a general form, Samuelson adds strength to the idea that markets are efficient.

Malkiel (1973) provides credence to the idea of random stock price movements. He performed a test in which he gave students a fictional stock that was initially worth $50. The closing stock price for that stock was determined by a coin flip. If the result was heads, the price would close a half point higher; if the result was tails, it would close a half point lower. Thus, each time, the price had a fifty–fifty chance of closing higher or lower than the previous day. The results of the coin flips were assembled into a chart and graph form. Malkiel took his results in chart and graph form to a chartist (now known as a technical analyst), whom he defined as a person who "seeks to predict future movements by seeking to interpret past patterns on the assumption that 'history tends to repeat itself.'" The chartist told Malkiel that he needed to buy the stock immediately. When Malkiel told him it was based purely on flipping a coin, the chartist was very unhappy. Malkiel argues that this indicates that the market and stocks can be just as random as flipping a coin. These studies of random stock price movements support the weak form of the EMH.

4.1.2.2 Support for the Semi-Strong Form of the EMH Several studies attempt to test the semi-strong form of market efficiency. These tests are typically event studies. An event study looks at a sample of similar events that occurred to different companies at different times and determines what effect(s) these events had on the stock price (on average) of each company. For example, Fama et al. (1969) study the stock market reaction to stock splits. The study finds that the market begins to anticipate a stock split more than two years before it actually happens and incorporates the consequences of the split the day it is announced. As may be seen in Exhibit 6, stock prices are shown to rise pre-split. This price action is a matter of some debate because stock splits do not technically add any value to a company. Fama et al. find that 72 percent of firms in their sample announced above-average dividend increases in the year after the split and proposed that stock splits signaled that dividend increases were on the horizon. On average, they find that stocks increased sharply prior to the split, but returns after the split were very stable. These results indicate that the implications of a stock split appear to be reflected in price immediately following the *announcement* of the split and not the event itself. This research supports the semi-strong form of market efficiency, because investors would not earn abnormal returns after the stock split information is publicly available. Numerous subsequent event studies also provide support for the semi-strong form of market efficiency.

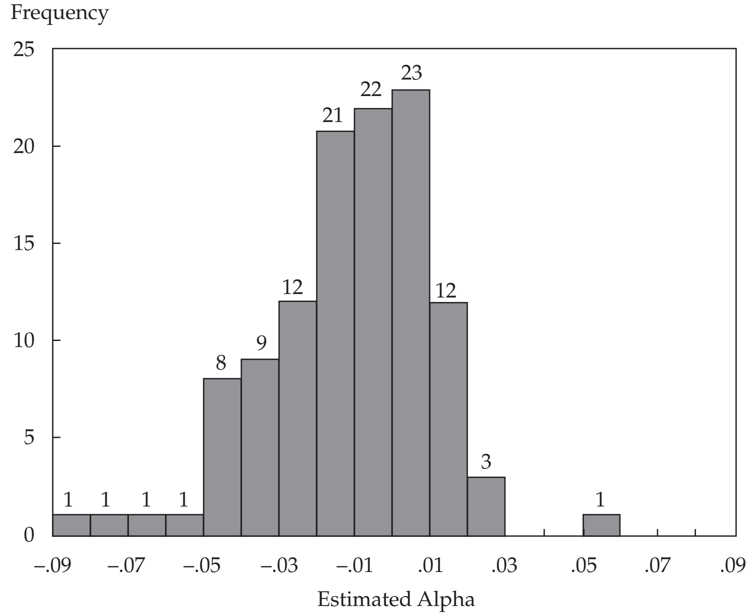
Exhibit 6 Stock Split Event Study



Source: Fama et al. (1969).

Other studies investigate returns to active management. The absence of positive returns to active management is taken as evidence of market efficiency. For example, Alfred Cowles (1933) analyzes thousands of stock selections made by investment professionals from 1928 to 1933 and finds no evidence to suggest that professional investors are able to outperform the market. Jensen (1967) investigates whether mutual fund managers had the skill to outperform the overall market over the long term. Using fund returns after fees but ignoring sales loads, he examines annual return data for the Standard and Poor's (S&P) 500, which he uses as a proxy for the market portfolio, and 115 mutual funds. He uses regression analysis to determine whether mutual funds in his data set generated positive alphas. His estimated alphas for all 115 mutual funds are summarized in Exhibit 7.

Exhibit 7 Estimated Alphas for 115 Mutual Funds



Source: Jensen (1967).

Jensen finds that the majority have estimated alphas below zero. The average fund's alpha is –0.011, or –1.1%. This means that after fees, but not including sales loads, the average fund underperforms the overall market by 110 basis points per year during the examination period. Examining the returns gross of fees, the results are marginally better. A majority still have negative alphas, with the average being –0.4%. Studies that demonstrate the ineffectiveness of professional investors, like this one, support the semi-strong form of market efficiency.

4.1.3 *Studies Challenging the EMH: Anomalies*

Some studies find evidence that appears to contradict market efficiency. These studies mainly describe apparent market anomalies or deviations from the efficient market hypothesis. A market anomaly must persist for a lengthy period to be considered evidence of market inefficiency. Otherwise, the market anomaly may be attributable to the sample period and a strategy that provided abnormal returns in the past may not provide abnormal returns in the future. Exhibit 8 provides a partial list of the studies that claim to identify market anomalies.

Exhibit 8 Selected Research Studies on Market Anomalies

Year	Authors	Article or Study Title	Anomalies Discovered
1968	Ball and Brown	"An Empirical Evaluation of Accounting Income Numbers"	Post earnings announcement drift
1976	Rozeff and Kinney	"Capital Market Seasonality: The Case of Stock Market Returns"	January effect: January stock returns were higher than in any other month
1981	Gibbons and Hess	"Day of the Week Effects and Asset Returns"	Monday effect: Stock prices tended to go down on Mondays
1981	Shiller	"Do Stock Prices Move Too Much to Be Justified by Subsequent Changes in Dividends?"	Excess volatility
1982	Rendleman, Jr., Jones, and Latane	"Empirical Anomalies Based on Unexpected Earnings and the Importance of Risk Adjustments"	Earnings surprises and their effect on the stock price
1985	De Bondt and Thaler	"Does the Stock Market Overreact?"	Stock market overreacts to bad news
1991	Ritter	"The Long-Run Performance of Initial Public Offerings"	Negative long-run performance of IPOs
1992	Fama and French	"The Cross-Section of Expected Stock Returns"	Value investing
1993	Jegadeesh and Titman	"Returns to Buying Winners and Selling Losers; Implications for Stock Market Efficiency"	Momentum

There are three main types of identified market anomalies: fundamental, technical, and calendar. There is, however, disagreement about whether these are actual anomalies or the result of incomplete models being used in the testing. In effect, the test is often a joint test of market efficiency and the pricing model being used to test for it. We will now review some of the primary anomalies in each category.

4.1.3.1 Fundamental Anomalies A fundamental anomaly is an irregularity that emerges when one considers a stock's future performance based on a fundamental assessment of the stock's value. Examples of fundamental anomalies are the performance of small-capitalization companies and value companies compared to large-capitalization companies and growth companies, respectively. The effect of company size on performance has been documented in a number of studies.[20]

Value and growth investing inherently assume that anomalies from the efficient market hypothesis exist. Value investors attempt to identify stocks that are priced below their intrinsic values in order to earn excess returns. Growth investors attempt to identify stocks with high growth opportunities, which are not yet reflected in current market prices, in order to earn excess returns. Value companies typically have, on a per share basis, lower than average price-to-earnings, price-to-book value, and price-to-sales ratios and higher than average dividend yields. Growth companies typically have, on a per share basis, higher than average price-to-earnings, price-to-book value, and price-to-sales ratios and lower than average dividend yields. A large body of evidence supports the premise that investors consistently overestimate the prospects of growth companies and underestimate the prospects of value companies. As a result, value stocks appear to generate anomalously high returns compared to growth stocks.

20 For example, Banz (1981) and Fama and French (1992).

Numerous studies show that low price-to-book value ratios (high book value to price ratios) are reasonably consistent predictors of future value.[21] A low price-to-earnings ratio (P/E) is another attribute that tends to correlate anomalously with outperformance. Several studies show that low P/E stocks outperform both high P/E stocks and the market in general.[22] Securities with low price-to-sales ratios also appear to exhibit fundamentally anomalous performance. O'Shaughnessy (1996) demonstrates that stocks with low price-to-sales ratios outperform stocks with high price-to-sales ratios as well as stocks in general. He believes that the price-to-sales ratio is the strongest single determinant of excess return. These studies appear to support the existence of a market anomaly.

However, other studies, including Fama and French (1995, 2008), contend that the studies on value investing do not identify anomalies but rather are a function of incomplete models of asset pricing. Fama and French, for example, propose a three-factor model as a more complete model than the capital asset pricing model (CAPM) to predict stock returns. The proposed model includes a market risk premium as in the CAPM, size of the firm based on equity market value, and the ratio of the firm's book value of equity to market value of equity. The latter two factors proxy for sensitivity to risk, and thus their inclusion is consistent with the rational pricing of stocks. The apparent size and value stock anomalies may be a function of incomplete models being used in testing for inefficiency rather than actual anomalies.

4.1.3.2 Technical Anomalies A technical anomaly is an irregularity that emerges when one considers past prices and volume levels. Technical analysis encompasses a number of techniques that attempt to forecast securities prices by studying past prices and volume levels. Common technical analysis strategies are based on relative strength and moving averages, as well as on support and resistance. For example, Brock, Lakonishok, and LeBaron (1992) analyze moving averages and trading range breaks on the Dow Jones Industrial Index from 1897 to 1985. The technical rules addressed in the study are:

- *Moving Averages.* Buy and sell signals are generated by the crossing of a short moving average with a long moving average. When the short moving average moves above (below) the long moving average, the signal is to buy (sell). They test long moving averages of 50, 150, and 200 days with short moving averages of 1, 2, and 5 days.
- *Trading Range Break (Support and Resistance).* A buy signal is generated when the price penetrates the resistance level, and a sell signal is generated when the price penetrates the support level. Brock et al. test support and resistance based on past 50, 150, and 200 days with signals generated when a maximum or minimum is violated by 1 percent. They then compute 10-day holding period returns following the buy and sell signals.

The authors conclude that the "results are consistent with technical rules having predictive power." However, they warn that transaction costs may reduce the benefits of trading based on technical anomalies. Numerous other researchers dispute the validity of technical analysis. These researchers believe that prices adjust rapidly to new stock market information and that technical analysis is unlikely to provide any advantage to investors who use it. However, proponents of technical analysis continue to argue the validity of certain technical strategies.

---

21 For example, Stattman (1980); Rosenberg, Reid, and Lanstein (1985); Chan, Hamao, and Lakonishok (1991); Fama and French (1992); and Lakonishok, Shleifer, and Vishny (1994).

22 See Ball (1978); Basu (1983); Jaffe, Keim, and Westerfield (1989); Chan, Hamao, and Lakonishok (1991); and Fama and French (1992).

4.1.3.3 Calendar Anomalies A calendar anomaly is an irregularity identified when patterns of trading behavior that occur at certain times of the year are considered. A well known calendar anomaly is the January effect. Historically, stocks in general—and small stocks, in particular—have delivered abnormally high returns during the month of January. Haugen and Jorion, two researchers on the subject, note that "The January Effect is, perhaps, the best known example of anomalous behavior in security markets throughout the world."[23] The January effect is particularly interesting because it has not disappeared despite being well known for 25 years. Arbitrage theory tells us that anomalies should disappear as traders attempt to exploit them in advance.

Some studies have shown that stocks earn higher returns on the last day and first four days of each month—the turn-of-the-month effect. Hensel and Ziemba (1996) examined returns of the S&P 500 over a 65-year period and found that US large-cap stocks consistently generate higher returns at the turn of the month. In fact, they found "that the total return from the S&P 500 over this sixty-five-year period was received mostly during the turn of the month." The study implies that investors making regular stock purchases may benefit by scheduling those purchases prior to the turn of the month.

4.1.3.4 Anomalies: Conclusion Support exists for both efficient markets and anomalous markets. Studies that claim to identify anomalies are often critiqued for their use of an assumed pricing model. When an assumed pricing model is used, it is impossible to say if the observed results are indicative of a true anomaly or simply a consequence of using an incorrect pricing model. In reality, markets are neither perfectly efficient nor completely anomalous; market efficiency is not black or white, but rather gray. In markets exhibiting substantial inefficiency, sophisticated investors may be able to outperform less savvy participants. Many analysts believe that such US large-capitalization stocks as GE and Microsoft are quite efficient, but US small-capitalization and international stocks offer more opportunities for outperformance. Alternative investment markets, such as real estate and venture capital markets, may be less efficient. They lack fluid and continuous prices, and information asymmetries may exist between market participants. This may restrict arbitrage from pricing away market inefficiencies.

4.1.3.5 Limits to Arbitrage Shleifer and Vishny (1997) develop a theory of limited arbitrage. They assume that implicit restrictions are placed on a fund's ability to arbitrage by investors' ability to withdraw their money. The potential for withdrawal of money imposes limits on the ability of the fund to take advantage of arbitrage situations in which two securities are not rationally priced (priced at intrinsic or fundamental value based on all available information), because securities' prices may remain in a non-equilibrium (irrational) state for long periods of time. In other words, when a firm or portfolio manager is viewed as incompetent or simply wrong about a trade, because certain securities remain irrationally priced for extended periods of time, investors may withdraw their money before the irrational pricing corrects itself and the position may have to be closed prematurely. In his 2010 book "The Big Short," Michael Lewis describes the situation where a hedge fund manager, Michael Burry, was criticized for years by his investors and backers for holding credit default swaps on sub-prime mortgages (effectively shorting the sub-prime housing market) only to have the investment pay off handsomely in the end. His ability to impose restrictions on withdrawal of money from his fund was the only reason he was able to make his investment strategy pay off.

Shleifer and Vishny's theory of limited arbitrage is in stark contrast to the EMH, which assumes that whenever mispricing of a publicly traded stock occurs, an opportunity for arbitrage profit is created for rational traders who should act on those opportunities, resulting in rational pricing (efficient markets). Why might rational traders

---

23 Haugen and Jorion (1996).

choose not to act on observed opportunities? If market participants are engaged in highly leveraged arbitrage trades and prices move against them and stay there for an extended time before returning to intrinsic value, they may eventually need to liquidate prior to realizing the gains expected to result from the prices moving to intrinsic value. In the professional money management business, clients may demand liquidity before a manager's strategy is fully implemented and a successful outcome is realized. To deliver funds, the manager may have to sell or close out positions at a loss. The possibility of an extended period of mispricing and the potential need for liquidity makes market participants less prone to take advantage of arbitrage opportunities. This action has the tendency to exacerbate the problem of pricing inefficiency.

Implicit in the limits to the arbitrage idea is that the EMH does not hold. Specifically, if market participants are engaged in highly leveraged arbitrage trades and prices move against them and stay there irrationally before returning to fundamental value, they may eventually need to liquidate prior to realizing the gains expected to result from the prices moving to fundamental value. Rational traders often work for professional asset management firms and invest other peoples' money. If they engage in arbitrage in reaction to a stock mispricing and the mispricing persists for an extended period, clients of the money management firm can (and do) withdraw their funds. The clients are not willing to wait for the manager's expectations to be met. To deliver funds, the manager must unwind positions at a loss. This is a reason for the restrictions placed on hedge fund withdrawals (i.e., lock-up periods).

4.2 Traditional Perspectives on Portfolio Construction

From a traditional finance perspective, a "rational" portfolio is one that is mean–variance efficient. The appropriate portfolio for an investor is constructed holistically by considering the investor's tolerance for risk, investment objectives, investment constraints, and investor circumstances. An investor will typically take or administer a risk tolerance questionnaire, document financial goals and constraints, and then adopt the output of a mean–variance model (optimized using software or human judgment) that matches the investor's risk tolerance category and accomplishes the investor's financial goals. In the case of institutional investors, they will consider these items from the perspective of the entity they are acting on behalf of. An investment adviser will consider these items from the perspective of the client when developing investment policy statements and asset allocations. Subject to investment objectives and constraints, a suitable portfolio is chosen from the opportunity set of mean–variance efficient portfolios. The output of the mean–variance model may be considered as a "rational" or optimal portfolio allocation.

However, this approach to portfolio construction implicitly assumes that investors (or their advisers) have perfect information and that investors behave rationally in forming their portfolios. If these assumptions do not apply, then portfolios may be constructed using other approaches resulting in portfolios that have too much or too little risk when compared to the optimal portfolio. Further, although a portfolio based on mean–variance optimization may be theoretically sound, it may fail to meet the needs of the investor because of behavioral considerations.

4.3 Alternative Models of Market Behavior and Portfolio Construction

The traditional finance perspective of market behavior may not satisfactorily explain observed market behavior and portfolio construction, but a significant challenge also exists for behavioral finance. There is no single unifying theory of behavioral finance to explain the observed market behaviors. In the absence of such a theory, supporters of traditional finance perspectives contend that the traditional finance perspectives remain superior to behavioral finance perspectives. A number of behavioral models have been advanced, but none has yet been accepted as presenting a complete or unifying description of market behavior. Four of the behavioral models advanced to explain market behavior and portfolio construction are discussed in the following sections. None of these models has yet achieved the kind of general acceptance among finance practitioners and academics that the EMH and mean–variance portfolio construction models have.

4.3.1 *A Behavioral Approach to Consumption and Savings*

Shefrin and Thaler (1988) propose an alternative to the traditional life-cycle model in which people are assumed to spend and save money rationally to achieve an optimal short-term and long-term consumption plan. They developed a behavioral life-cycle theory that incorporates self-control, mental accounting, and framing biases. In the traditional life-cycle model, self-control allows people to pursue long-term goals rather than focus on short-term satisfaction. In behavioral finance, the self-control bias recognizes that people may focus on short-term satisfaction to the detriment of long-term goals. Mental accounting is the phenomenon whereby people treat one sum of money differently from another sum of money even though money is fungible (interchangeable). Framing bias results in different responses based on how questions are asked (framed).

Shefrin and Thaler suggest that people classify their sources of wealth into three basic accounts: current income, currently owned assets, and the present value of future income. This mental accounting exists even though money is fungible. Mental accounting is a partial response to the issue of self-control. By classifying some wealth so that it is considered less available, it is less likely to be consumed in the short-term. People are assumed to be most likely to spend from current income (high marginal propensity to consume) and least likely to spend based on expectations of future income (low marginal propensity to consume). In other words, people lack self-control when it comes to current income. Any current income that is saved is reclassified as current assets or future income. The portion saved will increase with income. As Shefrin and Thaler indicated, "To the poor, saving is a luxury." Mental accounting and framing help people accommodate the competing goals of short-term gratification and long-term benefits. Rather than viewing money (their wealth) as fungible, people tend to frame their expenditure decisions taking into account the source of the wealth.

Individuals are hypothesized to first spend current income, then to spend based on current assets, and finally to spend based on future income. These propensities to consume have a variety of implications. For example, people may save a higher proportion of bonus income because they may classify bonus income as a current asset rather than current income and thus have a lower marginal propensity to consume it. If a government cuts taxes but does not reduce withholding rates, the ensuing tax refunds may be treated as current assets rather than current income. This may result in greater savings than if the tax reduction had been treated as current income. When spending from current assets, liquidity and maturity are taken into account. Basically, such short-term liquid assets as cash and checking accounts are liquidated first to finance current expenditures. Long-term, less-liquid assets, such as homes and retirement savings, are less likely to be used to finance current expenditures. However, individuals who view home equity as part of current assets are more likely to take out loans based on their home's value to finance current consumption than individuals who view their home as part of their retirement assets or future income. Similarly, individuals who classify pension assets as current assets rather than as a source of future retirement income are more prone to take loans against or spend their pension assets.

Shefrin and Thaler hypothesize that individuals will spend, for current consumption, most of their current income, varying portions of their currently owned assets, and very little based on their expectations of future income. The consumption/saving (investment) decisions made when individuals are subject to self-control, mental accounting, and framing biases differ from those of the rational economic individuals of traditional finance. Although mental accounting and framing will result in some saving for long-term goals, the outcome will not necessarily match the optimal short-term and long-term consumption plan of traditional life-cycle models. As a result, individuals will not achieve their theoretically optimal short-term and long-term consumption opportunities. Knowledge of behavioral propensities may help people move closer to the optimal solutions of traditional finance.

4.3.2 *A Behavioral Approach to Asset Pricing*

Some researchers believe that market behaviors are better explained from a behavioral perspective than a traditional perspective, which assumes that perfectly rational investors make wealth-maximizing decisions at all times using all available information. They find the traditional perspective difficult to accept because they observe investors displaying biased behaviors that lead to less-than-optimal decisions.

Shefrin and Statman (1994) begin to develop an alternative to the classic capital asset pricing model. Shefrin (2005, 2008) develops the idea further and proposes a behavioral approach to asset pricing using models, which Shefrin terms behavioral stochastic discount factor-based (SDF-based) asset pricing models. Shefrin, based on the results of empirical tests, concludes that investors do not make their decisions in an unbiased way. The stochastic discount factor to reflect this bias is a function of investor sentiment relative to fundamental value. The model focuses on market sentiment as a major determinant of asset pricing, which in turn is derived from systematic errors in judgment committed by investors. Shefrin asserts that sentiment causes asset prices to deviate from values determined using traditional finance approaches.

In order to have a tractable behavioral approach to asset pricing, it is necessary to have a well-defined measure of sentiment with an impact that can be traced on market prices and risk premiums. Shefrin (2005) proposes that the dispersion of analysts' forecasts serves as a proxy for the sentiment risk premium in the model. In support of this theory, he cites Ghysels and Juergens (2004), who determine that dispersion of analysts' forecasts is statistically significant in a Fama–French multi-risk-factor framework. Alternatively, the dispersion of analysts' forecasts may be a systematic risk factor not accounted for by other factors in the model. Doukas, Kim, and Pantzalis (2004) find that value stocks earn higher returns than growth stocks because the dispersion of analysts' forecasts is greater for value stocks—which supports dispersion of opinion as a measure for a source of risk.

Shefrin develops a stochastic process for sentiment and a fundamental SDF-based asset-pricing equation. The price of an asset is the expected value of its discounted payoffs. The discount rate captures the effects of the time value of money, fundamental risk, and sentiment risk. Sentiment pertains to erroneous, subjectively determined beliefs. If an investor's subjective beliefs about the discount rate match those of traditional finance, the investor is said to have zero risk sentiment. If an investor's subjective beliefs about the discount rate do not match those of traditional finance, the investor's beliefs are said to include risk sentiment. Thus, the discount rate on a security is the sum of the risk-free rate and fundamental premiums (corresponding to efficient prices) and a sentiment premium (reflecting sentiment-based risk).[24]

24 See Shefrin (2008).

Although Shefrin cites evidence that investors commit errors that result in inefficient prices in the aggregate, it is important to determine if these errors are either systematic or essentially random in nature. If they are systematic, then the errors may be predicted and exploited to earn excess returns. A logical assumption, in that case, is that rational and informed investors—however few in number—would act on these inefficiencies and thereby limit the scope of the pricing errors. If investors' errors are random in nature, however, then observing and modeling them presents a formidable challenge, as indicated in the original work by Shefrin and Statman (1994).

4.3.3 *Behavioral Portfolio Theory*

Shefrin and Statman (2000) extend their 1994 work to develop behavioral portfolio theory (BPT). BPT uses a probability-weighting function rather than the real probability distribution used in Markowitz's portfolio theory (1952). The optimal portfolio under BPT can differ from the perfectly diversified portfolio of Markowitz. In Markowitz's portfolio theory, risk-averse investors construct diversified portfolios based on mean–variance analysis and consideration of the covariance between assets. They are concerned about the expected return and variance of the portfolio as a whole. In behavioral portfolio theory, however, investors construct their portfolios in layers and expectations of returns and attitudes toward risk vary between the layers. The resulting portfolio may appear well-diversified, but diversification is incidental to and not necessarily an objective of the portfolio construction.

Shefrin and Statman contend that portfolio construction is primarily a function of five factors. First, the allocation to different layers depends on investor goals and the importance assigned to each goal. For example, if high importance is assigned to an upside potential goal, then the allocation of funds to the layer with the highest upside potential will be greater than if high importance is attached to minimizing potential downside losses. Second, the allocation of funds within a layer to specific assets will depend on the goal set for the layer. If a higher goal is set, then the assets selected for the layer are likely to be riskier or more speculative in nature. Third, the number of assets chosen for a layer depends on the shape of the investor's utility function. Risk-averse individuals have concave utility functions, meaning that utility increases at a decreasing rate with increases in wealth (diminishing marginal utility of wealth). The greater the concavity of the utility curve, the earlier the satiation for a specific security. Thus, the greater the concavity of the utility curve, the greater the number of securities included in a layer. Fourth, concentrated positions in some securities may occur if investors believe they have an informational advantage with respect to the securities. Fifth, investors reluctant to realize losses may hold higher amounts of cash so that they do not have to meet liquidity needs by selling assets that may be in a loss position. Further, the portfolios of investors reluctant to realize losses may continue to hold some securities not because of the securities' potential, but rather because of the investor's aversion to realize losses. Although the resulting portfolios may appear well-diversified, they may not, in fact, be well-diversified from a mean–variance perspective. In other words, the portfolio may not be mean–variance efficient.

Shefrin and Statman explain how BPT is consistent with the apparently irrational behavioral tendency of many people to purchase insurance policies and also buy lottery tickets, as discussed in Friedman and Savage (1948). A BPT investor maximizes expected wealth subject to the constraint that the probability of the wealth being less than some aspirational level cannot exceed some specified probability. A BPT investor can tolerate failure to achieve at least the aspirational level of wealth but only with a small probability. In other words, the investor maximizes expected wealth on a particular portfolio subject to a safety constraint. As a result, the optimal portfolio of a BPT investor is a combination of bonds or riskless assets and highly speculative assets. The BPT investor is essentially constructing a portfolio equivalent to an insurance policy and a lottery ticket.

In the first layer, the investor seeks safety by buying bonds or riskless assets in order to insure his aspirational level of wealth with a small maximum chance of failure. In the second layer, the investor is willing to take risk with the residual wealth. In consequence, a BPT-optimal portfolio can differ from the rational diversified portfolio that is mean–variance efficient. In the BPT model, risk aversion is taken into account by the constraint that limits the risk of failing to achieve the aspirational level of wealth.

EXAMPLE 3

Behavioral Portfolio Theory

Two BPT investors are developing portfolios. The portfolios will contain at most three layers: a layer of riskless investments, a layer of moderately risky investments, and a layer of highly risky speculative investments. The riskless investments (layer 1) are expected to return 1 percent; the moderately risky investments (layer 2) are expected to return −3 percent with 10 percent probability, 5 percent with 80 percent probability, and 9 percent with 10 percent probability; and the speculative investments (layer 3) are expected to return −50 percent with 15 percent probability, 12 percent with 50 percent probability, and 75 percent with 35 percent probability.

The first BPT investor has 2,000,000 euros and an aspirational level of 2,000,000 euros with a probability of 100 percent. In other words, this BPT investor will not tolerate any loss in wealth. The second BPT investor has 2,000,000 euros and an aspirational level of 2,100,000 euros with a probability of 80 percent. Further, this investor can tolerate some potential loss in wealth but cannot tolerate the portfolio declining below 1,800,000 euros. Construct the optimal portfolio for the first BPT investor. In addition, evaluate whether the second BPT investor's portfolio is optimal if the investor puts 1,568,627 euros in layer 1 and 431,373 euros in layer 3.

Solution:

The first BPT investor's portfolio will be approximately 100 percent in the layer of riskless investments given the inability to tolerate any losses. The second BPT investor has an aspirational level of return of 5 percent (100,000 euros). Given the safety level and a maximum potential loss of 50 percent on the speculative assets, the investor may put approximately 1,568,627 euros in layer 1 and 431,373 euros in layer 3. This portfolio will result in an expected return of 6.123 percent.

	Allocation	Expected Return	Portfolio Return
Layer 1	78.43%	1.00%	0.784%
Layer 2	0.00%	4.60%	0.000%
Layer 3	21.57%	24.75%	5.339%
Total	100.00%		6.123%

This portfolio will result in 1,800,000 euros with 15 percent probability, 2,067,451 euros with 50 percent probability, and 2,339,216 euros with 35 percent probability. The safety objective is met, but the portfolio is short of the aspirational goal. The portfolio will result in at least 2,067,451 euros with 85 percent probability rather than 2,100,000 euros with 80 percent probability. Based on risk tolerance, the investor may decide this is acceptable or may decide to lower her safety level objective.

(*Note*: The resulting portfolios are not necessarily mean–variance efficient because no consideration is given to the covariance of the investment layers.)

4.3.4 *Adaptive Markets Hypothesis*

Lo (2004) proposes the **adaptive markets hypothesis** (AMH). The AMH applies principles of evolution—such as competition, adaptation, and natural selection—to financial markets in an attempt to reconcile efficient market theories with behavioral alternatives. Similar to factors that influence an ecological system, markets are influenced by competition for scarce resources and the adaptability of participants. The greater the competition for scarce resources or in markets for profits and the less adaptable the participants, the greater the likelihood of not surviving. Following are two examples that have been simplified but serve to demonstrate the ideas behind the AMH. In a natural example, pandas are extremely non-adaptable, eating only bamboo. This reduces the likelihood of pandas surviving in significant numbers outside of protected settings. In a financial example, Long-Term Capital Management (LTCM) was faced with increasing competition that used the same arbitrage techniques as LTCM did. Rather than adapting and changing techniques, LTCM increased leverage and ultimately faced the possibility of non-survival.

Lo notes that biases identified by those researching in behavioral finance may be consistent with the AMH. These biases are simply the result of applying previously learned heuristics to a changed environment where they no longer work. The successful participant will adapt to the changed environment and develop new heuristics. Success is defined as survival rather than as having maximized expected utility.

Behavior of market participants is not necessarily that of a REM, but is rather behavior that is perceived to result in less-than-optimal rational outcomes. Lo discusses this in the context of Simon's notions of bounded rationality and satisficing.[25] As a result of informational, intellectual, and computational limitations, individuals use judgment to gather sufficient information, to adequately process the information, to identify with satisfactory sub-goals and limited objectives rather than try to achieve an optimum, and to make decisions that meet these sub-goals and objectives. Applying an evolutionary perspective to Simon's framework provides useful insights. For example, the choice of satisfactory goals is determined through trial and error, which can be viewed as equivalent to a process of natural selection. As experience increases, individuals learn and the heuristics they apply to a situation evolve. As these heuristics based on past experiences are applied to new situations, they may or may not be appropriate and additional learning takes place.

The AMH is a revised version of the EMH that considers bounded rationality, satisficing, and evolutionary principles. Under the AMH, individuals act in their own self-interest, make mistakes, and learn and adapt; competition motivates adaptation and innovation; and natural selection and evolution determine market dynamics. Five implications of the AMH are: 1) The relationship between risk and reward varies over time (risk premiums change over time) because of changes in risk preferences and such other factors as changes in the competitive environment; 2) active management can add value by exploiting arbitrage opportunities; 3) any particular investment strategy will not consistently do well but will have periods of superior and inferior performance; 4)

25 See Simon (1957).

the ability to adapt and innovate is critical for survival; and 5) survival is the essential objective. In other words, recognizing that things change, the survivors will be those who successfully learn and adapt to changes.

SUMMARY

With its simplifying assumption of rational investors and efficient markets, traditional finance has gained wide acceptance among academics and investment professionals as a guide to financial decision making. Over time, however, the limitations of traditional finance have become increasingly apparent. Individual decision making is not nearly as objective and intellectually rigorous, and financial markets are not always as rational and efficiently priced as traditional finance assumes. To bridge this gap between theory and practice, behavioral finance approaches decision making from an empirical perspective. It identifies patterns of individual behavior without trying to justify or rationalize them.

A practical integration of behavioral and traditional finance may lead to a better outcome than either approach used in isolation. By knowing how investors should behave and how investors are likely to behave, it may be possible to construct investment solutions that are both more rational from a traditional perspective and, because of adjustments reflecting behavioral insights, easier to accept and remain committed to. Although these behavioral insights will not lead easily or automatically to superior results, it is hoped that they will help many improve their investment approach and enhance risk management.

Among the points made in this reading are the following:

- Traditional finance assumes that investors are rational: Investors are risk-averse, self-interested utility-maximizers who process available information in an unbiased way.
- Traditional finance assumes that investors construct and hold optimal portfolios; optimal portfolios are mean–variance efficient.
- Traditional finance hypothesizes that markets are efficient: Market prices incorporate and reflect all available and relevant information.
- Behavioral finance makes different (non-normative) assumptions about investor and market behaviors.
- Behavioral finance attempts to understand and explain observed investor and market behaviors; observed behaviors often differ from the idealized behaviors assumed under traditional finance.
- Behavioral biases are observed to affect the financial decisions of individuals.
- Bounded rationality is proposed as an alternative to assuming perfect information and perfect rationality on the part of individuals: Individuals are acknowledged to have informational, intellectual, and computational limitations and as a result may satisfice rather than optimize when making decisions.
- Prospect theory is proposed as an alternative to expected utility theory. Within prospect theory, loss aversion is proposed as an alternative to risk aversion.
- Markets are not always observed to be efficient; anomalous markets are observed.
- Theories and models based on behavioral perspectives have been advanced to explain observed market behavior and portfolio construction.

- One behavioral approach to asset pricing suggests that the discount rate used to value an asset should include a sentiment risk premium.
- Behavioral portfolio theory suggests that portfolios are constructed in layers to satisfy investor goals rather than to be mean–variance efficient.
- The behavioral life-cycle hypothesis suggests that people classify their assets into non-fungible mental accounts and develop spending (current consumption) and savings (future consumption) plans that, although not optimal, achieve some balance between short-term gratification and long-term goals.
- The adaptive markets hypothesis, based on some principles of evolutionary biology, suggests that the degree of market efficiency is related to environmental factors characterizing market ecology. These factors include the number of competitors in the market, the magnitude of profit opportunities available, and the adaptability of the market participants.
- By understanding investor behavior, it may be possible to construct investment solutions that will be closer to the rational solution of traditional finance and, because of adjustments reflecting behavioral insights, easier to accept and remain committed to.

REFERENCES

Ball, R. 1978. "Anomalies in Relationships between Securities' Yields and Yield-Surrogates." *Journal of Financial Economics*, vol. 6:103–126.

Banz, R.W. 1981. "The Relationship between Return and Market Value of Common Stocks." *Journal of Financial Economics*, vol. 9:3–18.

Basu, Sanjoy. 1983. "The Relationship between Earnings Yield, Market Value, and Return for NYSE Common Stocks: Further Evidence." *Journal of Financial Economics*, vol. 12:129–156.

Bernanke, Ben S. 2009. Commencement of the Boston College School of Law. Newton, MA (22 May).

Bernoulli, Daniel. 1954. (originally published in 1738). "Exposition of a New Theory on the Measurement of Risk." *Econometrica: Journal of the Econometric Society*, vol. 22, no. 1:23–36.

Brock, William, Josef Lakonishok, and Blake LeBaron. 1992. "Simple Technical Trading Rules and the Stochastic Properties of Stock Returns." *Journal of Finance*, vol. 47, no. 5 (December):1731–1764.

Chan, L., Y. Hamao, and Josef Lakonishok. 1991. "Fundamentals and Stock Returns in Japan." *Journal of Finance*, vol. 46, no. 5 (December):1739–1764.

Cowles, Alfred. 1933. "Can Stock Market Forecasters Forecast?" *Econometrica: Journal of the Econometric Society*, vol. 1:309–324.

Doukas, John, Chansog (Francis) Kim, and Christos Pantzalis. 2004. "Divergent Opinions and the Performance of Value Stocks." *Financial Analysts Journal*, vol. 60, no. 6:55–64.

Fama, Eugene F. 1965. "Random Walks in Stock Market Prices." *Financial Analysts Journal*, vol. 21, no. 5 (September/October):55–59.

Fama, Eugene F., M. Jensen, L. Fisher, and R. Roll. 1969. "The Adjustment of Stock Prices to New Information." *International Economic Review*, vol. 10, no. 1 (February):1–21.

Fama, Eugene F. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance*, vol. 25, no. 2 (May):383–417.

Fama, Eugene F., and Kenneth R. French. 1992. "The Cross-Section of Expected Stock Returns." *Journal of Finance*, vol. 47, no. 2 (June):427–465.

Fama, Eugene F., and Kenneth R. French. 1995. "Size and Book-to-Market Factors in Earnings and Returns." *Journal of Finance*, vol. 50:131–155.

Fama, Eugene F., and Kenneth R. French. 2008. "Average Returns, B/M, and Share Issues." *Journal of Finance*, vol. 63:2971–2995.

Fox, Justin. 2009. *The Myth of the Rational Market*. New York: HarperCollins.

Friedman, M., and L. J. Savage. 1948. "The Utility Analysis of Choices Involving Risk." *Journal of Political Economy*, vol. 56, no. 4 (August):279–304.

Ghysels, E., and J. Juergens. 2004. "Do Heterogeneous Beliefs Matter for Asset Pricing?" Working Paper, University of North Carolina.

Glimcher, Paul. 2003. *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics*. Cambridge, MA: MIT Press.

Grossman, Sanford J., and Joseph E. Stiglitz. 1980. "On the Impossibility of Informationally Efficient Markets." *American Economic Review*, vol. 70, no. 3:393–408.

Gul, F., and W. Pesendorfer. 2008. "The Case for Mindless Economics." In *The Foundations of Positive and Normative Economics*. A. Caplin and A. Schotter, eds. New York: Oxford University Press.

Haugen, Robert, and Philippe Jorion. 1996. “The January Effect.” *Financial Analysts Journal*, vol. 52, no. 1 (January/February):27–31.

Hensel, C., and W. Ziemba. 1996. “Investment Results from Exploiting Turn-of-the-Month Effects.” *Journal of Portfolio Management*, vol. 22, no. 3 (Spring):17–23.

Jaffe, J., D. Keim, and R. Westerfield. 1989. “Earnings Yields, Market Values, and Stock Returns.” *Journal of Finance*, vol. 44, no. 1 (March):135–148.

Jensen, Michael C. 1967. “The Performance of Mutual Funds in the Period 1945–1964.” *Journal of Finance*, vol. 23, no. 2:389–416.

Kahneman, Daniel, and Amos Tversky. 1979. “Prospect Theory: An Analysis of Decision under Risk.” *Econometrica: Journal of the Econometric Society*, vol. 47, no. 2 (March):263–291.

Keynes, John Maynard. 1936. *The General Theory of Employment, Interest, and Money*. New York: Harcourt, Brace.

Knight, Frank. 1921. *Risk, Uncertainty, and Profit*. Boston: Beard Books.

Lakonishok, Josef, Andrei Shleifer, and Robert W. Vishny. 1994. “Contrarian Investment, Extrapolation, and Risk.” *Journal of Finance*, vol. 49, no. 5:1541–1578.

Lamont, Owen A., and Richard H. Thaler. 2003. “Can the Market Add and Subtract? Mispricing in Tech Stock Carve-Outs.” *Journal of Political Economy*, vol. 111, no. 2:227–268.

Lewis, Michael. 2010. *The Big Short*. New York: W.W. Norton & Company.

Lo, Andrew. 2004. “The Adaptive Markets Hypothesis.” *Journal of Portfolio Management*, vol. 30, no. 5 (30th anniversary issue):15–29.

Malkiel, Burton. 1973. *A Random Walk Down Wall Street*. New York: W.W. Norton & Company.

Markowitz, Harry. 1952. “Portfolio Selection.” *Journal of Finance*, vol. 7, no. 1:77–91.

O’Shaughnessy, James P. 1996. *What Works on Wall Street*. Columbus, OH: McGraw-Hill.

Raiffa, Howard. 1997. *Decision Analysis: Introductory Readings on Choices under Uncertainty*. Columbus, OH: McGraw-Hill.

Roberts, Harry V. 1959. “Stock-Market ‘Patterns’ and Financial Analysis: Methodological Suggestions.” *Journal of Finance*, vol. 14, no. 1.

Rosenberg, B., K. Reid, and R. Lanstein. 1985. “Persuasive Evidence of Market Inefficiency.” *Journal of Portfolio Management*, vol. 11:9–17.

Samuelson, Paul A. 1937. “A Note on Measurement of Utility.” *Review of Economic Studies*, vol. 4, no. 2 (February).

Samuelson, Paul A. 1965. “Proof That Properly Anticipated Prices Fluctuate Randomly.” *Industrial Management Review*, vol. 6, no. 2:41.

Savage, L.J. 1954. *The Foundation of Statistics*. New York: John Wiley.

Shefrin, Hersh. 2005. *A Behavioral Approach to Asset Pricing*. Burlington, MA: Elsevier.

Shefrin, Hersh. 2008. “Risk and Return in Behavioral SDF-Based Asset Pricing Models.” *Journal of Investment Management*, vol. 6, no. 3:1–18.

Shefrin, Hersh, and Meir Statman. 1994. “Behavioral Capital Asset Pricing Theory.” *Journal of Financial and Quantitative Analysis*, vol. 29:323–349.

Shefrin, Hersh, and Meir Statman. 2000. “Behavioral Portfolio Theory.” *Journal of Financial and Quantitative Analysis*, vol. 35, no. 2.

Shefrin, Hersh, and Richard Thaler. 1988. “The Behavioral Life-Cycle Hypothesis.” *Economic Inquiry*, vol. 26, no. 4:609–643.

Shleifer, Andrei, and Robert W. Vishny. 1997. “The Limits of Arbitrage.” *Journal of Finance*, vol. 52, no. 1 (March):35–55.

Simon, Herbert A. 1957. *Models of Man: Social and Rational*. New York: John Wiley and Sons.

Simon, Herbert A. 1991. *Models of My Life*. New York: Basic Books.

Simon, Herbert A. 1996. *The Sciences of the Artificial*. 3rd ed. Cambridge, MA: MIT Press.

Statman, Meir. 1999. “Behavioral Finance: Past Battles and Future Engagements.” *Financial Analysts Journal*, vol. 55, no. 6 (November/December):18–27.

Stattman, D. 1980. “Book Values and Stock Returns.” *The Chicago MBA: A Journal of Selected Papers*, vol. 4:25–45.

Thaler, Richard. 2009. “Markets Can Be Wrong and the Price Is Not Always Right.” *Financial Times* (4 August).

von Neumann, John, and Oskar Morgenstern. 1944. *Theory of Games and Economic Behavior*. Princeton, NJ: Princeton University Press.

PRACTICE PROBLEMS

The following information relates to Questions 1–6

Mimi Fong, CFA, a private wealth manager with an asset management firm, has been asked to make a presentation to her colleagues comparing traditional and behavioral finance. She decides to enliven her presentation with statements from colleagues and clients. These statements are intended to demonstrate some key aspects of and differences between traditional and behavioral finance.

Statement 1 (from a colleague): "When new information on a company becomes available, I adjust my expectations for that company's stock based on past experiences with similar information."

Statement 2 (from a client): "When considering investments, I have always liked using long option positions. I like their risk/return tradeoffs. My personal estimates of the probability of gains seem to be higher than that implied by the market prices. I am not sure how to explain that, but to me long options provide tremendous upside potential with little risk, given the low probability of limited losses."

Statement 3 (from a client): "I have always followed a budget and have been a disciplined saver for decades. Even in hard times when I had to reduce my usual discretionary spending, I always managed to save."

Statement 4 (from a colleague): "While I try to make decisions analytically, I do believe the markets can be driven by the emotions of others. So I have frequently used buy/sell signals when investing. Also, my 20 years of experience with managers who actively trade on such information makes me think they are worth the fees they charge."

Statement 5 (from a colleague): "Most of my clients need a well-informed advisor to analyze investment choices and to educate them on their opportunities. They prefer to be presented with three to six viable strategies to achieve their goals. They like to be able to match their goals with specific investment allocations or layers of their portfolio."

Statement 6 (from a client): "I follow a disciplined approach to investing. When a stock has appreciated by 15 percent, I sell it. Also, I sell a stock when its price has declined by 25 percent from my initial purchase price."

Statement 7 (from a client): "Overall, I have always been willing to take a small chance of losing up to 8 percent of the portfolio annually. I can accept any asset classes to meet my financial goals if this constraint is considered. In other words, an acceptable portfolio will satisfy the following condition: Expected return – 1.645 × Expected standard deviation ≥ –8%."

1 Which of the following statements is *most* consistent with expected utility theory?
  A Statement 1.
  B Statement 2.
  C Statement 3.

2 Which of the following statements *most likely* indicates a belief that technical anomalies exist in the capital markets?
  A Statement 2.
  B Statement 4.
  C Statement 6.

3 Statement 4 is *most* consistent with:
  A the adaptive markets hypothesis.
  B a behavioral approach to asset pricing.
  C Savage's subjective expected utility theory.

4 The clients of Statement 5 *most likely* exhibit:
  A loss-aversion.
  B bounded rationality.
  C mental accounting bias.

5 The client of Statement 6 is *most likely* behaving consistently with:
  A prospect theory.
  B expected utility theory.
  C behavioral portfolio theory.

6 The client of Statement 7 would *most likely* agree with which of the following statements?
  A I strive for a mean–variance efficient portfolio.
  B I construct my portfolio in layers to meet my goals.
  C I am loss-averse and have a value function that is steeper for losses than gains.

The following information relates to Questions 7–10

Professor Mehul Liu teaches several behavioral finance courses at a local university. In his current lecture, he discusses how behavioral finance differs from traditional finance.

Liu discusses how loss-averse investors assess risk and return. Liu then presents two investment choices to the students:

Exhibit 1		
Investment	**Expected Return**	**Expected Range of Returns**
A	6%	0% to 11%
B	12%	–10% to 20%

7 **Determine** the investment in Exhibit 1 that a loss-averse investor would *most likely* prefer. **Justify** your response.

Determine the investment in Exhibit 1 that a loss-averse investor would *most likely* prefer. (circle one)	Justify your response.
Investment A Investment B	

The topic of another lecture is prospect theory. Liu presents the students with the following two situations and asks them if they would accept or reject each one:

Situation 1 A 50% probability of winning $10,000 and a 50% probability of losing $4,000

Situation 2 A 50% probability of winning $10,000 and a 50% probability of losing $8,000

The students vote to accept Situation 1 but reject Situation 2. Liu then presents a third situation:

Situation 3 Choosing between losing $12,000 with 100% certainty, or accepting a gamble that offers a 50% probability of winning $6,000 and a 50% probability of losing $24,000

The students vote to accept the gamble in Situation 3.

8 **Explain** how the voting results in *each* of the three situations are consistent with prospect theory.

i. Accepting Situation 1

ii. Rejecting Situation 2

iii. Accepting the gamble in Situation 3

A student meets with Liu after one of his lectures. The student is participating in a mock investment competition that requires participants to create and manage a fictitious equity portfolio. Even though international equities are available as an investable asset class, the student elects to invest her entire portfolio in domestic equities.

Liu asks the student if she has ever considered including international equities in her competition portfolio given their diversification benefits and higher expected returns than domestic equities based on current consensus growth forecasts. The student responds that she has not considered international equities because she has not taken any courses in international investments that could provide her with expertise in this area. The student also indicates that she has the time and resources to research only domestic companies.

9 **Determine** whether bounded rationality has affected the student's investment decision-making process. **Justify** your response.

Liu presents the following hypothetical scenario during a lecture on behavioral portfolio theory (BPT).

Ann Lundstrom, a fictitious technology entrepreneur, is a BPT investor who is developing her portfolio. This portfolio will contain two layers: a layer of riskless investments and a layer of speculative investments. The riskless layer will earn 0.50%, and the probability distribution of the expected return on the speculative layer is shown in Exhibit 2.

Exhibit 2 Speculative Investment Layer Return/Probability

Expected Return	Probability
–25%	10%
12%	60%
50%	30%

Lundstrom plans to invest $1,000,000 and has an aspirational level of $1,050,000 with a probability of 75%. She can tolerate some potential loss in wealth but not more than $100,000 (minimum portfolio value of $900,000). Exhibit 3 presents two potential portfolio allocations for this scenario.

Exhibit 3 Portfolio Allocations

Layer	Allocation 1	Allocation 2
Riskless	59%	90%
Speculative	41%	10%

10 **Determine** which portfolio allocation in Exhibit 3 is *closest* to the BPT optimal portfolio for Lundstrom. **Justify** your response.

Determine which portfolio allocation in Exhibit 3 is *closest* to the BPT optimal portfolio for Lundstrom. (circle one).	
Allocation 1	Allocation 2

Justify your response.

SOLUTIONS

1 C is correct. Statement 3 is most consistent with expected utility theory. The client exhibits self-control and is able to defer consumption. This client is considering short-term and long-term goals and attempting to maximize the present value of utility. In Statement 1, beliefs are being updated using heuristics rather than Bayes' formula. Statement 2 is consistent with prospect theory; the client is overweighting the probability of a high financial impact outcome (gains on options) and underweighting the probability of a loss (the option premium cost).

2 B is correct. Statement 4 indicates the belief that buy/sell signals can be used to earn excess returns.

3 B is correct. Statement 4 indicates that markets can be influenced by the emotions of others (sentiment). This is consistent with a behavioral approach to asset pricing that includes sentiment such as the behavioral stochastic discount factor-based asset pricing model proposed by Shefrin.

4 C is correct. The clients discussed in Statement 5 exhibit mental accounting bias because they consider their portfolio by matching its layers to goals. The clients may not have time themselves to examine the investment universe and arrive at optimal solutions, but they rely on their adviser to do this for them. Thus, they do not exhibit bounded rationality.

5 C is correct. The client of Statement 6 is behaving consistently with behavioral portfolio theory. The client sells and holds a stock not because of the stock's potential, but rather from a fear of the stock declining in value and gains dissipating and an aversion to realizing losses. Loss-aversion in prospect theory is discussed from a different perspective.

6 A is correct. The client is expressing a portfolio goal that considers expected return and standard deviation. This is consistent with traditional finance and the client is likely to prefer a mean–variance efficient portfolio. There is nothing in the statement that indicates loss-aversion as opposed to risk-aversion or a preference for constructing a portfolio in layers.

7

Determine the investment in Exhibit 1 that a loss-averse investor would *most likely* prefer. (circle one)	**Justify your response.**
Investment A Investment B	A loss-averse investor will most likely prefer Investment A and accept a lower expected return to avoid the potential risk of loss presented by Investment B. The loss-averse investor is likely willing to accept a lower expected return to avoid any possibility of incurring a loss.

8 Prospect theory is an alternative to expected utility theory. This theory describes how individuals make choices in situations in which they must decide between alternatives that involve risk and how they evaluate potential losses and gains. Prospect theory considers how alternatives are perceived based on their framing, how gains and losses are evaluated, and how uncertain outcomes are weighted.

i. Accepting Situation 1

- Most people reject a gamble with even chances to win and lose unless the possible win is at least twice the size of the possible loss.

In this gamble, the possible win is 2.5 times the possible loss, so the student vote to accept Situation 1 is consistent with prospect theory. Accepting Situation 1 is consistent with prospect theory because experimental evidence shows that most people reject a gamble with even chances to win and lose, unless the possible win is at least twice the size of the possible loss.

ii. Rejecting Situation 2

- Most people reject a gamble with even chances to win and lose unless the possible win is at least twice the size of the possible loss.
- In Situation 2, the chances to win and lose are the same but the possible win is only 1.25 times the possible loss. Thus the student vote to reject Situation 2 is consistent with prospect theory.

Rejecting Situation 2 is consistent with prospect theory because experimental evidence shows that most people reject a gamble with even chances to win and lose, unless the possible win is at least twice the size of the possible loss. In Situation 2, the possible win is only 1.25 times the possible loss, so the student vote to reject the investment is consistent with prospect theory.

iii. Accepting the gamble in Situation 3

- People are risk-seeking when there is a low probability of gains or a high probability of losses.
- Deviations in decision making result in overweighting low-probability outcomes.

The gamble may appear more attractive than the sure loss, so the student vote to accept the gamble is consistent with prospect theory. Experimental evidence shows that risk-seeking preferences are held by a large majority of people when there is a low probability of gains or a high probability of losses. Therefore, the student vote to accept the gamble over the sure loss in Situation 3 is consistent with prospect theory.

9 Guideline answer:

- Bounded rationality describes the phenomenon whereby people gather some (but not all) available information.
- The student does not behave totally rationally because she is not gathering full information to identify international equity investment opportunities.
- Her decision meets the criterion specified of creating and managing a fictitious equity portfolio but is not necessarily optimal.
- Although higher returns may be possible in international equities, investing fully in domestic equities satisfices within the totality of the investor's decision-making environment.

The notion of bounded rationality recognizes that people are not fully rational when making decisions and do not necessarily optimize but rather satisfice when arriving at their decisions. People have informational, intellectual, and computational limitations. Bounded rationality describes the phenomenon whereby people gather some (but not all) available information, use heuristics to make the process of analyzing the information tractable, and stop when they have arrived at a satisfactory, but not necessarily optimal, decision.

The student does not behave totally rationally because she is not gathering full information to identify possible international equity investment opportunities and doesn't have the knowledge to do so. Her behavior is boundedly rational because her decision meets the criterion specified of creating and managing a fictitious equity portfolio but is not necessarily optimal. Although the decision is suboptimal, because higher returns may be possible in global markets, it satisfices within the totality of the student's decision-making environment. The student may have decided that she lacked the knowledge, time, and resources to research all alternatives. Given the student's apparently limited knowledge of international equities markets, and considering time constraints and the sole criterion of investing in equities, the decision to invest all of her portfolio in US equities may be reasonable.

10

Determine which portfolio allocation in Exhibit 3 is *closest* to the BPT optimal portfolio for Lundstrom. (circle one).	
Allocation 1	Allocation 2

Justify your response.

- Both portfolio allocations meet the safety objective of $900,000.
- Allocation 1 has a 90% chance of exceeding the aspirational level of $1,050,000, whereas Allocation 2 only has a 30% chance of exceeding it.

A BPT investor constructs a portfolio in layers to satisfy investor goals rather than be mean–variance efficient. The investor's expectations of returns and attitudes toward risk vary between the layers. In this case, Lundstrom has a safety objective of $900,000 and aspirational level of return of 5% ($50,000) with a 75% probability.

Given the expected returns for the riskless and speculative layers, Allocation 1 will result in the following amounts:

10% chance: (59% × $1,000,000) × 1.005 + (41% × $1,000,000) × (1 – 0.25) = $900,450

60% chance: (59% × $1,000,000) × 1.005 + (41% × $1,000,000) × (1.12) = $1,052,150

30% chance: (59% × $1,000,000) × 1.005 + (41% × $1,000,000) × (1.50) = $1,207,950.

Given the expected returns for the riskless and speculative layers, Allocation 2 will result in the following amounts:

10% chance: (90% × $1,000,000) × 1.005 + (10% × $1,000,000) × (1 – 0.25) = $979,500

60% chance: (90% × $1,000,000) × 1.005 + (10% × $1,000,000) × (1.12) = $1,016,500

30% chance: (90% × $1,000,000) × 1.005 + (10% × $1,000,000) × (1.50) = $1,054,500

Both portfolio allocations meet the safety objective of $900,000 (minimum value of $900,450 for Allocation 1 and $979,500 for Allocation 2).

Allocation 1 has a 90% chance of exceeding the aspirational level of $1,050,000, however, whereas Allocation 2 has only a 30% chance of exceeding it. As a result, only Allocation 1 meets both the safety objective and the 75% probability of reaching the aspirational level. Thus, Allocation 1 is closest to the BPT optimal portfolio for Lundstrom.