Journal of Risk and Uncertainty, 8:267-288 (1994)

Hope: An Empirical Study of Attitude Toward the Timing of Uncertainty Resolution

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Key words: atemporal risk attitude, timing of uncertainty resolution, weighted utility model

Abstract

Hope is experienced when there is enjoyment in delaying the resolution of uncertainty. The main objective of this article is to identify the phenomenon of hope. In addition, we empirically test several axiomatic theories of temporal preferences which have implications for attitudes toward the timing of uncertainty resolution. Overall, the data support the extension of recursive expected utility specification to incorporate a weighted utility model of attitude toward future uncertainty. We find that the instances where hopefulness are more prevalent tend to be associated with a small probability of occurrence of a large gain. Interestingly, the degree of hopefulness is not correlated with risk attitude.

> It is just the same thing if we are expecting some important letter carrying a definite decision, and it fails to arrive. In such cases there are really two different motives at work in us; the stronger but more distant of the two being the desire to stand the test and to have the decision given in our favor, and the weaker, which touches us more nearly, the wish to be left for the present in peace and quiet, and accordingly in further enjoyment of the advantage which at any rate attaches to a state of hopeful uncertainty, compared with the possibility that the issue may be unfavorable. (Schopenhauer, 1893, p. 64)

The purchase of lottery tickets is often described as "buying hope," as in the title of Clofelter and Cook's (1989) authoritative work on state lotteries. A lottery ticket typically involves a future period during which the final uncertainty is resolved. Some lottery tickets provide "instant" resolution with a small chance of being placed in a second-stage drawing for a larger prize. Thus, attitude toward timing of uncertainty resolution has some bearing on the perceived attitude toward risk. Even if one is always averse toward risks that resolve in the present period, one may still buy "hope" by purchasing a lottery ticket in order to enjoy the anticipation of winning. In the face of possible misfortune, one may be anxious about future contingencies. This can lead to the purchase of an insurance policy even when the degree of risk aversion is not otherwise sufficient to warrant paying the premium.

Hope is experienced when there is enjoyment in delaying the resolution of uncertainty often involving a potential gain. Concurrently, one may experience *anxiety* about an unfavorable resolution of the uncertainty. "There is more pleasure in hope than in fulfillment," according to a Japanese proverb, while "there is fear in every hope, and hope in every fear," says an Arab proverb. When the nature of the uncertainty involves a potential loss, the degree of anxiety is often stronger than that of hope, giving rise to a need for early resolution of uncertainty. Thus, we have the adage, "bad news first and good news last." Generally, a decision in favor of early resolution of uncertainty is the combined result of the potential benefit of planning and the possible need to reduce anxiety. It is however difficult to distinguish between these two causes based on observed choices. In contrast, a decision in favor of late resolution, in spite of the potential costs for not being able to plan, provides prima facie evidence of the incidence of hope.

The relevance of the timing of uncertainty resolution in economic modeling was considered in Dreze and Modigliani (1972) and Spence and Zeckhauser (1972). They observed that an expected utility maximizing consumer always prefers early resolution of uncertainty when it is possible to plan. Kreps and Porteus (1978) characterized the discounted additive expected utility model using a temporal consistency axiom, a payoff history independence axiom, and a timing indifference axiom which, in the absence of the possibility to plan, requires indifference between early and late resolution of uncertainty. They further axiomatized a more general specification by allowing nonindifference towards timing. This specification, which we call the recursive expected utility specification, comprises a recursive utility function for deterministic temporal consumption with an expected utility model for uncertainty involving future consumption.[1] Chew and Epstein (1989) extended the recursive expected utility specification by successively replacing expected utility with two classes of non-expected utility preferences, namely, weighted utility and the more general betweenness-conforming utility (see Chew, 1983, 1989; Fishburn, 1983; Dekel, 1986).

The primary objectives of this article are to identify the phenomenon of hope and to empirically test the axiomatic theories of timing preferences proposed by Kreps and Porteus (1978) and Chew and Epstein (1989). In addition, we explore the relation between individuals' attitudes toward the timing of uncertainty resolution and their attitudes toward risk. Our empirical study consists of two parts. The first part examines attitudes toward four types of risks, divided among two gain-oriented types, and two loss-oriented types. The second part examines timing preference in several settings. The overall experiment provides within-subject data on choice behavior across timing tasks as well as risk tasks, allowing us to study the relation between hopefulness and attitude toward risk. The first part of our empirical study essentially replicates the Tversky-Kahneman (1992) study. The second part of the study on timing attitude and the within-subject study of the relation between risk attitude and timing attitude appear to be novel.

There have been few empirical studies on intertemporal choice behavior (see, e.g., Lowenstein and Thaler, 1989). These few studies tended to focus on questions of dynamic consistency and the presence of positive time preference rather than on the effects of uncertainty. Segal (1990) developed preference specifications for two-stage lotteries without requiring the reduction-of-compound-lottery axiom. Interpreting the two stages in a two-stage lottery to occur at different times, the paper suggests that certain empirically observed violations of the reduction-of-compound-lottery axiom (Ronen, 1971; Snowball and Brown, 1979; Keller, 1985) are themselves instances of nonindifference to the timing of uncertainty resolution. However, in Segal's approach, actual consumption does not take place between the two stages. Consequently, the degree of timing nonindifference does not depend on any consumption prior to resolving the uncertainty in the second stage. In contrast, the degree of timing nonindifference in the Kreps–Porteus model as well as in the Chew–Epstein model may depend on the nature of consumption between the two stages.

The remainder of the article is organized into three sections. Section 1 presents the atemporal preference models and their implications for subjects' attitudes toward risk. The derivation of testable implications and results are presented in subsections. Section 2 extends the preference models discussed in section 1 to intertemporal choice and derives testable implications for attitudes toward the timing of uncertainty resolution. Results are presented in a subsection. We conclude in section 3.

1. Attitude toward atemporal risk

1.1. *Theoretical background*

Markowitz (1959) and Kahneman and Tversky (1979) posited the notion of *status quo* relative to which *gains* and *losses* are defined. We refer to risks as *hazards* (*prospects*) when they are oriented toward losses (gains). For example, insurance concerns hazards while lottery tickets represents prospects. Following Tversky and Kahneman (1992), we further distinguish between risks whose contingencies are plausible, i.e., with moderate probabilities, and those whose contingencies are implausible, i.e., with skewed probabilities, as illustrated in table 1.

Table 1. Research design for tasks on risk attitude

Threshold	**Status Quo**: *Prospect*	**Status Quo**: *Hazard*
Medium	**Global** **Risk Aversion** Investment Game	**Limited** **Risk Preference** Earthquake Insurance Vacation Trip
Small	**Limited** **Risk Preference** Game Lottery Ticket	**Global** **Risk Aversion** Car Insurance Mail Insurance

Many consider the prevalence of portfolio diversification and insurance purchase as evidence for risk aversion. This suggests that people are risk averse for medium prospects and skewed hazards. Earlier, Friedman and Savage (1958) observed that an individual who purchases insurance policy may also buy a lottery ticket, a skewed prospect. Such lottery purchase behavior may be taken as evidence of risk preference for skewed prospects. There have been few empirical studies of attitude toward medium hazards. A notable exception is a study by Kahneman and Tversky (1979) in which they found evidence for risk proness for medium hazards. For example, a majority of their subjects rejects a sure loss in favor of losing twice the amount with 50% probability. Recently, Tversky and Kahneman (1992) provide the first within-subject study of the fourfold pattern of risk preference depicted in table 1.

Let Y denote a set of consequences. A *lottery* m which yields outcome y_i with probability q_i, is represented by $\sum_{i=1} q_i\,[y_i]$. The set of all lotteries with outcomes in Y is denoted $D(Y)$. Let u be a von Neumann-Morgenstern utility function on Y. Then the *expected utility* $U_e(m)$ of m is given by:

$$U_e(m) = E(u, m) = \sum_{i=1}^{n} q_i u(y_i), \tag{1.1}$$

where $E(u, m)$ refers to the expectation of a function u with respect to the lottery m. The *expected utility certainty equivalent* μ_e is given by $u(\mu_e(m)) = U_e(m)$.

Most of the recent models of non-expected utility preferences (see Fishburn, 1988 and Machina, 1987, for surveys) can describe Allais–type choice behavior (Allais, 1953; see also MacCrimmon and Larsson, 1979; Kahneman and Tversky, 1979; Conlisk, 1986). Among them, weighted utility (Chew and MacCrimmon, 1979; Chew, 1983; Fishburn, 1983) and its generalization to the class of betweenness-conforming utility (Dekel, 1986; Chew, 1989) are the only theories that have been axiomatized in the timing preference context (Chew and Epstein, 1989).[2] Since the functional form of weighted utility is more tractable than that of the betweenness-conforming class, involving an implicit solution of an equation, we focus on the implications of weighted utility. Description of its extension to temporal preference is provided in the next section.

For $m = \sum_{i=1}^{n} q_i[y_i]$, the *weighted utility* $U_w(m)$ is given by:

$$U_w(m) = E[uw, m]/E[w, m] = \sum_{i=1}^{n} q_i w(y_i)\, u(y_i) / \sum_{i=1}^{n} q_i w(y_i), \tag{1.2}$$

where w is a positive-valued *weight* function. The *weighted utility certainty equivalent* $\mu_w(m)$ is given by $u(\mu_w(m)) = U_w(m)$. Expected utility corresponds to the special case of weighted utility where the weight function w is constant. The weighted utility $U_w(m)$ may be interpreted as the "expected utility" of u with respect to a "transformed" lottery which yields the outcome y_i with probability $q_i w(y_i)/\Sigma q_i w(y_i)$.

We label the status quo with 0. A typical risk in table 1 is of the form $q\,[x] + (1 - q[0]$. The risk is a prospect (hazard) if x is a gain (loss) relative to 0. It is a skewed (medium) risk if q is close (not close) to 0. Consider the forms of w and u functions presented in figure 1. The u function is concave for gains and convex for losses. The w function is

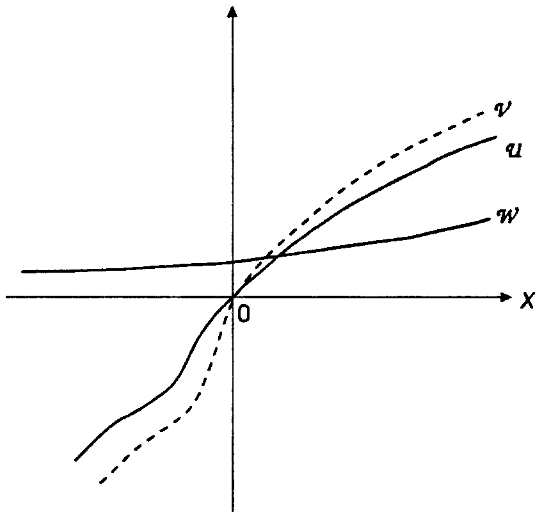

Figure 1. Weighted utility functions

increasing for gains and decreasing for losses. We normalize the u function to be 0 at 0, and the w function equals 1 at 0.

Below are four formal statements of our empirical hypotheses for attitudes toward risks represented in table 1.

Global Risk Aversion for Medium Prospects: For $x > y \geq 0, q \geq ½$, $[qx + (- q)y]$ is at least as good as $q\,[x] + (1 - q)\,[y]$.

Global Risk Aversion for Skewed Hazards: For any $x < 0$, $q[x] + (1 - q)[0]$ is not preferred to $[qx]$ for q sufficiently small.

Limited Risk Preference for Medium Hazards: There are $x < y \leq 0$ adn $q \leq ½$, such that $q[x] + (1 - q)[y]$ is strictly preferred to $[qx + (1 - q)y]$.

Limited Risk Preference for Skewed Prospects: There exists $x > 0$, such that for sufficiently small q, $q[x] + (1 - q)[0]$ is strictly preferred to $[qx]$.

Under weighted utility, global risk aversion for medium prospects corresponds to

$$u(qx + (1 - q)y) \geq [qw(x)u(x) + (1 - q)w(y)u(y)]/[qw(x) + (1 - q)w(y)], \quad (1.3)$$

for every $x > y \geq 0$ and $q \geq ½$. For expected utility, i.e., weighted utility with a constant weight function w, this inequality is satisfied when u is a concave function. For the more general weighted utility, we can find pairs of u and w functions with u concave and w

increasing for gains such that (1.3) is satisfied. In other words, the corresponding weighted utility preference is risk averse for such medium prospects. For example, consider the following u and w functions for $x \geq 0$:

$$u(x) = 1 - e^{-\lambda x}, \quad w(x) = e^{\rho x}. \tag{1.4}$$

It can be verified that for $q\lambda > \rho > 0$, the corresponding weighted utility is consistent with stochastic dominance and satisfies (1.3) (see, e.g., Chew, 1983, for the condition for weighted utility to be consistent with stochastic dominance.) Thus, in order to display global risk aversion for medium prospects, it suffices that $\lambda/2 > \rho > 0$.

Under expected utility, global risk aversion for medium prospects implies global risk aversion for all prospects and therefore excludes the possibility of limited risk preference for skewed prospects. A weighted utility preference can display such a limited risk preference at x if

$$qw(x)u(x)/[qw(x) + 1 - q] > u(qx). \tag{1.5}$$

For weighted utility, satisfying global risk aversion for medium prospects, i.e., (1.3), is compatible with satisfying (1.5) at some gain amount x. In particular, we demonstrate below that the weighted utility functions in (1.4) display limited risk preference for skewed prospects. Consider the skewed prospects in the statement of limited risk preference for skewed prospects such that the expected payoffs are given by k, i.e., $qx = k$. For such skewed prospects, weighted utility satisfies (1.5) if

$$1 - e^{-\lambda x} > (1 - e^{-\lambda k})\,(1 + (x - k)e^{-\rho x/k}), \tag{1.6}$$

which has to hold for sufficiently large x since the left hand side approaches 1 as x increases while the right hand side approaches $1 - e^{-\lambda k}$, which is less than 1.

It is easy to show that expected utility satisfies global risk aversion for skewed hazards whenever

u is concave at 0 and $u(x)$ is always below the tangent through 0 for $x < 0$. (1.7)

Such a u function can admit a strictly convex region, as illustrated in figure 1. Thus, for negative outcomes, expected utility, i.e., weighted utility with a constant w function, can concurrently satisfy global risk aversion for skewed hazards and limited risk preference for medium hazards. With an increasing w function over losses, as in figure 1, weighted utility can account for limited risk preference for medium hazards in conjunction with global risk aversion for skewed hazards without requiring a convex region in the utility function u. Finally, we note that an increasing, concave u function and an increasing, convex w function are jointly consistent with the condition for weighted utility to exhibit Allais-type choice behavior (see Chew and Waller, 1986).

1.2. Research design

We developed a range of hypothetical choice questions dealing primarily with subjects' attitudes toward the types of risk described in table 1.[3] Two choice comparisons were presented for each of the four cells. For each comparison, we elicit subjects' preferences between a given risky alternative versus receiving its expected value for sure. The questions selected, described at the end of this subsection, are in the nature of daily decisions to facilitate familiarity with the scenarios in the experimental instrument. Both the order of presentation of the questions and the order of presentation of the responses were randomized.

Implications on choice patterns for risk tasks. The choice patterns that correspond to the empirical hypotheses are described below. The relevant choice patterns are described in terms of the number of risk averse choices out of the two choice comparisons for each cell. The null hypothesis, based on chance, implies that all underlying choice patterns are equally likely.

A hypothesis is supported if the frequency of the observed choices falling within its implied patterns is significantly greater than chance. When the data support both a more general hypothesis H and a less general hypothesis H′, we say that H is empirically superior to H′ if after deleting the instances of choice patterns that are common to both H and H′, the renormalized frequency of the rest of choice patterns of H is significantly greater than the renormalized chance frequency.

Tasks

Medium prospects The investment scenario elicits the subject's preference for investing in a bank account that earns $1,600 for sure versus buying a stock with an 80% chance of earning $2,000 and a 20% chance of earning $0. The game scenario involves a comparison between receiving $5,000 for sure and a 50–50 chance of receiving $10,000 or nothing.

Skewed hazards In the mail insurance scenario, there is a $2 premium to insure against a 2% chance that a portable CD player valued at $100 will be lost in the mail. The car theft insurance scenario elicits the subject's preference between paying an optional theft insurance premium of $2 to protect against a .005% chance that his/her rented sports car valued at $40,000 will be stolen.

Hypothesis	#of Risk Averse Choices	Chance proportion
global risk aversion for medium prospects	2	25%
global risk aversion for skewed hazards	2	25%
limited risk preference for medium hazards	0 or 1	75%
limited risk preference for skewed prospects	0 or 1	75%

Medium hazards In the earthquake insurance scenario, there is a 50% chance a major quake will hit Southern California within the next twelve months. If that happens, the loss would be $8,000. The subject decides between the alternative of paying an actuarially fair preimum of $4,000, and facing a 50% chance of losing $8,000. The vacation trip scenario involves the fictitious country of Holidia. While vacationing in Holidia and driving a rental car, the subject is stopped by a policeman without being provided a reason. In the police station, the subject is told that he/she will be detained overnight and has to appear in court the next day. By agreeing to pay $400 now, the subject will be released the next day after appearing in court. Otherwise, the subject faces an 80% chance of being fined $500 and a 20% chance that there would be no fine before being released.

Skewed prospects The game scenario involves a comparison between receiving a one hundredth chance of winning $100 and receiving $1 for sure. In the lottery ticket scenario, the subject is asked to choose between receiving a lottery ticket which provides a millionth chance of winning $1 million and receiving $1 for sure.

Subjects. One-hundred-ten undergraduate students from a western university voluntarily participated in the experiment. The subjects, attending an introductory economics class, were told that the researchers would randomly draw the names of ten participants to receive $10 cash rewards. They were instructed to respond to the instrument based on their own knowledge and experience rather than to emulate what they thought would be the responses of others. Subjects were also informed their responses would be anonymous and treated in confidence.

1.3. Results

The observed choice patterns are presented in table 2. In the discussion of our results, we will often denote a risk averse choice as "A" and a risk preferring choice as "P". For example, in table 2a, ten subjects make no risk averse choice, i.e., two risk preferring choices (the number of "A" choices is 0) in the medium prospects scenarios.

Medium prospects The overall proportion of "AA" choices in table 2a is 59% (65/110), which is significantly greater than the chance frequency of 25% ($p < .0001$). This supports the global risk aversion for medium prospects hypothesis.

Skewed hazards The global risk aversion for skewed hazards hypothesis is supported since the proportion of "AA" choices in table 2a is 82% (90/110), which is significantly greater than the chance frequency of 25% ($p < .0001$).

Medium hazards The limited risk preference hypothesis is supported. The proportion of the choice patterns is table 2b with at least one "P" choice is 85% (93/110), which is significantly greater than the chance frequency of 75% ($p < .01$). In addition, we test a

Table 2. Observed choices for risk tasks

(a) M^+/S^-

# of A's		M^+ 0	1	2	
S^-	0	1	2	1	4
	1	3	3	10	16
	2	6	30	54	90
		10	35	65	110

(b) M^-/S^+

# of A's		M^- 0	1	2	
S^+	0	31	27	10	68
	1	9	13	4	26
	2	4	9	3	16
		44	49	17	110

strong form of the limited risk preference hypothesis, admitting only the "PP" choice pattern. The proportion 40% (44/110) of "PP" choices significantly exceed the chance frequency of 25% ($p < .0001$). The limited risk preference hypothesis is superior to the strong form of the limited risk preference hypothesis. Excluding the "PP" pattern, the relative chance proportion of the other limited risk preference pattern consisting of one "P" choice is 67% (2/3), which is not significantly different from the observed relative proportion of 74% (49/66) ($p < .23$).

Skewed prospects The limited risk preference hypothesis is supported. The proportion of choice patterns in table 2b with at least one "P" choice is 85% (94/110), which is significantly greater than the corresponding chance frequency of 75% ($p < .01$). We test a strong form of the limited risk preference hypothesis admitting only the "PP" choice pattern. Again, the proportion 62% (68/110) of "PP" choices exceeds significantly the chance proportion of 25% ($p < .0000$). The limited risk preference hypothesis is however not superior to the strong form of the limited risk preference hypothesis. Excluding the "PP" pattern, the observed relative proportion (62%) of the patterns consisting of one "P" choice is not significantly different from the relative chance proporition of 67% ($p < .49$).

Summary. There is overall support for our empirical hypotheses: global risk aversion for medium prospects and skewed hazards; limited risk preference for medium hazards and skewed prospects. A weak form of the global risk aversion hypothesis and a strong form of the limited risk preference hypothesis are also supported. Our finding is consistent with that of Tversky and Kahneman (1992). Expected utility provides a useful model of risk attitude when descriptive validity in terms of attitude toward skewed prospects or Allais-type choice behavior is not necessary. Like cumulative prospect theory, weighted utility provides a tractable alternative which can concurrently account for the observed attitudes toward the four kinds of risks in table 1 and still account for Allais-type choice behavior.

2. Attitude toward timing of uncertainty resolution

2.1. Theoretical background

In a two-period setting, let y refer to deterministic consumption in period 1, and $m = \Sigma q_i[z_i]$ represent the uncertain period 2 consumption. Let the *consumption plan* $[y, m]$ refer to the case where the consumer consumes y in period 1 and only knows which of the z_i's in $m = \Sigma q_i[z_i]$ will be consumed as period 2 begins. The case where the consumer already knows, as period 1 begins, which of the z_i's will be consumed in the second period is denoted by

$$\sum q_i[y, z_i]. \tag{2.1}$$

Note that the probability of consuming $[y, z_i]$ is q_i in both cases. Thus, the standard random variable representation of temporal uncertainty cannot distinguish between $[y, m]$ and (2.1). In other words, the random variable representation requires indifference toward the timing of uncertainty resolution.

A general *temporal lottery* is denoted by

$$\sum_{i=1}^{n} q_i\, [y_i, m_i], \tag{2.2}$$

which yields consumption plan $[y_i, m_i]$ with probability q_i. Consider:

$$\alpha[y, m] + (1 - \alpha)[y, m'] \text{ and } [y, \alpha m + (1 - \alpha)m']. \tag{2.3}$$

The left hand side of (2.3) (figure 2A) represents consumption of y in period 1 with the uncertainty on whether the stochastic consumption in period 2 is m or m' resolved just prior to consumption in period 1. On the other hand, the right hand side of (2.3) (figure 2B) represents the deterministic consumption of y in period 1, with the uncertainty on the stochastic consumption of m or m' in period 2 resolved just prior to period 2. In this article, we define the experience of *hope* to correspond to a preference for the RHS of (2.3) rather than the LHS. The opposite preference where the (LHS) is preferred to (RHS) defines the experience of *anxiety*. Following Kreps and Porteus (1978), the case where the LHS is always indifferent to the RHS regardless of the choice of α, y, m, and m' is referred to *timing indifference*.

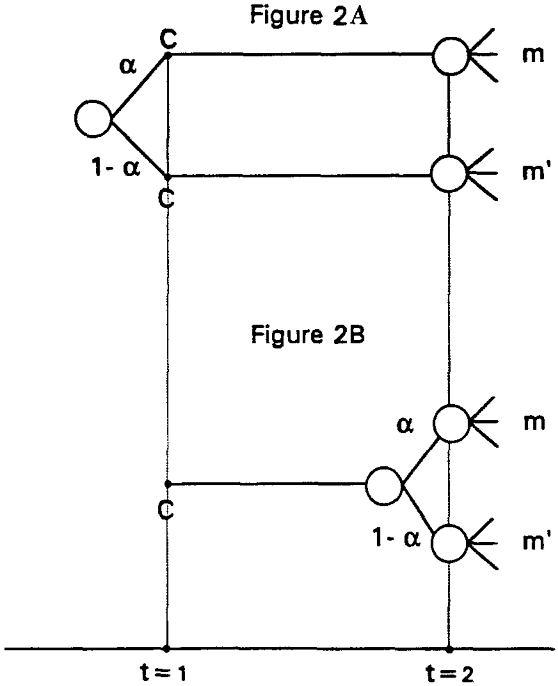

Figure 2. Consumption plans under different timing of uncertainty resolution

Recursive expected utility specification. Described below are several preference functionals on the set of temporal lotteries M. Let W, called an *aggregator,* be a continuous and increasing function on $Y \times Y$. The *recursive expected utility* of a temporal lottery d which yields $[y_i, m_i]$ with probability q_i is given by:

$$V(d) = \sum_{i=1}^{n} q_i W(y_i, \mu(m_i)), \tag{2.4}$$

with $\mu(m)$ replaced by the expected utility certainty equivalent $\mu_e(\text{m})$ defined by $\text{u}(\mu_e(\text{m})) = E[u, m]$. For simplicity of exposition, we adopt in the remainder of the article the following additive subclass of aggregator functions given by

$$W(y, z) = v(y) + \beta v(z). \tag{2.5}$$

This is similar to the standard discounted additive utility. A simple example of (2.5) is given by $W(x, z) = (x^{\rho} + \beta z^{\rho})^{1/\rho}$, with within-period VNM utility function being given by $u(z) = z^{\alpha}$. This specification is closely related to the one employed in Epstein and Zin's (1989) extension of the consumption capital-asset-pricing model which incorporates timing nonindifference. The CES discounted additive expected utility model corresponds to the case where $a = b$.

Recursive weighted utility specification. Chew and Epstein (1989) proposed a weaker axion on timing preference, called *quasi-timing indifference*—the decision maker is indifferent between early and late resolution in (2.3) when $[y, m]$ is indifferent to $[y, m']$. This seems psychologically more appealing than Kreps and Porteus' timing indifference axiom, which requires timing indifference even when the underlying temporal consumption programs differ sharply in attractiveness. Chew and Epstein showed that the class of preference specifications satisfying consistency and quasi-timing indifference generalized recursive expected utility by replacing the expected utility certainty equivalent with a betweenness-conforming certainty equivalent. In addition, Chew and Epstein axiomatized an intermediate case adopting the weighted utility certainty equivalent given in (1.2). This specification is referred to as *recursive weighted utility* where the utility of a temporal lottery d which yields $[y_i, m_i]$ with probability q_i is given by (2.4), with μ replaced by the weighted utility certainty equivalent μ_w, defined by $u(\mu_w(m)) = E[uw, m]/E[w, m]$.

Timing attitude and atemporal risk aversion. For ease of exposition, we define a *timing attitude function* $h = v°u^{-1}$. Under recursive expected utility with (2.5), a consumer is *globally hopeful* if early resolution is never preferred to late resolution. In other words, for every $m, m' \in D(Y)$,

$$\begin{aligned} V([y, \alpha m + (1-\alpha)m']) &= v(y) + \beta(y)h(U_e(\alpha m + (1-\alpha)m')) \\ &= v(y) + \beta(y)h(\alpha U_e(m) + (1-\alpha)U_e(m')) \\ &\geq v(y) + B(y)\{\alpha h(U_e(m)) + (1-\alpha)h(U_e(m')\} \\ &= \alpha V([y, m]) + (1-\alpha)V([y, m']) \\ &= V(\alpha[y, m] + (1-\alpha)[y, m']). \end{aligned} \tag{2.6}$$

It follows that the concavity of the function h is necessary and sufficient for the recursive expected utility model to exhibit global hopefulness. Similarly, the necessary and sufficient condition for a recursive-expected-utility consumer to be *globally anxious* is the convexity of the function h. One implication of recursive expected utility is that the nature of hopefulness (anxiety) in (2.6) remains the same when m is replaced by any other risk m'' which is indifferent to it, i.e., $U_e(m) = U_e(m'')$. The standard discounted additive expected utility corresponds to the case of a linear h function where the v function is a positive linear transformation of the u function (see figure 1). Consequently, discounted additive expected utility always satisfies timing indifference.

We develop the corresponding implications for the recursive weighted utility model here. Due to the result reached in section 1, we will henceforth maintain the requirement that w is increasing for gains, and explore recursive weighted utility for different assumptions on the behavior of w for losses. Let $w(m) = E(w, m)$. In the context of (2.6), suppose $u(m) > u(m')$. We have nonstrict preference for late resolution when

$$\begin{aligned} V([y, \alpha m &+ (1-\alpha)m']) \\ &= v(y) + \beta(y)h\{[\alpha w(m)U_w(m) + (1-\alpha)w(m')U_w(m')]/[\alpha w(m) \\ &\qquad + (1-\alpha)w(m')]\} \\ &\geq v(y) + \beta(y)\{\alpha h(U_w(m)) + (1-\alpha)h(U_w(m'))\} \end{aligned}$$

$$= \alpha V([y,m]) + (1-\alpha)V([y,m'])]$$
$$= V(\alpha[y,m] + (1-\alpha)[y,m']). \quad (2.7)$$

Observe that

$$\alpha U_w(m) + (1-\alpha)U_w(m')$$
$$< (>) [\alpha w(m)U_w(m) + (1-\alpha)w(m')U_w(m')]/[\alpha w(m) + (1-\alpha)w(m')]$$

when $w(m) > (<) w(m')$. In comparison with (2.6), the effect of the w function here makes it more (less) likely for a recursive-weighted-utility consumer to be hopeful. One difference in the implications between recursive expected utility and recursive weighted utility is that the degree of hopefulness under recursive weighted utility increases when we replace the preferred lottery m by another lottery m'' with the same utility but a higher expected weight, i.e., $U_w(m'') = U_w(m)$ and $w(m'') > w(m)$.

The good-news/bad-news adage as well as our introspection suggest that people are more hopeful when they deal with prospects than when they deal with hazards. More precisely, the degree of hopefulness for a prospect m versus the status quo is higher than that for a hazard m' derived from m by reversing the sign of each outcome in m. We called this the "good-news/bad-news" hypothesis. This is somewhat similar to the "reflection" hypothesis in Kahneman and Tversky (1979). For the recursive expected utility model, the following requirement on h corresponds to the good-news/bad-news hypothesis:

h is concave (convex) for positive (negative) values of its argument. (2.8)

Correspondingly, we may impose (2.8) on recursive weighted utility so that it can satisfy the good-news/bad-news hypothesis when the w function is sufficiently close to being flat. The utility functions of v and u which correspond to h in (2.8) are shown in figure 1.

For both recursive expected utility and recursive weighted utility, the degree of atemporal risk aversion depends only on the nature of the certainty equivalent functions μ_e and μ_w. Different degrees of hopefulness can then be modeled by a judicious choice of the timing attitude function h. Under both models, hope attitude and risk attitude are independent aspects of choice behavior. Comparing with recursive expected utility, recursive weighted utility can concurrently exhibit a larger range of combinations of attitudes toward risk and timing of uncertainty resolution by exploiting the incremental freedom to choose different w functions.

2.2. Research design

Tasks. The hypothetical questions dealing with subjects' attitudes toward the timing of uncertainty resolution are summarized in table 3. For each question, we elicit the subject's preference between having the uncertainty resolved earlier and having it resolved later. There are three scenarios.

Table 3. Observed choices for timing tasks

Grade report				α = 1%		α = 50%		Tax Refund		Tax Liability	
Doing Poorly	Doing Well	Frequency	%	q = 5%	q = 50%	q = 5%	q = 50%	Frequency	%	Frequency	%
E	E	43	39.1	*E	E	E	E	55	50.0	67	62.6
E	L	6	5.5	E	E	E	L	2	1.8	1	0.9
*L	E	43	39.1	E	E	L	E	2	1.8	0	0
*L	L	18	16.3	E	E	L	L	2	1.8	1	0.9
		110	100.0%	E	L	E	E	0	0	1	0.9
				E	L	E	L	1	0.9	1	0.9
				E	L	L	E	1	0.9	1	0.9
				E	L	L	L	0	0	0	0
				*L	E	E	E	12	10.9	4	3.7
				L	E	E	L	1	0.9	0	0
				*L	E	L	E	9	8.2	13	12.1
				L	E	L	L	1	0.9	1	0.9
				*L	L	L	E	12	10.9	8	7.5
				L	L	E	L	1	0.9	1	0.9
				*L	L	L	E	3	2.7	2	1.9
				L	L	L	L	8	7.3	6	5.6
								110	100.0%	107	100.0%

E represents early resolution of uncertainty.
L represents late resolution of uncertainty.
*represents implicit choice patterns under the global hopefulness hypothesis.

Grade report This concerns the hypothetical performance of the subject in an examination which takes place on a Tuesday prior to Thanksgiving. The subjects are asked to indicate whether they prefer to know their grades early, i.e., the next day, or late, i.e., the following Tuesday. In one case, "doing well," the subject expects to have done extremely well. In the other case, "doing poorly," the subject expects to have done extremely poorly.

Tax refund There is a probability α of receiving an uncertain tax refund, $q[x] + (1 - q)[y]$, which consists of a q chance of receiving x ($1,000 refund) versus a $(1 - q)$ chance of receiving y ($50 refund). The uncertainty involves a tax refund that may be resolved early, i.e., the next day which is a Friday, or late, i.e., a week from the following Monday. The four cases within this scenario involved two levels of α (1% and 50%), as well as two levels of q (5% and 50%).

Tax liability This is similar to the tax refund scenario except that there is a probability α of facing an uncertain tax liability $q[x] + (1 - q)[y]$ consisting of a q chance of paying x ($500) versus a $(1 - q)$ chance of paying y ($25). The four cases within this scenario involved two levels of α (1% and 50%), as well as two levels of q (5% and 50%).

Implications on choice patterns for timing tasks. As noted earlier, in settings involving observable choices, instances of early resolution preference are confounded with the potential benefits derived from planning. There is little planning benefit, however, when the probability α of having to face a prospect (hazard) m is close to 0 or 1, or when m is non-sizable, i.e., the magnitude of the expected value of m is small. For example, whatever the value of α, there is little planning benefit to know one week earlier whether you will be awarded a California lottery ticket (whose expected value is believed to be less than 30 cents). Generally, planning benefits are significant when the risks are sizable, and α in (2.7) is moderate. When confronted with the prospect of having incurred a disease, the potential planning benefit from early knowledge is especially significant if the disease is treatable and α is probable. In spite of such planning benefits, the individual may still want to delay knowing the state of his/her health, since such knowledge can affect adversely the enjoyment of present consumption.

We refer to the observed choice as being either "L" (late preferring) or "E" (early preferring). An "L" choice implies the presence of hope, but an "E" choice does not imply the presence of anxiety, given the confounding between anxiety and potential planning benefit.

The null hypothesis, based on chance, implies that all possible choice patterns are equally likely. In light of the potential planning benefits, we cannot distinguish among the implications of the timing indifference assumption, the discounted additive expected utility, and the global anxiety hypothesis, since they uniformly favor the "E" choice. We will refer to these hypotheses jointly as the timing indifference hypothesis.

Below, we summarize the implications for observable choices of the other hypotheses of interest.

Grade report The good-news/bad-news hypothesis implies either the "EE" or "LE" ("L"—"doing poorly"; "E"—"doing well") patterns. Since the "EE" pattern is also the implication of the timing indifference hypothesis, the good-news/bad-news hypothesis is superior to the timing indifference assumption only if the renormalized proportion of observed "LE" patterns is greater than the relative chance proportion of 1/3.

For the "doing poorly" case, it is remarkable that a majority (55%) of the subjects would rather know their grades after the long weekend. The global hopefulness hypothesis implies a preference for the "LL" pattern in the absence of planning benefit. In conjunction with planning benefit, all observed patterns are possible. At this level, we cannot distinguish between the implications of the chance hypothesis and the global hopefulness hypothesis. Thus, we consider restricted forms of the global hopefulness hypothesis—(a) at least one "L" choice; (b) the "LL" pattern.

Tax refund The subject exhibits hopefulness for a tax refund prospect if late preference is observed for $q[\$1000] + (1 - q)[\$50]$ versus the status quo [\$0]. We consider each of the four cases: (1) $\alpha = 1\%, q = 5\%$; (2) $\alpha = 1\%, q = 50\%$; (3) $\alpha = 50\%, q = 5\%$; and (4) $\alpha = 50\%, q = 50\%$. In light of the potential planning benefits, both the good-news/bad-news hypothesis and the global hopefulness hypothesis imply that instances of "L" choices are more likely for the cases with a small α or a small q. Thus, when an "E" choice is observed for the case where $\alpha = 1\%$ and $q = 5\%$, we expect the "E" choice for each of the other three cases. Otherwise, we expect the "E" choice at least for the case where $\alpha = 50\%$ and $q = 50\%$. Summarizing, the implied choice patterns consist of "EEEE," "LEEE," "LELE," "LLEE," and "LLLE."

Tax liability This scenario is almost a 'reflection' of the tax refund scenario. The subject is hopeful in the face of a tax liability hazard if late preference is observed for $q(-\$500] + (1-q)[-\$25]$ versus the status quo [$0]. Again, we consider each of the four cases: (1) $\alpha = 1\%, q = 5\%$; (2) $\alpha = 1\%, q = 50\%$; (3) $\alpha = 50\%, q = 5\%$; and (4) $\alpha = 50\%$, $q = 50\%$. In light of the potential planning benefits, the good-news/bad-news hypothesis implies only "E" choices. As in the tax refund scenario, the global hopefulness hypothesis implies that instances of "L" choices are more likely for the cases with a small α or a small q. Thus, the implied choice patterns consist of "EEEE," "LEEE," "LELE," "LLEE," and "LLLE."

Unlike the recursive expected utility model, under the good-news/bad-news restriction (2.8), recursive weighted utility can exhibit hopefulness in the presence of the tax liability hazard if w is increasing over losses. To see this, let $m' = [0]$ in (2.7). Then $U_w(m) < u(0) = 0$ and $w(m) < w(0) = 1$, so that $U_w(m)$ is less than $w(m)U_w(m)/[\alpha w(m) + 1 - \alpha]$, which is decreasing in α. This enhances the degree of hopefulness which runs counter to the implication of the convexity of the h function. Thus, when h is sufficiently close to being linear, recursive weighted utility model exhibits hopefulness. This can give rise to "L" choices when the potential planning benefit is weaker than the degree of hopefulness. Consequently, the frequencies of "L" choices are greater when α or q is small. The latter implication is indistinguishable from the implication of the global hopefulness hypothesis. This scenario provides a setting to empirically discriminate between the implications of recursive expected utility and recursive weighted utility models, both under the good-news/bad-news restriction.

Tax refund/tax liability The global hopefulness hypothesis implies the possibility of observing "L" choices in both the tax refund and the tax liability scenarios. The frequency of "L" choices in each case of the tax refund scenario is similar to the frequency of the corresponding "reflected" case in the tax liability scenario. Under the good-news/ bad-news restriction, both recursive expected utility and recursive weighted utility models imply the possibility of "L" choices for the tax refund scenario, particularly when α or q small. The recursive expected utility model implies only "E" choices for the tax liability scenario.

For recursive expected utility, to display "L" choices in the tax liability scenario, the effect of the increasingness of the w function needs to be stronger than that of convexity of the h function. In contrast, both the increasingness of the w function and the concavity of the h function contribute to the frequency of "L" choices for the tax refund scenario. Therefore, under recursive weighted utility, the frequency of patterns involving "L" choices for each case in the tax refund scenario is greater than that for the corresponding case in the tax liability scenario, especially when α and q lead to minimal potential planning benefit.

2.3. Results

Grade report As presented in table 3, the data reject the chance hypothesis ($\chi^2 = 37.56$, $df = 2, p < .0000$). The proportion of "EE" and the "LE" patterns both given by 39.1% are each significantly greater than the chance proportion of 25%. ($p < .0000$). The renormalized proportion 64.2% (43/67) of observed "LE" patterns is significantly greater than the corresponding renormalized chance proportion of 1/3 ($p < .0000$). Thus, the good-news/bad-news hypothesis is superior to the timing indifference hypothesis.

The proportion 60.9% of patterns corresponding to the global hopefulness hypothesis, namely, "EL," "LE," and "LL," is not greater than the chance proportion of 3/4. The proportion 16.4% of the "LL" pattern is not greater than the chance proportion of 1/4. Thus, neither form of the global hopefulness hypothesis is supported.

Tax refund The data presented in table 3 reject the chance hypothesis ($\chi^2 = 57.68$, $df = 14, p < .0001$). The implication of the timing indifference hypothesis is supported, since the proportion of "EEEE" is 50%, which significantly exceeds the chance proportion of 6.25% ($p < .0000$). The proportion 82.7% of observed choice patterns ("EEEE," "LEEE," "LELE," "LLEE," and "LLLE") that support the implication of the good-news/bad-news hypothesis as well as the global hopefulness hypothesis significantly exceeds the chance proportion of 31.25% (5/16). The renormalized proportion 64.5%, after removing the observed "EEEE" patterns, significantly exceeds the renormalized chance proportion of 26.67% (4/15) ($p < .0000$). Thus, both recursive expected utility and recursive weighted utility can efficiently describe the observed behavior under the good-news/bad-news restriction (2.9).

Tax liability The data presented in table 3 reject the chance hypothesis ($\chi^2 = 90.96$, $df = 14, p < .0000$). The implication of the timing indifference hypothesis as well as the recursive weighted utility model with the good-news/bad-news restriction is supported since the proportion 62.6% of "EEEE" observations is significantly greater than the chance proportion of 6.25% ($p < .0000$).

The proportion 87.8% of observed choice patterns ("EEEE," "LEEE," "LELE," "LLEE," and "LLLE") that support the implication of both the recursive weighted utility model under the good-news/bad-news restriction and the global hopefulness hypothesis significantly exceeds the chance proportion of 31.25%. The renormalized proportion 67.5% (27/40), after removing the observed "EEEE" patterns, significantly exceeds the renormalized chance proportion of 26.67% (4/15) ($p < .0000$). Thus, the recursive weighted utility model under the good-news/bad-news restriction, as well as the global hopefulness hypothesis, is superior to the recursive expected utility model under the good-news/bad-news restriction, as well as the timing indifference hypothesis.

Tax refund versus tax liability We compare the proportions of choice patterns across the tax refund and the tax liability scenarios, for those patterns that are significant in at least one scenario. The proportion 10.9% of "LEEE" patterns for the tax refund scenario is significantly greater than the corresponding proportion 3.7% for the tax liability scenario ($p < .02$). This supports the good-news/bad-news hypothesis, especially since both q and

α are small. The proportion 50.0% of "EEEE" patterns for the tax refund scenario is significantly less than the corresponding proportion 62.6% for the tax liability scenario ($p < .01$), which also supports the good-news/bad-news hypothesis. The proportion 10.9% of the "LLEE" pattern for the tax refund scenario is not significantly different from the corresponding proportion of 7.5% for the tax liability scenario ($p < .19$). The proportion 8.2% of the "LELE" patterns for the tax refund scenario is not significantly different from the corresponding proportion 12.1% for the tax liability scenario ($p < .34$). Overall, there is support for the recursive weighted utility model under the good-news/bad-news hypothesis. The implications of the global hopefulness hypothesis and the recursive expected utility model under the good-news/bad-news hypothesis are not supported.

Relation between attitude toward risk and attitude toward timing. Intuitively, one suspects the degree of early timing preference, i.e., anxiety, may be positively correlated with the degree of risk aversion. To investigate their relation, we use the Kendall's Γ to measure the nature of the association between the number of instances of early preferences in a timing scenario versus the number of instances of risk averse choices for a type of risk in table 1. For the tax refund scenario, none of the four Kendall measures supports the dependence of the number of early references on the number of risk averse choices for each of the four types of risk considered. Similarly, in the tax liability scenario, out of the four types of risks, there is no dependence between the number of early preferences and the number of risk averse choices. For the grade report scenario, there is no support for the dependence between timing preference and risk attitude for each of the risk types except for skewed prospects where Kendall's Γ is $-.16$ with $p < .04$.

Summary. Our findings suggest that the timing indifference assumption implicit in the classical models of temporal preferences cannot sufficiently portray the observed timing choice patterns. The global hopefulness hypothesis fares better. Except for the grade report scenario, it provides a fair account of the observed patterns for both the tax refund and tax liability scenarios. It fails to capture the statistically significant difference between the level of hopefulness when facing the prospect of a tax refund versus the level of hopefulness when facing the hazard of a tax liability.

There is support for imposing the good-news/bad-news hypothesis on recursive expected utility and recursive weighted utility models in both the grade report scenario and in the comparison across the tax refund and the tax liability scenarios. Both models can describe the observed patterns in the grade report and the tax refund scenarios. Only recursive weighted utility with an increasing weight function can account for the significance of the "LELE" and the "LLEE" patterns in the tax liability scenario.

Our analysis of the relation between timing preference and risk attitude reveals a striking finding: hopefulness and risk aversion are distinct preference phenomena which are not generally correlated with each other. Thus, it is important to employ temporal preference models that can disentangle these two aspects of individuals' preference makeups. While both the recursive expected utility and the recursive weighted utility model these phenomena independently, recursive expected utility cannot describe fully the range of risk and timing attitudes observed.

3. Conclusion

We derive and test a number of implications of the standard discounted additive expected utility model, the recursive expected utility model, and the recursive weighted utility model. Maintaining the good-news/bad-news hypothesis, the recursive weighted utility model is superior to the recursive expected utility model in describing observed choice behavior both for risky and timing choices. Recursive expected utility and recursive weighted utility models under the global hopefulness hypothesis are partially supported. The implications of discounted additive expected utility and the global anxiety hypothesis are not supported.

The recursive expected utility model is appealing when the modeling environment involves primarily medium prospects since it is more tractable than the recursive weighted utility model. When the context requires a full treatment of attitude toward risk and timing, the recursive weighted utility model is the only model derived from axioms on timing preferences that retains tractability and provides a degree of descriptive validity in modeling choice behavior.

The observed behavior for the risk tasks supports our empirical hypotheses on risk attitudes: global risk aversion for medium prospects as well as skewed hazards, and limited risk preference for medium hazards and skewed prospects. Expected utility can concurrently account for the above behavior except for limited risk preference for skewed prospects. With an additional weight function w which is increasing over gains, weighted utility can jointly display the modal behavior observed in all four settings.

The observed choice patterns for the timing tasks support the hypothesis that hope pertains to the enjoyment of a delay in resolving uncertainty that often involves potential gains, while anxiety leads to a need for early resolution of uncertainty concerning possible misfortune. Earlier, Epstein and Zin (1991) found that there is late preference based on a consumption capital-asset-pricing model derived from a representative recursive-expected-utility consumer using time series data on consumption and asset returns. This is compatible with our result which represents the first direct empirical confirmation of the phenomenon of hope. A positive correlation between being risk preferring and being hopeful seems to be a widely shared intuition. This is not supported, however, by our data, which reveals no such correlation between the two.

The present approaches to economic analysis involving time and uncertainty have, by and large, left out the role of attitude toward timing of uncertainty resolution. As reported in a recent article on personalized production of bicycles in Japan (*Fortune*, October 1990, p. 132), a custom bike takes three hours to make, but its delivery takes about two weeks. Says Koji Nishikawa, head of sales: "We could have made the time shorter, but we want people to feel excited about waiting for something special." Since the consumer has not seen the finished product when the order is placed, there is uncertainty about how much enjoyment the final consumption of the product will bring. The consumer might find out later about further changes in the delivery date, the price, or special features such as the color and style. Thus, the consumer is affected by (a) uncertainty about the quality of final consumption, (b) uncertainty about the timing of consumption of the (possibly uncertain) product or service, and (c) timing of the resolution of uncertainty concerning (a) and (b). This article addresses (a) and (c) as it pertains to (a). A fuller treatment of the issues raised here awaits further research.

Other aspects of consumer behavior draw on what we have learned about attitudes toward hope and toward risk. As an example, we may apply our results to discriminate among potential offenders. Becker's (1968) seminal treatment of the rational criminal is based on an expected utility model of his risk attitude. Even if based on actuarial considerations crime pays, our study suggests that an anxious person may be discouraged from committing a crime by the expectation of spending an extended period of time worrying about being eventually apprehended.

News and information both involve the potential for early resolution of uncertainty. Television news shows offer earlier, if partial, resolution of uncertainty in world events in which the average citizen has no direct stake. It is no wonder then that news coverage, in order to reduce anxiety, seems to be "biased" in favor of bad news. Information is *ex ante* believed to be valuable or useful because its receipt could enhance planning. News on the other hand generally pertains to events beyond one's control and does not usually provide the basis for planning. As suggested in the introduction, the differential attitude toward bad and good news found in this paper may be responsible for the generally negative news coverage by the media. The theoretical and empirical findings in this paper may be applied to model the nature of the news industry in order to shed light on its economic role in relation to the information industry.

Empirical studies of the timing of release of news concerning product development or earnings (Chambers and Penman, 1984) reveal that good news tends to be reported earlier than anticipated. This is compatible with our observed data on attitude toward timing of uncertainty resolution. Early reporting of good news increases the time interval during which the investor may enjoy the anticipation prior to the subsequent revelation of the nature of the news. This has the effect of increasing investors' demand for the company's stocks by associating their purchase with an element of hope. On the other hand, an inadvertent, often premature, announcement of bad news induces anxiety and generally leads to a demand for immediate resolution of the news. This may induce stockholders to sell in order to reduce his/her anxiety. Different classes of financial instruments have different appeal in terms of their risk and timing characteristics. An indulgence in the psychology of hope may partially account for holding an asset even when its continued holding is no longer supported by financial analysis. (See Dixit, 1992, for a recent contribution on this question.)

Wage contracts tend to result in compensations that are more rigid relative to fluctuations in the firm's performance. This has motivated the implicit contract literature (see, e.g., Rosen, 1985) to take the view that wage rigidity is a form of risk sharing between the risk averse workers and the less risk averse firm. Many compensation schemes involve additional attributes such as an annual bonus, a moderate prospect, or employee stock option, a delayed prospect which is sometimes skewed especially for new or entrepreneurial firms. Our results suggest that the nature of the riskiness of firm performance and the anticipation of potentially strong future earnings influence the perceived attractiveness as well as the degree of security associated with employment. A future direction of research may exploit the temporal preference models considered in this article to differentiate among firms in terms of their wage contract offers in a competitive environment.

Acknowledgements

We would like to thank John DiNardo, Robin Keller, Dan Klein, Maria Koskenoja, and Neal Stoughton for their helpful comments and suggestions. We would also like to thank the National Science Foundation (SES 88-10833) for research support.

Notes

1. The recursive expected utility specification was employed recently by Epstein and Zin (1989, 1991) and Weil (1990) to derive a consumption capital-asset-pricing model.
2. The *betweenness* property requires that the preference for a probability mixture between two given lotteries is intermediate between them.
3. To assure the clarity of the questionnaire, all questions were pretested using a different group of undergraduate students. We adopted all the questions used in the pretest since it did not reveal any problems.

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