Behavioral Portfolio Theory

by

Hersh Shefrin and Meir Statman
Department of Finance
Leavey School of Business
Santa Clara University
Santa Clara, CA 95053

Phone (408) 554-4385

email: hshefrin@mailer.scu.edu
mstatman@mailer.scu.edu

November, 1997

We thank Peter Bernstein, Fischer Black, Werner De Bondt, Daniel Kahneman, Harry Markowitz, and Drazen Prelec for comments on a previous draft of this paper. This work was supported by the National Science Foundation, grant NSF SES - 8709237, and the Dean Witter Foundation.

Behavioral Portfolio Theory

Abstract

We develop a positive behavioral portfolio theory and explore its implications for portfolio construction and security design. Portfolios within the behavioral framework resemble layered pyramids. Layers are associated with distinct goals and covariances between layers are overlooked. We explore a simple two-layer portfolio. The downside protection layer is designed to prevent financial disaster. The upside potential layer is designed for a shot at becoming rich.

Behavioral portfolio theory has predictions that are distinct from those of mean-variance portfolio theory. In particular, behavioral portfolio theory is consistent with the reluctance to have short and margined positions, an inverse relation between the bond/stock ratio and portfolio riskiness, the existence of the home bias, the use of labels such as "growth" and "income," the preference for securities with floors on returns, and the purchase of lottery tickets.

Behavioral Portfolio Theory

We develop behavioral portfolio theory as a descriptive theory, an alternative to the descriptive version of Markowitz's mean-variance portfolio theory. Behavioral portfolio theory links two issues, the construction of portfolios and the design of securities.

Portfolios recommended by financial advisors, such as mutual fund companies, have a structure that is both common and very different from the structure of mean-variance portfolios in the capital asset pricing model (CAPM). For example, Canner Mankiw and Weil (1997) note that financial advisors recommend that some portfolios be constructed with higher ratios of stocks to bonds than other portfolios, advice that is in conflict with “two-fund separation.” Advice consistent with two-fund separation calls for a fixed ratio of stocks to bonds in the “risky” portfolio along with varying properties of the risk-free asset, reflecting varying attitudes towards risk. Canner, Mankiw, and Weil call it “the asset allocation puzzle.”

They argue that the puzzle is not likely to be resolved by appealing to a variety of standard explanations, such as absence of a riskless asset, constraints on short sales, dynamic portolio allocation, nontraded assets, and nominal debt. They conclude: “that the advice being offered does not match economic theory suggests that our understanding of investor objectives … is deficient.” The objective of this paper is to develop a behaviorally based theory that addresses this deficiency.

Mean-variance investors evaluate portfolios as a whole; they consider covariances between assets as they construct their portfolios. Mean-variance investors care only about the expected returns and variance of the overall portfolio, not its individual assets. Mean-variance investors have consistent attitudes towards risk, they are always averse to risk. Behavioral investors are different.

Behavioral investors build portfolios as pyramids of assets, layer by layer, where layers are associated with particular goals and particular attitudes towards risk. Contrary to the prescriptions of mean-variance theory, covariances among securities are often overlooked. Consider, for example, the portfolios of institutional pension funds.

Typically, pension funds begin the construction of portfolios with an asset allocation decision that defines the layers, or asset classes, of the portfolio pyramid; so much for stocks; so much for bonds. Next, pension funds fill each layer with suitable securities. Pension funds allocate stock monies among equity managers and bond monies among fixed income managers. The layer-by-layer process of the construction of the pyramid virtually guarantees that covariances between asset classes will be overlooked. Jorion (1994) provides the following example.

Institutional investors who invest globally often put securities in one layer of the pyramid and currencies in another. They separate the management of securities from the management of currencies, delegating the management of currencies to “overlay” managers. As Jorion notes, the overlay structure is inherently suboptimal because it ignores covariances between securities and currencies. He calculates the efficiency loss that results from overlooking covariances as the equivalent of 40 basis points.

Contrary to the prescriptions of mean-variance, typical investors overlook covariances. Also contrary to the prescriptions of mean-variance theory, typical investors display inconsistent attitudes toward risk. Sharpe (1987) notes that while most portfolio optimization programs assume constant attitudes towards risk, experience shows that attitudes are not constant.

The line that divides the layers of typical pension portfolios is the line that divides assets into those needed for full funding of pension obligations and those that go beyond full funding. Sharpe describes pension committees as very tolerant of risk when the plan is overfunded but intolerant of risk when the plan is underfunded. When the pension fund is overfunded, writes Sharpe, the committee might say, “Go for it; be aggressive; we have plenty of protection; the cushion is big.” But when the fund is underfunded, the committee might say, “Don’t take many chances; we are under water already and need to be conservative.”

The tendency to overlook covariances and display inconsistent attitudes toward risk is not limited to institutional investors. It afflicts individual investors as well. Friedman and Savage (1948) have noted the common tendency among individuals to buy both lottery tickets and insurance. Individual investors, like institutions construct their portfolios as pyramids of assets. They hold cash and bonds in the "downside protection" layer of the portfolio and the goal of this layer is to prevent poverty. They hold growth stocks in the "upside potential" layer of the portfolio, and the goal of this layer is to make them rich. Financial advisors often present pyramid portfolios to their investors. See, for example, the pyramid portfolio by Wall (1993) in Figure 1.

Markowitz developed the mean-variance theory as a prescriptive theory, not a descriptive one. Behavioral portfolio theory is descriptive. We note that typical investors overlook covariances, but we do not recommend that they do so. Indeed, we also note that some investors, institutional and individual alike, use procedures that aid in the consideration of covariances. For example, money managers often apply mean-variance optimization and consider Sharpe ratios in the allocation of securities within their funds. But, as Jorion notes, consideration of covariances within each fund is quite different from consideration of covariances in the portfolio as a whole. The former leads to suboptimal solutions.

1. Building Blocks for Behavioral Portfolios

The link between goals and choices in the presence of uncertainty is at the center of Lopes' (1987) two-factor theory of risky choice. The first factor focuses on the goals of security and potential. The goal of risk-averse people is security. The goal of risk-seeking people is potential. Lopes notes that while some people are primarily motivated by security and others are primarily motivated by potential, the two motivations exist in some strength in all people.

The second factor in Lopes' theory is aspiration level. Aspiration levels vary among people. Many people aspire to be rich, but they differ in the amount of money they define as being rich.

Aspiration levels are, in effect, reference points, and reference points are a key feature of prospect theory (Kahneman and Tversky, 1979, 1992). Prospect theory builds on Markowitz (1952a), which in turn builds on Friedman-Savage (1948). Figure 2, from Lopes (1987) depicts the shapes of the associated utility functions.

Markowitz's name is so closely associated with mean-variance theory (1952b) that it is easy to overlook the fact that Markowitz (1952a) not only recognized that investors display both risk averse and risk seeking behavior, but made an important contribution on the road from Friedman-Savage to prospect theory.[1] We use the full term "Markowitz's mean-variance theory" to distinguish it from other work by Markowitz.

We build behavioral portfolio theory on the foundation of prospect theory and the two-factor theory of Lopes. We contrast the theory with Markowitz's mean-variance theory.

Prospect theory begins with the observation that people who face complex problems frame them into simpler subproblems. Framing is called *editing* in prospect theory. Editing is followed by *evaluation*. In the evaluation stage, framed alternatives are compared to one another and choices are made. Choices are affected by frames. Subjects who choose optimally when problems are framed in a transparent form often choose suboptimally when problems are framed in an opaque form. (Tversky and Kahneman, 1986).

In mean-variance theory, Markowitz (1952b) attempted to help investors overcome their handicap by teaching them to frame portfolios in a transparent form. The

[1] Friedman and Savage described the shape of a utility function consistent with buying both lottery tickets and insurance. The utility function has both concave and convex regions, with an inflection point that is invariant to wealth. Subsequently, Markowitz (1952a) proposed that the inflection point of the Friedman-Savage utility function be placed at "customary wealth," which usually coincides with current wealth. In Markowitz's framework, the utility function shifts with the level of customary wealth. Because the inflection point in the Friedman-Savage utility function is invariant to wealth, not all Friedman-Savage investors buy both insurance and lottery tickets. Markowitz's (1952a) investors do.

first step in framing portfolios in a transparent form consists of the construction of all feasible portfolios. The second step consists of the selection of the optimal portfolio from all feasible portfolios. But when investors are presented with securities, they do not always frame them into portfolios first. Instead, investors often choose securities one by one, overlooking the covariance of each with the overall portfolio.

Editing is the first stage in prospect theory and evaluation is second. Prospect theory investors evaluate prospects by a utility function that differs from the standard expected utility function in three ways. First, the argument of the prospect theory utility is gains and losses relative to a reference point, while the argument in the standard utility function is final wealth. Second, the prospect theory utility function is S-shaped. The function is concave in the domain of gains, consistent with risk-aversion. It is convex in the domain of losses, consistent with risk-seeking. The prospect theory utility function is depicted in the bottom right corner of Figure 2. Third, the editing stage determines the way expected utility is calculated. Specifically, investors frame monies into a variety of distinct mental accounts, and attach utility to each mental account in isolation from other mental accounts.

2. The Structure of Behavioral Portfolios

We turn now to the construction of a model of behavioral portfolios that embody the structure of prospect theory and Lopes' two factor theory. Imagine a two date model. The first date is the current date and the second date is the future date. The date 1 market is complete and involves spot trading in a perishable date 1 commodity and securities whose payoffs are determined at date 2. The uncertainty of date 2 outcome is represented by a finite number of states s_1, s_2,..., s_n ordered from low to high such that s_1 represents deep recession and s_n represents explosive boom. The symbol s_0 designates the first date.

Every investor is assumed to hold an initial portfolio represented by an endowment vector ω. Here $\omega(s_i)$ denotes the investor's initial endowment of the s_i-

contingent commodity. Assume that states are ordered so that the payoff to the market portfolio strictly increases with the index i of the state.

Prices on the date 1 market are given by a price vector r. Define date 1 consumption as the numeraire, and r_i as the state i price. The price r_i is the date 1 price of of an s_i-contingent claim. The investor's wealth level at date 1 is the dot product W = $r \bullet \omega$.

The application of prospect theory to the formation of portfolios involves two stages, 1) editing; and 2) evaluation. In the editing stage, investors divide their wealth into current consumption and securities which are placed into two layers, a "downside protection" layer and an "upside potential" layer. For example, in Sharpe's description of pension fund portfolios, the line between the downside protection and upside potential layers is the full funding line. The downside protection layer contains assets needed for full funding of pension obligations. The upside potential layer contains assets beyond those necessary for full funding. This portfolio structure reflects the major elements described by Lopes (1987): security, potential, and aspirations. Typical investors divide the portfolio into more than two layers. However, we describe a more basic two layer stylized portfolio.

Portfolios are composed of securities. Every security Z has a payoff profile $[z_i]$ where z_i denotes the gross return to security Z on date 2, should state s_i occur. Imagine that an investor purchases λ units of Z for his downside protection layer. This account has a payoff profile $[c_{iD}]$, where $c_{iD} = \lambda z_i$. In accordance with prospect theory, this payoff profile is evaluated by means of the function

$$\sum_i p_i v_D(c_{iD}-\alpha_D) \tag{1}$$

where p_i is the probability (or decision weight) attached to state s_i, v_D is the prospect theory utility function associated with the downside protection layer, c_{iD} is the payoff to holding λ units of Z at date 2 should state s_i occur, and α_D is the downside protection reference point, from which gains or losses are measured. Similar remarks apply if the security is allocated to the upside potential layer, with analogous terms v_U, c_{iU}, and α_U.[2]

The most natural reference point for gains and losses is the purchase price of an asset (Shefrin and Statman, 1985). The gain or loss is the difference between the current price and the purchase price. But assets can have more than one reference point. Each portfolio layer in our model has a *second* reference point that reflects its particular goal. The downside protection layer is designed to ensure survival even if financial disaster strikes. Therefore, the second reference point for that layer is zero. In contrast, the upside potential layer is designed for a shot at getting rich. Therefore the second reference point for this layer is an aspiration level that, in the eyes of the investor, constitutes being rich.

The value function v_D associated with the downside protection layer has the standard S-shape depicted in the lower right panel in Figure 2. However, because the aspiration level in the upside potential layer is higher than the purchase price, the value function v_U for this layer has the shape proposed by Markowitz (1952a) that is depicted in the lower left panel of Figure 2. Notice that v_U has three segments: a concave segment above the aspiration level, a convex segment between the purchase price and the aspiration level, and a convex segment below the purchase price. The first and third segments are standard in prospect theory, portraying risk aversion in the domain of gains and risk seeking in the domain of losses. The middle segment features the intermediate case in which outcomes are gains relative to the purchase price, but losses relative to the aspiration level. We assume that the investor is risk seeking in the middle segment, but not as much as when outcomes are also losses relative to the purchase price.

Investors attempt to choose optimal portfolios, but cognitive limitations prevent them from taking covariances into account. An investor maximizes overall utility V by allocating his wealth W into C for current consumption, D for the downside protection

[2] Reference points reflect the objective of a security with respect to the goal for the layer. For evaluation purposes, they are expressed in per dollar of investment, and can be regarded as target rates of return.

layer, and U for the upside potential layer.[3] He compares the marginal utility obtained from adding an increment of wealth to each layer and allocates his wealth incrementally to the layer that provides the highest marginal utility. For example, pension funds, described by Sharpe, act as if increments of wealth provide higher marginal utility when added to the downside protection layer than to the upside potential layer until the full funding level is achieved. After that, increments of wealth provide higher utility when added to the upside potential layer.

The utility associated with current consumption, the downside protection layer and the upside potential layer are denoted, respectively, by V_C, V_D and V_U. The functional forms of both V_D and V_U are based upon (1) and described in further detail below. Overall utility for investor h is:

$$V = V_C + \gamma_D V_D + \gamma_U V_U \qquad (2)$$

where γ_D and γ_U reflect both time discounting and the relative importance attached to layers. The parameters γ_D and γ_U capture Lopes' notion that both poles, security and potential, reside in everybody although their relative importance varies from person to person. The relative importance of the poles determines the structure of the portfolio.

The weighting parameters γ_D and γ_U in equation (2) determine the allocation of wealth to current consumption and to future consumption, as well as the allocation to the downside protection layer and to the upside potential layer. An investor with the high γ_D/γ_U ratio considers the goal of downside protection more important relative to the goal of upside potential, than an investor with a low γ_D/γ_U ratio. He allocates more of his wealth to the downside protection layer.[4]

---

[3]By utility V we mean decision weighted utility expressed as a sum of terms of the form described in equation (1), with each term corresponding to a specific layer.

[4] The additive form in (2) suggests strong separability between the two layers. Although this is true for most aspects of behavioral construction, especially ignoring covariance, there are elements where the two may not be entirely separable. In the next section we discuss connections that can arise from margin and short positions. In addition, the attitude toward taking on risk in the upside potential layer may be a function of the extent to which downside protection goals are met. This is similar, but not identical, to the *house money effect* described by Thaler and Johnson (1990).

3. Securities in Behavioral Portfolios

How many securities do investors choose for each layer? Which securities do they choose? How much do they allocate to each security? To gain insight into the content of behavioral portfolios, consider a set of securities, such as stocks, bonds, mutual funds and derivatives. As before, a security is represented as a payoff vector Z = $[z_i]$, where z_i denotes the payoff to holding one unit of Z if state s_i occurs[5]. The date 1 price of Z is given by the dot product $r \bullet Z$.

Consider the upside potential layer and imagine that the aspiration level for $1 invested by an investor is $2. That is, the investor aspires to double his money between dates 1 and 2. Imagine further that the investor has allocated a specific dollar amount to the upside potential layer. Which security will he buy with the first dollar? Assume that the function V_U in (2) is additively separable across security payoffs. Formally, if the investor holds λ_j units of security Z_j in a layer, for each j, then the utility contribution to (2) from the entire layer is $\sum_j E(v_U(\lambda_j Z_j))$. Here $E(v_U(\lambda_j Z_j))$ is a decision weighted sum analogous to (1).[6] This assumption reflects the fact that the investor ignores covariances. The investor can be seen as if he is ranking all available securities by the expected v_U-value associated with an investment of one dollar in each security. The security chosen for the first dollar is the security with the highest expected v_U-value. For example, consider two securities as candidates for the upside potential layer. Each security pays a positive amount in exactly one event, and the payoff state for security 1 is different from the payoff state for security 2. Security 1 pays $4 if its up event U_1 occurs while security 2 pays $3 if its up event U_2 occurs. Both pay zero if the down event occurs. The expected v_U-value of a dollar invested in each of the two securities is:

$$EV(\text{Security 1}) = p_{D1}v_U(0 - 2) + p_{U1}v_U(4 - 2)$$

$$EV(\text{Security 2}) = p_{D2}v_U(0 - 2) + p_{U2}v_U(3 - 2)$$

---

[5] For the moment, assume that all payoffs are nonnegative (limited liability) and short selling and margin loans are prohibited.

[6] When the decision weighting vector p is a probability distribution, then $E(v_U(\lambda_j Z_j))$ is expected utility in that it is the expectation of v_u. For ease of exposition, we use expected utility terminology even when p is not, strictly speaking, a probability distribution.

where:

EV is the expected v_U-value,

p_{D1} and p_{D2} are the probabilities of the down events for securities 1 and 2, and

p_{U1} and p_{U2} are the probabilities of the up events for securities 1 and 2.

Security 1 ranks higher than Security 2 when p_{U1} is sufficiently high relative to p_{U2} and v_U is not too concave in the above aspiration level.

Imagine that the first dollar was indeed invested in Security 1. Will the second dollar be invested in the same security? The likelihood that the second dollar will be invested in a different security increases when the v_U-function is more concave in the domain of gains and steeper and less convex in the domain of losses. Of course, the likelihood of allocating successive dollars to different securities determines the number of securities held in any given layer when the allocation process is complete. Other factors that affect the number of securities chosen for any given layer and their weights in the portfolio are transaction costs, the amount of wealth allocated to the layer and beliefs about the return distributions.

Behavioral portfolio theory predicts that an increase in transaction costs that contain a fixed component will reduce the number of securities contained in each layer of the portfolio. This is for reasons that are well articulated in standard finance. An increase in the amount allocated to a layer will increase the number of securities contained in that layer. To understand why, consider two investors, A and B who have identical utility functions and who have identical perceptions of the set of securities they face. However, imagine that A has allocated more money to his upside potential layer than B. As A and B allocate successive dollars among securities, their allocations within the upside potential layer are identical up to the point where B's money is exhausted. The extra money invested by A will generally expand the number of securities in A's upside potential layer and increase the amount allocated to each security including the ones held by both A and B.

To understand the effect of beliefs about return distributions on the number of securities in a layer, consider an investor who divided the money allocated to a layer among several securities in some way. Now imagine that following the decision, but before its implementation, the investor receives positive inside information about one of the securities he selected. Imagine that the information is such that it moves the rank of this "inside" security all the way to the top and the security remains at the top even after many dollars are invested in it. The amount devoted to the inside security will increase and it will displace lower ranked securities. Thus, the portfolio is likely to become more heavily weighted toward inside securities. Note that the effect of inside information on the construction of a portfolio does not depend on whether the information, objectively assessed, is real or illusory. Investors who believe that they can identify good securities by useless tips behave no differently from investors who receive inside information from presidents of companies.

So far we have assumed that investors cannot sell short or buy on margin and that all securities have limited liability. This assumption serves to decouple the downside protection layer from the upside potential layer, since it implies that the lowest payoff in each layer cannot fall below zero. However, layers do not feature limited liability. An investor with a short position in the upside potential layer might lose more than the entire amount in that layer if the price of the short security increases. If so, he will have to pay the difference from the downside protection layer. Thus, the effective floor for the upside potential layer is the value of the assets in the downside protection layer.

When margin loans and short selling are prohibited, an increase in the amounts devoted to “inside” securities generally leads to a decrease in the total number of securities in a layer. But this is not so when margin loans and short selling are allowed. The increase in the amount devoted to inside securities can come entirely from margin loans and from selling short "bad" securities. However, the characteristics of the utility function and mental accounting serve to discourage both margin loans and short selling.

Compare buying a security for cash to buying a security on margin. A decline in the value of the security bought for cash moves an investor into the domain of losses in the mental account of the security. However, a decline in the value of a security bought on margin not only moves an investor further into the domain of losses in the mental account of this security, it also creates the possibility that the margin will be fully exhausted. In such a case, the investor would move into the domain of losses in the mental accounts of other securities, as he is forced to "invade" other mental account and sell other securities to raise cash. Overall utility suffers if selling these other securities results in the realization of losses.

Buying on margin is discouraged mainly because losses in the various invaded mental accounts are not integrated. The total utility loss that results from a decline in the price of the margined security can be very high since the loss hits each invaded mental account close to the origin, where the utility function is most steep. Note that while devices such "stop loss" orders are designed to prevent invasions into other mental accounts, such devices are not always effective.

The reluctance to sell short parallels the reluctance to buy on margin. Indeed the reluctance to sell short is greater than the reluctance to buy on margin. There is a finite limit on possible invasion into mental accounts that comes with buying on margin. This is because the price of a stock cannot fall below zero. However, there is no upper limit on the price of a stock and, therefore, there is no upper limit on the losses that can come with a short position.

In sum, behavioral portfolios are structured as separate layers of a pyramid. Their contents depend on five determining factors. First are investor goals. An increase in the weight attached to the upside potential goal will be accompanied by an increase in the proportion of wealth allocated to the upside potential layer. Second are the reference points of the layers of the portfolio. A higher reference point for the upside potential layer will be accompanied by the selection of securities that are more "speculative." Third is the shape of the utility function. Higher concavity in the domain of gains reflects earlier satiation with a given security, and early satiation leads to an increase in the number of securities in a layer. Fourth is the degree of inside information, real or imagined. Investors who believe that they have an informational advantage in some securities will take more extreme positions in them. Fifth is the degree of aversion to realization of losses. Investors who are aware of their aversion to the realization of losses hold more cash so as to avoid the need to satisfy liquidity needs by realization of losses. Moreover, portfolios of such investors contain securities held solely because selling them entails the realization of losses. These portfolios might seem well diversified, but the large number of securities they contain is designed for avoiding the realization of losses, not the benefit of diversification.

4. Security Design

When mean-variance investors evaluate a security they care only about its mean return, variance, and covariance with other securities. Behavioral investors are different. Behavioral investors care about the shape of the entire return distribution. They have preferences for particular shapes of returns. A security designer who caters to behavioral investors asks: Which layer is the security for? What shape provides the best fit for this layer?

Securities differ in the shapes of their payoff distributions. The optimal payoff distribution for a security designed for the downside protection layer differs from one designed for the upside potential layer. We derive that the optimal payoff distributions for securities designed for each layer and present that derivation in the appendix.

The optimal payoff distribution for the upside potential layer is portrayed in Figure 3. The payoff distribution is call-like with steps set at reference points. Begin at the far left. For the deepest recession states, the payoff is zero.[7] The payoff then jumps

[7] Notice that the payoff is zero, not a positive number, in the very worst states. While it is common to imagine that there are risk free securities, with positive payoffs in every state, this is not so. There are certainly states in which the payoff is zero. Examples involve catastrophic events such as the revolutions in

to the purchase price. Finally, the payoff jumps to the aspiration level, and rises in a smooth fashion beyond the aspiration level. The optimal payoff distribution for the downside protection layer is depicted in Figure 4. It too begins at zero, rises to the purchase price, and rises in a smooth fashion beyond the purchase price.

The preceding discussion of the optimal security design is built on the assumption that investors screen all available securities as they make selections for their upside potential and downside protection layers. However, in practice, the cognitive abilities of investors are more limited than that. Labels, such as “stock” or “bond” provide help in processing information as they frame complex information into simple boxes. Behavioral investors begin the process of security screening by eliminating from consideration securities whose labels indicate that they are not likely to be suitable for a given layer. For example, investors might eliminate securities that carry the “stock” label from consideration for the downside protection layer because they know that, in general, stocks lack the desired properties for downside protection securities.

Labels always simplify information. Unfortunately, labels also distort information. Consider two pairs of labels, “junk” and “high-yield” and “foreign” and “domestic.” Both pairs of labels affect the perceived payoffs of securities, but they affect perceptions in different ways. Some investors might consider bonds carrying the “high yield” label for the downside protection layer but they might exclude identical bonds carrying the “junk” label. The junk label is an unsavory one and it affects perceptions of payoffs as if there has been an actual decrease in payoffs. Security designers are aware of the link between labels and perceptions. Drexel-Burnham-Lambert and mutual fund

Russia during 1917 and in China during 1949. The new regimes defaulted on the debt obligations of previous regimes, and payoffs were zero.

companies fought long and hard to promote the high yield label in place of the unsavory junk label[8].

The distinction evoked by the "foreign" and "domestic" labels is not a distinction between an unsavory security and a savory one but a distinction between a unfamiliar security and a familiar one. The distinction between foreign and domestic underlies the "home bias," the tendency of U.S. investors to overweight U.S. stocks while Japanese investors overweight Japanese stocks (Kang and Stulz, 1994). The foreign label on a security affects perceptions of security payoffs as if there has been an actual increase in the variance of payoffs. Glassman and Riddick (1996) find that portfolio allocations by U.S. investors to foreign and domestic securities are consistent with a belief by investors that the standard deviation of foreign securities are higher by a factor of 1.5 to 3.5 than their historical values.[9] See also Baxter and Jermann (1997).

The distinction between foreign stocks and domestic ones is an illustration of the distinction between risk, where probabilities are known, and uncertainty, where probabilities are not known. Familiarity with a security brings the situation closer to risk than to uncertainty. Uncertainty averse investors prefer familiar gambles over unfamiliar ones, even when the gambles have identical risk. For example, Heath and Tversky (1991) found that people who identify themselves as familiar with sports, but not politics, prefer to bet on sports events rather than on political events. This preference exists even when subjects judge the odds in sports bets as identical to the odds in political bets.

[8] Perceptions are captured in prospect theory by decision weights. Decision weights differ from probabilities. Typically, the decision weighting function is nonlinear. The weighting function reflects the tendency to overweight low probabilities and underweight high probabilities. Moreover, decision weights need not sum to unity (reflecting what Kahneman and Tversky call subcertainty). In many decision problems people do not know the true probabilities: they face uncertainty rather than risk. When this is the case, they still act as if they use weighting functions. However, the extent of their uncertainty is reflected in the sum of the probability weights. The greater the uncertainty, the smaller the sum. The greater the familiarity, the greater the sum. See Tversky and Kahneman (1992).

[9] Labels act as if they change the mean and variance of security payoffs. The analogy is useful in conveying the intuition of their effect, but the analogy should not be interpreted literally. For example, a reduction in the mean can lead to a short position in a security. We do not imply such a position.

Huberman (1997) describes uncertainty aversion in a domestic investment context. He finds that U.S. investors concentrate their holdings in the baby bells, the Bell Operating Companies, of their own region. Of course, investors who shun the baby bells of other regions, like investors who shun foreign stocks, give up some of the benefits of diversification.

Financial intermediaries, such as brokerage firms and insurance companies, design securities. Both the label and the payoff pattern of the Dean Witter Principal Guaranteed Strategy tell investors that it is designed for the downside protection layer. Dean Witter described the Principal Guaranteed Strategy as follows:

> "Mr. Stewart" has $50,000 to invest and a time horizon of 10 years. He is looking to add stocks to his portfolio for growth, but is concerned with protecting his principal. Based on his objectives and risk tolerance, "Mr. Stewart's" Dean Witter Account Executive structures the Principal Guaranteed Portfolio below, which includes "buy" rated stocks from Dean Witter's Recommended List.

To "protect" Mr. Stewart's $50,000 investment, the Principal Guaranteed Strategy calls for the purchase, for $24,951, of a zero coupon bond with a face value of $50,000 maturing in 10 years. This leaves $25,049 for stocks and brokerage commissions.

The Principal Guaranteed Strategy has a payoff pattern that is attractive for the downside protection layer. First, the bond portion ensures that, if held the full ten years, the payoff will not fall below the $50,000 initial purchase price. Second, the stock portion offers a chance for a gain. Recall that protection from a loss relative to the purchase price and a chance for a gain relative to the purchase price are the two defining characteristics of the optimal payoff pattern for the downside protection layer.

The Principal Guaranteed Strategy is a very simple strategy, but the fact that Dean Witter finds it profitable to sell it to investors indicates that cognitive limitations prevent many investors from designing the strategy on their own, and thereby saving brokerage commissions.

Framing is an important aspect of financial design. (See Shefrin and Statman 1993). The Principal Guaranteed Strategy has a frame that combines bonds and stocks into a single security. To understand the effect of this frame, imagine that the zero-coupon bond was placed in the downside protection account and the stocks were placed in the upside potential account. Then a decline in the price of the stocks would register as a loss in the upside potential account. However, by combining the payoffs of the stocks with that of the zero-coupon bond, the outcome is framed such that no loss registers.

The design and marketing of the Principal Guaranteed Strategy is consistent with behavioral portfolio theory, but it is puzzling within Ross' (1989) framework of security design and marketing. Investors in Ross' framework have no need for financial intermediaries to show them how to combine a zero-coupon bond with a collection of stocks. Moreover, Ross' investors know which securities they need for a move from their suboptimal portfolios to their optimal portfolios. What they do not know is the identity of investors willing to take the other side of the trade. This is where financial intermediaries enter in Ross' framework. Specifically, financial intermediaries know many investors and that knowledge enables them to match buyers and sellers. In contrast to investors in Ross' framework, investors in our framework have an opaque picture of their own portfolios. Financial intermediaries, such as Dean Witter, help investors by making that picture transparent.

Now imagine an investor with a higher aspiration level than the purchase price. This higher aspiration level marks the layer as an upside potential layer. Imagine that the investor aspires to have at least 45 percent more than the purchase price. Life USA, an insurance firm, offers *Annu-a-Dex*. Annu-a-Dex provides a guaranteed 45 percent return over a seven year horizon. An additional amount might be paid based on the performance of the stock market. Life USA describes the payoff:

> … your principal will increase by 45% in the next seven years, market correction or not. And if the market does better than that, you get half the action. All without downside risk. You get the ride without the risk …

Annu-a-Dex is appealing to an investor whose aspiration level is 45 percent above current wealth. As in Figure 3, the payoff distribution has a floor at the aspiration level, and it offers some measure of upward potential beyond the aspiration level. However, unlike the pattern depicted in Figure 3, Annu-a-Dex has no states in which the investor receives only his initial investment.

The Annu-a-Dex, like the Principal Guaranteed Strategy, is easy to construct. It combines a zero coupon bond with *half* a call option on the market. The face value of the zero coupon bond is 45 percent above the initial investment. The exercise price of the call is 45 percent above the current level of the market.[10]

The Principal Guaranteed Strategy and Annu-a-Dex share a common structure: zero coupon bonds combined with stocks or call options. The payoff structure of these securities has key features of the optimal security design depicted in Figure 3. However, the correspondence is not exact. In particular, Figure 3 depicts the optimal upside potential security as having a payoff which is zero up to a particular state, and then jumps above the aspiration level in subsequent states. In contrast, a call option has payoffs of zero up to a particular state but no jump. Instead, a call option has gradually increasing payoffs as it moves beyond the last state with a payoff of zero. The difference between the optimal security and a call option is due, at least in part, to the fact that the optimal security is designed to match the preferences of a particular investor, while call options can be viewed as a compromise among the preferences of many investors. To understand the point, consider a series of investors arranged in order of the "jump" points of their optimal security. Now, imagine that there are costs associated with the construction of securities that effectively limit the designer to one security for all investors: see Allen and Gale (1987). A cost minimizing compromise security will feature gradually increasing payoffs resembling the payoff pattern of a call option, rather than the individual security pattern depicted in Figure 3.

[10] For instance, suppose that the current value of the S&P 500 is 100. Consider a call option on the S&P 500, expiring in seven years, with an exercise price of 145. If getting half the action means receiving half the increase in the S&P 500 with a minimum of 45 percent, then this can be accomplished by owning one half of that call option. The remainder of the payoff is of course associated with the zero coupon bond.

5. Security Design by Corporations

Financial intermediaries design securities from basic components, such as stocks, issued by corporations and bonds, issued by corporations and governments. The division of labor between corporations, governments and financial intermediaries is similar in nature to the division of labor between manufactures and value-added resellers. Value-added resellers combine components from several manufacturers in a product that fits the needs of consumers. Each group, manufacturers and resellers, capitalizes on its relative advantage. Capitalizing on a relative advantage requires that each entity be aware of the needs of the others in the chain.

Why do corporations design mainly stocks and bonds? What determines capital structure? And what determines dividend policy? Standard answers to these questions focus on the role of stocks and bonds in resolving agency conflicts and the tradeoff between the tax advantages of bonds and the bankruptcy costs that they might impose. These roles are certainly important, but a complete rationale for stocks and bonds must include the roles of stocks and bonds in behavioral portfolios.

Corporations choose capital structure and dividend policy to maximize the combined market value of all the securities of the corporation. As managers divide the cash flows of the corporation between bonds and stocks and between dividends and capital gains, they consider the way investors fit these components into the pyramid structure of their portfolios. A good fit increases value while a poor fit decreases it. In particular, we argue that some corporations would issue bonds and dividend paying stocks even in a Miller and Modigliani world where there are no agency conflicts, information asymmetries, taxes, bankruptcy costs, or transaction costs. To understand our point, consider first the Miller and Modigliani argument about the irrelevance of capital structure in a MM world. Imagine that corporations issue stocks but not bonds. Investors who want higher leverage borrow (that is, issue bonds) and use the proceeds to buy more stocks, creating "homemade" leverage. Investors who want bonds buy them from investors who sell them as they create leverage. We argue that homemade leverage is unappealing to behavioral investors.

Recall the discussion about margin in a previous section, and note that homemade leverage involves buying stocks on margin. Homemade leverage creates the possibility that, in the event of a decline in the price of the stock, mental accounts beyond the one devoted to the particular stock would be invaded to fund margin calls. This is undesirable for behavioral investors. The danger of margin calls disappears when corporations, rather than investors, issue bonds. Note that bonds and unmargined stocks have limited liability. Therefore they reside within accounts that have zero floors. This zero floor makes corporate created leverage superior to homemade leverage for behavioral investors.

Next consider the optimal capital structure of a company. Recall Myers' (1984) argument that agency conflicts lead corporations to issue debt on assets-in-place, but not on growth opportunities. We argue that behavioral considerations reinforce the tendency to issue debt only on assets-in-place. This is because bonds which are not backed by assets-in-place might not offer sufficient downside protection. In other words, securities that are not backed by assets-in-place rank low on the menu of securities for inclusion in the downside protection layer.

The language of bond rating agencies is consistent with our argument. Moody's and Standard and Poor's, the major rating agencies for bonds, divide bonds into "investment grade" and "speculative grade" bonds. Until the advent of junk bonds it was rare for speculative grade bonds to be issued as such. Rather, speculative grade bonds were bonds issued originally as investment grade bonds by companies whose financial position has deteriorated subsequent to the date of issue. Bonds are designated as investment grade when the probability of payment as promised is very high. Evidence of high probability of payment includes the assets in-place backing of bonds. In terms of the portfolio pyramid, investment grade bonds are candidates for the downside protection layer. Speculative rated bonds are candidates for the upside potential layer.

Consider next the Miller and Modigliani argument about the irrelevance of dividend policy. Imagine that no corporation pays dividends. In an MM world, investors create "homemade" dividends by selling shares of stocks. However, homemade dividends are unattractive to behavioral investors because homemade dividends expose investors to the possibility that they would have to realize losses by selling shares at prices lower than the purchase price. As noted earlier, behavioral investors are reluctant to realize losses. Dividend paying stocks that make it easy to avoid the realization of losses offer an advantage.

There are implicit framing issues associated with dividends. Investors place dividends in the downside protection layer while capital gains reside in the upside potential layer.[11] If a corporation is to maximize the value of the securities it issues it must first ascertain that the dividends are sufficiently sticky (secure) to fit within the downside protection layer. The corporation must also note that the payment of dividends degrades capital gains and with them the upside potential of the stock, making it less appealing for the upside potential layer. A value maximizing corporation chooses a dividend policy that strikes the best balance between the advantages and disadvantages of dividends.

[11]The reference point for dividends is zero. For evaluation purposes, all cash flows whose reference point is zero are placed in the downside protection account.

Corporations with very volatile cash flows will choose not to pay dividends for two reasons. First, the volatility of cash flows makes dividends too uncertain for a good fit in the downside protection layer. Second, the payment of dividends degrades capital gains and lessens the attractiveness of the stock for the upside potential layer. So corporations with very volatile cash flows are likely to pay no dividends. The converse argument applies to corporations with very stable cash flows.

The pyramid structure of investors' portfolios also offers insights into the popularity of corporations as an organizational structure. Note that shares in a corporation, unlike shares in a partnership, offer a zero floor in the form of limited liability. This is an attractive feature for both the upside potential and downside protection layers.

6. Contrasting the Predictions of the Behavioral and the Mean-variance Theories

Behavioral portfolio theory predicts that investors construct portfolios and hold securities that are different from those predicted by mean-variance theory. In this section we highlight some pronounced differences.

First is short selling and margin buying. As Green and Hollifield (1992) emphasize, typical mean-variance portfolios feature large short and margined positions. But, as we show, short and margin positions are uncommon in behavioral portfolios.

Green and Hollifield go on to note that practitioners are suspicious of portfolios with large short and margined positions. To allay their suspicions, practitioners often implement mean-variance optimization with an extensive set of constraints that eliminate short and margined positions. We argue that such investors, in effect, get behavioral portfolios under the guise of mean-variance portfolios.

Many have tried to eliminate short and margined positions while staying within the mean-variance framework. For example, Black and Litterman (1991) argue that large short and margined positions are the result of errors in the estimation of expected security returns. They note that mean-variance optimization is highly sensitive to small changes in estimates of expected returns and suggest that expected returns be estimated in a way that minimizes estimation errors. However, Green and Hollifield find that estimation errors do not explain short and margined positions. Instead, they find that short and margined positions are inherent in mean-variance portfolios.

Green and Hollifield argue that the reluctance of investors to hold portfolios with short and margined positions is due to a lack of an understanding of the structure of mean-variance portfolios. In contrast, we argue that the reluctance of investors to hold such portfolios is due to the preferences of behavioral investors, preferences that are different from mean-variance optimization.

In the CAPM the market portfolio is mean-variance efficient. Canner, Mankiw, and Weil (CMW 1997) discuss an asset allocation puzzle within the CAPM. They note that financial advisors recommend that investors who want more aggressive portfolios increase the ratio of stocks to bonds. This advice is puzzling within the CAPM since it violates two-fund separation. Two-fund separation states that all efficient portfolios share a common ratio of stocks to bonds. Attitudes toward risk in the CAPM are reflected only in the proportion allocated to the risk-free asset.

Behavioral investors, unlike CAPM investors, do not follow two-fund separation. The parameters that are relevant to asset allocation in the behavioral framework are the relative importance of the upside potential goal relative to the downside protection goal (γ_u/γ_d), and the reference points of the upside and downside goals (α_d and α_u). The curvature of the value functions v_d and v_u, which capture risk tolerance, is of secondary importance.

Imagine two behavioral investors who are identical except that one is more aggressive than the other. The more aggressive investor attaches greater importance to the upside potential goal, and has a higher reference point for that goal. That investor allocates a higher proportion of his wealth to the upside potential layer, and a lower proportion to the downside protection layer. Which securities will the investors choose for the two layers?

Bonds and cash (the risk-free asset) are well suited to the downside protection layer but not to the upside potential layer. Indeed, some behavioral investors use a heuristic that excludes securities with the *bond* label from consideration for the upside potential layer and excludes securities with the *stock* label from the downside protection layer. Aggressive investors who use that heuristic use stocks to increase the allocation to the upside potential layer, thereby increasing the proportion of stocks to bonds in the overall portfolio.[12] We suggest that this heuristic underlies the asset allocation puzzle described by CMW.

An additional issue where mean-variance portfolio theory and behavioral portfolio theory contrast is the "home bias." The home bias refers to the finding that American investors hold more U.S. stocks and fewer foreign stocks than the amounts predicted by mean-variance optimization. The home bias is an especially prominent puzzle within the mean-variance framework because it cannot be dismissed as a mere

[12] The behavioral framework is similar in structure of a consumer choice model. Securities are evaluated like commodities. Think of cash, bonds, and stocks as normal goods. A reduction in the expenditure in the downside protection layer leads to fewer purchases of both cash and bonds. If bonds are unsuitable for the upside potential layer, as they will be for all but the least aggressive investors, then the shift in expenditure from downside protection to upside potential will lead to a reduction in bond holdings.

result of errors in estimates of mean-variance parameters. The puzzle remains even when estimates of the mean-variance parameters are modified within a wide range.

The home bias is consistent with behavioral portfolio theory. It is one manifestation of the role of labels, a role that does not exist in mean-variance portfolio theory. Consider a foreign stock and a domestic stock with an identical distribution of payoffs. Since foreign stocks seem less familiar than domestic stocks, the foreign label acts on perceptions of payoffs as if there has been an actual increase in the variance of payoffs. That perception leads to a low allocation to foreign stocks. A direct implication is a behavioral portfolio theory prediction that the home bias would decline as investors became more familiar with foreign stocks. There is no such prediction in mean-variance portfolio theory.

Labels affect perceptions of the payoffs of securities, but that is not their only role in behavioral portfolio theory. Labels also play a role in the construction of portfolios. Some labels designate goals, directing the attention of investors to particular layers of the portfolio pyramid. This is reflected, for example in the portfolio advice of mutual fund companies (Fisher and Statman, 1997). In particular, mutual fund companies construct portfolios as pyramids of mutual funds where labels convey the goal of each layer, such as “growth” or “income.”

A third contrast between mean-variance portfolio theory and behavioral portfolio theory pertains to the shape of the payoffs of optimal securities. In particular, behavioral portfolio theory predicts that payoff distributions of securities will feature “floors,” such as the floor created by a call option or the limited liability of stocks. Again, there is no such prediction in mean-variance portfolio theory.

Last is the issue of risk. Each mean-variance investor has a uniform risk-averse attitude toward risk, an attitude that applies to the portfolio as a whole. However, each behavioral investor has a range of attitudes towards risk, attitudes that vary across the layers of the portfolio. So, for example, behavioral investors might insist that their money market funds include no corporate bonds, even as they buy IPOs. The contrast between mean-variance portfolio theory and behavioral portfolio theory is especially sharp on the issue of securities with artificial risk, such as lotteries.

Lotteries contain no fundamental risk, meaning risk that is related to economic events. Instead, they have risk that is manufactured artificially. Behavioral buy lottery tickets for their upside potential layers when their aspiration levels are very high relative to the amount they allocate to upside potential layers. Investors with $1 cannot have a shot at a $5 million aspiration level other than through lottery tickets. Investors who allocate more money to the upside potential account and investors who have lower aspiration levels might satisfy their aspiration levels by buying call options rather than lottery tickets. Of course, mean-variance investors never buy lottery tickets.

7. Conclusion

We develop a positive behavioral portfolio theory and explore its implications for portfolio construction in security design. Portfolios within the behavioral framework resemble layered pyramids. Layers are associated with distinct goals, and covariance between layers are overlooked. We explore a simple two-layer portfolio model. The downside protection layer is designed to prevent financial disaster. The upside potential layer is designed for a shot at becoming rich.

Behavioral portfolio theory has predictions that are distinct from those of mean-variance portfolio theory. In particular, behavioral portfolio theory is consistent with the reluctance to have short and margined positions, the existence of the home bias, the use of labels on securities such as “growth” and “income,” the preference for securities with floors on returns, and the purchase of lottery tickets.

Appendix

Figures 3 and 4 portray the structure of the payoffs associated with securities that are optimally designed for the two layers of a behavioral investor's portfolio. The discussion below explains how the shapes in these figures arise from our model.

To characterize an optimal payoff distribution for the upside potential layer, consider the indifference map associated with v_U. Figure 5 illustrates four different indifference curves in a two equiprobable state example. Begin with point A which is on the highest indifference curve. At point A, consumption exceeds the aspiration point in both states. Notice that since the investor is in the concave portion of his v_U-function for both states, his indifference curve will have the typical convex shape. As we move northwest along this curve, the investor substitutes s_2-consumption for s_1-consumption. When the level of s_1-consumption hits the aspiration level, point B, the investor moves into the middle (convex) region of his v_U-function for s_1-consumption. Because the slope of the function is higher on the left side of the aspiration level than the right, a further substitution requires a jump in the marginal amount of compensating s_2-consumption. However, the convexity of v_U in this region implies that the amount of marginal compensation subsequently declines with further substitution. This is reflected in the shape of the indifference curve..

The lower indifference curves are similar, but feature fewer cases. For example, at point C along the third highest indifference curve, consumption cannot lie above the aspiration level in both states. As a result, the concave region associated with point A along the highest indifference curve does not exist here. One can think of arriving at point C by moving point A closer to C. As this occurs, points B and B' come closer together and eventually meet.

The middle region in the next indifference curve involves consumption below the aspiration level in both states, but where consumption is above the purchase price. The indifference curve has its shape because the investor is in the convex region of his v_U-function for both states. Moving northwest to point D leads to consumption in state s_1 that is below the purchase price. For the lowest indifference curve depicted, consumption is below the purchase price in both states.

The shape of the optimal payoff pattern for the upside potential account emerges from a maximizing procedure based on the indifference map and budget constraint. Suppose that the investor allocates amount W_U to the upside potential account. He can construct the payoff profile for security in this account by purchasing state claims at state prices r_1 through r_n. Figure 5 depicts various possible budget constraints at different regions of the indifference map. Subject to his budget constraint, what pattern would an investor choose? In keeping with the convention that states are equiprobable and ordered from deep recession to explosive boom, s_1-claims will be more expensive than s_2-claims. As a result the budget lines in Figure 5 are steeper than the negative 45 degree line.

Suppose that W_U were high enough to enable the investor to reach point A_0, which is risk free, meaning, it lies along the 45 degree line. Point A_0 is not optimal for the investor. Rather the investor would do better to sell some expensive s_1-claims and purchase additional s_2-claims. If s_1-claims are just a little more expensive than s_2-claims, then the optimal point may lie close to A_0. Specifically the optimal point would lie in the convex region of the indifference map. However, if s_1-claims are considerably more expensive, then the investor may end up at a point like B. Notably, s_1-consumption would be at the aspiration level in this case.

Kinks in the indifference curves tend to be trap points, in that they support the optimal choice for small variations in relative prices. Point D is an example of this phenomenon. For this type of indifference curve, the optimal point either lies at a point like D or along the boundary.

Figure 5 contains the essential elements that drive the major features of the optimal payoff distribution. Although Figure 5 only depicts two states, it depicts the structure of the projections for the multi-state case. Typically, the projection will lead to a demand point close to A_0 for the lowest priced states. As we move to higher priced states, we would encounter lower projections involving the lower indifference curves in Figure 5.

The reasoning associated with establishing the payoff shape in Figure 4 is the same.

References

Allen, F. and D. Gale, (1987), "Optimal Security Design", *Review of Financial Studies.* pp. 229-263.

Baxter, Marianne and Urban J. Jermann, (1997), "The International Diversification Puzzle is Worse Than You Think", *The American Economic Review.* pp. 170-180.

Bawa, V., (1978), "Safety First, Stochastic Dominance, and Optimal Portfolio Choice", *Journal of Financial and Quantitative Analysis*, vol 13, no. 2, pp. 255-271.

Black, F. and R. Litterman, (1991). "Asset Allocation: Combining Investor Views with Market Equilibrium", *Journal of Fixed Income*, Sept, pp. 7-18

Canner, N., N. G. Mankiw, and D. Weil, (1997). "An Asset Allocation Puzzle", *American Economic Review*, Vol 87, No. 1, pp.181-191.

Fisher, K. and M. Statman, (1997). "Investment Advice from Mutual Fund Companies", *Journal of Portfolio Management*. Fall issue, forthcoming.

Friedman, M. and L.J. Savage, (1948). "The Utility Analysis of Choices Involving Risk." *Journal of Political Economy* 56: pp. 279-304.

Glassman, D. and L. Riddick, (1996). "What is Home Asset Bias and How Should it be Measured?", University of Washington working paper.

Green, R. and B. Hollifield, (1992). "When Will Mean-Variance Efficient Portfolios be Well Diversified", *Journal of Finance*, Vol 47, No. 5, pp. 1785-1810.

Heath, F. and A. Tversky, (1991). "Preference and Belief: Ambiguity and Competence in Choice Under Uncertainty", *Journal of Risk and Uncertainty* 4, 4-28.

Huberman, G., (1997). "Familiarity Breeds Investment", Columbia University working paper.

Kahneman, D. and A. Tversky, (1979). "Prospect Theory: An Analysis of Decision Making Under Risk", *Econometrica*, pp. 263-291

Kahneman, D. and A. Tversky, (1992). "Advances in Prospect Theory: Cumulative Representation of Uncertainty", *Journal of Risk and Uncertainty*, 5, pp. 297-323

Kang, Jun-Koo and René M. Stulz, (1994). "Why is there a home bias? An Analysis of foreign portfolio equity ownership in Japan." University of Rhode Island and Ohio State University working paper.

Lopes, L., (1987). "Between Hope and Fear: The Psychology of Risk." *Advances in Expermintal Social Psychology*, Advances in Expermintal Social Psychology, Vol. 20, pp. 255-295.

Markowitz, Harry M., (1952a), "The utility of wealth." *Journal of Political Economy* 60: 151-158.

Markowitz, Harry M., (1952b), "Portfolio Selection." *Journal of Finance* 6, 77-91.

Myers, Stewart C., (1984), "The capital structure puzzle." *Journal of Finance* 39: 575-592.

Ross, S. (1989). "Institutional Markets, Financial Marketing, and Financial Innovation", *Journal of Finance*, XLIV, pp. 541-556.

Sharpe, William F., (1987). "The Risk Factor: Identifying and Adapting to the Risk Capacity of the Client." in *Asset allocation for Institutional Portfolios*, edited by Michael D. Joehnk, Illinios: Dow Jones Irwin.

Shefrin, Hersh and Meir Statman, (1985). "The disposition to sell winners too early and ride losers too long: theory and evidence." *Journal of Finance* 40 (July): 777-790.

Shefrin, Hersh and Meir Statman, (1993). "Behavioral Aspects of the Design and Marketing of Financial Products", *Financial Management*, Vol. 22, No. 2, pp. 123-134.

Thaler, R. and E. Johnson, (1990). "Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice". *Management Science* 36,6, pp. 643-660.

Tversky, A. and D. Kahneman, (1986). "Rational Choice and the Framing of Decisions", *Journal of Business*, pp. 251-278

Wall, G., (1993). *The Way to Save*, Henry Holt, New York, NY

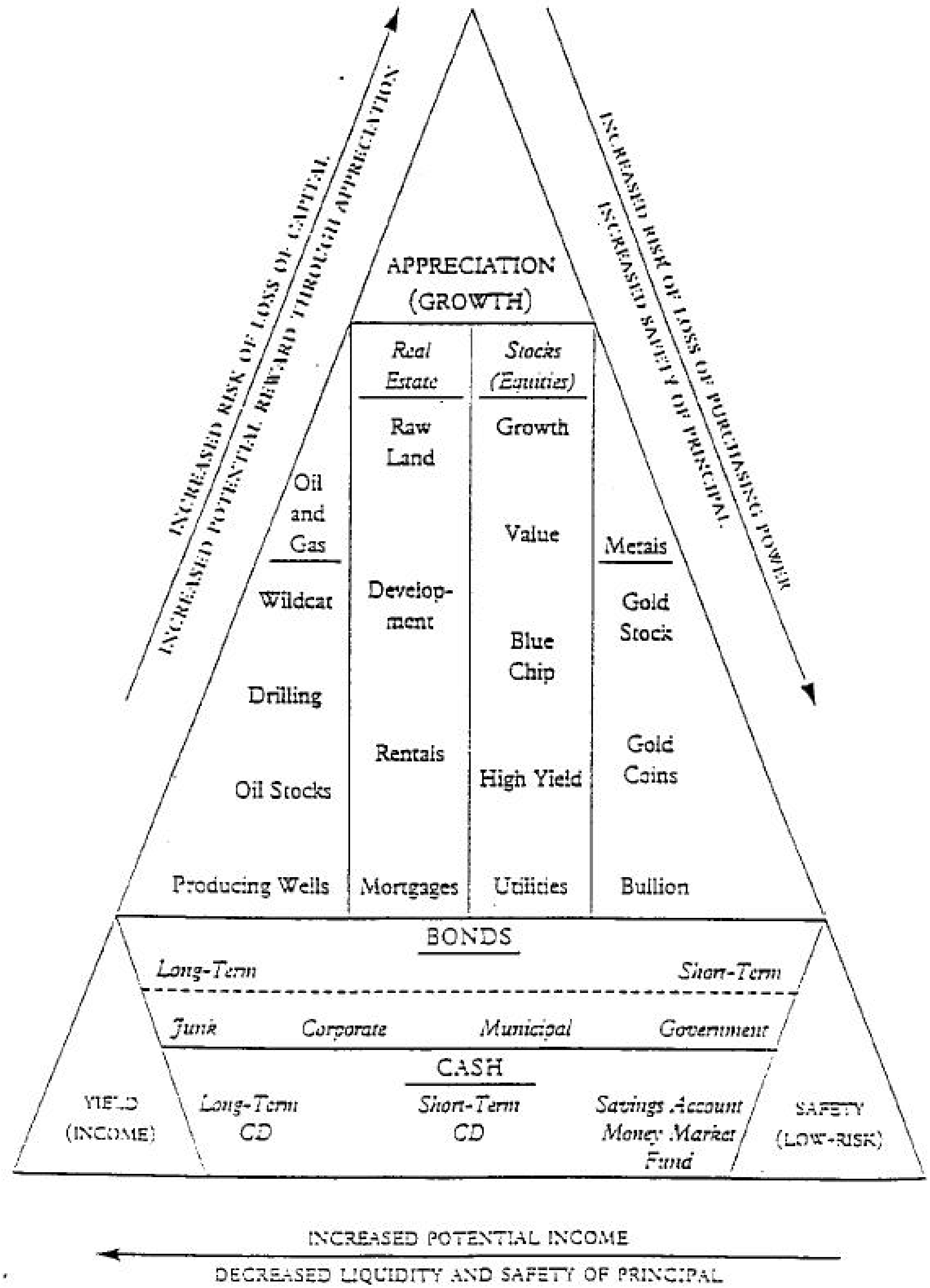

Figure 1: The Portfolio Pyramid

Source: (Wall, 1993)

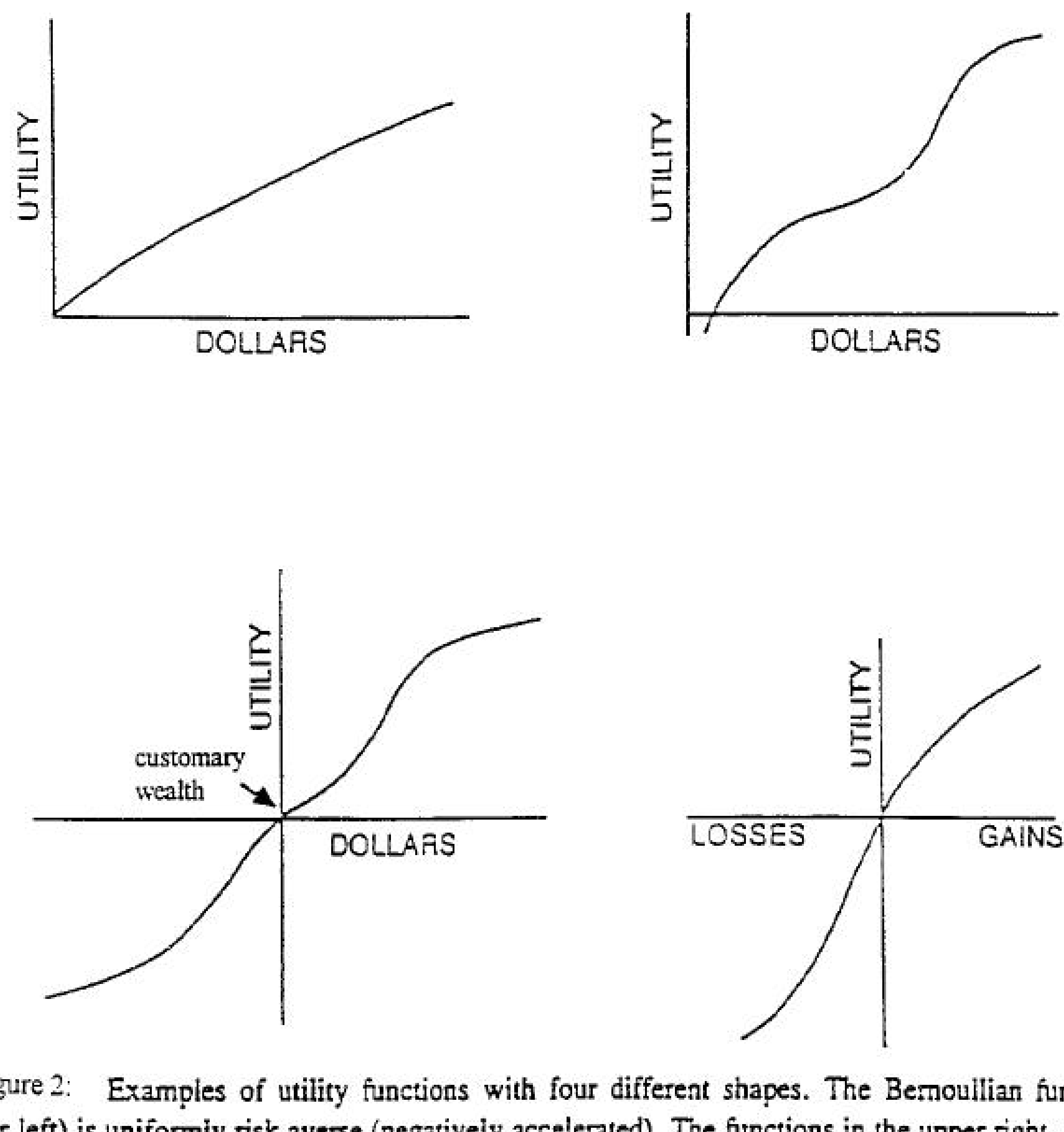

Figure 2: Examples of utility functions with four different shapes. The Bernoullian function (upper left) is uniformly risk averse (negatively accelerated). The functions in the upper right, lower left, and lower right (suggested by Friedman & Savage, 1948; Markowitz, 1952; and Kahneman & Tversky, 1979, respectively) have regions of risk aversion (negative acceleration) and risk seeking (positive acceleration). The upper two functions range from zero assets to large positive assets. The lower two functions range about a customary wealth level (e.g., the status quo).

Source: (Lopes, 1987)

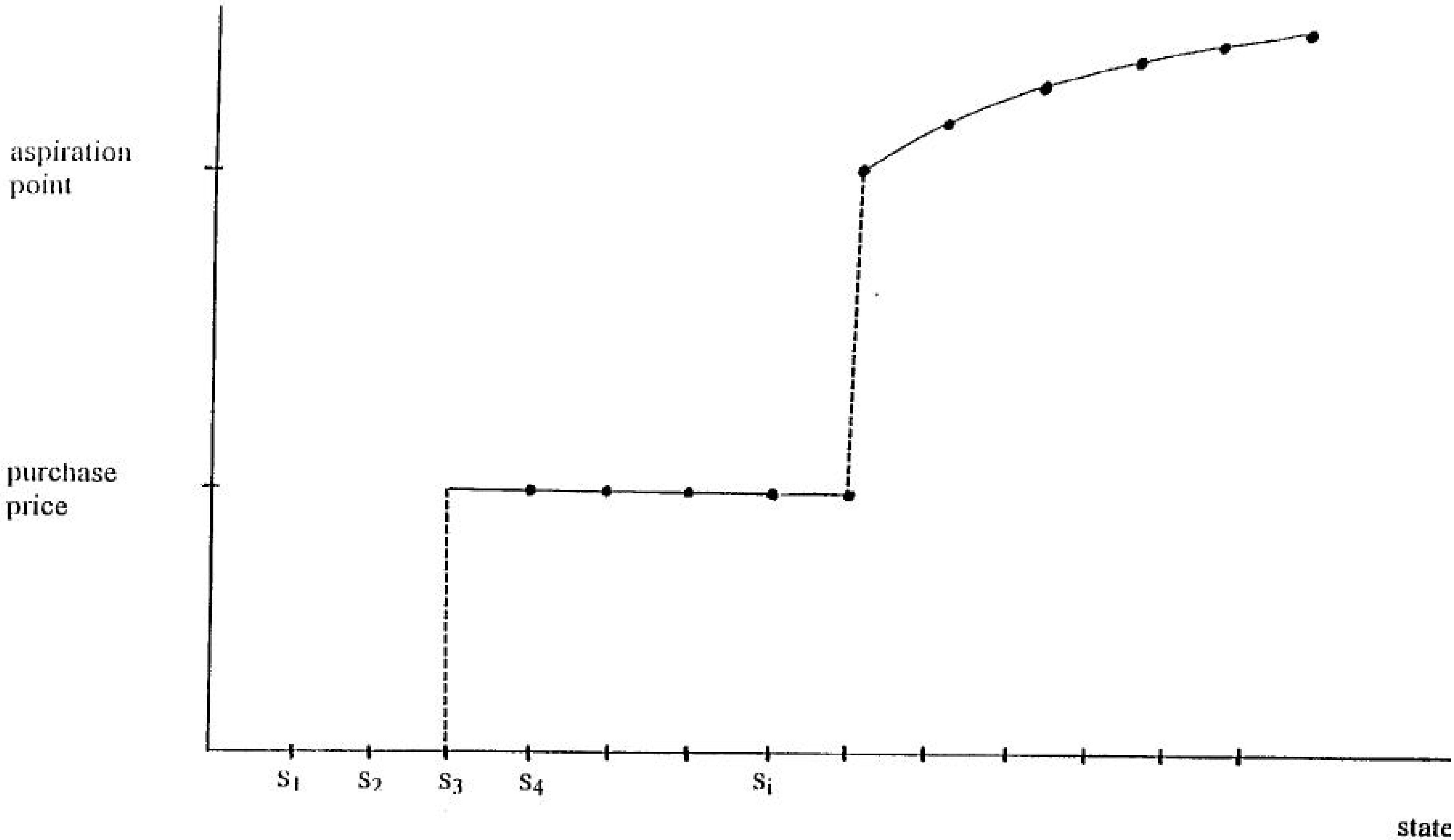

Figure 3: The shape of an optimal security for the upside potential layer.

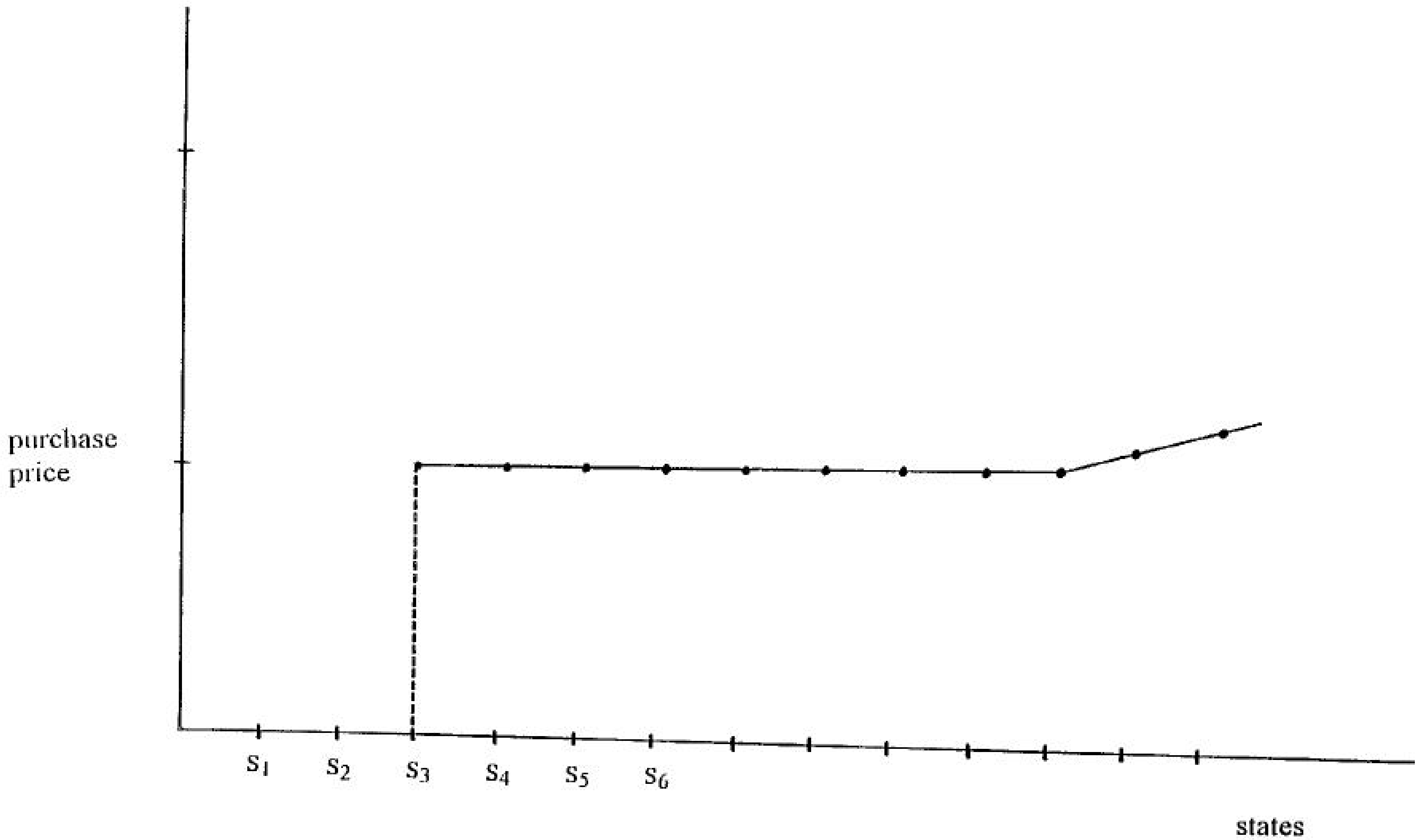

Figure 4: The shape of an optimal security for the downside protection layer.

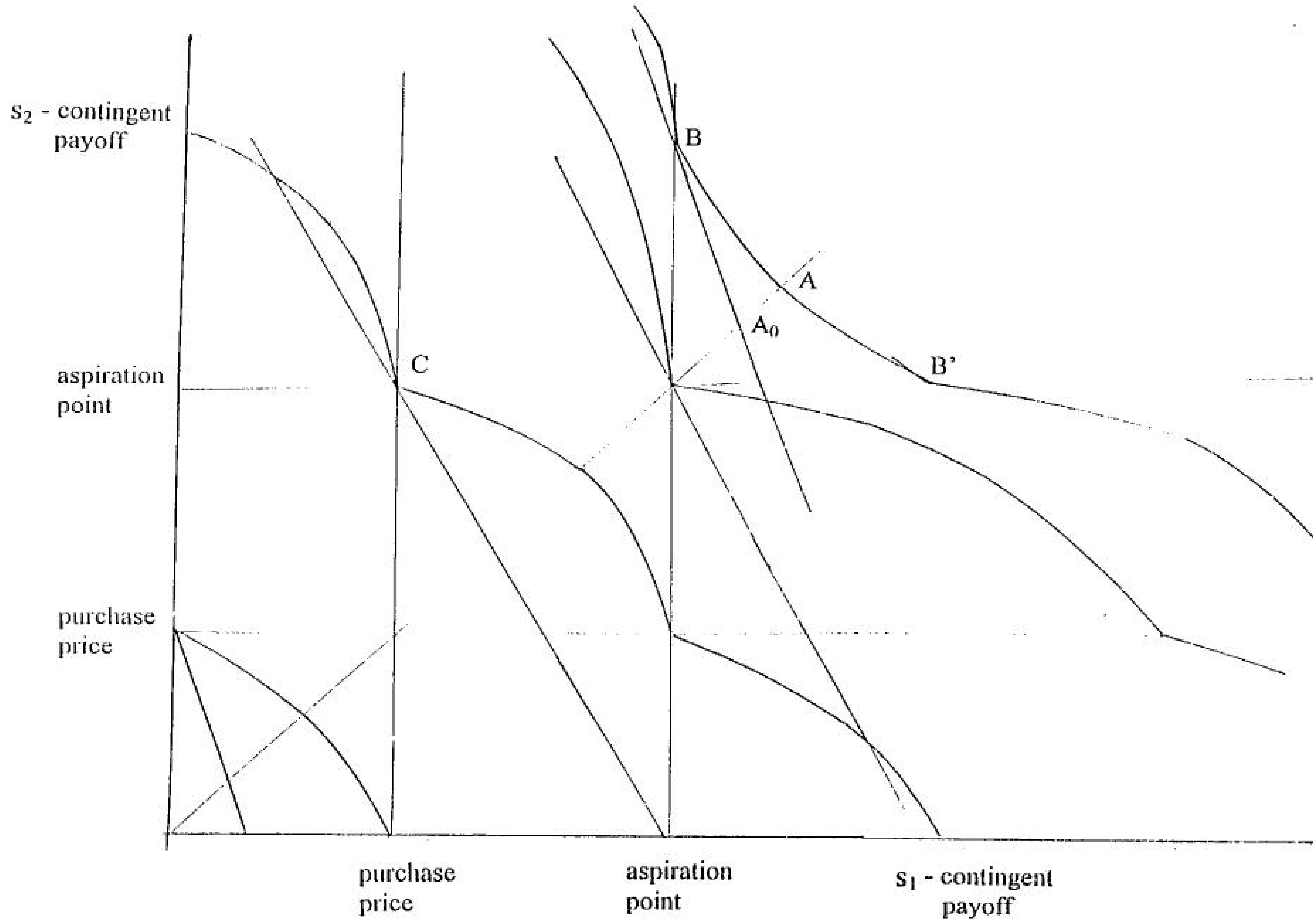

Figure 5: Indifference map projections for a utility function V_U for the upside potential layer.