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The Psychology of Risk: A Brief Primer

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Risk is commonly defined in negative terms--the probability of suffering loss, or factors and actions involving uncertain dangers or hazards. In contrast, the definition used in the social sciences relies on simply the degree of uncertainty--how much variance exists among the possible outcomes associated with a particular choice or action. Counter to intuition, an investment that will lose $5 for certain would therefore be classified as less risky than one that has an equal chance of yielding either a gain of $10 or a gain of $15. Uncertainty and value are treated as separable entities because expanding the notion of risk to include gains as well as losses adds considerable conceptual power. For example, depending on how a pair of options is described, a choice can appear as if between two losses or between two gains. Consider the following:

> ***Problem 1:*** *Imagine that you are faced with a life or death choice. The U.S. has safely quarantined all 600 people infected with an unusual virus, but is now certain that they will all die without some treatment. Resources are severely limited and the choice must be made between two scientific programs.*
>
> *Program A: If adopted, 200 people will be saved for certain.*
>
> *Program B: If adopted, there is a 1/3 probability that 600 people will be saved and a 2/3 probability that no people will be saved.*

People choose A over B by a ratio of three to one, showing a preference for the certain outcome. Now consider the same scenario with a different set of choices.

> *Program C: If adopted, 400 people will die for certain.*
>
> *Program D: If adopted, there is a 1/3 probability that no people will die and a 2/3 probability that 600 people will die.*

People choose D over C by a ratio of four to one, showing a preference for risk. However, note that the end results of A and C are exactly the same--200 people alive, 400 dead--as are those of B and D. According to classical theories of rationality, one cannot both prefer A to B and D to C. This paper will discuss why most people do.

Economic theories based on "perfect" rationality are undoubtedly powerful. If one wanted to describe or predict human behavior in the simplest possible manner, one would certainly want to begin by assuming (1) that people are motivated by their own self interests, and (2) that they can be extremely calculating when valuable opportunities arise, learning quickly from the success of others. Research on the psychology of risk does not begin by assuming that all human behavior is irrational, random, or thoughtless. Rather this research has centered on how people may be biased by

various social influences, by the way that they perceive the choices available, or by the cognitive rules of thumb that they use to simplify difficult decisions.

I. SOCIAL INFLUENCES ON JUDGMENTS OF RISK AND CONTROL

A. ILLUSION OF CONTROL.

In principle, the distinction between skill and luck would seem clear. Skill situations are characterized by a causal link between behaviors and outcomes. Success in skill tasks is controllable, whereas success in a chance activity is not. Yet the distinction is often not recognized. In a series of essays and studies, Ellen Langer showed how people often treat a chance event as if it involved skill and was therefore under their own control. Studies conducted in Las Vegas casinos have found that a dealer who experiences a run of bad luck risks losing his or her job. Dice players often concentrate carefully on the outcomes they desire, throwing their dice harder when they need higher numbers and tenderly when low numbers are required. Langer argued: "by encouraging or allowing participants in a chance event to engage in behaviors that they would engage in were they participating in a skill event, one increases the likelihood of inducing a skill orientation; that is, one induces an illusion of control. By introducing choice, familiarity with [the situation], active involvement, or competition into a chance situation where people cannot influence the outcome, they will show behavior more appropriate to a skill event."

Several lotteries conducted by Langer are telling as to power of the illusion of control. In the first study, Langer assessed the effects of choice, using randomly determined subjects who worked at two business offices in which drawings and sports pools were common. The experimental procedure was straightforward. Potential customers were approached and asked if they would like to buy a lottery ticket. The assistant explained that about fifty tickets in total were being sold, each costing $1. They were told the date of the drawing that would determine who won the entire pool. It being football season, the lottery tickets were two matched sets of standard football cards, each card with a picture of a famous player, his name and his team. Both sets were arranged first by team and then by the player's name. After agreeing to play, the first customer was given one of the sets and asked to select one of the cards. The customer named the card so that the assistant could find the matching card from the other set, drop it into a sealed carton, and make a note of the customer's name and card. The next customer was treated in the same way, except that after agreeing to play, they were handed a card that matched the choice of the preceding subject. Repeating this process, people were alternately placed in

the choice and the no choice condition. The important test came on the morning the lottery was to be held. The assistant approached each of the customers individually and explained: "Someone in the other office wanted to get into the lottery, but since I'm not selling tickets any more, he asked me if I'd find out how much you'd sell your ticket for. It makes no difference to me, but how much should I tell him?"

Choice dramatically increased the value of the ticket. Customers in the choice condition required an average of $8.67 before they would sell their tickets, in contrast to an average of only $1.96 in the no choice condition. The customers were oblivious to the effect, and not one of the subjects was willing to admit that either choosing or not choosing their card would have changed their selling price. However, many states have spent considerable funds so that people playing the lottery would be able to pick their own numbers.

In a second study, Langer demonstrated powerful effects of familiarity on the illusion of control. Again there were two groups of customers. In this study both groups were allowed to choose their own tickets. However, one group chose from cards identified by numbers, whereas the other group chose from cards identified by undecipherable hieroglyphics. Customers holding cards with the unfamiliar symbols agreed to sell back their tickets for substantially less than did those holding cards with familiar numbers.

This work would appear to have several implications for the psychology of investment, in which uncontrollable factors significantly affect one's final outcome. For example, research has shown that people overestimate their own control (i.e., underestimate risk) when given the opportunity to purchase a familiar option. Because people are generally highly familiar with their own company, they may be prone to under-appreciate the full degree of risk that occurs if they concentrate their security holding in the company's stock, as nearly half of all individual investors do. Both their salary and their savings then depend upon the health of a single company. This research may also help explain why stock trading volume tends to plunge following insider scandals, as it did during World War I, the early 1930s, and in the latter half of the 1980s. Langer showed that people bet less against a dapper, well spoken player than against a player looking disheveled and boorish (in her words, a "snook") even though in both cases the outcomes of the gamble were determined by tossing a coin. Realizing that one may be facing more sophisticated opponents is likely to reduce the illusion of control, thus decreasing the ease with which people will accept risk, even if the disadvantage is more illusory than real.

B. THE GROUP POLARIZATION EFFECT.

Among the most famous studies in social psychology are those that concern the effects of groups on decisions

concerning risk. This research began in the early 1960s using problems previously employed to assess individual differences in risk taking. Each "choice dilemma" described a situation in which an individual is presented with an option between a moderately attractive certain alternative, and a risky one that potentially has greater promise. For example:

> ***Problem 2:*** *Bob is playing chess in a tournament against a much stronger player. If he follows his present strategy he is certain to achieve a draw. Suddenly, Bob realizes that there is an alternate strategy that, if it succeeds, will quickly win the game, but will lead to sure defeat if not.*
>
> *Imagine that you are advising Bob. Listed below are several probabilities of the alternate strategy working. Please check the lowest probability that you would consider acceptable to make it worthwhile for Bob to choose the alternate strategy.*
>
> *[] 1 in 10 that the alternate strategy will succeed*
> *[] 2 in 10 that the alternate strategy will succeed*
> .....
> .....
> *[] 9 in 10 that the alternate strategy will succeed*
> *[] Bob should not choose the alternate strategy, no matter what the probabilities.*

People read the dilemmas and made their initial choices. Some subjects then met in groups, discussed the problems among themselves, and again made private choices. With the original set of problems, after discussion a clear majority of subjects later privately chose more risky options. Subjects given no chance to discuss did not systematically change their private views.

The effect of group discussion was first called the "risky shift," but continued work made it clear that this was an incorrect name. Some choice dilemmas consistently produce caution shifts. Such effects commonly occur when the risky option involves the possibility of ruining one's life, severely harming others, or dying. When people are initially conservative, finding the risky option acceptable only if its odds of success are very high, then after discussion they become even more conservative, becoming even less willing to accept any probability that the risky option will fail. The phenomenon has been more aptly named the "group polarization" effect because the shift can be either toward risk or toward caution, generally reflecting the initial biases of the individual discussants. Group discussion has been described by one European researcher as acting like a developer on exposed film: "it brings out the picture, but the outcome is predetermined."

Group polarization is not due to greater powers of leadership in those who advocate the extremes, or due to pressures to conform. Rather, the polarization effect is caused by social comparison and the number of arguments pro or con presented during discussion. First, before hearing the positions of others, people generally believe that *they* have answered in a more desirable fashion than most others would. Since not everyone can be better than average, group discussion generally provides people with surprising information as to what constitutes a socially ideal level of risk or

caution, causing an impetus to polarize in the favored direction. Second, the initial individual leanings toward risk or caution generally reflect the pool of arguments that will arise during discussion. Given that with most problems not everyone will have thought of all of these arguments, the difference between the number of arguments in favor or against risk is likely to widen during discussion, favoring the initially preferred pole. People are strongly swayed by new arguments in favor of a particular position. As one would expect, little movement is caused by discussion of highly familiar issues.

Two findings regarding group polarization may be particularly relevant to financial investments. First, research has shown that the direction of the shift due to discussion depends on the magnitude of the investment. After discussion, people become more risky with small stakes, but more conservative when the stakes are large. Second, the shift toward risk due to discussion has been found to increase as the difference between the expected return of the risky alternative and the certain outcome expands. Combining these two findings, one would expect that the acceptability of a small position in a high-growth, high-risk instrument is likely to rise after an investor is given time to "talk it over."

C. THE EFFECTS OF MOOD

The accepted psychiatric description of mania includes not only elevated mood, self-esteem and energy, but also "excessive involvement in pleasurable activities that have a high potential for painful consequences, [such as] buying sprees,... and foolish business investments." These symptoms aptly describe those shown across much of England during the South Sea Bubble of the 1700s and the U.S. during the 1920s. (Clinical wisdom is that a manic must never be given a credit card.) Similarly, economic depressions share the common clinical symptoms of indecisiveness, apathy, and loss of energy. Because many factors act so as to affect people's moods at the aggregate level, the clinical literature on mania and depression can help predict aggregate changes in investment preferences.

People strive to nurture positive moods. Consequently, elevated mood causes steeper demand functions for increasingly positive returns and for greater probabilities of return. Surprisingly, research has also shown that elevated moods are also characterized by a greater propensity to buy insurance against large losses. Positive moods are something people are willing to pay to protect. However, positive moods reduce the extent to which people accurately assess their own exposure to risk. Positive mood states lead people to examine fewer of the variables related to a particular decision, to pick these variables more quickly, and to process these few pieces of information more thoroughly. The three effects lead to overconfidence in their own decisions, because contradictory information is less likely to be uncovered and any

that does arise is more likely to be assimilated. Positive moods induce the illusion of control, causing people to have great difficulty recognizing when the connection between their own actions and any rewards they receive is missing. Manics credit themselves for all good things that happen. In contrast, depressives do not suffer from this illusion, and are readily able to distinguish between circumstances in which their actions are effective and those in which they are not. Negative mood states lead to an exhaustive examination of the variables, and to very long decision times.

At the aggregate level, positive moods would be expected to draw people toward high risk investments. By examining fewer of the potentially important sources of information available, investors are more likely to fail to realize the complexity of the information that must be mastered to successfully employ a given asset. In contrast, negative mood states at the aggregate levels increase the likelihood that investors become unable to make decision, becoming paralyzed while attempting to process all of the complex information available. General dysphoria is also likely to increase investors' willingness to accept low rates of return.

D. INTRINSIC MOTIVATION

What is the underlying motivation for actions that occur even when there are no immediately compelling external or physiological forces? What causes intrinsic motivation to persist or diminish? There are two common characteristics of freely chosen activities. First, by engaging in the behavior, the individual must gain some opportunity to evaluate his or her performance. Second, the behavior must be freely chosen, and not forced by some extrinsic threat or promised reward. Surveillance, deadlines, and rigidly held standards and requirements all significantly reduce the extent to which people will engage in an activity if left to themselves. These simple facts can explain some seemingly paradoxical behavior. For example, blood donation in England actually increased when hospitals stopped paying for blood. Payment reduced the extent to which people could provide themselves with positive feedback, defining their gift as having been a moral act untainted by extrinsic control. Similarly, in the 1960s, families covered by private pension plans voluntarily saved greater amounts of money than families that were not. (Controls were included for age, income level, geographical area, and the like.) The former did not need to save to enjoy a comfortable retirement, and could enjoy their increasing their savings as a freely chosen positive behavior.

Drawing upon this work, several factors would seem likely to increase investors' intrinsic motivation to change their investments. First, the initial decision to invest may be facilitated if people understand that their financial position does not require them to make these investments, but rather that it is a freedom that their financial situation provides.

Second, investors may become more motivated to trade to the extent that they believe that doing so is likely to provide them with meaningful performance feedback, information which allows them to assess and improve their own skills. To receive such feedback, investors need to believe that they personally have actively made informed choices, because then they will be able to attribute their performance to themselves and not to others or to luck. Several theorists have argued that investors use full service brokers so that they can have someone else to blame if the investment goes bad. In fact, investment advise may be sought so that people feel informed enough to be able to blame themselves.

II. DECISION THEORY: UTILITY AND PROBABILITY

A. AXIOMATIC MODERN UTILITY THEORY

Decision theories seek to describe how people should choose among sets of potential outcomes. These theories were first constructed when French nobles in the 18th Century called on their court mathematicians for help in playing cards and dice. We begin with *expected value* theory, which failed although it often seems intuitively compelling. The expected value of a given choice is calculated by multiplying the probability of each potential outcome by its monetary equivalent, and then summing across all of possible outcomes. In many cases, people do not use expected values in making their choices, nor do they think that they should. The expected value of insurance is negative, yet purchasing it is not always irrational. Expected values are also often ignored when given choices between positive outcomes. Consider the following problem:

> ***Problem 3:*** *The gamble is determined by tosses of a fair coin. On the first flip, a tail ends the game and you receive nothing, but a head gives $2 and the opportunity to flip again. Every time you flip another head, your cash prize for that round is double that of the previous one. The gamble ends the first time the coin comes up tails. Which would your prefer: (A) to play the gamble, or (B) $1,000,000?*

The expected value of the gamble, called the St. Petersburg paradox, is infinite: 1/2 x $2 + 1/4 x $4 + 1/8 x $8 + ..., ad infinitum. People are rarely willing to forgo even $100 to play.

Bernoulli argued that people could rationally reject the St. Petersburg gamble because there is no reason that monetary value (i.e., $x) and psychological utility (i.e., U($x)) need be perfectly related. (Utility is the economists' term for units of satisfaction or happiness.) In fact, because for most people the per dollar increase in utility appears to decline as dollar values grow larger, utility theory predicts that people are generally risk averse. Suppose one has a choice between (A) a certain $10 million and (B) an even chance of $20 million or nothing. To calculate which option to choose,

one must multiply the utilities of each possible outcomes by the probability of that outcome, and then choose the alternative that yields the highest sum. Consequently, the choice in this example depends on which is larger, 1.0 x U($10M) or 0.5 x U($0) + U($20M). Most people seem to feel that getting $10 million would make them about as happy as they can get. Setting no money to zero utility and $10 million to ten units of utility, $20 million might rate only a twelve. If so, then the choice should be Option A (i.e., 10 > 6). This framework can also explain why everyone could be rational and yet not make the same choices, for it allows different individuals to have different utilities for money.

To give utility theory a firm foundation, several theorists have attempted to derive the theory from a basic set of assumptions or axioms. These commonly include the following: **Cancellation:** states of the world that will occur regardless of one's choice should not affect one's preferences. If one prefers A to B, then one also prefers A+Z to B+Z. **Transitivity:** it is possible to assign each option a value that does not depend on the other available options. If one prefers A to B and B to C, then one also prefers A to C. This assumption is necessary so that options can be ordered. **Dominance:** if one choice is better along at least one dimension, and as good on all of the remaining dimensions, then it will be most preferred. **Invariance:** different descriptions of the same choice problem should all yield the same choice.

Although theories of rationality can be derived from these axioms, none of them describe how people actually make choices. For every axiom there is a case in which people's choices systematically violate the axiom. The first case discovered is listed below.

Problem 4: *The Allais Paradox*

Part I: Choose A or B	*Part II: Choose C or D*
Gamble A: 100% chance of $1M	*Gamble C: 11% chance of $1M* *89% chance of nothing*
Gamble B: 89% chance of $1M *10% chance of $5M* *1% chance of nothing*	*Gamble D: 10% chance of $5M* *90% chance of nothing*

Most people prefer A over B, wishing to avoid the small chance of getting nothing. People also prefer D over C, showing a willingness to forgo a slightly higher probability for a much greater potential reward. This pattern of choices violates the cancellation axiom because subtracting a 89% chance of $1M from A and from B turns them into C and D, respectively. Consequently, the only rational choices are both A and C or both B and D. Even utility theorists admit that they have trouble convincing themselves to follow either theoretically rational course of action.

B. PROSPECT THEORY

The most widely accepted descriptive theory of choice is Kahneman and Tversky's Prospect Theory, which first appeared in Econometrica in 1979. Many of the problems presented here are variations of those invented by Kahneman and Tversky. There are many components to the theory, and only the most important aspects will be described here.

According to the theory, there are three important properties of the psychological value assessment process. First, individuals view monetary outcomes not in terms of absolute wealth, but in terms of changes from some reference level, which is often the status quo. Second, there are not only diminishing positive psychological returns for positive consequences, but also diminishing negative psychological returns for negative consequences. The difference between losing $1 as opposed to $5 is not perceived as severe as the difference between losing $501 as opposed to $505. Finally, the resulting psychological value function is steeper for losses than for gains. Finding $10 is less of a positive change than losing $10 is a negative change. (A graph of a typical value function appears at the end of this paper.)

The shape of the value function has several important implications regarding people's choices, all of which have since been substantiated by a considerable body of research. First, because the value function for losses is convex, people are typically risk seeking in the domain of losses, the opposite of their behavior in the domain of gains. For example, because losing $200 is generally not twice as bad as losing $100, most people prefer an even chance of losing $200 or nothing over a certain loss of $100. Second, because the curve for losses is steeper than the curve for gains, few people will accept an equal chance of winning or losing the same amount when the stakes are high. Third, the largest psychological change per monetary unit occurs when crossing the threshold between losses and gains. The psychological effects of all other $1 monetary changes pale next to the one that occurs between losing $1 and breaking even. Finally, because people often allow their reference points to be shifted by the manner in which the particular problem is described, their choices are often inconsistent from an objective standpoint. In Problem 1, people prefer the sure option when the problem is framed as a choice between two gains (i.e., lives saved), but prefer the risky option when the problem is framed as between two loses (i.e., lives lost).

According to the theory, there are four important characteristics regarding how people weight a given probability when making their decisions. First, people underweight moderate and high probabilities. This contributes to general risk aversion for gains and risk seeking for losses. Second, there is a strong psychological change from high probabilities to certainty. Consider the following facetious example. Suppose you are forced to play Russian roulette, but are offered a chance to pay to remove one bullet from the gun. Would you pay more if there were two bullets in the gun or only one?

Although both purchases increase the probability of living by the same percentage, most people report that they would pay much more for the solo bullet, making survival a certainty. Third, people tend to treat small probabilities as if they were equivalent. People tend to prefer an .8 chance of winning $5K to a .4 of winning $9K, yet they prefer a .0004 chance of winning $9K to a 0.0008 chance of winning $5K. Not all 2:1 odds are created equal. Finally, there is a tendency to overweigh small probabilities. Consequently, people are generally risk seeking in the domain of losses, yet willing to insure themselves against unlikely disasters. This aspect of the probability weight function underlies the inconsistency shown in the Allais paradox. Improbable gains and losses both loom large. (A graph of a typical probability weight function appears at the end of the paper.)

C. FRAMING EFFECTS

Prospect theory divides the decision making process in two parts: a phase during which the available prospects are "framed" (i.e., put into a particular perspective) and edited, and then a phase of evaluation and choice, which was described in the previous section. The first part is controlled by norms and habits as well as the manner in which the problem is presented. Different editing processes may occur depending on how a particular set of choices is framed, causing preferences to shift. Several such framing effects have been explored.

First, frames can affect choice by influencing where the reference point is set. Consider the difference between discounts and surcharges. A price difference in favor of L(ow) over H(igh) can be framed as an advantage of L by making H the neutral reference point or as a disadvantage of H by making L the neutral reference point. If L is the neutral reference point, then the price difference will be seen as L minus H, that is, as a loss. If H is the neutral reference point, then the price difference will be seen as H minus L, that is, as a gain. Because the loss function is steeper than the gain function, an identical difference will not be perceived the same in the two different frames. Consider what might have happened to the use credit cards if the price difference between credit and cash gas purchases had been labeled as a *credit card surcharge*, rather than a *cash discount*.

Setting the reference point can also influence whether people are risk seeking or averse. Investment problems are somewhat more complicated than those presented thus far because most risky financial instruments are best described by a continuum of possible returns rather than by discrete outcomes, but consider the following:

Problem 5:

Frame I: An investor is presented with two choices: She can pick either Option A, which is certain to make money this year, or Option B, which has a 67% chance of making money this year.

Frame II: An investor is presented with two choices: She can pick either Option C, which is certain to make less than 15% this year, or Option D, which has a 40% chance of making less than 15% this year.

The first frame describes the choice in terms of gains (i.e., returns greater than 0%), which would be expected to increase the preference for the certain option, say, T-Bills over a portfolio of small firm stocks. In contrast, the second frame describes the choice in terms of losses (i.e., returns less than 15%), which would be expected to increase the preference for the riskier choice, say, a portfolio of small firm stocks over T-Bills.

Second, frames can make the likelihood of a rare event appear relatively large by segmenting the possible causes of that event into subcomponents. For example, the collective decision weight associated with four probabilities of .01 generally exceeds that of a single probability of .04 because of the tendency to treat all small probabilities as equal. Consider the following example:

Problem 6: *You have a chance to buy high yield bonds in a small chemical company. Your return is certain unless a leak occurs at the company's plant, in which case liability suits against the company will cause you to lose your entire investment.*

Frame I: "Experts agree that the current probability of a leak due to all factors is 4%."

Frame II: "Experts agree that there are four factors that can lead to a leak, each of which has a 1% chance of occurring: (i) total failure of the main coolant pump, (ii) cracks in the sealing gaskets caused by sudden changes in weather condition, (iii) human operator error, and (iv) malfunction in the electrical control system."

People weigh the risk of failure higher if the way the system can fail is divided into its subcomponents. Further subdivision increases the effect (e.g., "The main coolant pump can fail due to sudden changes in demand, an accidental severing of the wiring, failure of its reserve electrical system, or insufficient lubricant.") This divide and conquer strategy was effectively used by activists to rally protest against the construction of new nuclear power plants.

Finally, frames can affect choice by making uncertain outcomes appear certain. These "pseudo-certainty" effects can be made to occur if a problem is described as occurring in stages rather than solely in terms of the final outcomes. This is illustrated in the next two problems.

Problem 7:

A company is competing for a government contract. You have the option of receiving one of the following two securities:

Security A has a 25% chance of paying $3000 and a 75% chance of paying nothing.

Security B has a 20% chance of paying $4500 and a 80% chance of paying nothing.

Approximately four out of five people choose Security B.

Problem 8:

A company is competing for a government contract. The probability that the company will not receive the contract is 75%, in which case both of options below will yield nothing. If the company does win the contract, then:

Security C will pay $3000 for certain.

Security D has a 80% chance of paying $4500 and a 20% chance of paying nothing.

YOU MUST CHOOSE NOW, BEFORE THE WINNER OF THE CONTRACT IS ANNOUNCED.

Approximately three out of four people choose Security C. Because there is a 25% chance that the contract will be won, Security C has a 25% chance of yielding $3000, and Security D has a 20% chance of yielding $4500 (i.e., .25 x .80). Although securities A and C are functionally identical, only C is preferred. The payoff for C appears to be certain, although it is not, because the frame provided in Problem 8 encourages people to ignore the uncertainty in the initial stage, which is common to both choices.

D. HEURISTICS AND BIASES IN INTUITIVE FORECASTING

Probabilities in the problems above are stated precisely, which is rarely the case in the real world. Rather, probabilities must usually be estimated from a set of noisy and vague variables. People use many cognitive heuristics, mental rules of thumb, to make these estimates. These heuristics allow estimates to be made rapidly, expending a minimum of cognitive effort. The two heuristics that have received the most research attention will be described here. Of the dozens of heuristics that have appeared in the risk literature, most are variations of these two.

1) THE AVAILABILITY HEURISTIC: Judgments of relative frequency or of the likelihood of a future event are often made by assessing the degree to which the event is available--perceptually, in memory, or via construction from imagination. This heuristic is often accurate, but there are many factors that are uncorrelated with frequency that affect perceptual salience, the completeness with which we recall, or the degree to which something can be imagined.

The availability heuristic can lead to biased likelihood estimates because some information is highly salient. The media present biased samples because they must focus on the sensational and ignore statistically frequent (i.e., boring) events. Rarity and newsworthiness are much the same. However, this biased sample of information causes people to overestimate the frequencies of uncommon events. For example, the media report every suspected case of death by botulism, but rarely report death by diabetes. Although, the true ratio is approximately 1 to 10,000, research has shown that the number of deaths per year caused by botulism and by diabetes are commonly estimated as being equal. Similarly,

bankruptcy of a major corporation is newsworthy, but non-bankruptcy is not. Even experienced investors overestimate the frequency with which major corporations suffer bankruptcy.

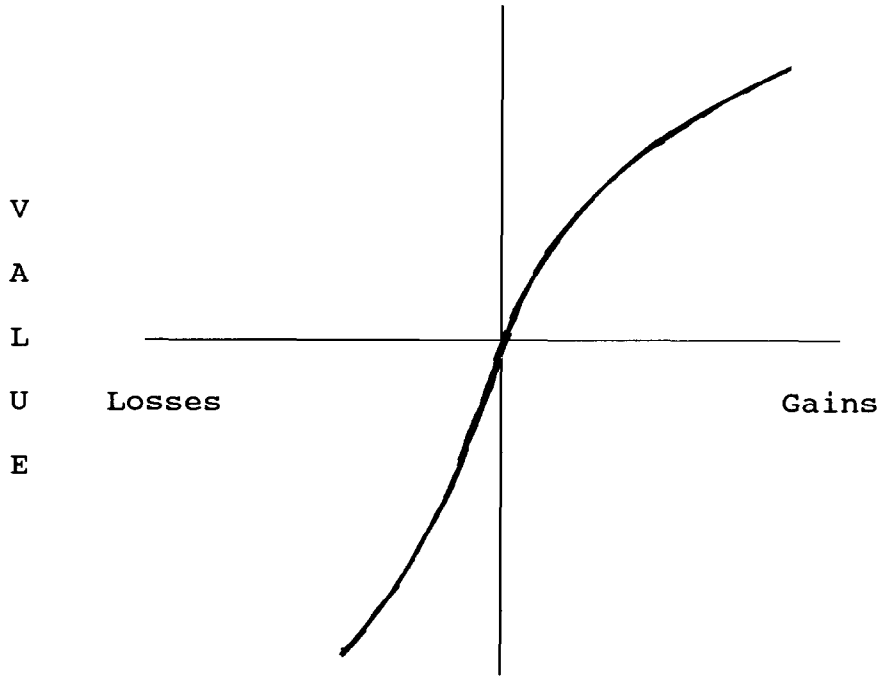
Availability from memory often leads to overconfidence in judgment. Consider the following question: Which company employs more people, Mobil or Chrysler? Even when rewarded for understating the probability that they have answered correctly, people greatly overstate the likelihoods that their answers to such questions are correct. The information one is missing is rarely given sufficient weight in balancing the confidence judgment. Memory induced biases can also occur when reasoning about a single case. How does an analyst decide whether a particular company is likely to show high levels of growth? A common intuitive strategy for making this type of judgment is to recall similar cases and then base the likelihood estimate on the percentage of these available cases in which there was also high growth. Unfortunately, irrelevant factors can bias retrieval by activating a narrow set of associative links. For example, an analysis performed on an the anniversary of a significant historical event may lead to high levels of recall from that time period. If the economic conditions that held then are significantly different from those of the present, biased estimates would be expected.

Reasoning by the use of cases and scenarios is rarely efficient because only a portion of the obtainable information is used. An effect called the "hindsight" bias appears due to the fact that some scenarios may be much easier to construct than others. People consistently exaggerate what could have been anticipated in foresight. Even recall of past predictions is systematically distorted. The hindsight bias generally occurs because the scenario that one believes led to the actual event becomes so compelling that it becomes difficult construct or imagine the alternative scenarios that would have led to different outcomes. This bias causes difficulty in learning from history. Success or failure appears inevitable once the outcome is known.

2) REPRESENTATIVENESS. The representativeness heuristic is a cognitive rule in which judgments are made by the degree of similarity. Causal judgments are often made as a function of the similarity between the cause and the actual outcomes, such as the magnitude of the possible causes and the magnitude of the effect. People initially had difficulty accepting that something small enough to be invisible, such as a virus, could cause a deadly disease. The use of the representativeness heuristic also makes it difficult for people to recognize when events are the result of a random process. Judgments of similarity can readily be made from small samples. People tend to expect that every part of a sequence, no matter how small, should appear "random," leading to what is known as the Gambler's Fallacy. When flipping a coin, the average number of tails or heads in a row is two. Expecting every part of any sequence of coin flips

to reflect this feature, after two heads have been flipped, people act as if a tail is, as it were, overdue. However, if a tail does not appear for four more flips--as is likely to occur once in any given sequence of 100 tosses--then people begin to reject the notion that the coin is fair. Similarly, it is difficult for people to accept the degree to which stock price changes are determined by a random process.

1) Prospect Theory Value Function



2) Prospect Theory Probabilty Weighting Function