Psychological Review
1992, Vol. 99, No. 1, 172–183

0033-295X/92/$3.00

Variable Risk Preferences and the Focus of Attention

James G. March
Graduate School of Business
Stanford University

Zur Shapira
Stern School of Business
New York University

Empirical investigations of decision making indicate that the level of individual or organizational risk taking is responsive to a risk taker's changing fortune. Several nonstationary random-walk models of risk taking are developed to describe this phenomenon. The models portray a risk taker's history as the cumulated realizations of a series of independent draws from a normal probability distribution of possible outcomes. This performance distribution is assumed to have an unchanging mean and a variance (risk) that changes. The changes are seen as determined by (a) a focus of attention on 1 of 2 reference points (an adaptive aspiration for resources and the survival point) and (b) the relation between current resources and the focal point. The models are elaborated by examining the impact of adaptive aspirations and attention focus on risk taking over time in a cohort of risk takers and in a renewing population of risk takers.

Theories of decision making under uncertainty most commonly assume that returns to decisions are draws from a probability distribution that is conditional on the choice made. Decision makers are generally assumed to prefer alternatives with higher expected values to those with lower ones, but they also are assumed to consider the riskiness of an alternative. Riskiness is associated with lack of certainty about the precise outcome of a choice and thus with variation in the probability distribution. Psychological studies of risk preference and risk taking emphasize the ways in which such variability affects choice.

Empirical investigations of choices by individuals and organizations indicate that preferences for variability are not constant but are responsive to changing fortune. The mechanisms of response are familiar to students of the psychology of decision making, but they yield a somewhat complicated picture:

1. *Risk taking and danger.* Risk taking appears to be affected by threats to survival. The reported effects, however, appear to be contradictory. On the one hand, it has been observed that increasing threats to survival stimulate greater and greater risk taking, presumably in an effort to escape the threats (Bowman, 1982; Bromiley & Wiseman, 1989; Mayhew, 1979). On the other hand, danger has been portrayed as leading to rigidity and to extreme forms of risk aversion (Greenhalgh, 1983; Staw, 1976; Staw, Sandelands, & Dutton, 1981; Roy, 1952; Stone, 1973).

2. *Risk taking and slack.* Risk taking appears to be affected by slack, that is, by resources in excess of current aspirations. Where slack is plentiful, it is pictured as leading to relaxation of controls, reduced fears of failure, institutionalized innovation, increased experimentation, and thus to relatively high levels of risk taking (Antonelli, 1989; MacCrimmon & Wehrung, 1986; J. G. March, 1981; Wehrung, 1989). Where slack is small (or negative), tight controls and efforts to improve productivity using known technologies and procedures are seen as producing relatively low levels of risk taking (Burns & Stalker, 1961; Czarniawska & Hedberg, 1985; Libby & Fishburn, 1977; Wehrung, 1989).

3. *Risk taking in the neighborhood of an aspiration level.* The idea of an aspiration-level reference point is central to modern theories of individual and organizational choice (J. G. March, 1988a; Tversky & Kahneman, in press). When they orient to a target and are close to it, individuals appear to be risk seeking below the target and risk averse above it (Hausch, Ziemba, & Rubenstein, 1981; Payne, Laughhann, & Crum, 1980, 1981; Tversky & Kahneman, 1974). A similar result has been observed in organizations (Bromiley, 1991; MacCrimmon & Wehrung, 1986; J. G. March & Shapira, 1987) and in societies (Brenner, 1983; Olson, 1963). The result is robust across a variety of circumstances involving fairly symmetric probability distributions of outcomes, but it appears to be sensitive to skewness in those distributions (Hershey & Schoemaker, 1980; Schneider & Lopes, 1986). It is consistent with a long history of observations in organizational studies that relate search activity to failure (Antonelli, 1989; J. G. March & Simon, 1958; Singh, 1986).

4. *Risk taking and the assimilation of resources.* Risk-taking behavior seems to be sensitive to risk takers' perceptions of whose resources are being risked. Greater risks are taken with new resources than with resources held for a longer time (Samuelson & Zeckhauser, 1988). Among successful managers, those who are older and have longer tenure take fewer risks than do those who are younger and have shorter tenure (MacCrimmon & Wehrung, 1990). Managers appear to be more inclined to take risks with an organization's resources than with their own (J. G. March & Shapira, 1987). Experimental subjects appear to be more inclined to take risks with the "house's" money

This research was supported by grants from the Recanati Foundation, the Russell Sage Foundation, the Spencer Foundation, and the Stanford Graduate School of Business.

We are grateful for the comments of Howard Kunreuther and Lola Lopes.

Correspondence concerning this article should be addressed to James G. March, Graduate School of Business, Stanford University, Stanford, California 94305-5015.

than with their own (Battalio, Kagel, & Jiranyakul, 1990; Thaler & Johnson, 1990).

5. *Risk taking and self-confidence.* Successful risk takers seem to feel that their past successes in risky situations are a result of their skills or their environment's munificence rather than their good fortune (Keyes, 1985; J. G. March & Shapira, 1987). That is, they accept some mixture of the following beliefs: that their past successes are attributable to their special abilities, that nature is favorable to them, and that they can beat the odds. This tendency to attribute favorable outcomes to enduring features of the situation rather than to good luck has been observed in experimental subjects (Langer, 1975), in athletes (Gilovich, Vallone, & Tversky, 1985), and in organizations (Boisjoly, 1988; Roll, 1986) and leads to a positive bias in anticipations.

In this article we use some relatively simple random-walk conceptions of performance, aspirations, and risk preferences to model this pattern of risk taking. The models build on earlier random-walk perspectives for variable risk preferences (J. G. March, 1988b; J. G. March & Shapira, 1987) and on more general applications of random walks to modeling adaptation (Levinthal, 1990, 1991). They emphasize focus-of-attention factors as critical to understanding human choice (Shapira & Venezia, in press; Tversky & Kahneman, in press).

Random-Walk Models of Risk Taking

In a random walk, an individual or organization begins with an initial supply of resources and accumulates (or depletes) resources over time by a sequence of independent draws from a distribution of possibilities (Dubins & Savage, 1965; Feller, 1968). In standard applications of random walks to adaptation, the usual focus is on changes in resources over time up to the point at which they reach a level that can be treated as absorbing. The absorbing state of interest is typically zero, but there are other possibilities (J. C. March & March, 1978; Romanow & Sellke, 1985).

Such models have a certain amount of appeal by virtue of their parsimony, their straightforward characterization of the process of engagement between a risk taker and the environment over time, and the ease with which they produce key observed features of survival experience. They yield distributions of exits (e.g., deaths, departure from jobs, endings of marriages, exhaustion of capital) over time that are qualitatively consistent with many empirical observations. As a result, they often provide plausible baseline interpretations of the distributions of exits within a cohort (Bartholomew, 1973; Levinthal, 1991).

The initial supply of resources in a random walk can be interpreted as a capital endowment. The mean can be interpreted as the capability or efficiency of the risk taker or, more generally, as the fit of the individual or organization to the environment (Levinthal, 1991). The variance can be interpreted as unreliability or risk taking. *Unreliability* is normally used to refer to variability that is relatively involuntary and *risk* to refer to variability that is relatively voluntary, but the distinctions are not always easy to maintain. We are interested in behavior that is neither strictly voluntary nor strictly involuntary but a mixture of the two. By pursuing a particular strategy, technology, market, control procedure, or product in a particular way, an individual or organization determines (within some constraints) the variability of possible experience. Thus, we may describe individuals or organizations that pursue actions with small variability in outcomes as either "reliable" or "risk averse" depending on the context. Those that pursue actions with large variability in outcomes can similarly be described either as "unreliable" or "risk seeking."

We consider a population of risk takers each of whom experiences history as the realizations of a sequence of independent draws from a normal performance distribution of possible outcomes. The population is initially homogeneous with respect to the mean and variance parameters of the performance distribution. Although we provide a few comments on nonstationary means, for the most part, we assume the mean of the distribution to be stationary and equal to zero. The variance parameter changes over time by a process that is common to all risk takers, but it produces a heterogeneous, nonstationary population as a result of differences in specific realized histories.

The variance depends both on the amount of current resources and on the history of reaching that amount. We assume that risk taking is controlled by two simple "decision" rules. The first rule applies whenever cumulated resources are above the focal reference point: Variability is set so that the risk taken increases monotonically with distance above the reference point. This rule, or a close proxy, is a common interpretation of risk aversion in the positive near neighborhood of an aspiration level or threat of death. A specific version might make the probability of landing below the reference point equal to some fixed (and presumably relatively low) number; that is, it might make the relation between distance from the reference point and risk linear.

Such rules have been examined in the literature on organizations (Singh, 1986), individuals (Kahneman & Tversky, 1979), and animals (Kamil & Roitblat, 1985). Presumably they reflect a combination of resistance to falling below the focal point and a limitation imposed on risk taking by the amount of available resources. Under this first rule, as a risk taker's resources (above a target) increase, the unreliability in outcomes that is tolerated becomes greater and greater. The rule is different in this respect from the function assumed in an earlier model of variable risk taking (J. G. March, 1988b). In that model, preferred risk was assumed to decline monotonically with the ratio of resources to aspiration. The differences between the models reflect an unresolved conflict in the research on variable risk taking—the impact of excess resources on reliability and risk taking (Bromiley, 1991; Bromiley & Miller, 1990).

The second decision rule applies whenever cumulated resources are *below* the focal reference point: Variability is set so that the risk taken increases monotonically with (negative) distance from the focal point. A specific linear version might make the probability of landing some fixed distance above the reference point equal to some fixed (and presumably relatively high) number. This rule provides an interpretation of risk seeking for losses. The further current resources are below the reference point, the greater the risk required to make recovery likely.

Risk can be varied in two ways—by choosing among alternatives with varying odds or by altering the scale of the investment in the chosen one, that is, by changing the "bet size."

Because the availability of the latter alternative depends on the resources available, there is a constraint on risk taking that can be quite severe as a risk taker exhausts resources. This resource constraint is not reflected explicitly in the present model. In effect, we assume that alternatives with any desired variance within a very wide range are available.

In keeping with earlier work on the psychology of risk taking (Atkinson, 1957; Lopes, 1987), we consider two target reference points: an aspiration level for resources that adapts to experience (Kuhl, 1978; Lewin, Dembo, Festinger, & Sears, 1944) and a fixed survival point at which resources are exhausted. Thus, the present models differ from a strict aspiration-level conception of targets by introducing a second critical reference point, the survival point, and by assuming a shifting focus of attention between these two reference points (Lopes, 1987; J. G. March & Shapira, 1987). The two rules make risk-taking behavior sensitive to (a) where a risk taker is (or expects to be) relative to an aspiration level and a survival point and (b) whether the risk taker focuses on the survival reference point or the aspiration-level reference point. Consequently, aggregate risk-taking behavior in a population is attributable partly to the way the process affects the accumulation of resources, partly to the way it distributes risk takers to success and failure (in terms of their own aspiration levels), and partly to the way it allocates attention between the two reference points.

Rules such as these are commonly cited by risk takers (Bowman & Kunreuther, 1988; MacCrimmon & Wehrung, 1986; J. G. March & Shapira, 1987) and have a certain amount of theoretical appeal, but they make it easy to confuse two quite different versions of the meanings of *risk.* In the first meaning, risk is associated with variability in the probability distribution conditional on a choice. In the second meaning, risk is associated with the danger of landing below, or the chance of landing above, a focal target. The behavioral rules specified earlier keep "danger" or "opportunity" constant under changing conditions. In a sense, therefore, they are "fixed-danger" and "fixed-opportunity" rules. As will become clear later in this article, however, any rule that keeps danger fixed as cumulated resources vary will produce variability in risk taking, and any rule that keeps risk taking (in the sense of variability) fixed will make danger variable.

The Specific Models

We assume that each risk taker begins with a certain level of initial resources that is common to all. The process for each risk taker continues through a sequence of draws from that risk taker's changing performance distribution until resources are exhausted. The term *resources* is intentionally general. It might include the capital assets of an entrepreneur or a business firm, the political support of a politician or a public agency, the reputation of a professional or a professional association. The history of any particular risk taker consists in a series of independent draws from a performance distribution. The realized draws are added sequentially to the resources to produce a history of cumulated resources or wealth.

Each of the basic models we consider assumes that the performance distribution from which draws are made by a particular risk taker is normal, with a mean of 0. The standard deviation of the distribution for any particular risk taker at time t is assumed to be a function of the cumulated resources of that risk taker at time t. Thus, all of the models are expressions for s_t, the standard deviation of the normal distribution from which a draw is made at time t. We assume that s_t is bounded by unavoidable risk (here assumed to be 10^{-1}) and by maximum possible risk (here assumed to be 10^9).

Model 0: Fixed Risk

In this model, we assume that the $s_t = s^*$ for all ts. This is the standard, homogeneous, stationary random walk.

In all subsequent models, we introduce an experience-based estimation of the mean of the distribution. We assume that each risk taker estimates the mean of possible realizations in the next time period to be equal to the mean of that risk taker's experience over previous time periods. That is, if E_t is the estimated return for period t, R_t is the accumulated resources at t, and k is the initial stake, then,

$$E_{t+1} = (R_t - k)/t.$$

If the estimated mean is low enough to make estimated resources at the end of the period less than zero, the estimated mean is assumed to be zero.

Model 1: Survival Reference Point

In this model, we assume that the risk taker has one reference focus, the survival point, and the level of risk taken depends on the distance from that point. It also depends on a (possibly erroneous) estimate by the risk taker of the mean of the distribution. Specifically,

$$s_t = (R_{t-1} + E_t)/D(p_d^*),$$

where $D(p_d^*)$ is the standard deviate of the normal distribution associated with p_d^*, the probability that the draw in this period will wipe out the cumulated resources up to this point—that is, the probability of death. The model makes the estimated probability of death constant over all levels of cumulated resources thus over time. By virtue of the assumption of a symmetric (normal) performance distribution, p_d^* is constrained to be less than .5.

Model 2: Aspiration Reference Point

In this model, we assume that the focus is always on an aspiration level ($L > 0$) for cumulated resources. The effect of the focus depends on whether resources are above or below the aspiration for them. Specifically,

$$s_t = \begin{cases} (R_{t-1} + E_t)/D(p_f^*), & \text{if } R_{t-1} \geq L_{t-1}, \\ (R_{t-1} + E_t + q)/D(p_s^*), & \text{if } R_{t-1} < L_{t-1}, \end{cases}$$

where L_t is the aspiration level at t, q is the distance above the aspiration level that is deemed "safe," p_f^* is the probability that a draw in this period will bring cumulated resources below the aspiration level, and p_s^* is the probability that a draw in this period will bring cumulated resources to a position at least q above the aspiration level. By virtue of the assumption of a symmetric (normal) performance distribution, p_f and p_s are each constrained to be less than .5, but they have no necessary relation to each other. The psychological basis for q ($q > 0$) lies in the frequent observation that there is a positive bias in aspirations (Revelle & Michaels, 1976), although its precise form is slightly different from that suggested by others (Lant, in press). When cumulated resources exceed the aspiration level, s_t is set so that the estimated probability (depending partly on the possibly erroneously estimated mean of the distribution) of landing below the aspiration level is constant. When cumulated resources are less than the aspiration level, the model assumes that risk is set so that the (possibly erroneously) estimated probability of "safe success," that is, of being above the aspiration level by some fixed amount, is constant over cumulated wealth.

Model 3: Shifting Focus

This model is a combination of the two single-reference-point models (Models 1 and 2). The risk taker attends either to the aspiration level or to the survival point but not to both. When attention is given to the survival point, the model is equivalent to the survival reference-point model (Model 1). When attention is given to the aspiration level, the model is equivalent to the aspiration reference-point model (Model 2). Attention can shift according to a number of different possible rules, and we introduce two more complicated rules in later sections. Initially, we consider only a simple probabilistic attention rule: Each risk taker attends to the survival point with probability u ($0 \leq u \leq 1$). The two single-reference-point models (Models 1 and 2) are then special cases of the shifting reference-point model (Model 3), with $u = 1$ and $u = 0$, respectively.

Risk-taking functions. The two basic risk-taking functions specified in the models are shown in Figure 1. Each function shows the risk taken at any level of cumulated resources. The aspiration level is assumed to be fixed. The functions plotted in Figure 1 are not utility functions. They show risk taking directly as the standard deviation of the performance distribution,

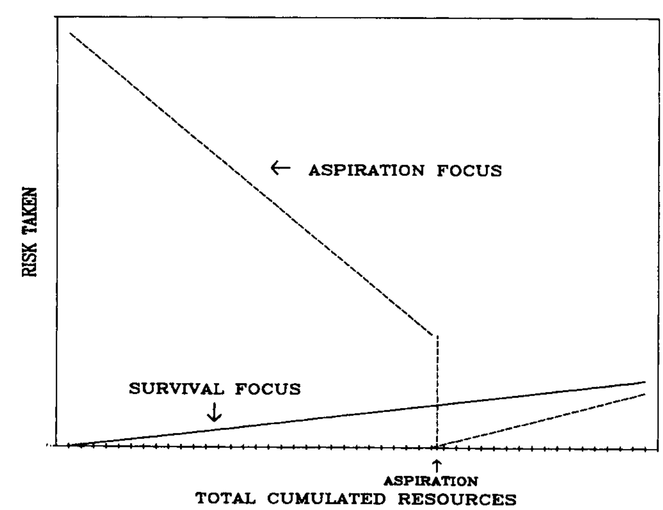

Figure 1. Risk taken as a function of cumulated resources for fixed-focus models of variable risk ($p_d = .0001$, $p_f = .05$, $p_s = .3$, $L = 30$, and $q = 10$).

rather than as a nonlinearity in the utility for money. The two specific functions reflect particular parameter values for each model; thus they should be viewed as representing a class of models. By varying the parameters, it is possible to vary the scale of risk taking arbitrarily—thus the relative position of the several plots on the y-axis. However, the qualitative pattern of relative risk taking as a function of cumulated resources for any one model remains as pictured.

Parameters of the models. Each risk taker is assumed to have a performance distribution that is normal with an unchanging mean, x, and a changing variance. Each risk taker begins with an initial stake, k, and an initial aspiration level equal to that stake plus or minus a small amount. In addition to x and k, the following parameters are involved:

p_d^*, the probability of death, that is, the probability of moving from the present resource position to a position below the survival reference point as a result of the draw this period (Models 1 and 3; $0 < p_d^* < .5$);

p_f^*, the probability of failure, that is, the probability of moving from the present resource position above the aspiration level to a position below the aspiration level as a result of the draw this period (Models 2 and 3; $0 < p_f^* < .5$);

p_s^*, the probability of success, that is, the probability of moving from the present resource position below the aspiration level to a "safe" position above the aspiration level as a result of a draw this period (Models 2 and 3; $0 < p_s^* < .5$);

q, the increment about the aspiration level that defines a "safe" success (Models 2 and 3; $q > 0$);

a, the learning parameter for adjusting the aspiration level, where R_t is the cumulated resources at t, L_t is the aspiration level for resources at t, and $L_t = aR_{t-1} + (1-a)L_{t-1}$ (Models 2 and 3; $0 \leq a \leq 1$);

u, the probability of attending to the survival reference point (Model 3; $0 \leq u \leq 1$).

Consistency With Empirical Data

Because the models can lead, through probabilistic variation, to a variety of outcomes in any particular case, it is necessary to consider the distribution of possible outcomes stemming from any particular set of parameters. To derive distributions, we use Monte Carlo simulations. Except where indicated, all of the simulations set $p_d^* = .0001$, $p_f^* = .05$, $p_s^* = .3$, $q = 2$, $k = 3$, and $u = .5$; thus they do not provide information on the sensitivity of the results to variations in those parameters. The emphasis is on comparing the models and on considering the effects of variations in the value of the aspiration adjustment parameter, a.

The three variable-risk models produce distinctly different patterns of risk taking, which lead to differences in the extent to which the several models fit the stylized empirical observations listed earlier:

1. *Risk taking and danger.* The survival reference-point model (Model 1) exhibits decreasing risk taking as survival is increasingly threatened. The aspiration reference-point model (Model 2) exhibits increasing risk taking as survival is threat-

ened. In the neighborhood of the survival reference point, the shifting-focus model (Model 3) exhibits oscillation between relatively small risks and relatively large ones as the focus of attention shifts. The effects in the cases of the two models that include aspiration reference points (Models 2 and 3) depend on the speed of aspiration adjustment.

2. *Risk taking and slack.* All of the models exhibit increasing risk taking as slack (resources in excess of aspirations) increases. Because the amount of slack is a joint function of accumulated resources and aspirations for them, it is sensitive to the rate at which aspirations adjust to experience.

3. *Risk taking in the neighborhood of an aspiration level.* In the neighborhood of current aspirations, the models using aspiration-level reference points (Models 2 and 3) exhibit higher risk taking when expectations are below the aspiration level than when they are above it. Thus, in the neighborhood of the target, they are risk seeking for "losses" and risk avoiding for "gains." Risk avoidance for gains is, however, less and less characteristic in these two models as the distance between the gains and the aspiration level increases. The survival reference-point model (Model 1) is insensitive to aspirations.

4. *Risk taking and the assimilation of resources.* Through aspiration-level adjustment, the two models with aspiration-level reference points (Models 2 and 3) make the effect of current resources on risk taking dependent on the length of time resources are held. Because risk taking depends on the relation between aspirations and current resources, and aspirations depend on the history of accumulation, there is a period of time after acquiring (or losing) resources when those accumulations are not fully discounted by adjustment in aspirations. The slower the adjustment of aspirations, the longer the period of time before resources are assimilated. The survival reference-point model (Model 1) is insensitive to aspirations and thus to assimilation of resources.

5. *Risk taking and self-confidence.* Even though all risk takers draw from distributions with the same mean, their realizations from those distributions vary. Some have cumulative experience that exceeds the true expected value and consequently overestimate the mean; others have less favorable cumulative experience and consequently underestimate the mean. Because the process differentially eliminates those with negative experience, it generates a positive bias in expectations. Risk takers following the rules in the three variable-risk models (Models 1, 2, and 3) generally take greater risks than they would if their estimates were correct. The only exception occurs when they are focused on the aspiration-level reference point and their biased expectations place them above the aspiration, whereas a correct estimation would place them below.

Table 1 summarizes the results. The fixed-risk model (Model 0) clearly does not predict human risk taking as it has been observed. The survival reference-point model (Model 1) has some of the qualitative features desired, but it fits the data less well than the others. Moreover, that model has a strong property that appears to be inconsistent with empirical observations. When focus is strictly on the survival point, individual histories vary, but they tend to converge to the survival point. As a result, most risk takers spend most of their histories barely surviving and taking very little risk.

The aspiration reference-point model (Model 2) and the shifting reference-point model (Model 3) come closest to reflecting the observed qualitative results. Because a shifting focus generates variability among individuals having the same resource level, the outcomes in Model 3 provide a possible interpretation of some of the puzzles in the empirical data. Risk takers who find themselves below their aspiration level are divided into two (unstable) groups, the first of which is focused on the dangers of death and the second of which is focused on the opportunities for being safely above the aspiration level. The two different foci lead to different levels of risk taking. Similarly, risk takers who find themselves above their aspiration level are divided into two (unstable) groups, the first of which is focused on the (distant) dangers of death and the second of which is focused on the (nearer) dangers of failure. Again, these two different foci lead to different levels of risk taking.

Table 1
Empirical Observations and Models Compared

Observations	Models
1. Low risk taking near survival point	1, 3
High risk taking near survival point	2, 3
2. High risk taking when well above aspiration level	2, 3
3. Risk seeking just below aspiration, risk avoiding just above	2, 3
4. Effect of one-time increase in resources is short-term increase in risk taking followed by decline	2, 3
5. Underestimate of risk	1, 2, 3

Resource Accumulation and Adaptive Aspirations

The variable risk taking portrayed in these models is dependent on three things. First are the changing resources of the risk takers; the risk taken by a particular risk taker changes as a result of the realizations of the random walk. Second are the changing aspirations of risk takers for resources. Aspirations adjust to experience (Lant, in press; Revelle & Michaels, 1976). Insofar as attention is directed to the aspiration focal point, such adjustments affect the risk taken. Third is the focus of attention. The level of risk taken depends on whether attention is directed to the survival point or to the aspiration level. In this section, we consider resource accumulation by survivors, its effect on aspirations for resources, and their joint effect on risk taking. In the next section, we examine the effects of the focus of attention.

Resource Accumulation by Survivors

Suppose risk takers all have the same, stationary performance distribution means, the same initial stakes, the same decision parameters, and the same learning parameter. Except where indicated, we assume $x = 0$, $k = 3$, $q = 2$, $u = .5$, $p_d^* = .0001$, $p_f^* = .05$, and $p_s^* = .3$. In the absence of involuntary risk, Model 1 (survival reference point) tends to trap most risk takers in a near neighborhood of the survival point. With nonnegative expectations, Models 2 (aspiration reference point) and 3 (shifting reference point) tend to generate increases in average gains of survivors over time. These increases, in turn, produce three major effects on risk taking: The first effect is the direct one from the tendency for cumulated resources to increase. Within the models, risk taking is high if a risk taker is relatively far above a reference point. In cohorts in which performance distributions have nonnegative expectations that are stable, the average level of risk taking among survivors is more likely to be determined by a history of being above the reference point than being below it and increasingly so as the cohort ages. Thus, risk taking tends to increase.

The second effect of increasing assets on risk taking stems from a systematic bias in the expectations of survivors. Cumulation of resources over time (in a process in which the average accumulation is zero) leads survivors to overestimate the expected mean of the process in which they are involved. This leads them generally to expect to have greater resources at the end of each time period than they will in fact have. As a result, except when they are in the near neighborhood of, and below, their aspirations, they take greater risks than they would have taken if they had correctly predicted their resources.

The third effect of increasing resources for survivors is to increase aspiration levels. As long as aspirations are below realizations, increasing aspiration levels will tend to reduce risk taking. At the limit, the changes in aspiration level negate the effects of increasing resources on risk taking because increases in resources are discounted by rising aspirations for them.

If we relax the assumption of homogeneous and stationary means, these effects on resource accumulation and risk taking are affected in relatively straightforward ways. Suppose that individual means (x_i) are distributed normally with mean = 0 and variance = 1. Such heterogeneity has substantial effects. Because losers are eliminated, there is a strong tendency to eliminate those risk takers with performance distributions having negative means. As a result of the differential survival and the consequent shifting composition of the population, heterogeneity in means generates much higher levels of average risk taking and cumulated resources among survivors than is found in homogeneous populations with means equal to the average of the heterogeneous population at Period 0. Those risk takers having advantages of fit do better and survive longer. As they do better, they take greater risks.

Suppose the means, x_i, are initially homogeneous but are not stationary. For example, we might imagine that the mean increases with experience in the manner of standard learning curves. Or we might imagine that the mean is related positively to cumulated wealth. Such changes in the mean lead to increases in the accumulation of resources by survivors and thus (in general) to increases in risk taking. However, if increases in the mean come at a decreasing rate, upward adjustments in the aspiration level reduce the level of risk taking.

Alternatively, we might imagine that variations in the mean of a performance distribution are linked to variations in the variance. The literature provides two, quite different, stories on the relation between risk and expected value. In one story, relatively standard in the literature on financial markets, risk and expected value are positively related (Feigenbaum & Thomas, 1986; Gibbons, 1982). In a second story, relatively standard in research on organizational search and change, risk and expected value are negatively related (Bowman, 1982; Bromiley, 1991; Bromiley & Miller, 1990). Within the present models, a positive correlation between risk and return increases, and a negative correlation decreases, the accumulation of resources by survivors and the average risk taken.

Effects of the Rate of Aspiration Adjustment

Unlike the survival reference point, which is insensitive to endogenous change, aspiration reference points adjust to reflect realized experience. The history dependence of aspirations combines with the importance of aspiration levels for risk taking to make the rate and character of these aspiration adjustments a key feature of models using aspiration-level reference points (Models 2 and 3). Self-referential aspiration adjustment leads to the aspiration level's being closer to current position than it would otherwise be. This, in turn, tends to constrain the risk taken by any risk taker focusing on the aspiration level, because risk taking is relatively low in the neighborhood of the aspiration level (see Figure 1). As a result, in both models using an aspiration-level reference point (Models 2 and 3), slower adaptation of aspirations leads to taking greater risks. For example, Figure 2 shows, for $a = 0.1$ and $a = 0.9$, the average risk taken by survivors over time for Model 2 (aspiration reference point only). When $a = 0.1$, the average risk taken by survivors by Period 100 is more than three times that taken when $a = 0.9$.

In a population of risk takers, the aspiration level of each risk taker may depend not only on that risk taker's achieved resources but also on the resource level reached by others—in particular, others who do better (Brenner, 1983; Bromiley, 1991). If j is the rank of a risk taker in terms of accumulated resources (where the risk taker with the greatest amount of resources in the population is ranked 1), and e ($0 < e < 1$) is a positive fraction, then the rank of a superior comparison target is equal to the nearest integer value of e_j. The lower the value of e, the higher the relative standing of the comparison target. (If

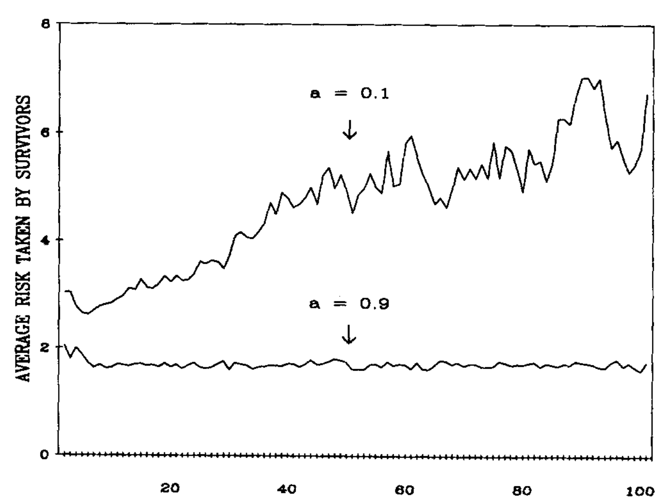

Figure 2. Average risk taken by survivors over 100 time periods for Model 2 ($a = 0.1, 0.9$; $N = 5{,}000$ [nonrenewed], $p_d = .0001$, $p_f = .05$, $p_s = .3$, $x = 0$, $q = 2$, and $k = 3$).

the nearest integer value of e_j is 0, then the rank of the comparison risk taker is assumed to be 1.) The aspiration updating function becomes

$$L_t = acR'_{t-1} + a(1-c)R_{t-1} + (1-a)L_{t-1},$$

where R'_t is the accumulated resources of the comparison risk taker at t, and c is the fraction of the weight assigned to R'_t (rather than R_t). The conspicuous consequence of having aspirations depend partly on the achievements of superior performers is increased average aspirations and frequency with which cumulated resources fall well below the aspiration level. This tends to increase risk taking, a tendency somewhat ameliorated (in the shifting-focus-of-attention models) by the focus on survival. Moreover, insofar as aspiration adaptation is related to the performance of superior others, rapid aspiration adjustment leads to higher levels of risk than does slow aspiration adjustment.

These effects of a on risk taking in situations involving homogeneous values for a suggest that a might be selected within a population of risk takers that was heterogeneous with respect to the adaptation rate. This speculation is true. Figure 3 shows the Period 100 distribution of the population across nine values of a, given a uniform distribution at Period 1, for the situation in which aspirations are entirely self-referential in the two aspiration reference-point models (Models 2 and 3). Risk takers with low values for a represent a substantially smaller fraction of the cohort of survivors at Period 100 than they did in the original cohort.

Focus-of-Attention Effects

At some levels of resources, the risk taking specified by the functions portrayed in Figure 1 is relatively insensitive to changes in focus from one reference point to the other. In other cases, the differences are large. For example, if the aspiration level is substantially above the survival point and the risk taker is close to the latter, a focus on the survival point will lead to taking very little risk, whereas a focus on the aspiration level will lead to taking a substantial risk. Conversely, if the risk taker is well above the survival point but barely above the aspiration level, a focus on the survival point will lead to substantially greater risk taking than will a focus on the aspiration level. The precise effects of increasing (or decreasing) the likelihood of focus on the survival point, relative to the focus on the aspiration level, depend on the decision rules and parameters, but a few general implications can be drawn.

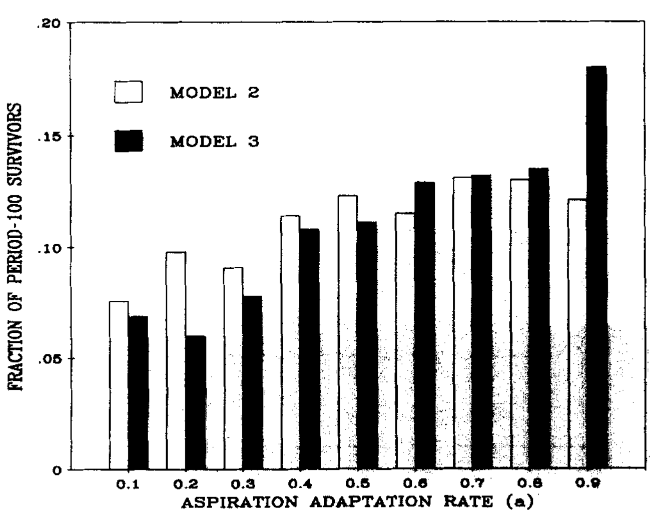

Figure 3. Period 100 distribution of a among survivors for heterogeneous a (M = 0.5) in Models 2 and 3 (N = 5,000 [nonrenewed], p_d = .0001, p_f = .05, p_s = .3, x = 0, q = 2, k = 3, and u = .5).

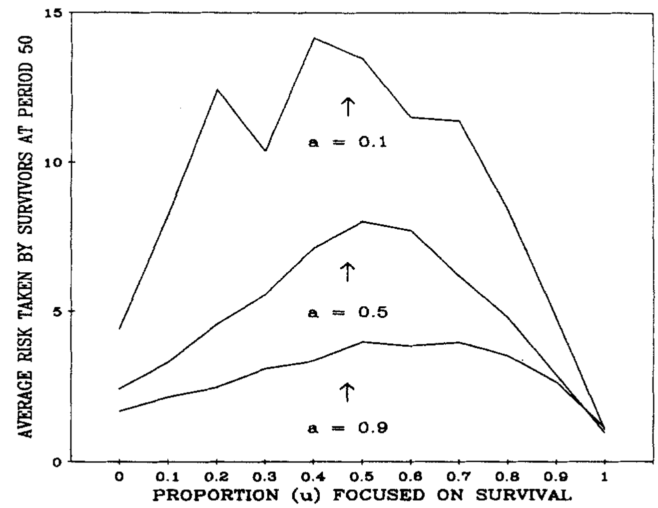

Figure 4. Average risk taken by survivors (Model 3) at Period 50 as a function of u and a (N = 5,000 [nonrenewed], p_d = .0001, p_f = .05, p_s = .3, x = 0, q = 2, and k = 3).

Effects of Varying Probabilistic Attention to Survival

Model 3, with its changing focus of attention, tends to generate patterns of risk taking that are different from those produced by the fixed-focus models. By varying the value of u, the probability of attending to the survival reference point in Model 3, we can examine how a fixed likelihood of attending to one reference point or the other affects risk taking. Because risk taking also depends on the rate of aspiration adjustment, we plot in Figure 4 the average risk taken in Period 50 as a function of u for three different values of a, where aspiration adjustment is self-referential. The observation (see Figure 2) that slower adjustment of aspirations leads to higher risk taking when u = .5 is confirmed as a general property for all values of $u < 1$. By narrowing the gap between realizations and aspirations, rapid adjustment of aspirations has a negative effect on average risk taking in situations such as this (in which assets tend to grow over time).

The plotted results with respect to u are sensitive to the specific parameters chosen, but the nonmonotone dependence of risk taking on u is quite general. Very high values of u, including u = 1, which is equivalent to the survival reference-point model (Model 1), lead to low levels of risk taking. This risk aversion leads to relatively low levels of accumulated resources, which reinforce the relatively low levels of risk taking. Very low levels of u, including $u = 0$, which is equivalent to the aspiration-level reference point model (Model 2), link risk taking to aspiration levels—which tend to adapt to accumulated resources, thus constraining risk taking. By producing fairly frequent attention to the aspiration-level reference point, moderate levels of u provide relatively high levels of risk taking when accumulated resources are low. Subsequently, when accumulated resources are relatively high, moderate levels of u direct attention to the survival point often enough to keep risk taking relatively high. The joint consequence is to make risk taking higher, on average, for intermediate values of u than for values that are either close to 0 or close to 1.

Effects of Alternative Attention-Allocation Rules

The analysis of Model 3, in which attention to the two reference points is allocated in a strictly probabilistic way, indicates some reasons why fixed-focus models—Model 1 ($u = 1$) and Model 2 ($u = 0$)—generally generate less risk taking than a shifting-focus model ($0 < u < 1$). But the assumption of a constant probability of attending to survival seems too limiting as a description of behavior. It seems possible that attention shifts according to some features of experience rather than strictly as a probabilistic process. Consider the following two different ways by which attention might be allocated to one or the other focal point.

Model 3, Variant A: Relative distance. The probabilities of attending to the survival reference point and the aspiration reference point are inversely proportional to their relative distances from the current resource position of the risk taker. The closer cumulated resources are to zero, the greater the probability of focusing on the survival point; the closer they are to the aspiration level, the greater the probability of focusing on the aspiration level.

Model 3, Variant B: Learning from experience. The probability of attention to the survival reference point, rather than to the aspiration-level reference point, changes as a result of simple trial-and-error learning. Trial-by-trial experience associated with a focus on one point or the other leads to modifications in the likelihood of maintaining or changing a focus. Success (defined as cumulated resources being above the aspiration level) decreases the chance of a change in focus, whereas failure (resources below the aspiration level) increases the chance of a change. To simplify the variation, we assume that whenever current cumulated resources fail to achieve the current aspiration, the focus of attention shifts and that whenever the cumulated resources exceed the aspiration level, the focus of attention remains the same.

These variants on the shifting-focus model result in risk-taking patterns that differ from each other as well as from the previous models. Because both resources and aspirations tend to rise over time, the (stable) survival reference point becomes more distant over time, and the (adaptive) aspiration-level reference point comes closer. Moreover, resources tend to exceed aspirations as long as the latter do not adapt too rapidly to the former. Where the focus of attention is tied to the relative distances between current cumulated resources and the two reference points (Variant A), the changing distances lead to increased attention on the aspiration level over time. When the risk taker learns which focus to adopt as a result of experience (Variant B), the frequency with which focus is shifted depends on the frequency with which cumulated resources fall below aspirations and thus on the speed with which aspirations adjust to experience.

As a result of these differences, an experience-based focus (Variant B) generally leads to more frequent attention to the survival point than does a distance-based focus (Variant A). The differences are shown in Figure 5 over 100 time periods. If expectations are nonnegative, higher rates of focusing on survival are associated with higher levels of risk taking. Clearly, that effect arises not from focusing on survival when it is most threatened, but from focusing on a nonthreatening survival point when resources are plentiful. Differences in risk taking, in turn, lead to differences both in the fraction of a cohort surviving up to any particular period (greater when relative distance matters, i.e., Variant A) and in the average cumulated gains of survivors up to any particular period (greater when experience matters, i.e., Variant B).

The effects of the rate of aspiration adjustment in the two variants are also different in important ways from what they are in the purely probabilistic version of a shifting-focus model (Model 3). As in the probabilistic version, higher values for a lead to lower levels of risk taking at Period 50. However, in contrast to the probabilistic version, which tends to eliminate high-risk takers, Variants A and B lead to the elimination of low-risk takers. Risk takers with higher values for a are less likely to survive (as long as aspirations are self-referential). This seemingly contradictory result is produced by the fact that in the rule-based models (Variants A and B), slow adaptation of aspirations leads to relatively low risk taking early (when most deaths occur) and relatively large risk taking later.

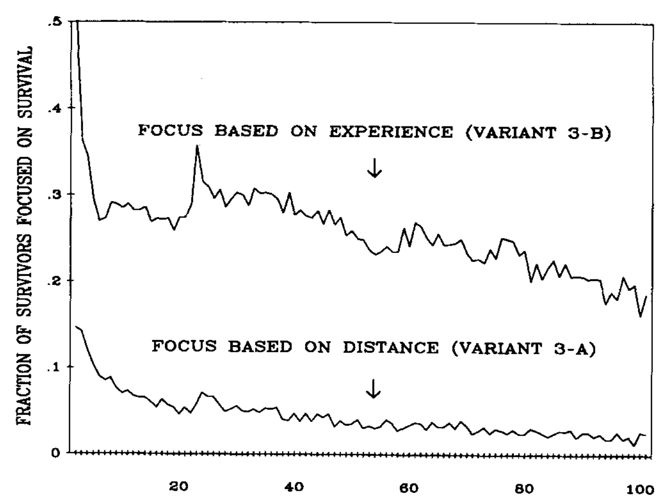

Figure 5. Fraction of survivors focused on survival reference point over 100 time periods for Variant 3-A and Variant 3-B (N = 5,000 [nonrenewed], $p_d = .0001$, $p_f = .05$, $p_s = .3$, $x = 0$, $q = 2$, $k = 3$, and $a = 0.5$).

Risk Taking and Survival in Renewing Populations

Random-walk models do not ordinarily treat the effects of competition directly. The game of life is portrayed as a game against nature rather than a game against other actors. Nevertheless, it is possible to exercise the present models to explore a few aspects of competitive effects and to use those analyses as a basis for some discussion of the survival advantages (and disadvantages) of particular risk-taking rules. In this section, we explore the trade-off between cumulated resources and survival by considering the changing character of a renewing population that is heterogeneous with respect to the risk-taking rules followed.

Differential Survival Over Time

Suppose we have a population that consists of individual risk takers, each of whom follows the rules of one of the variable-risk models. Thus, each risk taker is of a particular model type, and the model type for each risk taker is invariant as long as that risk taker endures. We exclude Model 0 because comparisons would depend on an arbitrarily chosen value for s^*. We focus on the five other models and use identical values for p_d, p_f, and p_s (i.e., $p_d = .0001$, $p_f = .05$, and $p_s = .3$). We assume that every risk taker who fails is replaced by a new risk taker with a stake, k, the same as that provided to risk takers in the original cohort. Note that this specifies an expanding resource base because each departing risk taker leaves with a negative cumulated resource level and is replaced by a new risk taker with a new positive stake.

The five different sets of rules produce different patterns of risk taking in the five subgroups of risk takers. The different patterns of risk taking lead to different survival rates and different accumulation of resources among survivors. Changes in the distribution of types in a renewing population depend, however, not only on death rates among the types but also on their birth rates. As risk takers are eliminated, they are replaced by new risk takers. We assume that the probability of a replacement's being of a particular type is some mix of the current proportion of the population found in that type and the current share of population resources held by that type.

By these assumptions, we describe a simple birth and death process that captures (in a very specific way) the trade-off between protecting survival by reducing risk and strengthening reproductive capability by taking risks successfully. Insofar as the probability of a replacement's being of a particular type is proportional to the current number of survivors of that type, high reproduction rates tend to be associated with low risk taking. Insofar as the probability of a replacement's being of a particular type is proportional to the total resources held by survivors of that type, high reproduction rates tend to be associated with high risk taking.

The process can be illustrated in purest form by considering a population in which all risk takers follow the fixed-risk model (Model 0) but vary in the level of risk they take. Suppose there are four types of fixed-risk takers: In Type 1, $s^* = 1$; in Type 2, $s^* = 2$; in Type 3, $s^* = 3$; and in Type 4, $s^* = 4$. If each of the types initially includes 25% of the population, the changing distribution over time depends sharply on whether replacements are proportional to the numbers of survivors of each type or the total amount of resources held by survivors of each type. As Figure 6 shows, types that are relatively risk averse are significantly more favored by a numbers-dependent reproductive process than by a resources-dependent reproductive process.

In the same spirit, we examine the distribution of rules in the population over time from an initial distribution in which each of the five variable-risk models (Models 1, 2, 3, 3-A, and 3-B) represents one fifth of the population. The distribution depends on the specific parameter values chosen for p_d, p_f, and p_s, but there are three general things that can be said. First, the relative positions of the various types change over time, so that superiority depends on the time horizon involved. Second, the long-term proportion of the population represented by risk takers who focus only on survival (Model 1) is highly dependent on the replacement process and the rate at which aspirations adjust (among other risk takers). To the extent that replacement depends on the numbers of survivors rather than on their resources, risk takers focusing on survival only (Model 1) are favored, particularly when aspirations adjust slowly. To the extent that replacement depends on resources, risk takers focusing on survival only (Model 1) tend to be eliminated.

Third, aspiration levels that are upwardly other-referential, rather than self-referential (i.e., $e < 1$, $c > 0$), tend to increase risk taking, resource accumulation by survivors, and the rate of failure of risk takers following the aspiration-level models (Models 2 and 3). As a result, the consequence of emphasizing other- rather than self-referential aspirations depends on the replacement rules. Where replacement depends on numbers, a survival focus rule (Model 1) is strengthened by having aspirations (of others) attend to the performances of others. Where replacement depends on resources, other-referential aspirations tend to strengthen the position of two-reference-point risk-taking types at the expense of those having an unconditional focus on one reference point or the other.

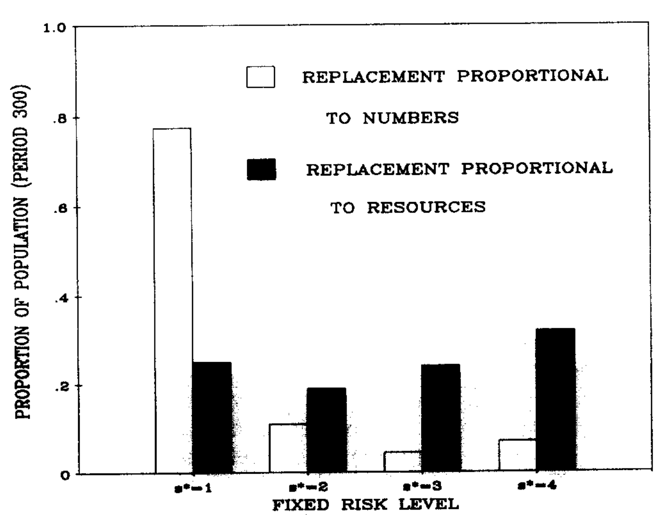

Figure 6. **Proportion of population with s^* = 1, 2, 3, and 4 at Period 300 for two different replacement rules (N = 200 [renewed], p_d = .0001,** $p_f = .05$, $p_s = .3$, $x = 0$, $q = 2$, $k = 3$, and $v = 100$).

Differential Survival When Relative Resource Position Matters

In the preceding discussion, the birth rate of a type depends on the relative position of the type, but the survival of individual risk takers does not depend on the performance of others in the population. Suppose that survival requires that a risk taker's cumulated resources not only be greater than zero but also be large enough to place that risk taker within the top v percent of the population. Such a requirement makes the absorbing barrier at zero irrelevant unless more than $(100 - v)$ percent of the population falls below zero in a particular time period.

Not surprisingly, where the zero point is (almost) irrelevant to survival, a focus on it does not help in the long run. For example, consider a renewing population consisting of risk takers following each of the five variable-risk models (Models 1, 2, 3, 3-A, and 3-B). Suppose that each of the five types initially represents 20% of the population, replacement is proportional to cumulated resources, aspirations are other-referential, and relative position matters ($v = 90$). Figure 7 shows the proportion of the population represented by two of the types (those following Models 1 and 3-B) over time. In the short run, the survival reference-point model (Model 1) dominates the experience-based, shifting-focus model (Variant B of Model 3) as well as other types. In the longer run, it is dominated by Variant B as well as by the others.

The broad general implication is that insofar as relative position with respect to resources matters to survival, a focus on an adaptive aspiration level is strongly favored over a focus on survival. This is true even when replacement rules emphasize numbers rather than resources. The only partial exception is when aspirations are other-referential, rather than self-referential. Generally, though not universally, the two determinate variants of a two-reference-point strategy (Models 3-A and 3-B) are more successful than is a strictly probabilistic shift in focus (Model 3).

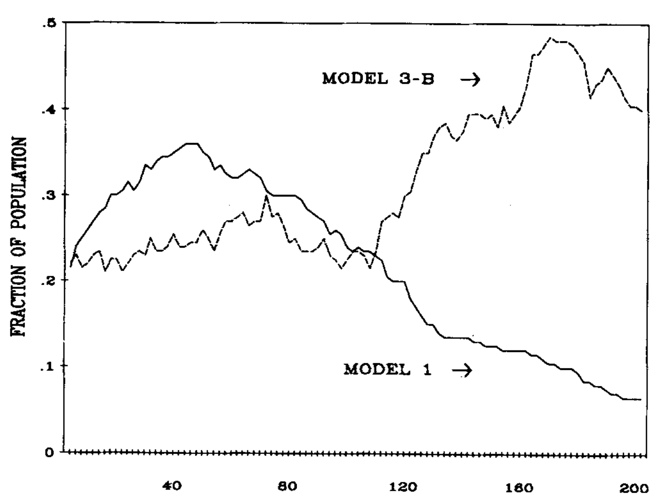

Figure 7. Fraction of population in Models 1 and 3-B over 200 time periods where relative position matters and replacement is governed by resources ($N = 200$ [renewed], $p_d = .0001$, $p_f = .05$, $p_s = .3$, $x = 0$, $q = 2$, $k = 3$, $a = 0.5$, and $v = 90$).

Concluding Remarks

Random-walk models of variable risk taking are stylized representations of relatively complicated processes of attention, choice, rules, procedures, and habit. The notions underlying the present models are an amalgam of ideas portraying individuals and organizations as more or less consciously choosing a level of risk (or unreliability) and of ideas portraying the level of risk (or unreliability) as being a largely unintended consequence of variation in experience, conflict, and control. In both perspectives, one core idea is that the implicit trade-off between the downside dangers and the upside possibilities of variability is organized less by explicit calculation of their net attractiveness than by attending primarily to one or the other and relating the dangers (or possibilities) to a specific target. From this point of view, for example, slack resources can be seen as focusing attention on the advantages of greater variability and experimentation rather than on the dangers.

The models have some claim to usefulness as descriptions of risk-taking behavior. They seem to capture important empirical regularities. Specifically, they can show unstable risk-taking behavior in the neighborhood of death, relatively high levels of risk taking when slack resources are large, risk seeking for losses and risk aversion for gains in the neighborhood of a target, a tendency to change risk preference over time with the same resources, and a tendency to underestimate risks as a result of favorable experience with them.

Exercising the models suggests the following three additional descriptive attributes of variable risk taking. First, in most cases as time goes on, the survivors in a cohort of risk takers will tend to have resources that are fairly substantial, relatively high aspirations for resources, and positive biases in their estimates of the means of their own performance distributions. Second, the rate at which a risk taker's aspirations adjust to that risk taker's own experience is a significant factor in determining risk preference. When aspirations are self-referential, slow adaptation of aspirations to a risk taker's own experience generally leads to greater risk being taken than does fast adaptation. On the other hand, when aspirations are tied to the performance of superior others, fast adaptation tends to lead to greater risk taking than does slow adaptation. Third, the way in which attention is shifted from one reference point to another makes a difference. For example, where attention is allocated to the two reference points by a fixed-probability process, the level of risk taking depends nonmonotonically on the likelihood of attending to the survival point.

The analysis here also confirms previous suggestions that there may be broad survival advantages to variable risk taking oriented to an adaptive aspiration level (J. G. March, 1988b). The precise nature of those advantages depends, however, on interactions among the rate of aspiration adjustment (Levitt & March, 1988), the extent to which aspirations attend to one's own achievements compared to attention to others (Herriott, Levinthal, & March, 1985), the extent to which the focus of attention shifts between a survival point and an aspiration level and the rules governing such shifts (Lopes, 1987), and other specifications of the situation (e.g., the correlation between risk and return, the level of competition, and the "birth process" by which eliminated risk takers are replaced). Thus, although it is possible to see how rules such as those described here might come to dominate risk strategies, it is not possible to rationalize them unconditionally within the present framework.

References

Antonelli, C. (1989). A failure-induced model of research and development expenditure: Italian evidence from the early 1980s. *Journal of Economic Behavior and Organization, 12,* 159–180.

Atkinson, J. (1957). Motivational determinants of risk taking behavior. *Psychological Review, 64,* 359–372.

Bartholomew, D. J. (1973). *Stochastic models for social processes* (2nd ed.). New York: Wiley.

Battalio, R. C., Kagel, J. H., & Jiranyakul, K. (1990). Testing between alternative models of choice under uncertainty: Some initial results. *Journal of Risk and Uncertainty, 3,* 25–50.

Boisjoly, R. (1988). Ethical decisions—Morton Thiokol and the space shuttle Challenger disaster. *American Society of Mechanical Engineers Journal, 87-WA/TS-4,* 1–13.

Bowman, E. H. (1982). Risk seeking by troubled firms. *Sloan Management Review, 23,* 33–42.

Bowman, E. H., & Kunreuther, H. (1988). Post-bhopal behaviour at a chemical company. *Journal of Management Studies, 25,* 387–402.

Brenner, R. (1983). *History—the human gamble.* Chicago: University of Chicago Press.

Bromiley, P. (1991). Testing a causal model of corporate risk-taking and performance. *Academy of Management Journal, 34,* 37–59.

Bromiley, P., & Miller, K. D. (1990). Strategic risk and corporate performance: An analysis of alternative risk measures. *Academy of Management Journal, 33,* 756–779.

Bromiley, P., & Wiseman, R. (1989). *Risk taking by declining organizations.* Unpublished manuscript, University of Minnesota, Carlson School of Management.

Burns, T., & Stalker, G. M. (1961). *The management of innovation.* London: Tavistock.

Czarniawska, B., & Hedberg, B. (1985). Control cycle response to decline. *Scandinavian Journal of Management Studies, 2,* 19–39.

Dubins, L. E., & Savage, L. J. (1965). *How to gamble if you must: Inequalities for stochastic processes.* New York: McGraw-Hill.

Feigenbaum, A., & Thomas, H. (1986). Dynamic and risk measurement perspectives on Bowman's risk-return paradox for strategic management: An empirical study. *Strategic Management Journal, 7,* 395–408.

Feller, W. (1968). *An introduction to probability theory and its applications* (Vol. 1, 3rd ed.). New York: Wiley.

Gibbons, M. R. (1982). Multivariate tests of financial models: A new approach. *Journal of Financial Economics, 10,* 3–27.

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology, 17,* 295–314.

Greenhalgh, L. (1983). Organizational decline. *Research in the Sociology of Organizations, 2,* 231–276.

Hausch, D. B., Ziemba, W. T., & Rubenstein, M. (1981). Efficiency of the market for racetrack betting. *Management Science, 27,* 1435–1452.

Herriott, S. R., Levinthal, D., & March, J. G. (1985). Learning from experience in organizations. *American Economic Review, 75,* 298–302.

Hershey, J. C., & Schoemaker, P. J. (1980). Prospect theory's reflection hypothesis: A critical examination. *Organizational Behavior and Human Performance, 25,* 395–418.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47,* 263–291.

Kamil, A. C., & Roitblat, H. L. (1985). The ecology of foraging behavior: Implications for animal learning and memory. *Annual Review of Psychology, 36,* 141–169.

Keyes, R. (1985). *Chancing it.* Boston: Little, Brown.

Kuhl, J. (1978). Standard setting and risk preference: An elaboration of the theory of achievement motivation and an empirical test. *Psychological Review, 85,* 239–248.

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology, 32,* 311–328.

Lant, T. (in press). Aspiration level adaptation: An empirical exploration. *Management Science.*

Levinthal, D. A. (1990). Organizational adaptation, environmental selection, and random walks. In J. Singh (Ed.), *Organizational evolution: New directions* (pp. 201–223). Newbury Park, CA: Sage.

Levinthal, D. A. (1991). *Random walks and organizational mortality. Administrative Science Quarterly, 36,* 397–420.

Levitt, B., & March, J. G. (1988). Organizational learning. *Annual Review of Sociology, 14,* 319–340.

Lewin, K., Dembo, T., Festinger, L., & Sears, P. (1944). Level of aspiration. In J. M. Hunt (Ed.), *Personality and the behavior disorders* (Vol. 1, pp. 333–378). New York: Ronald.

Libby, R., & Fishburn, P. C. (1977). Behavioral models of risk taking in business decisions: A survey and evaluation. *Journal of Accounting Research, 15,* 272–292.

Lopes, L. L. (1987). Between hope and fear: The psychology of risk. *Advances in Experimental Social Psychology, 20,* 255–295.

MacCrimmon, K. R., & Wehrung, D. A. (1986). *Taking risks: The management of uncertainty.* New York: Free Press.

MacCrimmon, K. R., & Wehrung, D. A. (1990). Characteristics of risk taking executives. *Management Science, 36,* 422–435.

March, J. C., & March, J. G. (1978). Performance sampling in social matches. *Administrative Science Quarterly, 23,* 434–453.

March, J. G. (1981). Footnotes to organizational change. *Administrative Science Quarterly, 26,* 563–577.

March, J. G. (1988a). *Decisions and organizations.* Oxford, England: Basil Blackwell.

March, J. G. (1988b). Variable risk preferences and adaptive aspirations. *Journal of Economic Behavior and Organization, 9,* 5–24.

March, J. G., & Shapira, Z. (1987). Managerial perspectives on risk and risk taking. *Management Science, 33,* 1404–1418.

March, J. G., & Simon, H. A. (1958). *Organizations.* New York: Wiley.

Mayhew, L. B. (1979). *Surviving the eighties.* San Francisco: Jossey-Bass.

Olson, M. (1963). Rapid growth as a destabilizing force. *Journal of Economic History, 23,* 529–552.

Payne, J. W., Laughhann, D. J., & Crum, R. L. (1980). Translation of gambles and aspiration effects in risky choice behavior. *Management Science, 26,* 1039–1060.

Payne, J. W., Laughhann, D. J., & Crum, R. L. (1981). Further tests of aspiration level effects in risky choice behavior. *Management Science, 27,* 953–958.

Revelle, W., & Michaels, E. (1976). The theory of achievement motivation revisited: The implications of inertial tendencies. *Psychological Review, 83,* 394–404.

Roll, R. (1986). The hubris hypothesis of corporate takeovers. *Journal of Business, 59,* 197–216.

Romanow, A. L., & Sellke, T. (1985). Performance sampling and multiple choices: Brownian motion models. *Journal of Mathematical Sociology, 11,* 223–244.

Roy, A. D. (1952). Safety first and the holding of assets. *Econometrica, 20,* 431–449.

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1,* 7–59.

Schneider, S. L., & Lopes, L. L. (1986). Reflection in preferences under risk: Who and when may suggest why. *Journal of Experimental Psychology: Human Perception and Performance, 12,* 535–548.

Shapira, Z., & Venezia, I. (in press). Size and frequency of prizes as determinants of the demand for lotteries. *Organizational Behavior and Human Decision Processes.*

Singh, J. V. (1986). Performance, slack, and risk taking in organizational decision making. *Academy of Management Journal, 29,* 562–585.

Staw, B. M. (1976). Knee-deep in the big muddy: A study of escalating commitment to a chosen course of action. *Organizational Behavior and Human Performance, 16,* 27–44.

Staw, B. M., Sandelands, L. E., & Dutton, J. E. (1981). Threat-rigidity effects in organizational behavior: A multilevel analysis. *Administrative Science Quarterly, 26,* 501–524.

Stone, J. M. (1973). The theory of capacity and the insurance of catastrophic risks. *Journal of Risk and Insurance, 40,* 231–243, 339–355.

Thaler, R. H., & Johnson, E. J. (1990). Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice. *Management Science, 36,* 643–660.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185,* 1124–1131.

Tversky, A., & Kahneman, D. (in press). Loss aversion in riskless choice: A reference dependent model. *Quarterly Journal of Economics.*

Wehrung, D. A. (1989). Risk taking over gains and losses: A study of oil executives. *Annals of Operations Research, 19,* 115–139.

Received September 13, 1990
Revision received April 9, 1991
Accepted April 17, 1991 ■

U.S. Postal Service

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Required by 39 U.S.C. 3685)

1A. Title of Publication: Psychological Review

1B. Publication No.: 4 4 8 8 0 0

2. Date of Filing: 9/23/91

3. Frequency of Issue: Quarterly

3A. No. of Issues Published Annually: 4

3B. Annual Subscription Price: $24/Member, $60/Indv., $ 120/Inst.

4. Complete Mailing Address of Known Office of Publication *(Street, City, County, State and ZIP+4 Code) (Not printers)*: 1400 N Uhle Street, Arlington, VA 22201

5. Complete Mailing Address of the Headquarters of General Business Offices of the Publisher *(Not printer)*: 1200 17th Street, NW, Washington, DC 20036

6. Full Names and Complete Mailing Address of Publisher, Editor, and Managing Editor *(This item MUST NOT be blank)*

Publisher *(Name and Complete Mailing Address)*: American Psychological Association, 1200 17th Street, NW Washington, DC 20036

Editor *(Name and Complete Mailing Address)*: Walter Kintsch, Dept. of Psychology, University of Colorado, Campus Box 345, Boulder, CO 80309

Managing Editor *(Name and Complete Mailing Address)*: Susan Knapp, 1400 N Uhle Street, Arlington, VA 22201

7. Owner [illegible]

Full Name	Complete Mailing Address
American Psychological Association	1200 17th Street, NW Washington, DC 20036

8. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages or Other Securities *(If there are none, so state)*

Full Name	Complete Mailing Address
NONE	

9. For Completion by Nonprofit Organizations Authorized To Mail at Special Rates *(DMM Section 423.12 only)*
The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes *(Check one)*

(1) [x] Has Not Changed During Preceding 12 Months
(2) [ ] Has Changed During Preceding 12 Months
(If changed, publisher must submit explanation of change with this statement.)

10. Extent and Nature of Circulation *(See instructions on reverse side)*	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies *(Net Press Run)*	7,866	7,880
B. Paid and/or Requested Circulation 1. Sales through dealers and carriers, street vendors and counter sales	2,650	2,710
2. Mail Subscription *(Paid and/or requested)*	3,050	3,405
C. Total Paid and/or Requested Circulation *(Sum or 10B1 and 10B2)*	5,700	6,115
D. Free Distribution by Mail, Carrier or Other Means Samples, Complimentary, and Other Free Copies	154	163
E. Total Distribution *(Sum of C and D)*	5,854	6,278
F. Copies Not Distributed 1. Office use, left over, unaccounted, spoiled after printing	2,012	1,602
2. Return from News Agents	-----	------
G. TOTAL *(Sum of E, F1 and 2—should equal net press run shown in A)*	7,866	7,880

11. I certify that the statements made by me above are correct and complete

Signature and Title of Editor, Publisher, Business Manager, or Owner: Paul Miyamoto, Director, Publishing Services

PS Form 3526, Feb. 1989 *(See instructions on reverse)*