Marketing Letters 10:3 (1999): 267–283

Risk Perception in the Short Run and in the Long Run

JAMIL BAZ
Lehman Brothers

ERIC BRIYS
Lehman Brothers

BART J. BRONNENBERG
University of Texas

MICHÈLE COHEN
University of Paris I

ROBERT KAST
CNRS, Greq Aix-Marseille

PASCALE VIALA
European Investment Bank

LUC WATHIEU
Harvard Business School

MARTIN WEBER
University of Mannheim

KLAUS WERTENBROCH
Yale School of Management

Abstract

There is an ongoing controversy in financial economics regarding the role of time horizon in portfolio selection. This problem is relevant in a broader context, wherever consumers or managers make decisions that involve both time and risk. The purpose of this paper is to review recent findings from the decision making literature so as to shed new light on how the short run vs. long run contingency may determine risk taking and perception.

Key words: decision making under risk and uncertainty, time horizon, risk perception, temporal diversification

Introduction

Conventional wisdom suggests that investors with a long time horizon should invest more heavily in risky assets, namely stocks, than investors with a short time horizon. Actuaries have even devised a rule of thumb for computing the percentage of bonds versus stocks one should hold as a function of one's age. This rule is surprisingly simple: this percentage is said to be equal to one's age. In other words when one turns eighty, one should hold

eighty percent bonds and twenty percent equity! The reverse holds true for a twenty-year old.

This notion that risk taking should depend on time horizon does not solely pertain to the financial domain. In marketing, as brand-management systems have emphasized short-term sales response, there has been a drift from advertising towards price promotions, which are known to be the low risk alternative in terms of their ability to boost demand in the short run (Blattberg and Neslin, 1989).

Yet, theoretical research in finance, under standard assumptions about utility functions, has rejected the intuitive notion that the optimal risky asset proportion should depend on the decision maker's time horizon (Merton, 1969; Samuelson, 1969). This paper reviews a set of recent conceptual innovations in the literature on decision making under risk and over time in order to facilitate a re-examination of the issue of risk perception in the short run and in the long run.

In the next section, we review a set of developments around the notion of risk attitude and its re-conceptualization under two circumstances that relate to the short run versus long run contingency: when there is uncertainty about probabilities and when there is background risk. Then we examine how a better understanding of time preferences and other dynamic influences on preferences may enrich the realistic study of risk perception in the short run and in the long run. In the concluding section, we highlight three research themes (risk management in consumer choice, risk management in new product development, and managerial decision making under ambiguity) which are seen as promising areas for further applied research.

1. Risk and Risk Perception

In real-world decision-making contexts, uncertainty comes from the human inability to access and assess all decision-relevant information in its complexity and relatedness. That incapacity causes decision-makers to adopt a simplified view of their environment, where risk and uncertainty remain as an integral and exogenous component.

Since Markowitz (1952), there has been extensive research on how decision-makers should choose among composite alternatives that combine stochastic outcomes. The basis for Markowitz' ideas was that "a portfolio of securities is entirely different from holdings considered individually" (Bernstein, 1996). Indeed, the riskiness of a composite portfolio depends on how the various forms of uncertainty combine, potentially interact with each other to either cancel out or multiply each other's influence.

However, whereas such traditional theories specify how people should make decisions in the face of uncertainty and what the world would look like if people did in fact behave as specified, several of their underlying assumptions and implications are being systematically violated.

First, consider the Allais paradox (Allais, 1953). Subjects are first requested to express their preferences between two prospects. The first, called *A*, guarantees winning \$3,000 with probability 1, while the second, called *B*, is a lottery that yields \$4,000 with probability 0.8. Next, subjects also choose between lottery *C* of winning \$3,000 with

probability 0.25 and lottery D of winning \$4,000 with probability 0.20. Typical preferences are $A \succ B$ and $D \succ C$. Since $C = 0.25\ A + 0.75\ \delta_0$ and $D = 0.25\ B + 0.75\ \delta_0$ (where δ_0 is the "null-prospect" of winning 0 with probability 1), such preferences violate the independence axiom, the key axiom of expected utility theory. Recent advances in decision making under risk relate this type of violation to a "probability weighting function" that offers an effective formal equivalent to the concept of "risk perception." Second, decision-makers appear to be not only sensitive to risk about outcomes but also to (second-order) uncertainty or *ambiguity* (Ellsberg, 1961). Ellsberg points out that most people prefer a lottery with known probabilities than a subjectively equivalent lottery with unknown probabilities. Third, most theoretical developments examine a decision-maker whose initial situation is riskless. In reality, there is generally some undiversifiable "background risk" that needs to be accounted for in a correct analysis.

This section reviews significant advances regarding these three components: probability-weighting functions, ambiguity, and background risk. Even though it remains to be actively documented, it is likely that these three components are affected by decision horizon in a way that ultimately affects risk taking.

1.1. The Probability Weighting Function

The probability weighting function provides decision theorists with a formal tool to represent an individual's risk perception, distinct from the concept of risk aversion. We can trace the origins of this tool to the debates surrounding the type of risk aversion allowed by the traditional model of expected utility.

The most natural way to define risk aversion is as a tendency to choose, when possible, to avoid risk. More precisely, *weak risk aversion* characterizes a decision-maker who always prefers to any random variable X the certainty of its expected value $E(X)$. Another way to define risk aversion is to define it as a dislike of some type of (mean preserving) increasing risk. For example, *strong risk aversion* refers to an aversion towards mean-preserving spreads (Rothschild and Stiglitz, 1970). Cohen (1995) gives a more elaborate overview of the different concepts of risk aversion. Remarkably, a notion as simple as aversion to increasing variance (well-known by finance practitioners) is not always compatible with the definition of weak risk aversion. This is particularly apparent in the expected utility model of von Neumann and Morgenstern (1947). In this classical model, aversion to increasing variance is compatible with weak risk aversion only under very restricted circumstances (e.g., when the utility function is quadratic, or when the encountered random variables are normal or uniform, see Ingersoll, 1987). The expected utility model has also been questioned for its descriptive validity (e.g., in the Allais paradox) and for the difficulty to interpret von Neumann's utility function, which is not merely an index of wealth satisfaction.

The probability weighting function is embedded in the rank-dependent expected utility model[1] (RDEU), a recent model of decision under risk that proves to be compatible with observed behavior such as the Allais paradox. A decision-maker behaves in accordance with the RDEU model when his/her preferences can be characterized by two functions u

and f: a continuous, increasing, cardinal real-valued utility function u interpreted as utility on certain outcomes, and an increasing function f from [0,1] to [0,1] with $f(0)=0$ and $f(1)=1$ that we call the probability-weighting function. For a discrete random variable X denoted by $(x_1, p_1; \ldots x_k, p_k; \ldots; x_n, p_n)$ with ranked outcomes $x_1 < x_2 < \cdots < x_n$, and probabilities $p_i \geq 0$ (such that $\Sigma_i\, p_i = 1$), we can define $q_i = p_{i+1} + \cdots + p_n$, and write the RDEU associated with X as

$$u(x_1) + f(q_1) \cdot [u(x_2) - u(x_1)] + f(q_2) \cdot [u(x_3) - u(x_2)] + \cdots + f(q_{n-1})[u(x_n) - u(x_{n-1})]. \quad (1)$$

A "RDEU decision maker" takes the utility of the worst outcome $u(x_1)$ and weighs the additional possible increases of utility $u(x_i) - u(x_{i-1})$ by his personal perception $f(q_i)$ of the probability q_i of having at least x_i. According to this interpretation, if the decision maker behaves in such a way that $p \geq f(p)$, it means that (s)he underestimates all the additional utilities of gains (consistent with the Allais paradox). In this sense, (s)he can be called pessimistic under risk.

A very simple example can be used to show the role of a probability weighting function: let X be an asset that yields x with probability p and y with probability $1-p$. The valuation of this asset in a RDEU model is $V(X) = [1 - f(1-p)] \cdot u(x) + f(1-p) \cdot u(y)$ if $x < y$ and $V(X) = f(p) \cdot u(x) + [1 - f(p)] \cdot u(y)$ if $y < x$. It has been shown (see, e.g., Chateauneuf, Cohen, Meilijson, 1997) that any type of risk aversion in RDEU implies $f(p) + f(1-p) < 1$ and the decision-maker always underestimates the probability of the best outcome and overweighs the probability of the worse outcome. The different concepts of risk aversion, while all equivalent in EU theory, have different characterizations for u and f in RDEU model, (Chateauneuf, Cohen, and Meilijson, 1997; Chew, Karni, and Safra, 1987).

From an empirical point of view, the probability weighting function f has been assessed by, among others, Abdellaoui (1998), Tversky and Wakker (1995), Wu and Gonzalez (1996), and axiomatically justified by Prelec (1997).

We don't know of any findings regarding the impact of time horizon (e.g., remoteness in time of a lottery) on the shape of the probability weighting function. Are people more or less pessimistic regarding risks that occur in the long run? A rigorous study of this relationship would be a sensible start for a re-examination of risk perception in the short run and in the long run.

1.2. Uncertainty about probabilities

So far, we have assumed that probability distributions are given. In the context of expected utility theory, probabilities are exogenous, i.e., they are not part of the beliefs of the decision maker. In the case of subjective expected utility, decision makers use their own subjective probability distributions. When such is the case, one would think that there are some decision situations where decision makers feel certain about subjective probabilities

and others where they do not feel so confident. In subjective expected utility theory, there is no room for uncertainty about probabilities. For a simple lottery, which pays 100 if an event occurs and nothing if the event A does not occur, the subjective expected utility of the lottery is always $\Pr(A) \cdot u(100) + [1 - \Pr(A)] \cdot u(\mathrm{O})$, regardless of how sure the decision makers feel about the probability of the event. But imagine that you have to assess the stock price distribution of a well-known stock versus the distribution of a rather unknown stock. You might feel more certain (or competent) in judging the well-known stock versus the unknown stock. On average, people are averse to the ambiguity of betting on an unknown event. Following this idea you prefer to bet on the well-known stock versus betting on the unknown stock.

The effect of ambiguity on decision making under uncertainty was most clearly demonstrated by the famous Ellsberg paradox. Ellsberg (1961) posed a two-color problem (and a more elaborate three-color problem) using two urns, Urn I containing 50 red and 50 black balls and Urn II containing 100 balls in an unknown combination of red and black. Many people prefer to bet on red from Urn I (rather than betting on red from Urn II) *and* prefer to bet on black from Urn I rather than betting on black from Urn II. In addition, they are indifferent between the two colors when betting on only one of the two urns. Since Ellsberg, there have been numerous demonstrations that attitudes towards ambiguity impacts decision-making under uncertainty (see Camerer and Weber, 1992 for an overview).

There are numerous competing theories to model ambiguity effects and numerous studies to demonstrate the effect. Luce (1991), Luce and Fishburn (1991), Schmeidler (1989), Sarin and Wakker (1992), Starmer and Sudgen (1989), Tversky and Kahneman (1992), Tversky and Wakker (1995) and Wakker and Tversky (1993) have developed Choquet expected utility theory (as well as "cumulative prospect theory") to allow for nonneutral attitudes towards ambiguity. First, rank the states s_{i} from 1 to n based on their utilities $\mu(f(s_i))$. Then, Choquet expected utility is defined as

$$u(f(s_1)) * p(s_1) + \sum_{i=2}^{n} u(f(s_1)) * \left[p\left(\bigcup_{j=1}^{i} s_j \right) - p\left(\bigcup_{j=1}^{i-1} s_j \right) \right] \tag{2}$$

The rank-dependent extension of prospect theory (called cumulative prospect theory) uses Choquet integrals to compute decision weights. The twist is that Choquet weighting reflects around the origin.

In our thinking, ambiguity effects can best be understood by the fact that a decision maker prefers to bet on some sources of uncertainty over some other sources of uncertainty, i.e., preferences are source-dependent. If you have German students bet on German stocks, they will most likely prefer this bet to a bet on Japanese stocks (everything else being equal), see Kilka and Weber (1998) for this specific example. Japanese students, in contrast, might prefer to bet on their home stocks, i.e., the ambiguity effect might well depend on the knowledge or competence a decision maker has in evaluating an event, see Heath and Tversky (1991), Tversky and Fox (1995), Keppe and Weber (1995), Fox,

Rogers and Tversky (1996) and Wu and Gonzalez (1998) for more empirical research on this topic.

Now, what does this imply for risk perception in the long run and in the short run? To the best of our knowledge, it has not been investigated how ambiguity effects relate to risk perception. Intuitively, one would say that lotteries where subjects show strong ambiguity aversion would also be judged to be more risky—but we don't know. There is also very little known about ambiguity effects over time. Thus there is room for research on how ambiguity affects short term vs. long term risks. Discussing ambiguity in the light of uncertainty over preferences or even second order probabilities, one might hypothesize that ambiguity diminishes or reduces over time as the decision maker learns more about the probability of the event (or (s)he feels more competent in judging the event).

1.3. Background risk

Standard textbooks deal with risk aversion in the following context: either a decision maker has a certain wealth and is faced with a choice that makes his wealth become risky (investment problems), or the initial wealth is risky and the decision maker considers possibilities to hedge, insure, or get partially rid of the risky part of his/her wealth. In both cases, the comparison is between a risky situation and a riskless one.

In contrast, the recent literature on background risk addresses the issue of how to deal with situations where some risks remain out of reach for the decision maker. Such situations are relevant to a number of real life (and even economic) problems, for instance an increase or a deterioration in risk perception, a non-insurable risk (wages, for instance), or a risky investment which cannot be hedged by financial instruments (incomplete markets).

A number of puzzling results appeared in the literature, which questioned the validity of the traditional approach when background risk prevails. For instance, Kihlstrom, Romer and Williams, (1981) showed that an increase in risk aversion (measured by Arrow-Pratt's index, in the context of expected utility theory) does not imply a decrease in risky investment, in the presence of background risk. Similar results can be found in the insurance literature (e.g., Doherty and Schlesinger, 1983).

The main difficulty with background risk is that a riskless benchmark is not available anymore to compare situations. As a consequence the literature has dwelled on relevant refinements of the notion of risk aversion. Main contributions are: Pratt and Zeckhauser's (1987) "Proper risk aversion" (risk aversion is proper if adding an undesirable risk to wealth has a negative impact on the attitude towards other risks), Kimball's (1993) "Standard risk aversion" (any risk that makes a small reduction in wealth more painful, also makes any statistically independent undesirable risk more painful), Gollier and Pratt's (1996) "Risk vulnerability" (an undesirable background risk increases aversion to other independent risks). Yet another approach is to focus on relevant notions of "risk increase" (see Eeckhoudt and Gollier, 1997 for a survey).

With tools and results which have been developed only so recently, the literature on time horizon effects in the presence of background risk cannot be expected to be very broad.

However, the topic attracts a growing attention and a comeback to seminal approaches as the ones proposed by Samuelson (1963, 1989) and by Merton (1969). For instance, an empirical paper from Guiso, Japeeli and Terlizee (1996) on the relation between age and risk taking in a cross-section of Italian household shows that young people (facing higher income risk) hold smaller proportion of risky assets in their portfolios. Yet, Bodie, Merton and Samuelson (1992) showed that young people with constant relative risk aversion should take greater investment risks than older ones. In a recent paper, Gollier and Zeckhauser (1997) concentrate on the following question: under what conditions on the von Neumann-Morgenstern utility function would longer time horizon increase risk aversion? Such characterizations are highly technical (fourth derivative) and do not shed much light on individual behavior in front of time horizon and the resolution of uncertainty. However they yield interesting nonintuitive results which show that one needs to be careful with problems of risk perception in the long run when background risk prevails.

2. Dynamics of Risk and Risk Perception

2.1. Time diversification

Over the last three decades much research has been devoted to the study of the notions of risk and diversification. More specifically, it has been shown in a one-period context that investors can achieve so-called mean-variance efficient equity portfolios by diversifying across a number of stocks. This result is reminiscent of the old saying that one should not put all one's eggs into the same basket. The next step has been to consider a multi-period framework including not only stocks but also bonds. Indeed, conventional wisdom holds that investors with a long time horizon should invest more heavily in risky assets, namely stocks, than investors with a short time horizon. This time horizon effect is usually interpreted from the point of view that in the long run stocks out perform bonds and that younger investors have more time to recoup in case things turn sour in the equity market. This is the so-called time-diversification effect.

Although this effect seems at first intuitive, several classical theories in finance do not support it. Indeed, this conventional wisdom is usually attributed to a fallacy (Samuelson, 1963, Merton and Samuelson, 1974). Both Samuelson (1969) and Merton (1969) show that the optimal risky asset proportion is independent of the investor's age. All else equal, the young manager and the old widow should both invest the same percentage of their wealth in equity. This result is obtained in an intertemporal context with a stationary distribution of returns and under a specific set of utility functions.[2]

This debate has been recently renewed by Bodie (1995). Bodie took an alternative stance by relying upon an option-theoretic framework instead of using an expected utility framework. Taking as a measure of the riskiness of an investment the cost of insuring it against earning less than the risk-free rate over the investor's time horizon, Bodie showed that the riskiness of stocks increases rather than decreases with the length of the time-horizon. In other words, by defining riskiness in a shortfall insurance context, Bodie was

able to turn the conventional wisdom upside down. His result makes sense if one considers that, indeed, the price of an insurance contract against the risk of a shortfall should increase with its maturity. A twenty-year insurance policy should be more expensive than a one-year insurance policy.

The time-diversification debate is far from being settled. The surprising feature though in Bodie's contribution is that his result is derived in a preference-free framework.

2.2 Special issues with dynamic risks

Growth, feedback and externalities are an inalienable part of economic and marketing decision-environments (see, e.g., Arthur, 1994). Therefore, the perception of long-run risk will likely depend in part on the dynamics in the market place caused by these phenomena. In contrast, perception of short-run risks can be relatively immune to the influence of longer-run dynamics of markets.

Feedback. For the long run, the relevant question with respect to the time dependence of risks is: does uncertainty have a tendency to cancel itself out over time? Or do the forces that create decision risk accumulate or even multiply the variability of the decision outcomes over time? For example, if the occurrence of a success (in a general sense) is positively influenced by a past failure and vice versa then we may speak of negative feedback among outcomes. If on the other hand, successes depend positively on previous successes (and the same for failures) then positive feedback among outcomes exists. With such feedback, uncertainties in winning or losing tend to cancel out in the first case but accumulate in the latter.

Samuelson (1991) posits a "rebound" model of long-term market behavior in which returns on risky stocks are negatively correlated through time and a "momentum" model of long-term market behavior in which returns are positively correlated through time. The question is how this contingency might impact risk-taking by investors. Samuelson finds, under some conditions, that investors allocate a larger portion of their wealth to risky stocks when they find themselves investing in rebound markets than when market behavior is consistent with the momentum model. Central to the issue of time-dependence of risk perception, he hypothesizes that the difference in risk taking across rebound- and momentum-markets increases with the length of the planning horizon.

Behavioral economists confirm that feedback effects may exist. De Bondt and Thaler (1985) find that equity markets over-react, i.e., that equity markets seem to behave consistent with rebound markets. Also, the gambler's fallacy (a gambler's tendency to avoid betting on recent winners and to favor outcomes which have not come up for a while, Clotfelter and Cook, 1993) and recency biases (Rabin, 1998) may contribute in the same way to time-dependence of risk attitude and perception.

Dynamic risks caused by feedback are also examined in the literature on positive network externalities. Arthur (1994) uses the Pólya urn scheme (Pólya, 1931), as a model for the dynamic process with which market shares of two competing new technologies evolve. A Pólya urn scheme is a process where repeated draws from two types of balls (the

two "technologies"), result in replacement with more balls of the most recently drawn type. Such a process displays positive feedback. The standard Pólya urn scheme starts with one ball of each type, say a red ball and a black ball. Subsequently a draw of any type results in replacement of two balls of the same type. For example, after the first draw there may be either two red balls and one black ball or one red ball and two black balls. Because of the feedback, the next draw is more likely of the color with the highest share (enforcing the dominance subsequently). After many draws, the share of red balls in the urn converges to a fixed value on [0,1]. The limiting distribution of this limiting share turns out to be a uniform distribution (Johnson and Kotz, 1977).

The above case, short-term uncertainty is low (two possible payoffs with known probabilities) whereas a-priori uncertainty about the long term market share is high (long-term shares are uniformly distributed, i.e. literally anything may happen). Indeed, the variance in outcomes is less after one round of the process that the up-front variance in the long-term outcomes.

Therefore, managers facing similar positive feedback will likely perceive the evolution of market shares as a long-term risk although this evolution is most sensitive to current events. The stylized example above also offers an interpretation for why firms develop a portfolio of products. If uncertainty accumulates through time, it seems prudent to allocate resources to multiple independent new products, rather than putting all resources of a firm behind a single project at a time.

Payoff externalities. When looking at intertemporal choices, another question must be raised: can the perception of long-run risk be affected by the organizational environment of the decision maker?

Research in finance does support this view. For instance, it has been noted that both corporations and institutional investors appear to be concerned by the timing of returns and to exhibit a preference for the short run. One argument usually given is that they bear more risk in the long run (see also the preceding discussion). However, theoretical work suggests that their intertemporal choices are more likely to be influenced by the existence of *payoff externalities* resulting from various market imperfections. Indeed, this may explain that opting for the short-run could be viewed as a way to 'play safe', regardless of the inherent level of risk.

The literature emphasizes that information problems or incentive issues could drive a preference for the short-run. One can take as an example the work on corporate myopia, which attempts to rationalize that industrial firms display a bias toward short-term investment. Some models highlight that *reputation concerns* can cause a preference for the early resolution of uncertainty. They typically show that a manager may need to produce early returns in order to convey private information (Holmstrom, 1982; Webb, 1993). For example, in Holmstrom (1982), the manager is concerned by his labor market value. Thus, s/he chooses an investment project that delivers the cash flows rapidly in order to quickly resolve the market uncertainty regarding his/her ability. In Webb (1993) and Thakor (1993), the short-term investment bias results from the manager's effort to mitigate an adverse selection problem in financial markets. Webb looks at corporations that must obtain credit from banks in a world of asymmetric information about the quality of

earning streams. Since lenders cannot discriminate between firms on an ex ante basis, managers of 'good' firms invest in projects that yield early returns in order to prove quality. Hence, they can subsequently try to renegotiate loan contingencies or proceed to additional borrowings at 'fair' financial terms.

The literature on corporate myopia shows also that the preference for the short run may be driven by *principal-agent* concerns. For example, Noe and Rebello (1997) demonstrate that, in order to minimise cash flows expropriation, shareholders may have to devise compensation schemes tied to the short-term performance. Thus, managers tend to concentrate on short-term returns and to forgo long-term investment projects.

What conclusion can we draw from these examples? Perhaps that the perception of long-run risk can be hard to isolate from the decision-maker's concern for the early (or late) resolution of uncertainty when externalities prevails.

2.3. Preference dynamics

Individual time preferences are usually captured by the rate at which consumers discount future outcomes, or by the rate of intertemporal substitution, at which consumers trade off present and future outcomes. In the standard expected utility framework, the elasticity of intertemporal substitution is the inverse of the coefficient of relative risk aversion (see, e.g., Benartzi and Thaler, 1995). Yet recent empirical research has not only suggested that the two are independent (Barsky, Juster, Kimball, and Shapiro, 1997) but also that uncertainty about future outcomes may affect how outcomes are discounted (Ahlbrecht and Weber, 1997; Stevenson, 1992). Ahlbrecht and Weber (1997) confirmed the finding by Stevenson (1992) that risky outcomes are less discounted than certain outcomes, perhaps due to a cognitive difficulty to account simultaneously for both risk and time concerns. Below, we suggest that several non-normative features of time preference may affect intertemporal choice under uncertainty in several ways.

Short-term risk seeking and dynamic inconsistency. First, some dynamic preference inconsistencies may appear as short-term risk seeking. Strotz (1956) showed that consistent utility maximizing consumers discount future outcomes at a constant rate [e.g., $v_t(x) = v_0(x)/(1 + r)^t$, or exponential discounting, where v is the value of an outcome x, obtained immediately at time $t = 0$ or later at $t > 0$, and r is the discount rate]. Yet actual preferences are often characterized by non-constant discounting [e.g., $v_t(x) = v_0(x)/(1 + t)$, or hyperbolic discounting, where the discount rate increases with the number of periods; see Ainslie, 1975; Kirby, 1997; Laibson, 1996; Strotz, 1956]. Impulsive behaviors such as smoking that have uncertain, delayed, negative consequences may be viewed as risk seeking in the long run, although they often correspond to dynamically inconsistent preferences. This perspective suggests that future research should examine if long-term risk seeking may be modeled as impulsive behavior via non-constant discounting or, conversely, whether certain types of impulsive behavior can be represented without resorting to non-constant discounting (as in Wathieu, 1997b). Self-control via precommitment could indeed be seen as an attempt to forestall future risk seeking choices at a time

(e.g., the point of purchase) when preferences are still risk neutral or risk averse (see Wertenbroch, 1998; Wertenbroch and Carmon, 1997 for implications of self-control in marketing).

Short-term risk aversion and myopic loss aversion. Work by Benartzi and Thaler (1995) suggests that what looks like short-term risk aversion in repeated choices may result from loss aversion (Kahneman and Tversky, 1979). Specifically, decision makers with loss averse utility functions who evaluate each choice in a series of risky individual decisions (i.e., myopically) prefer not to make choices that may lead to losses, even when the expected value of these choices is positive (Lopes, 1981; Samuelson, 1963). However, evaluating a series of such gambles jointly may yield positive expected utility even under loss aversion. Thus, what Benartzi and Thaler (1995) term myopic loss aversion amplifies risk aversion in standard utility models and leads to inconsistent preferences depending on whether decision makers take a short-run or long-run perspective. The effect of myopic loss aversion can be attenuated by precommitment (Strotz, 1956), specifically to an aggregate evaluation mode. For example, considering that long-term stock returns have historically been highly positive (but see Jorion and Goetzmann, 1999), long-term investors may maximize returns by preventing themselves from re-evaluating their portfolios on a regular basis (Redelmeier and Tversky, 1992; Kahneman and Lovallo, 1993; Wathieu, 1997b). Note, however, that consumers may be unable to anticipate preference inconsistencies due to myopic loss aversion (see Loewenstein and Adler, 1995). Nevertheless, frequent outcome feedback may create self-control problems as it can shift one's reference point and induce myopic loss aversion, leading to choices that one may prefer not to make from a long-term perspective.

Experiential learning. Recent work by March (1996) suggests that risk taking behavior is learned by decision-makers and is not an exogenous trait of humans or utility functions. March uses experiential learning to explain why decision-makers are risk-seeking in losses and risk-averse in gains. According to the theory of experiential learning, humans from preferences based on past choices, i.e., they reinforce preference for options with past positive rewards and they discount preferences for options with past negative rewards. March reviewed the consequences of various such positive or negative reinforcement mechanisms for choices between a certain prospect X and a risky prospect that yields 0 with probability p and $X/(1-p)$ with probability $(1-p)$. His studies with simulated subjects suggests that various experimental learning rules induced longterm preferences for the certain prospect when X is positive and induced long-term preferences for the risky prospect when X is negative despite the fact that those preferences were initially balanced.

The experiential learning hypothesis further appears juxtaposed to ideas about the positive association between risk aversion and age noted previously in the discussion on the time-diversification effect. Namely, in the domain of positive outcomes, experiential learning links risk aversion to accumulated learning, which in turn is linked to age.

Resolution preference. Thaler (1981) found that large gains are discounted less heavily than other outcomes (the "magnitude effect"). Perhaps because of their overwhelming

salience that distracts from temporal distance. Or, perhaps, because of hope (Chew and Ho, 1994): the value of large gains that occur with small probabilities increases with delays in uncertainty resolution. If a lottery implies the possibility of a large gain, then hope and the magnitude effect will bias risk perception towards making that risk more attractive in the long run. The same bias would result from a preference for flexibility/reversibility (Henry, 1974; Kreps, 1979) that should naturally lead to a desire to postpone irreversible risks.

Uncertainty about future preferences. Time may also introduce uncertainty about one's preferences, not just outcomes, when consumers have to predict their own future preferences (Kahneman and Snell, 1990). For example, a consumer who buys groceries for an entire week has to predict how often he or she will prefer frozen yogurt over ice cream for dessert that week. This prediction is often subject to uncertainty. How do consumers deal with this uncertainty? Several lines of research have looked into variety seeking as a strategy to construct portfolios to diversify away the risk of not knowing precisely what one will want in the future, even controlling for changes in the environment. Simonson (1990) showed that consumers prefer a greater degree of variety among purchases from a product category when they choose simultaneously for future consumption than when they choose items sequentially, one at a time at the time of consumption (Simonson and Winer, 1992). Including even less preferred items as part of the set may be considered a premium to insure against regret and the risk of not liking any particular item at the time of consumption (cf. Kahn, Ratner, and Kahneman, 1997; Simonson, 1992). Read and Loewenstein (1995) have reinterpreted these findings as reflecting a bias in consumers' predictions of how fast they reach satiation. Specifically, consumers predict that they will be satiated faster than they really do (time contraction), resulting in excessive diversification. What has not been examined yet, is whether and how the length of the delay between purchase and consumption may affect preference uncertainty and hence choice.

3. Summary and Themes for Further Research

Several theories of time diversification in finance have dismissed the decision horizon as an irrelevant variable. In contrast, this paper argued that risk taking under a short horizon is likely to be different than risk taking under a long horizon. This derives from a review of a variety of recent contributions on realistic features of individual preferences over time: dynamic inconsistencies, loss aversion, experiential learning, resolution preferences, and uncertainties about preferences. These behavioral elements were reinforced by our contention that through feedback and externalities, decision situations under risk are structurally affected by the decision horizon.

We have also suggested that a good place to start further research would be to study the impact of the decision horizon on (1) probability perception, via the probability weighting function (how does a longer horizon affect pessimism and optimism?), (2) ambiguity (is a longer horizon causing lack of confidence in subjective beliefs?), and (3) background risk (is a longer horizon associated with an increase in non-diversifiable/non-insurable risks?).

On the more applied side, we can see three themes of research in marketing where the role of decision horizons on perceptions of risk will be important.

Risk management in consumer choice. As suggested above, pre-commitment and variety-seeking can be usefully re-examined as an issue of risk perception in the short vs. the long run. But many other aspects of consumer behavior can also be seen as the outcome of a risk-reduction strategy. For instance, between two risks of identical description, consumers prefer the risk that has a stronger brand name attached to it. This is essentially a phenomenon of decreased risk perception towards a risk (a branded good) that has persisted in the long run. Issues of product warranties, and of waiting time perception, among others, can fruitfully be re-examined along the same line.

Risk management in new product development. The inherent riskiness of new product introduction should induce firms to develop a portfolio of products. Research questions that have been left largely unanswered in marketing are whether positive feedback markets indeed show more diversification than markets where negative feedback has set in.

Managerial decision making and ambiguity. Managerial decision environments are usually ambiguous. It seems therefore very fruitful to study in more depth how ambiguity affects decision making in the short and the long run. For instance, Fox and Tversky (1995) find that aversion to ambiguity is limited to situations where the decision-makers feel they lack competence. Thus decision-makers prefer to gamble on known chances, in situations where they are admitted novices, while they don't mind taking risks on the basis of vague information when they feel competent. Perhaps this interaction between ambiguity-aversion and perceived competence explains the paradoxical observation that troubled firms tend to engage in developing new but risky ventures whose success probabilities are vague at best as opposed to following a more conservative policy involving less ambiguous possibilities for recovery or growth. This observation is somewhat paradoxical (Bowman, 1980, 1982) in that from finance we are used to low-profit going hand in hand with low-risk. The finding of Fox and Tversky (1995) suggests that gambling on ambiguous ventures offers a troubled firm the luxury of short-run hope and optimism.

Notes

1. This model is due to Quiggin (1982), with variants of this model due to Yaari (1987) and Allais (1988).
2. Nielsen (1985) shows that compounding lotteries increase their attractiveness if there is a chance that the compound leads to a wealth level where the degree of risk aversion is lower than the initial wealth level, or if the investor has some sort of limited liability.

References

Abdellaoui, Mohammed. (1998). "Parameter-Free Elicitation of Utilities and Probabilities Weighting Functions" Working Paper, GRID.

Ainslie, George. (1975). "Specious Rewards: A Behavioral Theory of Impulsiveness and Impulse Control," *Psychological Bulletin* 82, 463–496.

Albrecht, Martin and Martin Weber. (1997). "An Empirical Study on Intertemporal Decision Making Under Risk," *Management Science* 43 (6), 813–826.

Allais, Maurice. (1953). "Le Comportement de l'Homme Rationnel Devant le Risque: Critique des Postulats et Axiomes de l'école américaine," *Econometrica* 21, 503–546.

Allais, Maurice. (1988). "The General Theory of Random Choices in Relation to the Invariant Cardinal Utility Function and the Specific Probability Function," in *Risk, Decision and Rationality,* B. R. Munier (Ed.), Reidel: Dordrech, 233–289.

Arthur, Brian. (1994). *Increasing Returns and Path Dependence in the Economy,* Ann Arbor, MI: The University of Michigan Press

Barsky, Robert B., et al. (1997). "Preference Parameters and Behavioral Heterogeneity, An Experimental Approach in the Health and Retirement Industry," *The Quarterly Journal of Economics* 112 (May), 537–579.

Benartzi, Shlomo and Richard H. Thaler. (1995). "Myopic Loss Aversion and The Equity Premium Puzzle," *Quarterly Journal of Economics* 110 (February), 73–92.

Bernstein, Peter L. (1996). *Against the Gods: The Remarkable Story of Risk,* New York, NY: John Wiley and Sons Inc.

Blattberg, Robert C. and Scott A. Neslin. (1989). "Sales promotion: the Long and the Short of it," *Marketing Letters* 1 (1), 81–97.

Bodie, Zvi. (1995). "On the Risk of Stocks in the Long Run," Financial Analysts Journal 51 (3), 18–22.

Bodie, Zvi, Robert Merton, and William Samuelson. (1992). "Labor Supply Flexibility and Portfolio Choice in a Life-Cycle Model," *Journal of Economic Dynamics and Control* 16.

Bowman, Edward H. (1980). "A Risk Return Paradox for Strategic Management," *Sloan Management Review* 21 (3), 17–31.

Bowman, Edward H. (1982). "Risk Seeking by Troubled Firms," *Sloan Management Review* 23 (4), 33–42.

Camerer, Colin and Martin Weber. (1992). "Recent Developments in Modeling Preferences: Uncertainty and Ambiguity," *Journal of Risk and Uncertainty* 5, 325–370.

Chateauneuf, Alain, Michele Cohen, and Isaac Meilijson. (1997). "New Tools to Better Modelize Behavior Under Risk and Uncertainty: An Overview," *Revue Finance* 18, 1.

Chateauneuf, Alain. (1998). "Comonotonicity Axioms and RDEU Theory for Arbitrary Consequences," *Journal of Mathematical Economics,* forthcoming.

Chew, Soo Hong, Edi. Karni and Zvi Safra. (1987). "Risk Aversion in the Theory of Expected Utility with Rank Dependent Preferences," *Journal of Economic Theory* 42, 370–381.

Chew, Soo Hong, and Johanna L. Ho. (1994). "Hope: An Empirical Study of Attitude Towards Timing of Resolution," *Journal of Risk and Uncertainty* 8, 267–288.

Clotfelter, Charles T., and Philip J. Cook. (1993). "The "Gambler's Fallacy" in Lottery Play," *Management Science* 39, 1521–1525.

Cohen, Michéle. (1995). "Risk Aversion Concepts in Expected and Non-Expected Utility Models," *The Geneva Papers on Risk and Insurance Theory* 20, 73–91.

De Bondt, Werner and Richard H. Thaler. (1985). "Does the Stock Market Overreact?," *Journal of Finance* 40 (3), 793–805.

Doherty, Neil A. and Harris Schlesinger. (1983). "Optimal Insurance in Incomplete Markets", *Journal of Political Economy* 91 (6), 1045–1054.

Eeckhoudt, Louis and Christian Gollier. (1997). "Changes in risk and risk taking: a survey," Cahiers du GREMAQ nr. 97.29.472, Toulouse.

Ellsberg, Daniel. (1961). "Risk, Ambiguity and the Savage Axioms," *Quarterly Journal of Economics* 75, 643–669.

Fox, Craig R., Brett A. Rogers, and Amos Tversky. (1996). "Option Traders Exhibit Subadditive Decision Weights," *Journal of Risk and Uncertainty* 13, 5–17.

Fox, Craig R. and Amos Tversky. (1995). "Ambiguity Aversion and Comparative Ignorance," *Quarterly Journal of Economics* 110 (3), 585–603.

Gollier, Christian and John Pratt. (1996). "Risk Vulnerability and the Tempering Effect of Background Risk," *Econometrica* 64, 1109–1124.

Gollier, Christian and Richard Zeckhauser. (1997). "Horizon Length and Portfolio Risk," IDEI Working Paper, 11, Toulouse.

Guiso, Luigi, Tullio Japeeli, and Daniele Terlizzese. (1996). "Income Risk, Borrowing Constraints, and Portfolio Choice," *American Economic Review* 86, 158–172.

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

Henry, Claude. (1974). "Investment Decisions under Uncertainty: The "Irreversibility Effect," *American Economic Review* 64 (6), 1006–1012.

Holmstrom, Bengt. (1982). "Managerial Incentive Problems-a Dynamic Perspective," in *Essays in Economics and Management in Honor of Lars Wahlbeck.* Helsinki: Swedish School of Economics.

Ingersoll, Jonathan E. (1987). *Theory of Financial Decision Making,* Totowa, NJ: Rowman and Littlefield, Chap 5.

Johnson, Norman L. and Samuel Kotz. (1977). *Urn Models and Their Applications,* New York, NY: John Wiley and Sons.

Jorion, Phillipe and William N. Goetzmann. (1999). "Global Stock Markets in the Twentieth Century," *The Journal of Finance,* forthcoming.

Kahn, Barbara E., Rebecca K. Ratner, and Daniel Kahneman. (1997). "Patterns of Hedonic Consumption over Time," *Marketing Letters* 8 (January), 85–96.

Kahneman, Daniel and Dan Lovallo. (1993). "Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking," *Management Science* 39, 17–31.

Kahneman, Daniel and Amos Tversky. (1979). "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica* 47, 263–291.

Kahneman, Daniel and Amos Tversky. (1984). "Choices, Values and Frames," *American Psychologist* 39 (4), 342–347.

Kahneman, Daniel and Jackie Snell. (1992). "Predicting a Changing Taste: Do People Know What They Will Like?," *Journal of Behavioral Decision Making* 5, 187–200.

Keppe, Hans J. and Martin Weber. (1995). "Judged Knowledge and Ambiguity Aversion," *Theory and Decision* 39, 51–77.

Kihlstrom Richard, David Romer, and Steve Williams. (1981). "Risk Aversion With Random Initial Wealth", *Econometrica* 49, 911–920.

Kilka, Michael and Martin Weber. (1998). "Home Bias in International Stock Return Expectations," Working Paper, Universität Mannheim.

Kimball Miles (1993). "Standard Risk Aversion", *Econometrica* 61, 589–611.

Kirby, Kris N. (1997). "Bidding on the Future: Evidence against Normative Discounting of Delayed Rewards," *Journal of Experimental Psychology: General* 126, 54–70.

Kreps, David M. (1979). "A Representation Theorem for Preference for Flexibility," *Econometrica* 47, 565–77.

Laibson, David (1996), "Hyperbolic Discount Functions, Undersaving, and Savings Policy," *NBER working paper* 5635.

Loewenstein, George and Daniel Adler. (1995). "A Bias in the Prediction of Tastes," *Economic Journal* 105, 929–937.

Lopes, Lola L. (1981). "Decision Making in the Short Run," *Journal of Experimental Psychology: Human Learning and Memory* 7, 377–385.

Luce, R. Duncan. (1991). "Rank-and Sign-Dependent Linear Utility Models for Binary Gambles," *Journal of Economic Theory* 53, 75–100.

Luce, R. Duncan and Peter C. Fishburn. (1991). "Rank-and Sign-Dependent Linear Utility Models for Finite First-Order Gambles," *Journal of Risk and Uncertainty* 4, 29–59.

March, James G. (1996) "Learning to be Risk Averse," *Psychological Review* 103:2, 309–19.

Markowitz, Harry M. (1952). "Portfolio Selection," *Journal of Finance* 7(1), 77–91.

Merton, Robert C. (1969). "Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case," *Review of Economics and Statistics* 51(3), 247–257.

Merton, Robert C. and Paul A. Samuelson. (1974). "Fallacy of the Log-Normal Approximation to Optimal Portfolio Decision Making Over Many Periods," *Journal of Financial Economics* (1).

Nielsen, Lars T. (1985). "Attractive Compounds of Unattractive Investments and Gambles," *Scandinavian Journal of Economics* 87, 463–473.

Noe, Thomas H. and Michael J. Rebello. (1997). "Renegotiations, Investment Horizons, and Managerial Discretion," *Journal of Business* 70 (3), 385–407.

Pólya, George. (1931). "Sur Quelques Points de la Théorie des Probabilités," *Annales de l'Institut Henri Poincaré* 1, 117–161.

Pratt, John and Richard Zeckhauser. (1987). "Proper Risk Aversion," *Econometrica* 55, 143–154.

Prelec, Drazen. (1988). "The Probability Weighting Function," *Econometrica* 66 (3), 497–527.

Quiggin, John A. (1982). "A Theory of Anticipated Utility," *Journal of Economic Behavior and Organization* 3(4), 323–343.

Rabin, Matthew. (1988). "Psychology and Economics," *Journal of Economic Literature* 36(1), 11–46.

Read, Daniel and George Loewenstein. (1995). "Diversification Bias: Explaining the Discrepancy in Variety Seeking Between Combined and Separated Choices," *Journal of Experimental Psychology: Applied* 1, 34–49.

Redelmeier, D. A. and Amos Tversky. (1992). "On the Framing of Multiple Prospects," Psychological Science 3, 191–193.

Rothschild, Michael and Joseph Stiglitz. (1970). "Increasing Risk: I. A definition," *Journal of Economic Theory* 2, 225–243.

Samuelson, Paul A. (1963). "Risk and Uncertainty: The Fallacy of the Law Of Large Numbers," *Scientia* 98, 108–113.

Samuelson, Paul A. (1969). "Lifetime Portfolio Selection by Dynamic Stochastic Programming," *Review of Economics & Statistics* 51 (3), 239–46.

Samuelson, Paul. A. (1989). "The Judgement of Economic Science on Rationale Portfolio Management: Indexing, Timing and Long-Horizon Effects," *Journal of Portfolio Management* (Fall), 3–12.

Samuelson, Paul A. (1991). "Long-Run Risk Tolerance When Equity Returns are Mean Regressing: PseudoParadoxes and Vindication of 'Businessman's Risk'," in *Money, Macroeconomics, and Economic Policy: Essays in Honor of James Tobin,* William C. Brainard, William D. Nordhaus, and Harold W. Watts eds., Cambridge, MA: MIT Press.

Samuelson, Paul A. (1997). "Proof by Certainty Equivalents That Diversification-Across Time Does Worse, Risk Corrected, Than Diversification-Throughout Time," *Journal of Risk and Uncertainty* 14, 129–142

Sarin, Rakesh and Peter P. Wakker. (1992). "A Simple Axiomatization of Nonadditive Expected Utility," *Econometrica* 60, 1255–1272.

Schmeidler, David. (1989). "Subjective Probability and Expected Utility without Additivity," *Econometrica* 57, 571–587.

Simonson, Itamar. (1990). "The Effect of Purchase Quantity and Timing on Variety Seeking Behavior," *Journal of Marketing Research* 27 (May), 150–162.

Simonson, Itamar. (1992). "The Influence of Anticipating Regret and Responsibility on Purchase Decisions," *Journal of Consumer Research*, 19 (June), 105–118.

Simonson, Itanar and Russell S. Winer. (1992). "The Influence of Purchase Quantity and Display Format on Consumer Preference for Variety," *Journal of Consumer Research*, 19 (June), 133–138.

Starmer, Chris and Robert Sudgen. (1989). "Violations of the Independence Axiom in Common Ratio Problems: An Experimental Test of Some Competing Hypotheses," *Annals of Operations Research*, 19, 79–101.

Stevenson, Mary K. (1992). "The Impact of Temporal Context and Risk on the Judged Value of Future Outcomes," *Organizational Behavior and Human Decision Processes* 52, 455–491.

Strotz, Robert H. (1956). "Myopia and Inconsistency in Dynamic Utility Maximization," *Review of Economic Studies* 23, 165–180.

Thakor, Anjan V. (1993). "Information, Investment Horizon, and Price Reactions," *Journal of Financial and Quantitative Analysis* 28, 459–82.

Thaler, Richard H. (1981). "Some Empirical Evidence on Dynamic Consistency," *Economics Letters* 8, 201–207.

Tversky, Amos and Craig. R. Fox. (1995). "Weighing Risk and Uncertainty," *Psychological Review* 102, 269–283.

Tversky, Amos and Daniel Kahneman. (1992). "Advances in Prospect Theory: Cumulative Representation of Uncertainty," *Journal of Risk and Uncertainty* 5, 297–323.

Tversky, Amos and Peter P. Wakker. (1995). "Risk Attitudes and Decision Weights," *Econometrica* 63, 1255–1280.

von Neumann, John and Oskar Morgenstern. (1947), *"Theory of Games and Economic Behavior,* Princeton University Press, Princeton, NJ.

Wakker, Peter P. and Amos Tversky. (1993). "An Axiomatization of Cumulative Prospect Theory," *Journal of Risk and Uncertainty* 7, 147–176.

Wathieu, Luc. (1997a). "Hierarchies and the Self-Control of Risk Attitude," in R. Nau, E. GrØnn, M. Machina and O. Bergland (eds.), *Economic and Environmental Risk and Uncertainty: New Models and Methods,* Dordrecht: Kluwer Academic Publishers, 227–243.

Wathieu, Luc. (1997b). "Habits and the Anomalies in Intertemporal Choice," *Management Science* 43 (11), 1552–1563.

Webb, David C. (1993). "The Trade-Off between Cash Flow and net Present Value," *Scandinavian Journal of Economics* 95 (1), 65–75.

Wertenbroch, Klaus. (1998). "Consumption Self-Control via Purchase Quantity Rationing of Virtue and Vice," *Marketing Science,* forthcoming.

Wertenbroch, Klaus and Ziv Carmon. (1997). "Dynamic Preference Maintenance," *Marketing Letters* 8 (January), 145–152.

Wu, George and Richard Gonzalez. (1996). "Curvature of the Probability Weighting Function," *Management Science* 42, 1676–1690.

Wu, George and Richard Gonzalez (1998). "Nonlinear Decision Weights in Choice under Uncertainty", *Management Science* (in press).

Yaari, Menahem. (1987). "The Dual Theory of Choice under Risk," *Econometrica* 55, 95–115.