Economic Valuation of Mortality Risk Reduction: Assessing the State of the Art for Policy Applications

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Proceedings for Session IV
--Table of Contents—

PREFERENCES FOR ENVIRONMENTAL OUTCOMES: CONSISTENT WITH DISCOUNTING MODELS OR NOT?

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Summarization

Dr. Keller began by saying that she would talk about two experiments. The first experiment is about people's preferences for sequences of long-term environmental consequences (forthcoming in *Organizational Behavior and Human Decision Processes)*. The second experiment is about valuing lives lost or saved over time. This experiment is more recent and hasn't yet been submitted to a journal. Other work (Keller and Strazzera, "Examining Predictive Accuracy Among Discounting Models," forthcoming in the *Journal of Risk and Uncertainty*), which looks at hyperbolic discounting versus the standard exponential discounting models, is not covered in the talk.

The first experiment looks at people's preferences for sequences (over time) of outcomes of air quality, near shore ocean water quality, and personal health, as well as individual income. Their study found that people have a preference for either having a constant sequence over time, e.g., for having their health level stay the same over time, or an improving sequence over time – that is, a slight or moderate improvement over time in health, air, and water quality. However, people treat income differently. For income, their studies showed, people prefer a decreasing sequence over time, consistent with discounting models. Discounting models assume that people's attitude is "if you're going to give me a fixed amount of money over time, give it to me at the beginning."

The second experiment looks at sequences of lives lost or saved over time. There they found a preference both for steeply decreasing sequences and constant sequences. When saving lives is at issue, there is a preference for steeply decreasing sequences; when losing lives is at issue, they found a preference for spreading those losses out rather than incurring them all at one consolidated point in time. Both experiments were hypothetical experiments.

Their research was motivated by environmental decision problems, where, for example, the goal is to regulate air quality, water quality, conservation of forests, etc. Their research, and the management science decision analysis background underlying it, was aimed at coming up with methods to enable decision makers to support and justify their decisions.

There are some key characteristics of these types of problems. First, there are multiple attributes involved. They involve, for example, monetary cost and non-monetary benefits. In addition, they involve outcomes at different points in time, sometimes over multiple generations. Their experiments looked only up to 50 years, and did not explicitly try to look at extremely long time horizons.

The focus of their research was to look at people's preference patterns for environmental or health attributes which have sequences over time. There has been quite a bit of work in psychology and in the overlap between psychology and economics on observed discounting rates. But the questions in these studies often ask people to express preferences over specific points in time (e.g., "would you prefer to have $10 today or $12 in a year"), and the studies try to figure out the implied discount rate from that. The study carried out by Dr. Keller and her colleagues used a different kind of question, which looked at a whole pattern over time, whole sets of sequences.

To illustrate, Dr. Keller asked the audience which sequence they would prefer for their salary over 50 years: it could be moderately increasing, it could be constant, or it could be moderately decreasing. Then she asked, similarly, whether people would prefer their health and their air quality to be moderately increasing, constant, or moderately decreasing over 50 years. She noted that by design, the average is the same over all of three options (decreasing, constant, or increasing), so it's an equal average amount per year, and that they assume that utility of outcomes is linear with outcome amount.

Dr. Keller noted that the subjects in their study were business students, and that could have had an effect. She also noted that, among the members of the NCEE workshop audience, who she had asked to vote a preference by raising their hands, all three options (increasing, constant, and decreasing over time) were preferred by some people. A key point, therefore, was this: different outcomes (e.g., environmental or health or income) can result in different preference patterns – a result that is not allowed by discounting models. At issue, she noted, is a philosophical question but also a very practical question if one is trying to figure out how to make decisions or recommend decisions to policymakers. That is, what kind of patterns would people like to see?

Dr. Keller reiterated that their study was designed so that all sequences had equal average outcomes. She noted some rationales for discounting (preferring a decreasing sequence, in which one has more now and less later). With a decreasing sequence, you can invest money so it will grow in the future. Also, there's a psychological notion of your time perspective, that way out in the future things "look smaller" (i.e., are less important to you), just like something far away looks smaller. She reiterated that they found, however, that people had a preference for constant or increasing sequences for the health and environmental outcomes, and that those are not consistent (would not have been predicted by) a standard discounting model.

Forty-eight graduate school of management students at the University of California at Irvine volunteered to participate in the first experiment. They were given excerpts from newspaper articles about beach and air pollution to read, to get them thinking about those issues. Then they were asked to rate seven different sequences: a "valley" sequence (in which the outcome first got worse and then got better); moderately increasing; constant over time; moderately decreasing; a "hill" sequence (in which the outcome first gets better and then gets worse); steeply increasing; and steeply decreasing. The valley sequence and hill sequence were chosen by very few participants, so she focused on the increasing sequences, the decreasing

sequences, and the constant sequence.

They expected to see a preference for an increasing sequence of environmental attributes. In a lot of the psych studies it's been found that people just like things to keep getting better. They found that the preference patterns for air quality, water quality and health improvements were all similar to each other, with moderately increasing or constant sequences generally preferred. The pattern for income, however, was different. For income, the sharply decreasing sequence was generally preferred. This implies that we should be cautious about applying models that apply to monetary outcomes to these other types of outcomes (e.g., environmental quality outcomes).

Dr. Keller noted that in other literature, studies have used different subject pools, such as psychology undergraduate students or people going to a museum, and that a study can get different results depending on the subject pool. Not surprisingly, business students did seem to obey discounting when money was at issue, which might be similar to the results that one would get with economists; but these results might be different from the results if other groups of subjects had participated. The implication is that, for a real world problem, you want to talk to the real stakeholders and figure out what their perspectives are. The main point, however, is that one can get quite widely different perspectives with the different attributes.

Dr. Keller briefly discussed an alternative preference model developed by Lowenstein and Prelec (1993). They fit the Lowenstein and Prelec (1993) model to the rating data they had, and they also fit the traditional exponential discounting model to those data. They found that the Lowenstein and Prelec model outperforms the traditional exponential discounting model. The main point here is again that there can be different kinds of models that will capture the kinds of preferences that have been observed, and they're not the discounting model.

Experiment two looked at a different kind of outcome: the number of lives lost in different time periods, or the number of lives saved in different time periods. Again, the researchers were interested in the kinds of preference patterns they observed. In this case, they looked at gain versus loss domains. They did this experiment because of results in the psychology literature, that have been called anomalies, that are not consistent with discounting, the model that has been thought to be the appropriate normative model.

In this second experiment, the participants were 75 business students at California State Polytechnic University at Pomona. They were asked to rank-order five three-year-long sequences of outcomes in each of eight scenarios. Scenarios varied according to whether lives were being lost or saved, whether the sequence starts now or 15 years in the future, and in the number of lives at issue (60 versus 36,000). The average annual outcome was equal in all five sequences in a scenario. Again, they assumed the utility of the outcomes is linear in the number of lives (which Dr. Keller noted as a big caveat).

In one scenario, for example, the problem was framed as follows: you can save lives in different ways. You're the policymaker. What pattern do you want? You have 60 lives that can

be saved and you can save them two years from now, not in the first two years, or you can spread it out equally, or you could save them all now. If you save them all in the first year, it's steeply decreasing because you've got 60 saved and then zero and zero.

In the lives lost scenarios, the outcomes are multiplied by -1. Now 0, 0, -60 is steeply decreasing because it's zero down to minus 60. Discounting requires steeply decreasing sequences to be preferred.

Over all eight scenarios, fewer than half of the subjects conformed with the standard discounting model – i.e., fewer than half preferred steeply decreasing sequences. Although the steeply decreasing sequences were popular, the constant sequence was also popular.

The first-ranked sequences were most commonly the steeply decreasing sequences and the constant sequences. Again, discounting models imply everybody would prefer steeply decreasing sequences, but they observed a very strong preference for constant sequences as well.

Dr. Keller noted that, in their written comments many subjects said something like, "If I'm going to save lives I can consolidate them all together and save them now." When lives being lost was the issue, significantly more subjects said something like, "Well, if I'm going to lose lives, I could put it way to the end" (a steeply decreasing sequence); however, a lot of people said something like, "Well, let's just spread it out. Don't have a big hit in any one year" (a constant sequence). So there appears to be a gain/loss domain asymmetry. This result replicates the kind of pattern seen in other kinds of discounting studies, she noted, which didn't look at sequences but just at two points in time, assessing a discount rate from that, and seeing if the discount rate was different in gains and losses.

Another study was done, by Dr. Jeffrey L. Guyse, on money outcomes. That study was similar to the lives outcomes study. Comparing the results of the two studies, Dr. Keller pointed out that more people chose the constant sequence as their most preferred sequence when looking at lives than at money. She reiterated that the subjects were business students. In the two studies, two decreasing sequences were offered as possibilities, one steeply decreasing and one moderately decreasing. More people chose the steeply decreasing sequence when money was involved than when lives were involved. Dr. Keller reiterated the key point – that they observe a difference in preferences across the attributes (e.g., for money versus for lives saved). Instead of looking at the subjects' top-ranked sequence, one could also average the ranks. When this method is used for lives, the constant sequence is most preferred.

In summary, the majority of the participants in the second experiment did not conform with the traditional discounting model. Fewer than 50 percent ranked the steeply decreasing sequence first. Both steeply decreasing and constant sequences were the most often first-ranked sequences for mortality and survivor outcomes. The constant sequence got the highest mean ranking. These results are in contrast with the results of experiment one, where constant or increasing sequences were rated highly for health, air quality, and near shore ocean water quality.

Dr. Keller then discussed a few caveats. First, all subjects saw all scenarios. That's good in the decision analysis sense. A policymaker would want to be shown all the different scenarios. More extreme effects would probably have been observed if they hadn't done that.

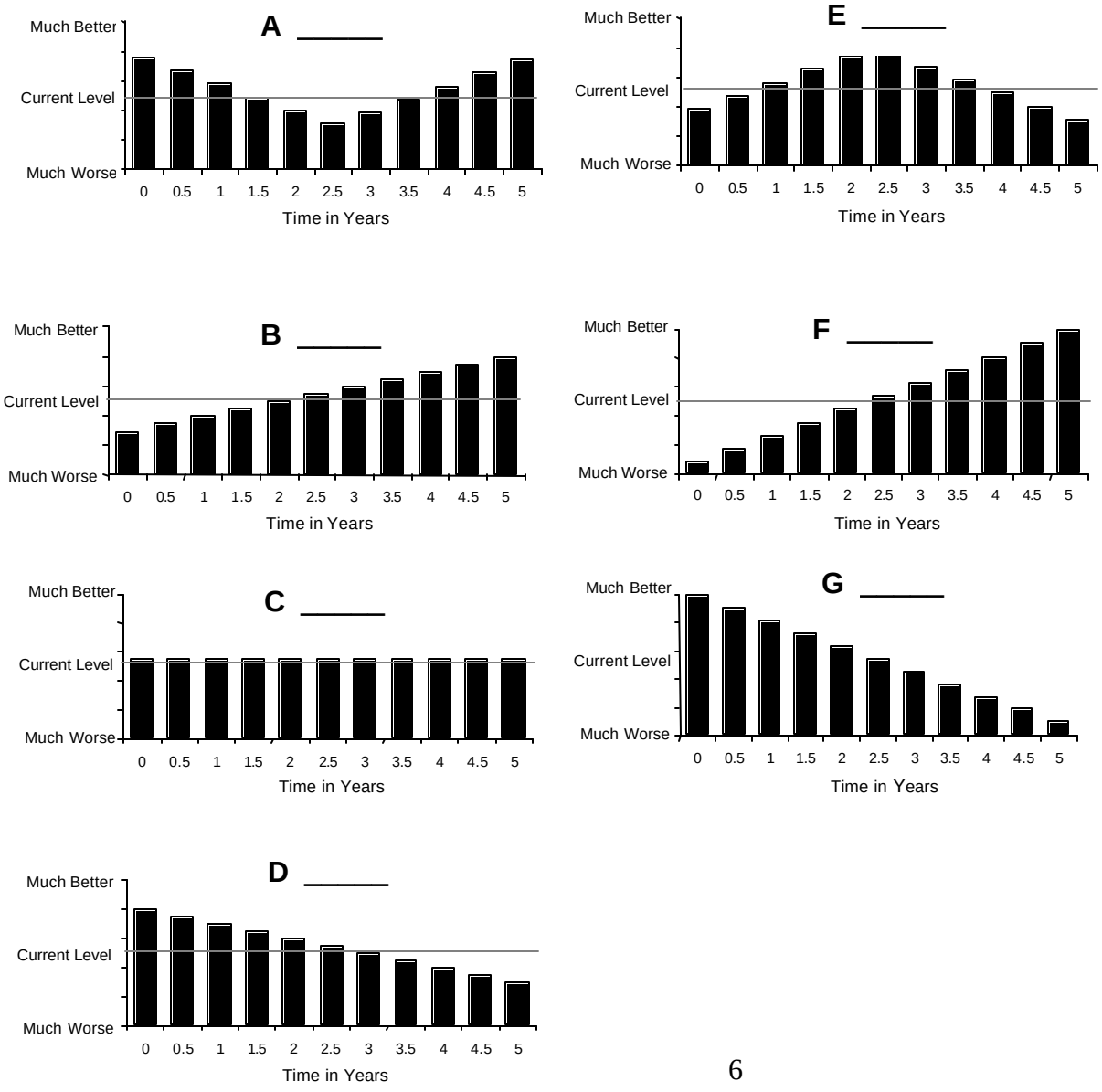
Secondly, the experiments were hypothetical. She commented, however, that this didn't seem to be a problem. When people were asked to write down what they were thinking, they came up with reasons for their choices that made sense, as long as one is willing to believe that not only discounting reasons are sensible. For example, people would say, "Well, I don't want to have all the losses occur in one year. I'd like them to be spread out." Or some people would say, "Well, I want things to get better for my daughter. I want everything to get better over time." People had a lot of different philosophical reasons for why they made their different choices.

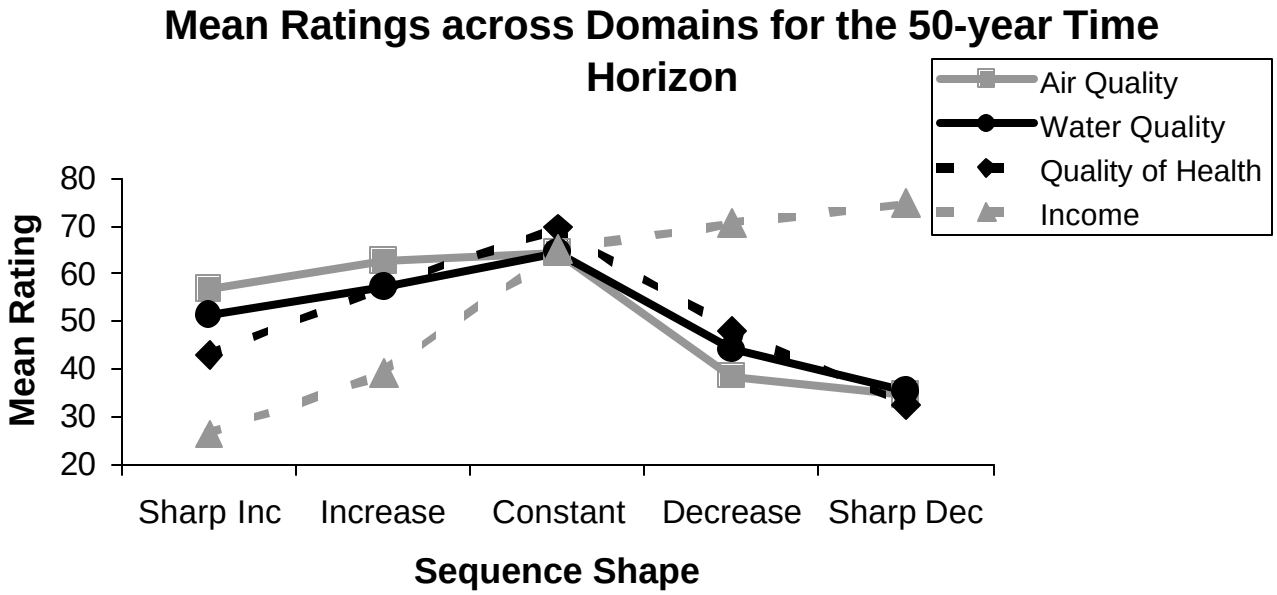
Wrapping up, Dr. Keller asked how outcomes over time should be handled in practice. She offered a few possibilities. A common approach is to price out the attributes into money at each time period, and then discount back to the present with a single discount rate. Given the results she presented, however, that wouldn't seem to make sense, she noted. Or at least one should consider doing something different, or at least consider whether or not it's appropriate for the specific domain that one's working in. Secondly, depending on the context and what one is trying to capture and to convey to a decision maker, it may be better not to discount, but to just compute the sum of outcomes over time.

A third possibility is to not aggregate over time, but instead present the entire time stream to the decision maker. Dr. Keller acknowledged that this can be difficult. Especially with very complicated problems, it may be necessary to do some aggregation. She noted, however, that a lot of practitioners in decision analysis and risk analysis who deal with outcomes over time have concluded that it's better not to just aggregate all the results into one or two numbers and tell the decision maker, "This one's a five and this one's a four, make your decision, five is better." It's preferable to let decision makers see what the implications are behind the model.

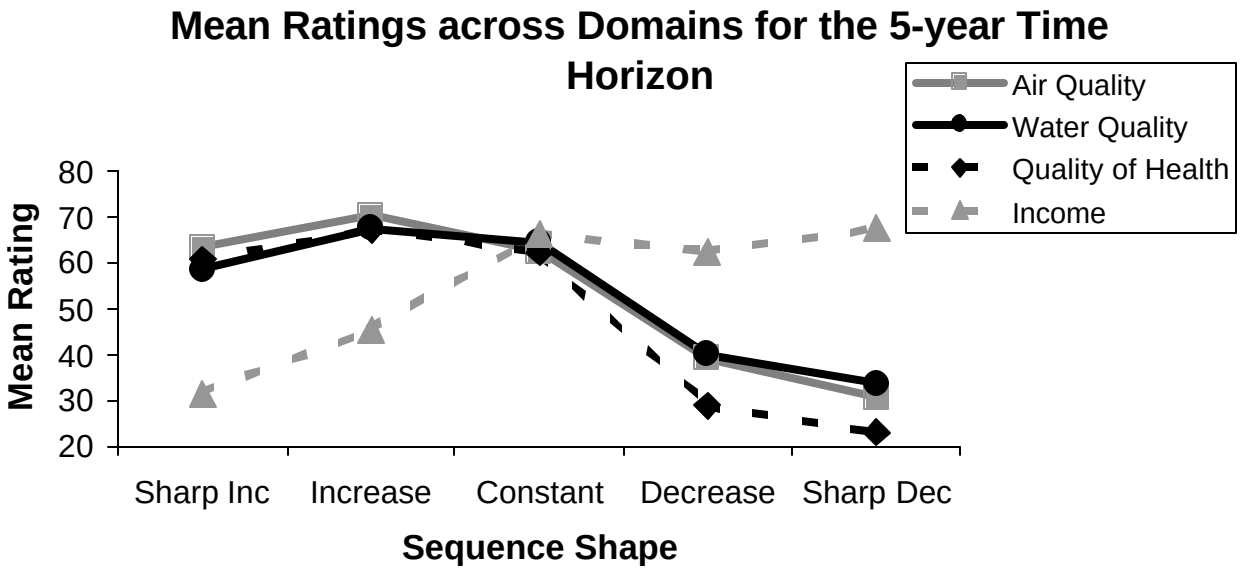
Another possibility was raised in several hour-long interviews carried out with four practitioners in decision analysis and risk analysis, who were asked their opinions about these issues. Sometimes discounting issues or outcomes over time has led to redefining the structure of the problem with multiple attributes. For example, there may be issues of equity across generations or equity across people over time, or across subgroups. That might then be an attribute that might actually be formally modeled and measured, rather than just applying discounting. For example, if people have certain preferences for spreading outcomes over time, or for uniformity of outcomes over time, then that could be formally modeled rather than hidden in the discounting model calculations.

The Seven Sequence Graphs used in Experiment 1. This figure depicts the five-year scenario for either air quality or near-shore ocean water quality. The same graphs were used (without the "current level" line) for quality of health with the y-axis being relabeled with a qualitative health scale or a total payment scale. The x-axis was also re-scaled to 50 years in all four scenarios.



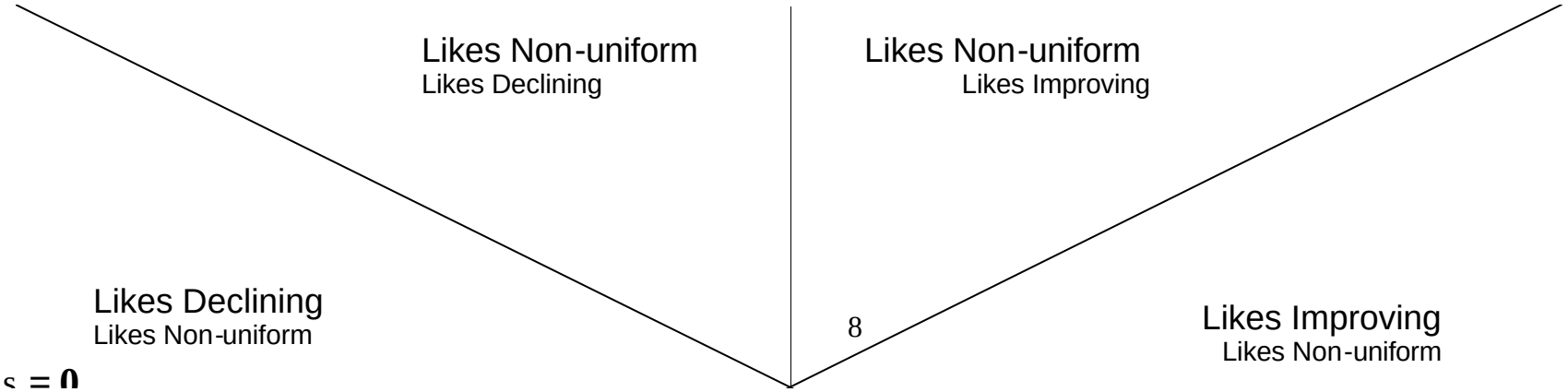


Experiment 1 Results: Mean Ratings for 5-year/50-year Time



Horizons Across the Environmental, Health and Income Domains.

Partitioning of the Parameter Space in Loewenstein and Prelec's Model for Preferences Over Outcome Sequences into eight possible sign-magnitude combinations. The pair labels in each segment identify the major [top] and minor [bottom] motive associated with parameter values in that segment. The partitioning in this figure is similar to that used by Loewenstein and Prelec (1993, Figure 3 p. 99). The least-squares best-fitting (β, σ) pairs for the mean ratings data in the eight scenarios appear in the parameter space with the codings: A = Air Quality, W = Near-Shore Ocean Water Quality, H = Quality of Health, M = Monetary Income, 5 = Five-year time horizon, and 50 = Fifty-year time horizon.



Multiple Discount Rates: the Influence of Decision Context on Choices over Time

--Working Paper*--

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Multiple Discount Rates: the Influence of Decision Context on Choices over Time

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1.0 Introduction

Policy analyses commonly assume that people's preferences for present as compared to future consumption are reflected adequately in a single, invariant rate of time discount. The particular rate to be used is a subject of continuing dispute, with attention focusing on capital market imperfections, perceived transaction costs, inflation rates, and the like. The practice of using a single rate, however, has remained largely unquestioned, as documented in thousands of benefit-cost, environmental management, health risk and other policy analyses conducted by public sector agencies every year.

Recent findings from behavioral research question this reliance on a single rate of discount. Two patterns, based on experiments examining individual's expressed choices over sets of options that exhibit different rates of time preference, are particularly well supported. The first result is that people typically use higher rates to discount near-term outcomes relative to those occurring at more distant times (Benzion, Rapoport & Yagil, 1989; Cropper, Aydede & Portney, 1994, Liabson, 19xx). As a result, a change occurring over the next year will in most cases count for more, all else equal, than will an otherwise identical change occurring five or ten years in the future. Although this result is not yet widely accepted by policy analysts, it can be addressed by conventional explanations of behavior such as the declining marginal utility of goods over time.

The second result is that people commonly discount future losses at a lower rate than future gains (Thaler, 1981; Loewenstein, 1988). As a result, losses occurring in the future typically count relatively more in terms of present value calculations, for example, than do equivalent future benefits. Although this finding follows directly from the influential research of Kahneman and Tversky, whose experiments demonstrated that individuals value current losses more highly than formally equivalent current gains (Kahneman & Tversky, 1979), welfare economists and policy analysts have been hesitant to employ the distinction in cost-benefit and risk-benefit calculations.

This paper provides further evidence for both these findings. Three different perspectives are emphasized:

The relationship between the framing of an option as a gain or as a loss and the observed rate of time preference.

The role of different attributes of goods – including a variety of financial, environmental, and health consequences – in contributing to differences in intertemporal choices.

The importance of psychological and affective concerns in helping to explain and predict variations in reported time preference.

The search for reasons for the observed differences in discount rates is important as an aid in the prediction of socially desirable rates of time preference. We argue that, under a wide range of circumstances, people's implied rates of time preference should be expected to vary systematically with changes in the evaluation context. This observation is consistent with the extensive research conducted by behavioral decision theorists on the importance of framing and context for how people make choices and form judgments (Kahneman, Slovic & Tversky, 1982; Payne, Johnson & Bettman, 1992) and the role of affective and emotional concerns (Slovic et. al., in press). In many important and familiar policy contexts, we conclude, the continued use of a single discount rate no longer can be supported.

Behavioral research foundations

Research by Kahneman and Tversky in the mid-1970s set the stage for much of the current behavioral research concerning how people make choices over time. As predicted by Prospect Theory (Kahneman & Tversky, 1979), individuals commonly value losses much more than commensurate gains: the hurt of a loss exceeds the pleasure of a formally equivalent gain. The translation of this psychological finding for policy analysts is that people typically demand more to give up a good (their willingness-to-accept compensation, or WTA) than they are willing to pay (their WTP) to acquire an otherwise identical entitlement. This reference, or endowment, effect is pervasive, widely reported, and does not appear to be diminished by repeated valuations or repetitions of market exchanges (Kahnman, Knetsch & Thaler, 1990).

The extension of the endowment effect to intertemporal choices suggests that options over time framed in terms of an individual's willingness to accept compensation should elicit lower discount rates (implying a higher future worth) than will choices framed in terms of willingness to pay (for which higher discount rates would imply a lower future worth). Initial tests of this hypothesis, conducted by both economists and psychologists, provide supportive evidence for reported differences in the rates of time preference for gains and losses. Thaler (1981), for example, reported estimated discount rates for gains that were 3 to 10 times greater than for losses, with several subjects exhibiting negative discounting for losses (a topic we return to in the next section). In another test, participants in a study by Loewenstein (reported in Loewentstein & Prelec, 1992) were indifferent (on average) between receiving a gain of $10 immediately or $21 in one year and indifferent between losing $10 immediately or $15 in one year.

Different discount rates also have been observed for choices made in the near-term as opposed to those farther away in time. Cropper, Aydede and Portney (1994), for example, report survey results showing a strong preference for saving

lives in the present as compared to the future: 47% of respondents preferred saving 100 lives today to saving 7,000 lives in 100 years, and 38% chose to save 100 lives today rather than 4,000 lives in 25 years. Benzion et al (1989) refer to this as the "common difference" effect, which echoes the intuition that people are more sensitive to the difference between gains or losses now as compared to one year from now than they are to the identical difference in outcomes between future years. In his review of the standard discount model, Weitzman (1998, p. 202) notes the appeal of this finding: "Few are the economists who have not sensed in their heart of hearts that something is amiss about treating a distant future event as just another term to be discounted away at the same constant exponential rate gotten from extrapolating past rates of return to capital."

The difference in near-term and far-term rates is, at least in part, an example of proportion dominance (ref – Slovic, 2000?) as well as decreasing sensitivity: people care not just about the absolute quantities that are involved in an exchange but also the proportional magnitude of the proposed changes. Thus, a delay from 1 to 2 years is a doubling in time whereas a delay from 10 to 11 years is only a 10 percent increase in waiting time; this proportional difference may lead to a change in feelings and, in turn, influence the reported discount rates. Waiting cuts both ways, however, with both anticipation (of a positive outcome) and dread (of an adverse consequence) contributing to the finding that, when presented with a sequence of outcomes, people may prefer to postpone the better outcomes to the end and to deal in the near term with outcomes having adverse consequences. As summarized by Loewenstein and Prelec (1991), "sequences of outcomes that decline in value are greatly disliked, indicating a negative rate of time preference" as well as a sharp contradiction with predictions of the standard discounted utility model favoured by most economists and policy analysts.

Several researchers have investigated whether discount rates may also vary with differences in the type of the good, but here the results are mixed. Cropper,

Aydede and Portney (1994), for example, concluded that the discount rate for life-saving over time is, on average, equal to the discount rate for money. Chapman (1996), on the other hand, found strong evidence for domain independence when subjects were asked to make choices over hypothetical amounts of future health and money. She concluded that "separate cognitive mechanisms" may be used for health as compared to financial decisions over time. Experiments conducted by Luckert and Adamowicz (1993), which compared choices over environmental assets to choices involving stocks and bonds, also showed that differences in the type of good can influence the revealed rate of time preference.

Similarities or differences in responses to goods relate to their attributes and to the relative weights that are placed on these components of meaning and value. Responses to the individual attributes of goods may be either cognitive or emotional in nature and, in turn, these two types of responses may interact. Research on the role of affect and emotion in decision making has helped to identify the individual contributions of emotional and cognitive responses to stimuli (e.g., Zajonc's research showing the greater speed of affective over cognitive reactions) as well as their interactions (e.g., ways in which emotional responses may influence or inhibit subsequent cognitive evaluations; Luce, Bettman & Payne, 1999). In particular, findings that demonstrate significant correlations between affective responses and choices among either gains or losses (e.g., Peters & Slovic, 1996; Zinberg & Mahlman, 1998) suggest that it may be helpful in explaining the results of intertemporal choices to look to the attributes of the goods in question rather than more simple, wholistic descriptions of their type. This idea is consistent with the observation made by Chapman (1996: 771), who stated "Comparing discount rates for health and money is somewhat like comparing apples and oranges. Health and money outcomes differ in so many respects that it is difficult to know what is responsible for the domain independence."

Results from experiments that examine each of these three questions – differences in discount rates for gains and losses, variations in rates for different types of goods, and reasons for the differences in implied discount rates based on the attributes of the stimuli -- are presented in the next section. The linkage from the observed differences in stated time preferences to preliminary explanations remains tentative, in that the reported research results are preliminary. However, before research demonstrating the existence of multiple discount rates will be adopted more widely by policy analysts, we believe that an increased emphasis on explanatory mechanisms is necessary. Predictions of how individuals will respond to different intertemporal choices in a specific evaluation setting is not possible without an improved identification and understanding of the factors that underlie and contribute to their implied discount rates. We return to this central topic of choosing a discount rate to match the evaluation context in a concluding discussion section.

Experimental Results

The time preference tests presented in this paper employ two different experimental settings.

a). Large-sample tests (n = 150-275) using student samples, conducted at the U of Oregon in the fall of 2000 and the summer of 2001. Respondents were recruited through notices in the student newspaper, offering payment of $10 for their participation in a one-hour paper-and-pencil survey covering a range of topics. Approximately one-half of the questions related to a variety of choices over time, whereas the other half were unrelated judgment tasks.

b). Small-group tests (n = 3-5) using largely student populations, also conducted in Eugene, Oregon during the fall of 2000 and both spring and summer of 2001. Individuals were again paid for their time spent in completing paper-and-pencil questionnaires, but for these tests only 3-5 persons attended each 30-minute session. This small-group format was selected to help make sure that participants clearly understood the required tasks; the small-group

setting allowed for a trained facilitator (Burns, one of the authors) to talk through a first page of instructions and to then be available for any questions of clarification that arose during completion of the questionnaire.

3.1. Experiment 1: Gains and losses

Background. Choices between present and future options involve exchanges that fall into one of four categories. These can be illustrated as comparisons among the four quadrants formed by a vertical axis indicating the future gain or loss of the good being valued and a horizontal axis indicating the gain or loss in the presence of money or some other stimulus used as the value numeraire.

As shown in Figure 1 below (Knetsch & Gregory, 2001), this depiction distinguishes between the two most well-known valuation options: an individual's maximum willingness to pay (Q 1), in which (hypothetical) money is given up in the present to secure a future gain, and the individual's minimum willingness to accept compensation (Q 3), in which (hypothetical) money is received in the present to accept or offset a future loss. Both quadrants depict real exchanges involving tradeoffs between current and future consumption, with Q1 exchanges showing the present value of a future gain in terms of the amount an individual is willing to give up now to obtain in (i.e., their willingness to pay, or WTP) and Q3 exchanges showing the present value of a future loss in terms of the amount demanded to accept it (i.e., their willingness to accept compensation, or WTA).

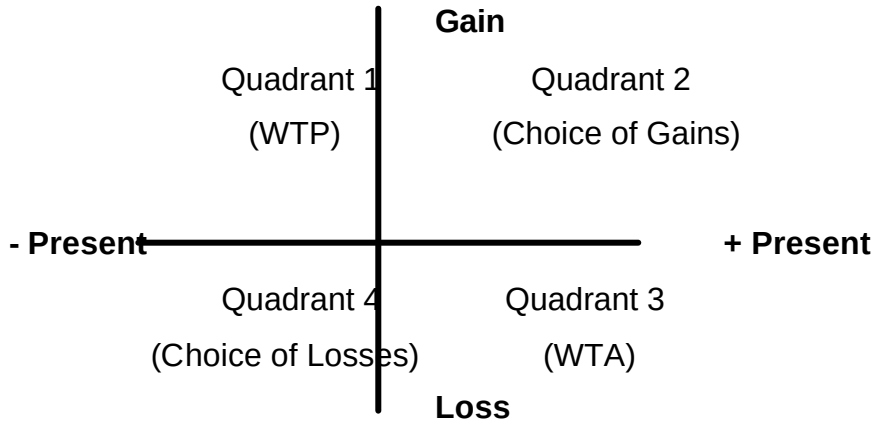

Figure 1. Combinations of Gains and Losses

The other two quadrants show either a choice of equivalent gains (Q 2) or a choice of equivalent losses (Q 4). As noted in Bateman et. al., 1997, these measures are fundamentally different from the Q1 and Q3 exchanges because they are based on tradeoffs measured in terms of opportunity costs rather than in terms of actual sacrifices. Measures of the equivalent gain or equivalent loss provide an assessment for evaluation purposes of the tradeoff from a reference state of not having either, so that participants are choosing between a present and future gain, without having to give up anything (for Q2) or being forced to give up one or the other without any compensating gain (for Q4) (ref – Knetsch, 2001?). The difference is important because, as indicated by substantial experiment evidence, opportunity costs are valued less than are out-of-pocket expenses (ref.), and this greater reluctance to give up real entitlements means that use of the WTP measure (Q1) will lead to higher discount rates than will the equivalent gain measure (Q2) and, similarly, use of the WTA measure (Q3) will lead to lower discount rates than will the equivalent loss measure (Q4).

Identification of these four quadrants, linked to the distinction between actual and equivalent gains and losses, isolates a possible source of inconsistency in interpreting the results of previous studies of intertemporal choice. This inconsistency derives from the confounding of the endowment effect and choices over gains and losses with expressed valuations over time. Cropper, Aydede & Portney (1994), for example, asked subjects a choice-of-gains, Q 2 question: choose between Program A, which will save 100 lives now, and Program B, which will save 200 lives 25 years from now. Benzion et al (1989) compared how much people would pay to speed up a future gain (or to delay a future loss) with how much they would demand to delay a future gain (or speed up a future loss), which are Q 1 and 3 comparisons. Loewenstein & Prelec (1992) asked questions that involved choices between two gains or between two losses, which are Q 2 and Q 4 valuations. As supported by the new experimental evidence

presented in the next section, a more systematic comparison of across-quadrant results is required to isolate the implied rate of expressed time preferences.

In addition, choices within each quadrant potentially are as important as are choices across quadrants. For a Q1, WTP question, for example, possible options include receiving a future gain, postponing a future loss, speeding up a future gain, and eliminating a future loss. Although each of these framings provide a measure of a person's willingness to pay now for a favourable future outcome, it seems entirely plausible that individuals will express a different rate of time preference for these positive future opportunities even if all other aspects of the proposed choice are the same. Similarly, Q3 options that all involve a future loss -- eliminating a future gain, incurring a future cost, delaying a future benefit, and speeding up a future loss -- may well differentially effect individuals' expressed rates of time preference. We return to this within-quadrant choice-of-measures question in the discussion section of this paper.

Design. Several tests of the sensitivity of time preferences to alternative gain & loss frames were conducted. We first describe in detail an experiment comparing responses for all four quadrants that uses a change in vacation days as both the numeraire and future outcome, and then describe the design of other tests that use different goods and/or different question frames.

Participants in the vacation days experiment were asked to consider a trade between having days of vacation in the present or in the future. Subjects in a large-sample test read a short scenario stating that their employer was offering an opportunity to change some of the days of holidays they were entitled to, with the offsetting changes taking place in the current year and five years from now. Four versions of the question were created, corresponding to different framings of present and future gains and losses; one of the four was randomly presented to each individual. For example, respondents in the Quadrant 1 group (N=38) were asked to state the maximum number of vacation days they would give up

this year to receive 11 more days of vacation 5 years from now. The scenario and time preference question are shown below.

Imagine that you work for a medium-sized company that recently has been bought by a larger company. Your job is assured and you plan to continue working at this company indefinitely.
In order to help integrate the benefits packages of the two companies, the new owners are proposing that you (and some of the other current employees) give up some number of vacation days you have this year (2000) and gain 11 extra vacation days in 2005 (5 years from now). You currently have 17 days of vacation every year, which is (and will remain) the most anyone is given, regardless of seniority. You have a chance to give up some number of vacation days this year in order to receive 11 additional days of vacation in 2005.
Due to staffing requirements, only those employees willing to give up the largest number of days this year, in order to receive the 11 extra days in 2005, will get the opportunity to make the trade.
What is the maximum number of vacation days you would give up this year to receive 11 more days of vacation 5 years from now, in 2005?

A second group (N=37) was asked "the minimum number of added days you would require this year to just equal giving up 11 days of vacation 5 years from now", which is a Q 3 question. Two additional groups (N=38) were asked variations of these same questions, involving receiving or giving up 11 days of vacation time 5 years in the future, that encompassed the remaining two valuation quadrants. In each case, participants were asked to circle the appropriate number of vacation days from a list (pre-tested to ensure adequate scope) printed below the question.

Other experiments designed to elicit expressed time preferences for gains and for losses focused on the critical Q1 (WTP for gains) and Q3 (WTA for losses) comparisons. Subjects in corresponding tests were given a more streamlined

introductory scenario but were presented with a similar evaluation question involving trades of vacation days between two time periods, as shown below. They were then asked to write in the number of days that would provide an equal exchange between the current year (2001) and three years from now (2004). Quadrant 1 participants, for example, were asked the following question:

You work for a company and receive 15 days of vacation time each year. For budgetary and organizational reasons, the company would like you to switch some days this year and some other days three years from now (all other years would remain unchanged). You would give up 4 vacation days this year in exchange for receiving additional vacation days three years from now (in 2004). We want to know how many additional days you feel you would need to receive in three years to just balance giving up the 4 days this year.

I feel it would be an even exchange if I have _____ vacation days added to my normal 15 days in 2004, to balance giving up the 4 days this year.

Other questions to compare gain and loss responses used similar formats but introduced different goods to examine differences in expressed discount rates in the context of gaining or losing a variety of items, including environmental and health as well as financial choices. For example, the corresponding WTP and WTA evaluation questions asked of participants who valued an investment certificate were as follows:

Q1: What is the largest amount of money you would pay now to receive an investment certificate worth $1000 in 3 years?

QIII: What is the smallest amount of money you would accept now to give up an investment certificate worth $1000 in 3 years?

Participants were also given questions concerning the choice of time periods for one of the two environmental policies, maintaining habitat used by birds (row 3) and allocating personnel for cleaning animals oiled by an accidental spill (row 4),

and were asked to state the change in the number of hours three years in the future that would just offset an increase (or decrease) in hours this year. For example, Quadrant 3 participants asked about allocating resources to clean oiled birds were asked the following question:

The parks department allocates 800 total hours per year to cleaning animals oiled by pollution in local waterways. The department plans to increase the time devoted to these purposes by 100 hours this year and decrease it in 2003. What decrease in total hours for cleaning oiled animals in 2003 would just offset the increase of 100 hours this year?

It would be an even exchange if _____ hours are lost in 2003.

A similarly worded question, balancing resources used for routine roadside maintenance (a human health concern) between the current year and three years in the future, was also asked of some participants.

Results. The vacation day and other gain – loss results are shown in Table 1. As shown in row 1, which presents results from the large-group vacation day experiment, participants' responses reflect the expected pattern of valuation asymmetries and the Q1 vs. Q3 comparisons are significant at the .0001 level (based on results of a two-tailed t-test on the mean responses). The lowest valuation of an additional 11 vacation days five years from now was given by the Q 1 (WTP) respondents; their mean response of 5.4 days implies a discount rate of 15 % (or 17 %, using the median response). The highest valuation of the 11 additional vacation days was given by the Q III (WTA) respondents; their mean response of 11.7 days implies a slightly negative discount rate (or 0% after rounding, which equals the median response). Responses for Q 2 (mean = 8.3 days) and Q 4 (mean = 7.2 days) are intermediate, as anticipated, as are the respective implied discount rates of 6% and 9%.

Rows 2-6 of Table 1 show similar results, with (in each case) significant differences between the implied discount rates in the context of paying now for a future gain as compared to accepting compensation now in return for agreeing to a future loss. Row 2 shows the results of the two-quadrant comparison that asked about the choice of vacation days. Rows 3 and 4 show results for two environmental goods: habitat maintenance for birds and the allocation of resources to clean oiled animals as the result of an accidental spill at sea. Row 5 present results for an investment certificate and Row 6 shows results for allocating funding to a roadside maintenance initiative. In each case, the Q 1 and Q3 results are significantly different and follow the expected pattern that previously has been demonstrated when comparing choices over prospective gains and losses.

3.2 Experiment 2: Type of Good

Background. As noted earlier, there is some evidence that people may use different time preference rates to discount the future value of different types of outcomes. Luckert and Adamowicz (1993), for example, note differences in expressed time preference rates for environmental as compared to financial goods as well as for private as compared to public goods. This latter distinction, between private and social rates of time preference, is well known to economists and has been the subject of an extensive literature (ref.). Evidence for variations in discount rates relating to the type of good also derives from observations of public policy choices, in that decisions leading to improvements in environmental or health effects that will accrue primarily in the distant future (e.g., more than 50 years from now) are nonetheless routinely favoured by many individuals. This implies a lower rate of discount than typically is assumed for financial mechanisms, because any positive discount rate larger than 3% or 4% renders insignificant long-term adverse or beneficial effects.

Additional evidence for differences in observed discount rates between types of goods comes from studies of peoples' assessments of sequences of outcomes

over time. Loewenstein & Sicherman (1991), who conducted an early study of time preferences over sequences of outcomes, reported that workers receiving an income of $150,000 over six years preferred to postpone receipt of most of the money until later in the sequence, which decreases the present value of the associated income stream and implies negative, rather than positive, discounting. Chapman (1996) also reported a preference for increasing sequences among many (but not all) health and income options presented to University of Chicago students. Guyse, Keller and Eppel (2000) re-examined this earlier work and reported that their subjects (graduate business students) preferred the conventional decreasing sequences over time for most options involving financial (income-based) outcomes but preferred constant or increasing sequences for environmental and health outcomes.

Our examination of these results in light of other recent research on behavioral decision making resulted in the observation that the important concern was perhaps not the *type* of good (e.g., environmental or health or financial) but rather the *characteristics* of the good and whether these characteristics might induce a consistent difference in the psychological response of participants. This emphasis on characteristics might, in turn, explain the differences in conclusions reached by previous researchers regarding the effect on discount rates of difference in the type of good. For example, by varying the characteristics of the alternative, health effects might induce either a highly-charged emotional response (e.g., effects on the safety of children) or a slight response (e.g., improvements in the office equipment of government workers) depending on the nature of the proposed choice. Similarly, some environmental effects (e.g., impacts on rare or endangered species) might elicit far stronger reactions that others (e.g, improvements in litter control at a local park). Thus, we anticipated that different conclusions about the domain sensitivity of expressed time preferences could be reached depending on the characteristics of a specific environmental, financial, or health good.

Some researchers also have suggested a moral basis for why certain health or environmental choices, by their very nature, may not be subject to the same type of discounting calculations as a bank certificate or many other common investment options. For example, Shelling (1999) stresses the ethical dimension of choices made over time, concluding that decisions such as the amount of aid to provide over time for different developing countries is primarily a moral choice rather than strictly a time-preference deliberation. Research by Baron and Spranca (1997) on protected values, or by Tetlock and others (1996) on what are referred to as "taboo tradeoffs", also may be relevant, in that ethical and moral dimensions of a comparison of options over time may strongly affect observed choices in ways that render questionable any strict comparison of implied time preference rates.

We return to this discussion in the next section of this paper. As pointed out by previous researchers, the question whether people use different discount rates for different types of goods holds important implications for the theory and practice of economic cost-benefit analysis. Cropper et al (1994: 260), for example, note that they "find it comforting that the general public appears to agree with the discounting of future lives saved and, furthermore, that its discount rate for life-saving is, on average, equal to its discount rate for money." Luckert and Adamowicz (1993: xx), on the other hand, conclude their review of experimental results with the warning that "it may therefore be appropriate for governments to consider using lower rates of discount than the private sector, and to vary the rate used according to the type of good being evaluated."

Design. The design of experiments to investigate the effect of changes in the choice of good on implied discount rates was guided by three considerations. First, we wanted to look both at choices made over discrete points in time (e.g., this year versus five years from now) and at sequences of choices over time. Second, we wanted to keep constant the magnitude of the proposed change over the different types of good in order to avoid unintentional confounding with the

magnitude effect (Chapman & Elstein, 1995), whereby expressed discount rates have been found to be lower for larger magnitude outcomes. Third, we wanted to be able to define the goods involved in the experiments in terms of their more fundamental attributes, in that we anticipated that differences in implied discount rates might have relatively more to do with the perceived characteristics of the stimuli than with their more abstract classification as financial, environmental, or health-related items.

Two different experiments were used to examine differences in implicit discount rates corresponding to the type and definition of goods. A first experiment asked participants to evaluate sequences of changes in benefits (gains) and costs (losses) over time, some of which involved monetary changes and others environmental changes. As shown in Figure 2, these changes were shown as constant increments (or decrements) from a neutral value line over a specified period of time. All options shared the common characteristic of providing benefits (or costs) for the first 5 years followed by costs (or benefits) starting after 10 years and continuing for the lifetime of the respondent. For example, the monetary option ("dollars each year from a money market investment") showed costs ("money you pay out each year") of $350 for years 1 – 5, followed by benefits ("money you receive each year") of $400 starting in year 11 and continuing "over your lifetime." The parallel environmental option ("species on the endangered list") showed costs ("health of species degraded: add 3 species to endangered lists each year") for years 1 – 5, followed by benefits ("health of species improved: remove 4 species from endangered lists each year") starting in year 11.

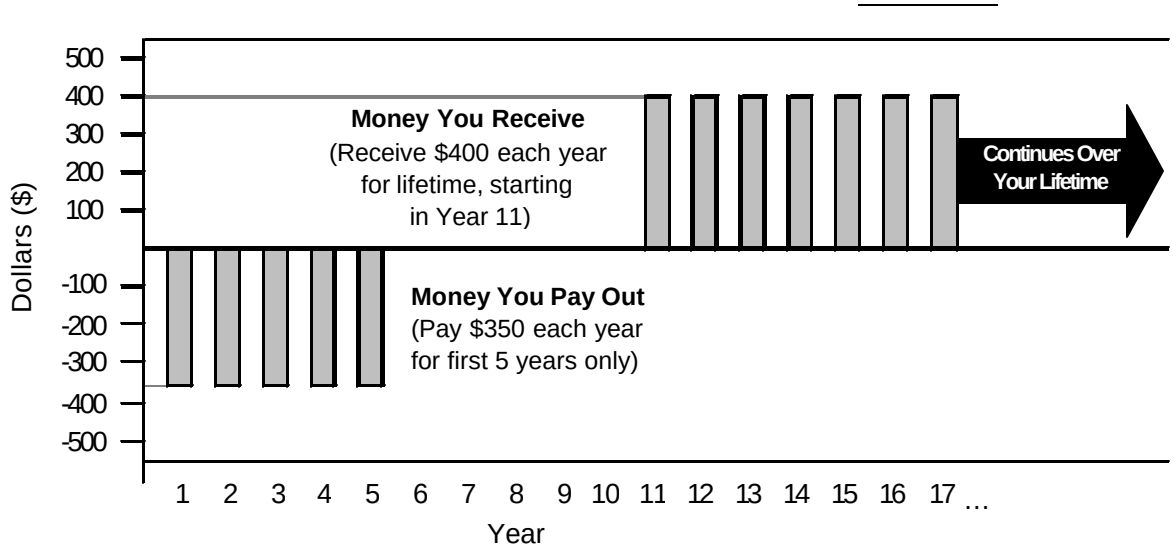

Figure 2: Example of type-of-good experiment (showing dollars each year from money market investment)

Correspondence among the types of goods was achieved by presenting similar patterns of gains and losses over time, with roughly comparable overall benefit-cost ratios. These reflected pre-tests of acceptable amounts, because the reported attractiveness of the sequences varied among subjects according to the intuitive discount rate that they employed. For example, using a discount rate of 10%, the net present (discounted) value of the two Q1 sequences noted above (pay $360 or have 3 species added for years 1-5, followed by receive $400 or have 3 species removed starting after 10 years) show a benefit-cost ratio of just over 1.0. The net present values of the parallel Q3 sequences (receive $400 or have 4 species removed for years 1-5, followed by pay $350 or have 3 species added starting after 10 years) show a positive benefit-cost ratio of about 1.3. At a higher discount rate of 15%, both Q1 options become less attractive (B/C ratios

of about 0.5) because of the delayed gains whereas the parallel Q3 options become more attractive (B/C ratios of about 3) because of the delayed losses.

For both the financial and environmental sequences, participants were asked to state whether they thought this stream of costs and benefits would provide “a good deal” using a 0 - 6 scale (with endpoints “not a good deal” and “a very good deal and a mid-point of 3”) provided after each question. Two costs-first and two benefits-first versions were included for both the financial and environmental options. These varied according to the assumed benefit-cost ratios so as to cover the range of anticipated outcomes; for example, the two versions of the Q1 financial option showed payments for years 1-5 of either $360 or $220, whereas the comparable environmental option showed either 3 or 2 species each year that would be added to the endangered species lists. Each subject responded to two sequences, one environmental and one financial, with one gains-first and one losses-first scenario.

A second experiment employed a two-quadrant design similar to that previously used to study gains and losses. Subjects were asked about their willingness to make tradeoffs over specified periods of time in their allocation of resources to policies involving environmental goods (e.g., cleanup of contaminated soils, maintenance of bird habitat), health initiatives (e.g., traffic safety initiates, playground equipment used in schools), financial options (purchase of a bank certificate), and consumer purchases (holiday options). Questions were randomly assigned, with participants asked for alternating Q 1 and Q 3 responses.

The key experimental manipulation was to vary the affective context within which each type of good was presented. Given that affective considerations already have been shown to be an important determinant of choices made within a current time period (ref), we anticipated that contextual variations in the affective presentation of an item might also lead to variations in expressed time

preference rates. If so, then differences in rates should be observed not only *across* different types of good but also *within* the same type of good, as a consequence of attribute-based variations in context that would, in turn, influence their affective response.

For example, the Quadrant 1 version of the initial, low affect vacation days question informed respondents that "The company you work for was taken over by a larger corporation and the new owners ask you to give up 6 of your vacation days this year in exchange for receiving additional vacation days three years from now (in 2004)." The high-affect version of this same question informed respondents that "A *co-worker* has some family obligations and asks you to give up 6 of your vacation days this year in exchange for receiving additional vacation days *from him*" in the future. Similarly, one of the low affect environmental questions asked about allocations of worker days to maintain habitat used by "populations of common birds such as sparrows and starlings," whereas the parallel high affect question asked about personnel allocations to maintain habitat used by "populations of rare birds such as osprey and eagles." For the intertemporal health-choice task of allocating resources to programs designed to ensure safety, the low affect context was to fund "programs designed to ensure the safety of office equipment used by state employees" and the high affect context was to fund "programs designed to ensure the safety of playground equipment used by children enrolled in public schools." A five-point "intensity of feelings" scale, from "very boring" to "very exciting," was included to provide a check on these assertions of low and high affect contextual changes.

Results. Results from the sequenced choice of goods experiment are shown in Table 2. Both sets of comparisons (i.e., those calculated at the lower and higher discount rates) show very similar results. Four findings are relevant.

1. The Q1 (WTP) and Q3 (WTA) responses are dramatically different. In all four cases, the pay first/receive benefits later option (Q1) was considered a fairly

good deal; in all four cases, the receive benefits first/pay later option (Q3) was considered a decidedly bad deal.

2. This gain-loss result is striking in light of the associated benefit-cost ratios, which run in favor of the Q3 options. In each case, whether an implied discount rate of 10% or 15% was used, the Q3 option shows a positive net present discounted value whereas the Q1 option shows a negative net present discounted value. However, in each case the Q1 option was preferred.

3. In the WTP cases, the financial options were considered to be significantly more attractive than were the environmental options (refer to t-test results). In the WTA cases, the environmental options were only slightly preferred to the financial options and the differences are not significant (reference t-test results). We return to this point in the discussion section.

4. In both the 10% and 15 % options, participants were insensitive to the difference between the higher and lower value alternatives (RG: true for June, 2001 but in Nov, 2000 not true for Q1. Note why). This insensitivity to rather large changes in the resulting monetary values is consistent with results found by other behavioral decision researchers (e..g, Kahneman, Sunstein & Schkade, 1999).

Results from the two-quadrant characteristics of goods experiments are shown in Table 3. Reading vertically in the table for one type of good, differences between Q1 and Q3 responses generally are again large and in the expected direction, adding to the information supportive of a distinction being made between treatment of options framed over time as either willingness to pay or as compensation demanded alternatives. For example, the implied discount rate is 26% for the Q1 investment certificate question ("What is the largest amount you would pay now to receive an investment certificate worth $1000 in 3 years?") as compared to only 10% for the Q3 equivalent ("What is the smallest amount you would accept now to give up an investment certificate worth $1000 in 3 years?"). The sole exception is the high affect investment certificate responses.

Reading horizontally across the table for one type of good, differences in the low and high affect ratings are sometimes significant, sometimes not. The environmental affect ratings show the largest margin and are significantly different; the financial (investment certificate) ratings show the smallest margin and are not significantly different. Differences in the low and high affect responses for both the Q1 and Q3 questions are sometimes significant, sometimes not. Both differences are significant for the environmental option, whereas only the Q1 responses are different for the Vacation days option and only the Q3 responses are significantly different for the Financial option.

These results generally support our assertion that it is not so much the type of good but, instead, its characteristics that matter. As shown in Figure 3, the

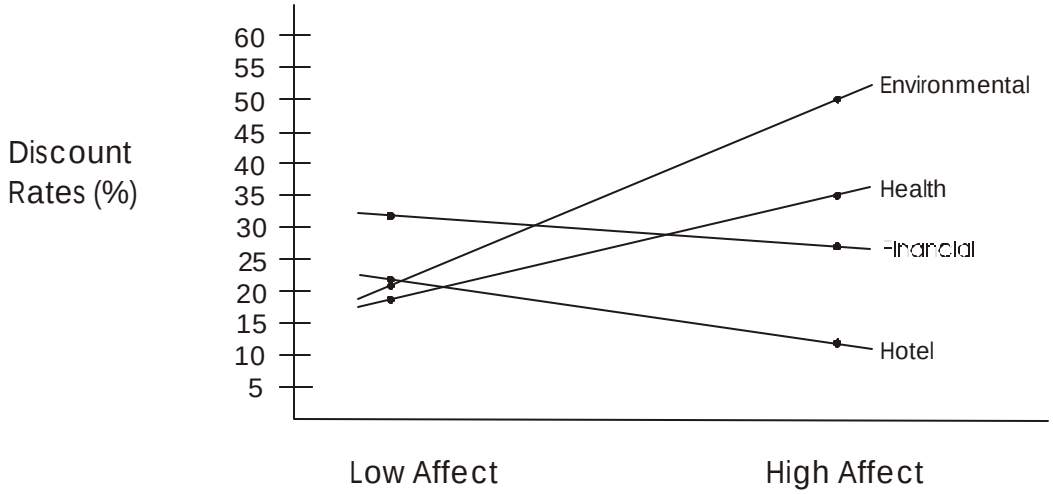

Figure 3: Discount rates for high and low affect environmental and financial goods

implicit discount rates for the Q1 *low-affect* environmental good are lower than the implicit discount rates for the low-affect financial good, whereas the implicit discount rates for the Q1 *high-affect* environmental good are higher than the implicit discount rates for the high-affect financial good. Additional results (discussed below) support the more general point: *within* each domain of goods, the associated attributes leading to the creation of high or low affect responses may influence desired intertemporal choices and result in systematic variations in implicit discount rates.

Discussion

The results of these experiments provide evidence for the importance of contextual influences on stated discount rates and, in turn, support the existence of multiple discount rates. If decisions taken on behalf of the public are to mirror people's preferences and how individuals naturally think about choices over time, then the use of discount rates – and, in turn, the practices of benefit-cost and policy analyses -- should be responsive to contextual influences on how people think about choices involving benefits, costs, and risks occurring over time.

The results are especially strong for Q1 (willingness to pay) as compared to Q3 (compensation demanded) differences in the framing of decisions over time. This is an extension of the early Kahneman/Tversky/Knetsch/Thaler findings. The results are demonstrate that choices over time are different for different types of goods, although these data support the perspective that it is the characteristics of the goods that matter, not simply the type of good. Further, the results are also suggestive of a link between affective and emotional considerations and the magnitude of the contextual difference in discount rates.

We emphasize that these results are preliminary and more conclusive evidence must await the results of further experiments. In particular, there is more to learn in three areas.

A. Understanding the strong aversion to losses that is showing up in Q 3 results
1. Demonstration of strong aversion to Q3 losses (accepting a gain now but incurring a loss later). A surprisingly large proportion of the Q3 respondents reported a *negative* implied discount rates for future losses (see Table 4). This showed up already in the Table 2 sequence results, where inferior Q1 options were chosen over superior Q3 options

2. Work of Loewenstein (1992, 19xx) and others demonstrates the role of context resulting in intentional anticipation and delay: subjects want to postpone good stuff, get bad stuff over with quickly. So one way that losses are dealt with is by wanting to get them over quickly. This effect is demonstrated in Table 5 below. The scenario is school children playground accidents. Postponing accidents as far as possible into the future should have been the preferred option, but only 1/3 subjects chose this. Nearly ½ participants chose what was expected to be the least preferred option, which was to have more accidents occur as soon as possible.

Another example shows again how strongly participants seek to avoid having to face Q3 losses. For each of the examples shown in Table 6, respondents were asked to select their preferred choice between the two options shown under each letter (one set of respondents chose between the two A1 options, another set of respondents chose between the two A2 options, etc.). In the bank investment A1 example, theQ3 option should be preferred for any implicit discount rate greater than 3%. Yet only 42% of respondents selected the more attractive Q3 scenario (RG: more). When the implicit rate of discount was increased to 17% (example A3), a significantly higher percentage of respondents selected the Q1 option. The same is true of the traffic accident scenario. Although we had anticipated that all subjects would prefer to have fewer accidents this year and postpone having more accidents into the future, respondents were nearly evenly split between the two A1 alternatives. Further, even though at normally assumed discount rates the Q3 example in A2 should have been selected by most participants, a surprisingly high percentage of respondents chose to avoid the losses highlighted in the Q3 example in favor of the nominally less attractive Q1 option.

<u>B. Understanding contextual effects *within* quadrants</u>. For example, we asked participants to respond to the same present/future exchange but switched the present and future portions of the question:

days gain in 3 years to give up 4 days now *versus* # days give up now to gain 5 days in 3 years (see Table 7)

Table 7 shows these two different ways to ask the same Q1, willingness-to-pay question involving payments in the present to secure a future gain. The wording of one question (mean = 8.1; discount rate =) focuses on the future *gain* or receipt of vacation days, whereas the wording of the second question (mean = 2.2; discount rate =) focuses on the current *loss* or relinquishment of days. These results are consistent with many well-known examples of framing effects noted by Kahneman and Tversky (e.g,. the Asian flu example, whereby strikingly different policy choices are made depending on whether the emphasis is placed on lives saved or lives lost) but here we observe the effect of contextual changes (or alternative frames) in an intertemporal decision framework.

C. Understanding the role of affect, emotions, and other psychological or social considerations (e.g., fairness) on expressed time preferences for gains and for losses. (Cite also Loewenstein 200x, "Risk as Feelings"). Further discussion of Table 3, but note that additional experimental results are in hand, to be discussed in separate paper (Gregory, Knetsch, Mertz & Slovic, 2001).

If these results, showing differences in observed rates of time preference
-if options are framed as gains as compared to losses,
-for different types of goods, based on a description of their characteristics
-for different goods, based on affective and psychological considerations
are confirmed by future studies, then there are interesting and possibly significant implications for both the theory of how choices are made over time and the practice of discounting as it normally is applied as part of benefit-cost analyses. (more discussion to follow)

Table 1: Comparison of time preferences over gains and losses

	Quadrant I	Quadrant II	Quadrant III	Quadrant IV	T-test result for QI – Q III	Median Test
Vacation days (large group)	5.4days(5.0) dr: 15 %	8.3days (8.0) dr: 6 %	11.7days (11.0) dr: 0%	7.2days(6.0) dr: 9 %	T=5.94 P<.001	P<.001
Vacation days (small group)	2.2 (2.0)		7.8 (10.0)		T=7.23 P<.001	
Habitat maintenance	124.5 (100)		78.4 (100)		T=2.86 P<.01	
Cleaning oiled animals	342 (300)		73 (50)		T=6.44 P<.001	P<.001
Investment certificate	440 (500) dr: 26%		741 (750) dr: 10%		T=4.99 P<.001	P<.001
Roadside maintenance	178 (175) dr: 21%		103 (100) dr: 0%		T=4.36 P<.001	P<.001

Table 2: Sequenced choice of goods balancing present and future gains & losses
(mean responses using 0-6 “how good a deal” scale)

Type of good	Q1	B/C ratio (Fin/Env’t)	Q3	B/C ratio (Fin/Env’t)	t-test, Q1 vs Q3
Lower (10%) dr comparisons		1.0 / 1.5		1.25 / 2.0	
Financial	4.6		0.8		T=13.85 P<.001
Environmental	3.1		1.4		T=3.60 P<.001
t-test, fin vs. env’t	T=4.15 P<.001		T=1.57 n.s.		
Higher (15%) dr comparisons		0.5 / 0.75		3.0 / 4.5	
Financial	5.2		0.7		T=15.86 P<.001
Environmental	4.1		1.0		T=8.12 P<.001
t-test, fin vs env’t	T=2.91 P<.01		T=0.57 n.s.		
t-test, fin vs. fin	T=1.95 P=.05		T= n.s.		
t-test, envt vs envt	T=2.01 P<.05		T= n.s.		

Table 3: Two quadrant comparison of characteristics of goods, showing mean (median) responses and implied discount rates (Nov, 00)

Item	Condition	Low affect	High affect	
Vacation days		Company request	Co-worker request	Low/high affect t-tests
	Q1: Number of days gain in 3 yrs to give up 6 days now	13.0 (12.0) dr = 29%	9.9 (7.0) dr = 18%	T=2.26 P<.05
	Q3: Number of days give up in 3 yrs to gain 6 days now	4.9 (4.5) dr = -7%	5.3 (6.0) dr = -4%	n.s.
	Affective scale means	2.8	3.3	
Investment certificate		Buy/sell from bank	Buy/sell from neighbor	
	Q1: Largest amount pay now to receive $1000 in 3 years	440 (500) dr = 31%	480 (500) dr = 26%	n.s.
	Q3: Smallest amount accept now to give up $1000 in 3 years	741 (750) dr = 10%	482 (500) dr = 28%	T=1.87 P=.06
	Affective scale means	3.1	3.4	
Environmental		Maintain roadsides	Clean oiled animals	
	Q1: # hours gained in 3 years to offset loss of 100 hours now	178 (175) dr = 21%	342 (300) dr = 50%	T=3.99 P<.01
	Q3: # hours lost in 3 years to offset gain of 100 hours now	103 (100) dr = 0%	73 (50) dr = 11%	T=2.38 P<.05
	Affective scale means	2.5	3.8	
Holiday	Q1: # days gain in 3 yrs to	7.1 (6.0)	5.6 (4.0)	

	give up 4 days now	dr = 21%	dr = 12%	
Health	Q1: # fewer accidents in 3 yrs to accept 100 more now	170 (140) dr=19.5%	242 (200) dr = 34.5%	
Q1 – Q3 low affect	Q1 – Q3 high affect			
Vac t = 9.03, p<.001	Vac t=3.99, p<.001			
Inv t=4.99, p<.001	Inv t=3.03, p<.01			
Env t=4.36, p<.001	T=6.86, p<.001			

Table 4: Gain – loss results showing negative implied Q3 discount rates

(RG: March, 2001) – add more on experiment

Stimuli	Q1 mean response	Implied rate of discount	Q3 mean response	Implied rate of discount		
Vacation days – company request	12.4	27.4%	4.1	-13.5%		
Roadside habitat - common birds	191	24.0%	54.6	-22.5%		
Holiday in hotel, Kansas City	7.1	21 %	4.2	1.6%		
Safety equipment – office workers	68.2	3.2%	49.7	- 6.8%		
Cleaning up contaminated soil	110.6	13.8%	52.3	-12.8%		
Reduction in adult accidents	170.6	19.5%	53.5	-23.2%		

Table 5: Preferred sequencing of losses over time

(n = 64)

This year	Next year	2 years from now	% preferring
Same as now	More accidents	Same as now	18.8
Same as now	Same as now	More accidents	32.8
More accidents	Same as now	Same as now	48.4

Table 6: Bank opportunities and traffic accidents

(June, 2001 results)

Bank Opportunities			
A1	A2	A3	A4
Pay $3200 now, receive $3500 in 3 yrs 57.6	Pay $160 now, receive $175 in 3 yrs 40.6	Pay $3200 now, receive $5100 in 3 yrs 93.8	Pay $160 now, receive $255 in 3yrs 83.9
Receive $3200 now, pay $3500 in 3 years 42.4	Receive $160 now, pay $175 in 3 years 59.4	Receive $3200 now, pay $5100 in 3 years 6.3	Receive $160 now, pay $255 in 3 years 16.1
A1 vs A3: chisq=11.46, p=.0007			
A2 vs. A4: chisq 12.49, p = .0004			
Traffic Accidents			
A1	A2	A3	A4
113 *more* accidents this year, 113 *fewer* next year 45.5	113 *more* accidents this year, 118 *fewer* next year 71.0	113 more accidents this year, 124 fewer accident next yr 65.6	113 more accidents this year, 135 fewer accident next yr 80.0
113 *fewer* accidents this year, 113 more accidents next yr 54.6	113 fewer accidents this year, 118 more accidents next yr 29.0	113 fewer accidents this year, 124 more accident next yr 34.4	113 fewer accidents this year, 135 more accidents next yr 20.0
A1 vs A2: chisq = 4.27 p = .04			
A1 vs A3: chisq = 2.67, p = .10			

Table 7: Within-quadrant contextual comparisons

Vacation days	Q1: # days gain in 3 yrs to give up 4 days now	Q1: # days give up now to gain 5 days in 3 yrs	Q3: # days give up in 3 yrs to gain 4 days now	Q3: # days gain now to give up 5 days in 3 yrs
Mean	8.1	2.2	2.7	7.8
Median	8.0	2.0	2.5	10.0
DR				
Habitat maintenance	Q1:			
Mean				
Median				
DR				
Bank offer				
Mean				
Median				
DR				

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Parents' Valuation of Latent Health Risks to Their Children
--Working Paper*--

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Parents' Valuation of Latent Health Risks to Their Children

--Working Paper*--

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1. Introduction

A key aspect of environmental policy in the United States involves reducing hazards faced by children. Children frequently are at greater risk than adults from environmental hazards such as lead poisoning, pesticides, drinking water contaminants, and exposure to solar radiation (USEPA 1996). Additionally, President Clinton's Executive Order #13045 (*Federal Register* 1997) directed federal agencies to address environmental health and safety risks that disproportionately affect children. Appropriate policy aimed at reducing these risks will differ depending on the hazard considered; yet all such policies operate at least partly through adult caregivers who are responsible for children's behavior. For example, parents can be encouraged to take protective actions that will reduce exposure to environmental hazards. Effectiveness of this approach, however, will depend upon parents' beliefs about risks to their children's health, as well as how they make choices between their children's health, their own health and other goods.

This paper extends previous work by Dickie and Gerking (1996, 1997) to look at decisions parents make for themselves and their children to reduce risk of skin cancer from solar radiation exposure (Scotto, Fears, and Fraumeni 1982, MacKie, Fruedenberger and Aitchison 1989, Finkel 1998, American Cancer Society 2001). Skin cancer is the most common type of cancer occurring in the U.S. (American Cancer Society 2001) and solar radiation exposure during childhood is an important determinant of lifetime skin cancer risk (Reynolds *et al.* 1996, Robinson, Rigel, and Amonette 1997, and Creech and Mayer 1998). In fact, as much as 80% of a person's lifetime accumulation of solar radiation exposure occurs before the age of 18 (American Academy of Dermatology 2001) Two questions are addressed using data from a survey of 160 parents of children aged 3-12. (1) What determines parents' (ex ante) subjective beliefs about their own and their children's risk of getting skin cancer? (2) How do parents' trade off changes in skin cancer risk to themselves against changes in skin cancer risk to their children? Estimation of this tradeoff is important because it can be interpreted as a measure of parents' altruism toward their children. In

general, greater altruism inspires greater confidence that informed parents will take action to protect their children from environmental hazards.

These issues seldom have been directly examined in prior research on children's health, although a few studies have estimated parents' willingness to pay to improve the health of children (for a survey of this literature, see Dickie and Nestor 1998). For example, Agee and Crocker (1996), using a similar approach to that developed by Dickie and Gerking (1991), estimate a production function for risk perceived by parents that their child will develop chronic, lead-induced health impairments. Their analysis, however, does not consider how risk perceptions are formed. Risk perceptions have been extensively studied in previous work (Kunreuther 1976, Lichtenstein *et al.* 1978, Grether and Plott 1979, Kahneman and Tversky 1982, Arrow 1982, Slovic, Fischhoff, and Lichtenstein 1985, and Tversky, Slovic, and Kahneman 1990), but not in cases where parents form beliefs about risks to a child.

The remainder of the paper is divided into five sections. Section 2 develops the theoretical model to be applied. Section 3 describes the survey data collected. Section 4 presents evidence on the determinants of beliefs held by parents about skin cancer risks to themselves and their children. Section 5 estimates an indifference map for parents to support calculation of the tradeoff between skin cancer risks to themselves and their children. Section 6 concludes.

2. Model

This section develops a simple, one-period household production function model. Extension to a multi-period framework would be more appropriate particularly for modeling timing of occurrence of skin cancer, but this issue is not explicitly considered here. For ease of exposition, the model deals only with perception and valuation of skin cancer risks within a family and altruism of parents toward their children. The issue of altruism toward persons outside the family would not be difficult to incorporate, but would draw attention away from the family decision-making issues that are the main focus here. In any case, the model described below is familiar so the discussion is kept brief.

A parent's lifetime utility (U) function is

$$U = U(X, R^*_{PN}, R^*_{PM}, R^*_{CN}, R^*_{CM}), \qquad (1)$$

where X denotes a composite good, R^*_{ij} denotes perception of lifetime risk of getting skin cancer, P denotes the parent, C denotes the child, M denotes melanoma skin cancer, and N denotes nonmelanoma skin cancer. Thus, for example, R^*_{CM} denotes perceived risk of the child developing melanoma skin cancer at some point during his/her life. This formulation abstracts from consequences of sunlight exposure such as suntanning/sunburning and aging/wrinkling of skin and draws attention to two types of risk comparisons: (1) between illnesses of different severity (melanoma vs. nonmelanoma) faced by either the parent or child and (2) between the parent and child for a particular type of illness. The model assumes that family resources are allocated to maximize utility of an altruistic parent (or the consensus utility function of two altruistic parents), a working hypothesis adopted in most research on economics of the family (Becker 1991, Behrman, Pollak and Taubman 1995). The possibility of divergent interests of family members is ignored, although it recently has been applied to value environmental risks in a household production framework (see Smith and van Houtven 1998). Also, the intragenerational issue of unequal treatment of siblings, a common theme when analyzing parents' investment in their children (Rosenzweig and Schulz 1982, and Pitt, Rosenzweig, and Hassan 1990), is ignored and only one child is

included in the model. This simplification allows later analysis to focus more directly on how parents make tradeoffs in health risks between themselves and their children.

Parent's perceived risk about their own chances of getting skin cancer are formed according to

$$R^*_{Pj}=R^*_{Pj}(R_{Pj},q,g) \quad (2)$$

Where R_{Pj} denotes actual risk of skin cancer ($j=N,M$), q denotes the parent's attitudes toward and awareness of effects of sunlight exposure, and g denotes family characteristics such as the number of children present in the household and whether a spouse is present. Actual skin cancer risks to parents, in turn, are determined by

$$R_{Pj}=R_{Pj}(G,W_P) \quad (3)$$

where G denotes a purchased good that both parent and child may use to reduce harmful effects of sunlight exposure, such as a sun protection product, and W_P denotes aspects of the parents' genetic endowment and history of exposure to solar radiation. Genetic factors such as skin type and complexion and, for example, a history of bad sunburns are important to consider in the context of skin cancer.

Additionally, a parent's perceptions about the child's risk of risk of skin cancer is given by

$$R^*_{Cj}=R^*_{Cj}(R^*_{Pj},R_{Cj},q,g) \quad (4)$$

where R_{Cj} is the actual risk of skin cancer faced by the child and is determined similarly to equation (3) as shown in equation (5)

$$R_{Cj}=R_{Cj}(G,W_C) \quad (5)$$

and where W_C denotes genetic endowment and exposure history of the child. Thus, parents are assumed to see risk to their children as a function of perceived risk to themselves, actual risk to their children, attitudes and family history. This formulation allows for the extreme view that parents form risk beliefs about risks to their children using only their own risk as a reference point. Alternatively, it allows for parents to form beliefs about risks to their children by disregarding beliefs about their own risk and

considering only risk factors facing their children. These two possibilities are considered in Section 4, which looks at empirical evidence on how parents form beliefs about risks faced by their children.

Parents maximize utility subject to the budget constraint

$$I=X+q_G G \tag{6}$$

where I denotes income, q_G denotes the price per unit of G and where the price of X has been normalized to unity. Under standard assumptions, the utility-maximizing choice of G can be expressed as a function of the exogenous variables in the model (I,q_G,q,g,W_P,W_C). Appropriate substitutions show that R^*_{Pj} and R^*_{Cj} can be expressed in terms of these variables as well as shown in equation (7).

$$R^*_{ij}=f(I,q_G,q,g,W_P,W_C) \tag{7}$$

Thus, in this model, beliefs about skin cancer risk can be expressed as the outcome of utility maximizing consumption choices. In an earlier study, Dickie and Gerking (1996) examined how adults form perceptions about their own chances of getting skin cancer. This study develops additional evidence on this point; but the main focus is on parents' perceptions of the likelihood that one of their children will get skin cancer.

Additionally, an indifference map can be developed by solving for the change in expenditure on G that holds parents' utility constant:

$$d(q_G G)=\Sigma_{ij}((q_x U_{R^*_{ij}}/U_x)dR^*_{ij})-WdT. \tag{8}$$

Equation (8) can be used to calculate the ex ante willingness to pay or option price of reductions in different types of skin cancer risk faced by the parent and the child. These option prices are the coefficients of dR^*_{pj} and dR^*_{cj} $(j=M,N)$ which are monetized marginal rates of substitution between perceived risk and the composite good. Also, by setting $d(q_G G)=0$, the perceived risk-risk tradeoff between the child's health and the parent's health can be calculated as the ratio of the coefficients of dR^*_{pj} and dR^*_{cj}. Risk-risk tradeoffs have been calculated in other studies in the context of one person facing two (or more) hazards (Viscusi, Magat, and Huber 1991). The analysis presented here reformulates this

concept in the context of parents trading-off risk to themselves against a similar risk to a child. Moreover, notice that the desired risk-risk tradeoff (the ratio of monetized marginal rates of substitution) reduces to $U_{R^*_{pj}}/U_{R^*_{cj}}$. In the timeless world considered here, this ratio reflects the parent's strength of preference at the margin for reducing his or her own skin cancer risk versus reducing risks faced by the child. Thus, it measures altruism of parents toward their children in the context of an environmental hazard, extending work by Viscusi, Magat and Forrest (1988).

A key aspect of the survey design involves defining a good *G* so that the four risks changes in equation (8) can be varied independently. This feature is important so as to avoid joint production problems that can complicate both estimation of option prices and development of risk-risk tradeoffs (see Hori 1975 and Bockstael and McConnell 1983 for additional details). In the context of the model at hand, the approach taken involves: (1) defining a hypothetical sunscreen lotion as a bundle of attributes offering different levels of melanoma and nonmelanoma skin cancer protection for adults and children and (2) varying these attributes independently. Product labels would convey information about attributes of the sunscreen products to survey respondents. Thus, this approach builds on earlier studies that have used labels to convey risk information and to elicit preferences for risk reduction (see, for example, Viscusi, Magat, and Huber 1986 and Dickie and Gerking 1996).

3. Data

To implement the model, data were collected during summer of 2000 in an in-person survey of 160 parents of children aged 3-12. All survey respondents lived in Hattiesburg, MS metropolitan statistical area. The location, climate and racial composition of this community make it a desirable setting for a study of risk beliefs about skin cancer. Hattiesburg lies near the coast of the Gulf of Mexico and has a subtropical climate with a great deal of sunshine. Also, African-Americans comprise 26% of the population; thus, risk beliefs between groups with widely divergent skin cancer rates can be examined. Melanoma incidence among whites is about 16 times the incidence among blacks (Ries, *et al.* 1999). Approximately 70% of respondents had participated ina survey focused on acute respiratory illness

experienced by adults and children. These respondents originally had been recruited by dialing telephone numbers in the Hattiesburg area at random during daytime and evening hours on both weekdays and weekends. At the conclusion of the earlier survey, conducted at the University of Southern Mississippi during June-July 2000, respondents indicated whether they were willing to participate in a second survey to be conducted later that summer. Those who indicated a willingness to participate were contacted by telephone during the recruitment of subjects for the skin cancer survey. A fresh round of random digit dialing was used to recruit the remaining 30% of the sample. As telephone calls were made, those contacted were given a brief introduction in which the general idea of the survey was explained, and people were added to the sample if they agreed to participate and if they had at least one biological child between the ages of 3-12 living at their home. Respondents were told that they would receive $30 for participating and were asked to choose a convenient time to come to the University of Southern Mississippi for the interview.

The interview began by ascertaining the race and age of the respondent, the age and gender of all biological children living in the respondent's home, and the number of the respondent's other children who may live elsewhere. Of the 160 sample parents, 51 (32%) were African-American, 110 (69%) were women, and 84% had either one or two biological children living with them. From among the children between the ages of 3-12, one child was randomly selected (if there was more than one) and designated the sample child. The remainder of the survey then obtained information about the parent/respondent and the sample child. Information was not obtained about other children to limit the length of the interview, to avoid repetitive questioning, and because in the model described above, parents treat each child equally. The interview then turned to a brief series of general questions about experiences with skin cancer, such as whether the respondent had ever been diagnosed with this disease or had known of anyone (relatives, friends, or public figures) who had it and/or died from it. Respondents also were asked if they ever had thought about the possibility of getting skin cancer as well as the possibility that their children might get it.

After these preliminary questions, respondents were shown two posters (one for melanoma and another for non-melanoma). As shown in the example in Figure 1, each poster had two risk ladders. The ladder on the left hand side had 51 numbered steps going from zero to 100 in increments of two and the risk ladder on the right hand side broke down the interval between the first and second rung (i.e., between zero and two chances in 100) into 10 smaller steps. Interviewers explained the concept of chances in 100, pointed out the reference risks shown beside some of the steps on the two ladders, and then showed respondents how to use the two ladders to represent a risk estimate. They then asked respondents to place a pin on the steps that best reflected their own chances of getting both melanoma and non-melanoma skin cancer at some point later in life (or getting it again if the respondent had already had it). After respondents completed this task, attention was directed to the sample child. Interviewers first asked whether the respondent believed that the other natural parent's future risk of skin cancer was higher, lower or about the same as their own and reminded respondents that there may be other factors leading the sample child's risk to be different as well. Then respondents were asked to estimate the lifetime risk of melanoma and non-melanoma skin cancer faced by the sample child using two risk ladders that were identical to the one shown in Figure 1. In answering for both themselves and the sample child, respondents were instructed not to consider the severity of the diseases and to focus only on the chances of occurrence. Interviewers also emphasized that the ladders were to help respondents collect their thoughts about skin cancer risk and did not represent "quiz questions" with right or wrong answers.

Table 1 shows means of initial risk assessments for both types skin cancer risk made by white and black parents for themselves and their sample children. On average, white parents placed their own lifetime risk of getting melanoma and non-melanoma skin cancer at steps 17.3 and 27.7, respectively, while black parents placed the corresponding risk estimates at steps 6.2 and 7.6. These estimates are larger than actual lifetime skin cancer risks estimates reported in Ries *et al.* (1999), which place lifetime melanoma and non-melanoma risks for whites at about steps 1.5 and 20, and for blacks at about steps 0.2 and 0.3. Thus, people in the lowest risk categories appear to have overestimated their own risk by the

greatest amount. This outcome is consistent with observations by other investigators that people tend to overestimate small risks. Or, it may imply that some respondents did not understand the difference between the two types of skin cancer as melanoma risks were overestimated by a greater amount than non-melanoma risks. Yet, 16% of respondents represented their risk of non-melanoma skin cancer on the small (right-hand) ladder (see Figure 1) and 32% of respondents did the same to represent their risk of melanoma skin cancer. Additionally, the fact that the survey introduced the possibility of getting skin cancer again if the respondent already had had it does not appear to be a significant complicating factor. Sample members were relatively young (recall that all were parents of a child aged 3-12); their average age was 36 years, 96% were less than 50 years old, and only one reported personal experience with either form of this disease.

Also, Table 1 shows that risk estimates for sample children tended to be lower than those provided for the parent/respondents. For example, white parents placed their sample child's non-melanoma risk at step 21.9 (on average), while placing their own risk at step 27.7. The only exception in this regard is that African-American parents placed melanoma skin cancer risk faced by their children at step 6.6, while placing their own risk at step 6.2. This outcome conflicts with the possible hypothesis that parents will estimate higher risks for their children than for themselves because children have more years of life remaining in which to get skin cancer. However, it may reflect parents' beliefs that they take greater precautions regarding skin cancer risks with their own children than their parents did in an era when less information was available about consequences of solar radiation exposure. Also, it may reflect a broader desire on the part of some parents to see harm come to themselves before coming to their children and/or an expectation that medical science will find ways to reduce future risks below the levels faced today. In any case, this finding together with the speculative explanations, points to an opportunity for more theoretical work as well as additional empirical estimates to see whether it emerges in related settings.

In the next segment of the survey, interviewers provided information to respondents about skin cancer risks and asked questions about skin cancer risk factors. To begin, respondents were told that the

average person has an 18 percent chance of getting non-melanoma skin cancer and a 1.4 percent chance of getting melanoma skin cancer. Interviewers identified these points on the two sets of risk ladders using different colored pins, further indicated that skin cancer risk is higher for some demographic groups than others, and then moved the pins to show the applicable risks for the respondent's and sample child's race/gender group. Lifetime non-melanoma and melanoma risks shown were 28 percent and 1.8 percent for white males, 0.4 percent and 0.2 percent for black males, 12 percent and 1.4 percent for white females, and 0.2 percent and 0.2 percent for black females.

Then, interviewers collected information regarding genetic and lifestyle risk factors for both the respondent and the sample child. Data collected about genetic risk factors included natural skin color, sensitivity of skin to direct sunlight, eye color, natural hair color, freckles, and moles as well as whether an immediate relative ever had been diagnosed with skin cancer. Information obtained about lifestyle risk factors included time spent outdoors between 11 a.m. and 3 p.m. in a typical week during the summer months, a judgment as to whether lifetime exposure to sunlight had been more or less time than average, experience with bad sunburns, protective clothing (i.e., hats and long sleeve shirts) worn while in direct sunlight, and use of sun protection products.

After providing (and receiving) information about genetic and lifestyle risk factors, respondents were asked to make a second estimate of lifetime melanoma and non-melanoma skin cancer risk for themselves and their sample children. Respondents made these estimates using the same risk ladders as before, so their own initial estimates and average risk estimates provided by the interviewers were in view. As shown in Table 1, mean revised risk estimates are lower than initial risk estimates in all cases considered. Yet, even after receiving information about the two types of skin cancer, demographic group, African-Americans continued to provide apparent overestimates of risk for themselves as well as their children and all respondents continued to substantially overestimate the lifetime risk of developing melanoma skin cancer. For example, white parents, on average, placed their own risk of melanoma at step 10.1 on the ladder, reflecting a risk estimate about 5 times higher than the actual risk they were

shown. Also, respondents generally continued to estimate greater skin cancer risks for themselves than for their children.

The final part of the survey assessed willingness to pay for a hypothetical sun protection product. Respondents were shown one of four labels describing the hypothetical sunscreen and were given time to read it as if they were thinking of buying the product for the first time. Labels were randomly assigned to respondents and each label was presented to 40 respondents. Each of the labels (see Figure 2 for an example) indicated that the new sunscreen would be similar in some respects to currently marketed products (available in a variety of SPFs, non-comedogenic, oil-free, and unscented); but that it would be more water-resistant and offer greater levels of skin cancer protection. The four labels differed in the amount of skin cancer protection offered. One label (the label shown in Figure 2) offered "clinically proven maximal protection against exposures that increase chances of both melanoma and non-melanoma." A second label offered limited protection against these exposures, while the third and fourth labels offered maximal protection against one type of skin cancer, but limited protection against the other.

Interviewers reviewed the features of the sunscreen label shown and then asked how much it would reduce both melanoma and non-melanoma skin cancer risks for both respondents and their sample children if they began using it right away according to the directions. Respondents then had an opportunity to make new estimates of lifetime skin cancer risk on each ladder which, when compared to the revised risk estimate discussed previously, reflected the perceived effectiveness of the product. Also, respondents were asked whether they would buy enough of the product to last one year for themselves and their sample children at one of eight prices. Interviewers instructed respondents not to consider buying the sunscreen for other people, such as other household members. Prices were randomly assigned to respondents, did not depend on the label shown, and each price was presented to 20 respondents. If respondents said that they would buy (not buy) at the stated price, they were asked if their decision would be the same at a higher (lower) price. Table 2 shows the resulting frequency distribution of initial prices for the sunscreen offered. Among white respondents, 70% indicated that they would buy the sunscreen at

the initial price offered, whereas 29% of blacks chose to buy at the initial price. The survey then concluded by ascertaining marital status, schooling completed, occupation, and household income for each respondent.

4. Determinants of Risk Beliefs

This section estimates determinants of parents' beliefs about skin cancer risk faced by their sample child. Data described in the previous section are applied to estimate equation (4) developed in Section 2. Estimates of this equation are useful in showing the extent to which parents use their own risk as a reference point in assessing a similar risk to their children. To obtain the equation estimated, equation (5) was substituted into equation (4) to obtain

$$R^*_{Cj}=g(R^*_{Pj},G,W_C,g,q) \qquad j=M,N \qquad (9)$$

Two regressions are estimated, one for melanoma risk and another for non-melanoma risk, and estimation accounts for endogeneity of parent perceptions of their own skin cancer risk (R^*_{Pj}) and use of the sun protection product, G.

Table 3 reports results of estimating equation (9) along with means and definitions of all variables used. In both regressions shown, the dependent variable is the initial step number from the risk ladder chosen by the parent/respondent to estimate perceived lifetime skin cancer risk to the sample child, measured as chances in 100. Instruments for parent's own perceived risk of skin cancer (both melanoma and non-melaoma) and for the sample child's use of sun protection products were constructed using predicted values from regressions of these variables on measures of (I,q_G,q,g,W_P,W_C), as discussed in connection with equation (7) in Section 2. Results of these regressions are reported in Appendix A. Also, in Table 3, the regressions reported were jointly estimated because medical and epidemiological evidence suggests that melanoma and non-melanoma risk factors are somewhat different. Whereas particular types of "dangerous" moles (large, irregularly shaped, with shades of varying colors, and/or having a flat portion) and irregular but intense exposure to solar radiation are thought factors leading to greater risk of melanoma, non-melanoma risk has not been associated with these factors.

Results presented in Table 3 show that parents appear to have relied heavily on their estimate of skin cancer risk to themselves in making estimates of skin cancer risk to their sample child. In the survey, parents made risk estimates for themselves before being asked to make risk estimates for their sample child. Thus, a possible interpretation of this outcome is that parents recognized genetic similarities between themselves and their children and that some skin cancer risk factors are inherited characteristics. In any case, the coefficients of the parent perceived risk variable in both the melanoma and non-melanoma equations equation were positive fractions that differed from zero at conventional significance levels. Both coefficients also were significantly less than unity, reflecting the previously discussed tendency for parents to make lower estimates of skin cancer risk for their children than they made for themselves.

In contrast, parent/respondents appear to have disregarded information about the sample child's skin color and complexion type as well as whether the child had freckles and/or particular types of moles in forming beliefs about both melanoma and non-melanoma skin cancer risk. Effects of these factors on skin cancer risks, however, may already have been picked up in the parent risk variable just discussed if it can be interpreted as a marker for transmission of genetic characteristics from parent to child. In this same vein, the child's gender has no effect on the parent's risk assessment even though females tend to have lower risk than males in the general population. This result also supports the notion that parents form beliefs about the child's risk through the lens of their own risk and do not explicitly the child's own risk factors.

Additionally, results from both the melanoma and non-melanoma equations indicate that respondents took account of perceived skin cancer risks faced by the other biological parent in making the risk assessment for the sample child. If parent/respondents believed that the other biological parents' risk was higher (lower) than their own, a higher (lower) risk estimate was made for the sample child. These effects were significant in both regressions at less than the 5% level under a one-tail test. This outcome is not surprising because, as discussed in Section 2, respondents were reminded that the other biological

parent's risk should be considered just prior to asking for a risk assessment for the child. Yet, it does reinforce the interpretation above that parents make skin cancer risk assessments for their children partly on the basis of inherited characteristics.

Parents also based their sample child's risk assessment of both melanoma and non-melanoma on prior exposure to solar radiation and ethnicity. On the one hand, if the child had ever used sunscreen, parents lowered their risk estimate by 12.1 percentage points in the case of non-melanoma and 10.6 percentage points in the case of melanoma. On the other hand, if the child had experienced three or more bad sunburns over his/her lifetime, parents increased their risk assessment by about 9.8 percentage points in the case of non-melanoma and 5.7 percentage points in the case of melanoma. Also, African-American respondents provided lower risk assessments for their children by 11.4 percentage points in the case of non-melanoma and by 7.6 percentage points in the case of melanoma. These results are noteworthy in that the survey elicited initial risk assessments *before* focusing on solar radiation exposure history and socioeconomic/demographic measures. Thus, these results again suggest that parents are at least broadly familiar with skin cancer risk factors and take them into account when making risk assessments for their children.

5. Tradeoffs Between Parent and Child Health

Empirical estimates showing how parents make tradeoffs between their own health and the health of their children are based on equation (7) from Section 2 together with data described in Section 3. As previously discussed, equation (7) shows how parents vary expenditures on G in the face of perceived skin cancer risk changes to themselves and their children, holding utility constant. Expenditure data were obtained from responses about intentions to buy the hypothetical sun protection product. More specifically, dG is measured as the amount that respondents said they would pay for one year's supply of the sunscreen for themselves and their sample children. Perceived risk changes were measured by the difference between the revised and final steps chosen on the risk ladder, with the expectation that greater differences would be associated with higher intended expenditures.

The intended expenditure data are analyzed using the double-bound model described by Hanemann (1991), Cameron and Quiggen (1994), and Alberini (1995). Three issues warrant further discussion before discussing results. First, respondents intended expenditures for the hypothetical sunscreen may have been influenced not only by its perceived effectiveness in reducing skin cancer risk, but also by its perceived effects on sun tanning, premature aging of skin, and possibly other factors. These joint production issues are ignored in developing the estimates presented below because earlier work (Dickie and Gerking 1996) focused extensively on these issues in a similar context, finding that they were relatively unimportant in determining willingness to pay for reducing skin cancer risk. Second, the expenditure data obtained from the survey pertains to a one-year's supply of sunscreen, rather than the lifetime supply envisioned in the theoretical model. This discrepancy is treated as an errors-in-variables problem in which the always non-negative disturbance imparts a downward bias to the estimate of the constant term, but has no effect on other estimates. Third, the analysis allows for probable simultaneity between sunscreen expenditure and perceived risk change. Appendix B reports estimates of four equations for perceived risk change (parent and sample child risk of both melanoma and non-melanoma skin cancer) as a function of genetic risk factors, historical behavior, and socioeconomic/demographic characteristics. The estimator for the intended expenditure equation is adapted from methods developed by Amemiya (1978, 1979) for simultaneous probit and tobit models. Amemiya showed that his estimator was more efficient than the more commonly employed two-stage estimator that uses predicted values of jointly determined variables as regressors.

Results from estimating the double-bound model are shown in Table 4. Coefficients presented are marginal effects, interpreted as the change in willingness to pay for the hypothetical sunscreen for a one-unit change in an explanatory variable. As shown, three of the four risk change variables have marginal effects that are not significantly different from zero at conventional levels. The marginal effect of risk change for the sample child, however, is positive and significantly different from zero at less than the 5% level using a two-tailed test. This estimate suggests that parents are willing to pay about $3.18 for a one-

percentage point reduction in non-melanoma risk to the child. Table 4 also indicates that willingness to pay for the sunscreen is higher for parents who were shown one of the two labels offering maximum protection from melanoma and who said that their sample child would use it.

An illustrative estimate of the marginal rate of substitution between risk to parents and risk to their children can be calculated simply by taking the ratio of the marginal effects of two risk changes reported in Table 4 (see discussion of equation (8)). Disregarding its low t-statistic, the point estimate of willingness to pay by parents' to reduce their own non-melanoma risk is $1.29 and the corresponding point estimate for sample children is $3.18, as discussed above. Thus, the marginal rate of substitution in this case would be about 2.47, a result suggesting that parents are willing to accept about a 2.5 percentage point increase in non-melanoma skin cancer risk to themselves in return for lowering this risk to their children by one percentage point. Of course, this calculation only is an illustration in light of the fact that the marginal effect of a change in parent risk on willingness to pay for the sunscreen did not differ significantly from zero. Additionally, a Wald test for equality of the marginal effects of parent non-melanoma risk change and children's non-melanoma risk change yields a p-value of 0.39. Thus, the null hypothesis that the marginal rate of substitution between risk to children and risk to parents equals unity cannot be rejected a conventional levels of significance.

6. Conclusion

This paper has looked into the way in which parents view their children's health using data collected from a survey of risk beliefs about skin cancer. The survey involved an extensive questionnaire administered to 160 parent/respondents living in Hattiesburg, MS with biological children currently aged 3-12. Evidence was presented suggesting that parents form beliefs about risks to their children largely through the lens of their beliefs about risks to themselves. In estimates presented, parents' own risk beliefs were a key determinant of their beliefs about their children's risk, while the children's genetic risk factors appeared to be relatively unimportant. An implication of this outcome is that public information

policies about skin cancer risks to children is to make certain that parents understand that they themselves are at risk.

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Table1: Mean Values of Perceived Risk

	Parent				Child			
	Non-Melanoma		Melanoma		Non-Melanoma		Melanoma	
	Initial Risk	Revised Risk	Initial Risk	Revised Risk	Initial Risk	Revised Risk	Initial Risk	Revised Risk
White	27.67	21.85	17.28	10.09	21.90	15.23	13.93	5.87
Black	7.64	4.33	6.18	3.45	6.78	3.67	6.58	2.51

Table 2. Number of "Yes" and "No" Responses by Initial Price.

	White		Black	
Initial Price	Yes	No	Yes	No
$ 5	14	0	3	3
$10	14	1	1	4
$15	11	1	3	5
$20	15	3	0	2
$30	8	4	2	6
$40	6	6	2	6
$50	5	7	3	5
$60	3	11	1	5
Total	76	33	15	36

Table 3: Parent's Perception of Children's Skin Cancer Risk, 3SLS Estimates[a]

Explanatory Variable	Non-melanoma	Melanoma
Respondent's Own Perceived Risk[c]	0.49	0.645
	(6.026)	(10.796)
Child Uses Sunscreen[c]	-12.139	-10.602
	(-2.304)	(-2.813)
Child complexion is fair	-0.266	-1.517
	(-0.098)	(0.778)
Child skin is type1	1.642	0.668
	(0.689)	(0.396)
Child has freckles	2.989	-0.370
	(1.244)	(-0.22)
Respondent thinks other parent has higher risk	3.868	3.35
	(1.824)	(-2.199)
Respondent thinks other parent has lower risk	-4.3013	-3.551
	(-1.863)	(-2.245)
Child has had 3 on more bad sunburns	9.771	5.693
	(2.954)	(2.409)
Child is female	-1.504	-0.515
	(-0.901)	(-0.433)
Respondent is black	-11.395	-7.637
	(-2.959)	(-2.699)
Respondent knows people who have had skin cancer	0.775	0.005
	(0.369)	(-0.003)
Child has a "dangerous"mole	----- [b]	-0.829
		(-0.61)
Child has had irregular exposure	----- [b]	-0.886
		(-1.098)
Constant	16.577	12.775
	(3.430)	(3.656)

a.t-statistics in parentheses beneath coefficient
b. Excluded variable
c. Endogenous variable.

Table 4: Parent's Willingness to Pay for Reductions in Skin Cancer Risk

Explanatory Variable	Marginal Effect[a]
Parent's non-melanoma risk change[b]	1.294 (1.211)
Children's non-melanoma risk change[b]	3.188 (2.001)
Parent's melanoma risk change[b]	0.473 (0.362)
Children's melanoma risk change[b]	-2.048 (-1.064)
Respondent is black	-5.186 (-0.764)
Respondent uses sunscreen	4.338 (0.426)
Child uses sunscreen	43.285 (3.451)
Maximum non-melanoma protection label	-4.198 (-0.601)
Maximum melanoma protection label	13.524 (2.146)
Constant	-13.044 (-1.342)

a.t-statistics in parentheses beneath marginal effects
b. Endogenous variable.

Appendix Table A-1. Reduced Form Equations. Estimated Coefficients (*t*-statistics).

Explanatory Variable	Respondent's own Initial Risk Assessment (Non-Melanoma)	Respondent's own Initial Risk Assessment (Melanoma)	Child's use of sun protection products
Respondent complexion is fair	-5.646 (-0.825)	-0.766 (-0.124)	-0.132 (-1.057)
Respondent skin is Type 1	6.841 (1.281)	4.866 (1.010)	0.004 (0.039)
Respondent has freckles	-4.392 (-1.014)	0.457 (0.117)	0.119 (1.509)
Respondent has a "dangerous" mole	10.308 (2.365)	6.538 (1.662)	0.095 (1.199)
Respondent exposure has been irregular	-1.871 (-0.462)	-0.041 (-0.011)	-0.004 (-0.048)
Respondent has had 3 or more bad sunburns (with peeling/blisters)	6.561 (1.325)	5.975 (1.338)	0.057 (0.631)
Respondent had bad sunburn as child or teenager	-5.900 (-1.225)	-4.843 (-1.115)	0.133 (1.511)
Respondent is female	2.926 (0.689)	2.833 (0.739)	0.088 (1.139)
Respondent age in years	0.022 (0.078)	0.226 (0.872)	0.006 (1.159)
Respondent thinks own lifetime exposure is greater than average	-1.540 (-0.354)	-8.457 (-2.153)	-0.034 (-0.432)
Respondent thinks own lifetime exposure is less than average	-1.732 (-0.399)	-7.870 (-2.012)	-0.049 (-0.617)
Child complexion is fair	4.385 (0.683)	-0.271 (-0.047)	-0.001 (-0.009)
Child skin is Type 1	3.323 (0.606)	-1.951 (-0.394)	-0.064 (-0.640)
Child has freckles	-5.415 (-1.037)	-2.886 (-0.612)	0.033 (0.341)
Child has a "dangerous" mole	2.026 (0.320)	1.669 (0.292)	0.137 (1.187)
Respondent thinks other parent has higher risk	2.616 (0.593)	1.054 (0.265)	-0.052 (-0.640)
Respondent thinks other parent has lower risk	8.395 (1.843)	2.669 (0.649)	-0.151 (-1.816)
Child exposure has been irregular	0.428 (0.111)	0.597 (0.172)	0.076 (1.084)
Child has had 3 or more bad sunburns (with peeling/blisters)	10.203 (1.570)	7.830 (1.336)	-0.102 (-0.864)
Child is female	2.899 (0.867)	-0.926 (-0.307)	0.059 (0.964)

Appendix Table A-1 (Continued) Reduced Form Equations. Estimated Coefficients (*t*-statistics).

Explanatory Variable	Respondent's own Initial Risk Assessment (Non-Melanoma)	Respondent's own Initial Risk Assessment (Melanoma)	Child's use of sun protection products
Child age in years	-1.099 (-1.725)	-0.270 (-0.470)	-0.016 (-1.418)
Race = Black	-13.419 (-2.161)	-11.216 (-2.002)	-0.527 (-4.650)
Respondent knows of relative, friend or public figure diagnosed with skin cancer	3.772 (0.898)	1.350 (0.356)	0.031 (0.411)
Family income	2.362 (0.496)	-1.127 (-0.262)	-0.059 (-0.682)
Family income	2.776 (0.460)	-1.542 (-0.283)	-0.024 (-0.220)
Number of children	-1.233 (-0.649)	0.474 (0.276)	-0.028 (-0.811)
Respondent is married	-2.289 (-0.529)	-4.190 (-1.074)	-0.063 (-0.795)
Respondent is college graduate	2.578 (0.630)	-0.900 (-0.244	0.051 (0.687)
Respondent is employed	2.635 (0.553)	2.001 (0.465)	-0.024 (-0.274)
Respondent has blue-collar occupation	-4.086 (-0.987)	0.741 (0.198)	-0.132 (-1.747)
Respondent looks better with tan	-2.285 (-0.436)	5.461 (1.155)	0.016 (0.168)
Child looks better with tan	6.865 (1.449)	-5.195 (-1.215)	0.026 (0.299)
Constant	22.146 (1.757)	9.892 (0.870)	0.667 (2.901)
R^2	.37	.27	.58
F statistic p-value	<.001	.07	<.001
N	160	160	160

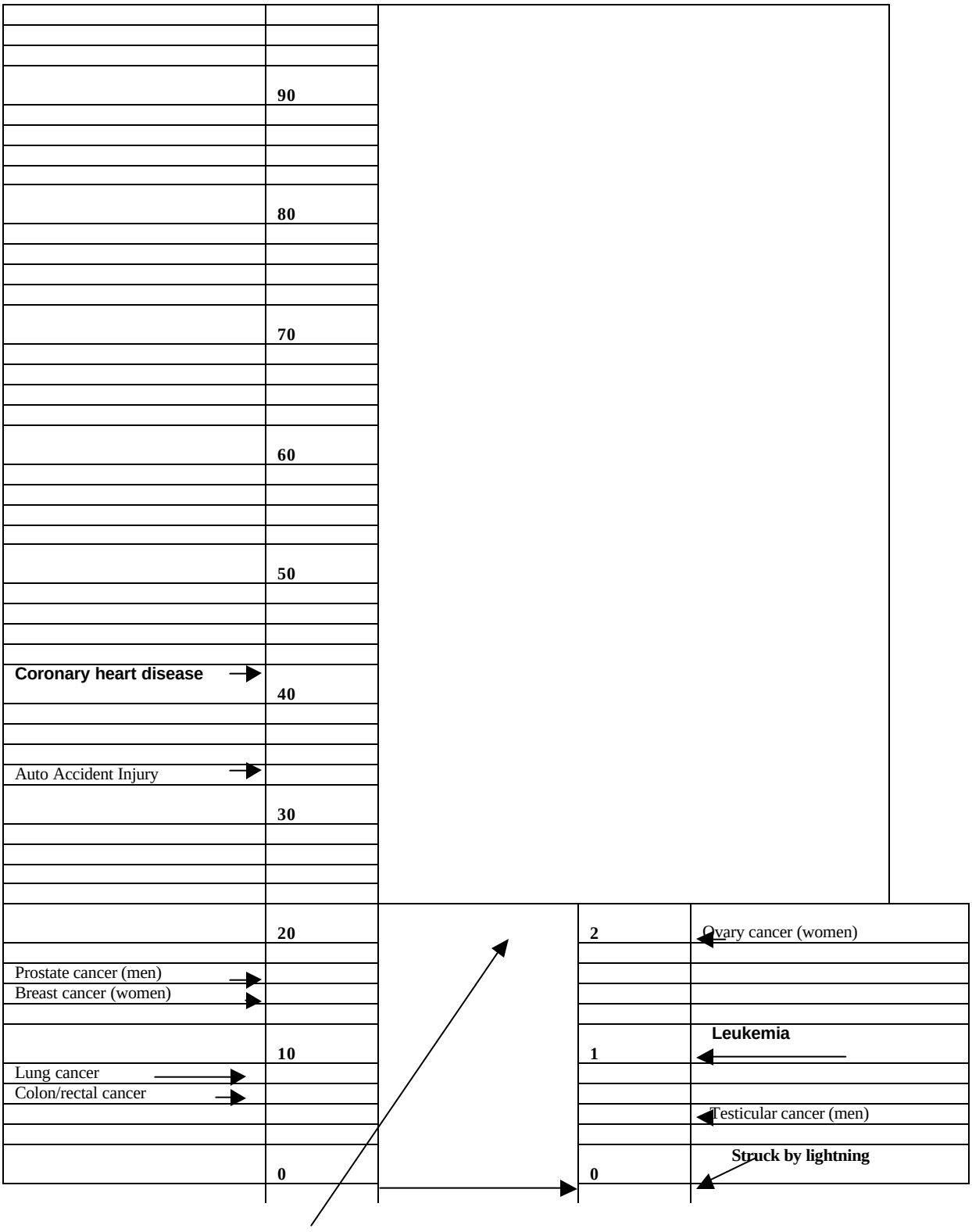
Appendix Table A-2. Reduced Form Equations: Changes in Perceived Risks. Estimated Coefficients (*t*-statistics).

	Changes in Perceived Risk with Use of New Sunscreen			
	Non-Melanoma Risk Change		Melanoma Risk Change	
Explanatory Variable	Respondent	Child	Respondent	Child
Respondent complexion is fair	-3.555 (-1.764)	1.425 (1.010)	-5.124 (-3.074)	0.328 (0.345)
Respondent skin is Type 1	-2.851 (-1.691)	-0.455 (-0.386)	-0.030 (-0.021)	-0.778 (-0.979)
Respondent has freckles	-0.815 (-0.595)	0.371 (0.387)	-0.255 (-0.225)	-0.172 (-0.266)
Respondent has a "dangerous" mole	0.335 (0.256)	1.470 (1.603)	0.094 (0.087)	0.385 (0.623)
Respondent is female	-1.179 (-0.918)	-0.809 (-0.900)	-0.505 (-0.475)	-1.287 (-2.125)
Respondent age in years	-0.076 (-0.850)	0.018 (0.295)	-0.099 (-1.342)	-0.040 (-0.940)
Respondent thinks own lifetime exposure is greater than average	-0.873 (-0.639)	-1.122 (-1.174)	-0.547 (-0.484)	-0.171 (-0.266)
Respondent thinks own lifetime exposure is less than average	1.381 (1.057)	0.643 (0.702)	0.119 (0.110)	0.233 (0.379)
Respondent thinks inherited risk factors give self greater than average chance of skin cancer	2.883 (1.503)	-0.145 (-0.108)	3.845 (2.423)	0.122 (0.135)
Respondent thinks inherited risk factors give self lower than average chance of skin cancer	0.515 (0.257)	0.490 (0.350)	-2.318 (-1.400)	-0.620 (-0.657)
Child complexion is fair	-0.669 (-0.335)	-3.190 (-2.282)	2.758 (1.669)	-1.545 (-1.641)
Child skin is Type 1	2.529 (1.509)	1.878 (1.600)	-0.648 (-0.467)	-0.150 (-0.189)
Child has freckles	1.192 (0.783)	1.030 (0.967)	2.039 (1.620)	0.118 (0.164)
Respondent thinks inherited risk factors give child greater than average chance of skin cancer	-2.909 (-1.455)	-1.822 (-1.301)	-1.696 (-1.025)	1.068 (1.132)
Respondent thinks inherited risk factors give child lower than average chance of skin cancer	-1.944 (-1.019)	-0.629 (-0.471)	1.691 (1.071)	1.178 (1.309)
Respondent thinks other parent has higher risk	-0.127 (-0.094)	0.742 (0.779)	1.950 (1.733)	-0.021 (-0.033)
Respondent thinks other parent has lower risk	2.257 (1.585)	0.343 (0.344)	1.165 (0.988)	-0.983 (-1.464)
Child has had 3 or more bad sunburns (with peeling/blisters)	-0.047 (-0.034)	0.866 (0.900)	0.096 (0.085)	1.452 (2.238)

Appendix Table A-2 (Continued). Reduced Form Equations: Changes in Perceived Risks. Estimated Coefficients (*t*-statistics).

Explanatory Variable	Respondent	Child	Respondent	Child
Child is female	-0.197 (-0.174)	0.460 (0.582)	-1.351 (-1.447)	0.103 (0.193)
Child age in years	-0.087 (-0.458)	-0.139 (-1.048)	0.102 (0.651)	0.029 (0.329)
Race = Black	0.659 (0.366)	0.676 (0.536)	-0.317 (-0.213)	0.122 (0.144)
Family annual income	3.161 (2.150)	0.523 (0.508)	3.341 (2.747)	0.638 (0.920)
Family annual income	0.517 (0.276)	-0.261 (-0.199)	1.459 (0.941)	1.498 (1.695)
Number of children	0.324 (0.549)	-0.538 (-1.301)	0.618 (1.266)	-0.243 (-0.872)
Respondent is married	0.001 (0.001)	-1.703 (-1.764)	-0.618 (-0.542)	-0.487 (-0.749)
Respondent is college graduate	-2.293 (-1.892)	-0.171 (-0.201)	-2.192 (-2.187)	0.361 (0.631)
Respondent is employed	0.480 (0.329)	0.326 (0.319)	-1.250 (-1.035)	-0.925 (-1.344)
Respondent has blue-collar occupation	0.146 (0.117)	-0.648 (-0.744)	1.146 (1.113)	0.326 (0.555)
Respondent would use new sunscreen if purchased	1.750 (0.948)	0.945 (0.731)	0.285 (0.187)	0.647 (0.743)
Child would use new sunscreen if purchased	1.160 (0.572)	1.103 (0.777)	0.114 (0.068)	-0.278 (-0.291)
Label indicates maximum non-melanoma protection	1.109 (1.084)	-0.794 (-1.109)	1.067 (1.261)	-0.623 (-1.291)
Label indicates maximum melanoma protection	-0.901 (-0.919)	0.106 (0.155)	0.639 (0.788)	0.040 (0.087)
Respondent non-melanoma RISK1	0.192 (4.272)	-0.002 (-0.078)	-0.010 (-0.264)	0.007 (0.350)
Child non-melanoma RISK1	-0.170 (-1.992)	0.195 (3.261)	-0.263 (-3.732)	-0.095 (-2.356)
Respondent melanoma RISK1	-0.049 (-0.743)	0.025 (0.536)	0.206 (3.792)	0.136 (4.376)
Child melanoma RISK1	0.287 (2.405)	0.092 (1.096)	0.304 (3.083)	0.329 (5.851)
Constant	2.410 (0.666)	0.814 (0.321)	3.178 (1.062)	2.437 (1.428)
R^2	0.440	0.530	0.570	0.740
F statistic p-value	0.001	0.001	0.001	0.001
N	153	153	153	153

FIGURE 1
PARENT'S LIFETIME CHANCE OF **NON-MELANOMA** SKIN CANCER


90
80
70
60
50
Coronary heart disease
40
Auto Accident Injury
30
20
Prostate cancer (men)
Breast cancer (women)
10
Lung cancer
Colon/rectal cancer
0
2
Ovary cancer (women)
Leukemia
1
Testicular cancer (men)
Struck by lightning
0

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Clinically proven maximal protection against long-term skin damage from incidents of over-exposure to sun

Used before high exposure, helps reduce chances of Melanoma skin cancer

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* Gentle enough for faces – even under make-up *
* Hypoallergenic * PABA-free * Unscented *
* Contains Aloe and Vitamin E *

IMPLICATIONS OF RISK AND POPULATION CHARACTERISTICS FOR THE VSL: RESULTS FROM CANADIAN AND U.S. SAMPLES

Presented by Alan Krupnick, Resources for the Future
Co-Authored by Anna Alberini, University of Maryland,
Maureen Cropper, World Bank and University of Maryland, and
Nathalie Simon, U.S. EPA

Summarization

Dr. Krupnick began his presentation by saying he would Ado a little bit of a cook=s tour@ through the literature on risk characteristics, the theoretical predictions mainly from the life cycle model, and the empirical stated preference literature, and then he would discuss their own research in the U.S. and Canada.

There have been too few studies, he noted, and the studies that there are have different contrary results to one another, which suggests that the robustness of these studies and our understanding of what=s driving willingness to pay (WTP) for risk reductions is fairly poor. There are several characteristics of the risk (e.g., the size and timing of the risk change, the baseline risk, and important risk qualities, such as dread and controllability) and several characteristics of the individual valuing the risk reduction that will affect the individual=s WTP for a risk reduction. Dr. Krupnick discussed several of these.

On the size of the risk change: First, he noted that life cycle models make some testable and definite predictions about how VSLs should vary. The expectation is that WTP will change proportionally to the change in risk, and therefore VSL will remain constant. The empirical studies almost always find an insensitivity to scope, however, and he noted that their study is not an exception in that. It passes a Aweak@ external scope test but not a proportional scope test. He cited a recent paper by Roe and Teisl which provides some theoretical justification for insensitivity to scope. One possible reason for the insensitivity to scope, they suggest, may be declining absolute risk aversion. That assumption can lead to an insensitivity to scope.

On the issue of baseline risk: the prediction is that a higher baseline risk leads to a larger WTP, but this is a very small effect. Dr. Krupnick commented that this is the Adead anyway@ effect noted by Pratt and Zeckhauser, and it would be expected to be small. Not surprisingly with a small effect, the empirical literature on this is inconclusive. Dr. Krupnick noted that in their work on mortality risk in the U.S. and Canada, they don=t find any effect of the baseline risk on WTP. He noted, however, that the baseline that they give people in their study is their age-, race-, sex-, cohort-baseline, so it=s correlated to other things in the model. It=s not people=s perceived baseline. They do find some proxy effects, that is, some effects on WTP that may be related to subjects= baseline risks, he noted, that still need to be investigated. They find, for example, that family history of cancer or having a chronic illness can contribute to a higher

WTP. So subjects may feel that their baseline risk is higher than the one being given to them in the study.

On risk qualities: dread and uncontrollability appear to be the most salient risk qualities in the literature. It could be reasoned that reductions in risks that have a lot of dread and uncontrollability associated with them would be valued more than reductions in the familiar and controllable risks. Dr. Krupnick cited Revesz (1999), the paper that is the centerpiece of EPA=s Cancer Mortality Valuation White Paper, which suggests adjusting EPA=s standard VSL by a factor of two for involuntariness and uncontrollability and by at least a factor of two for dread. Dr. Krupnick agreed with the SAB=s conclusion that the literature wasn=t mature enough yet to support this. Dr. Krupnick mentioned some new literature in this area. In the Magat-Viscusi-Huber study, terminal lymph cancer VSL was found to be equal to auto death VSL, in a pairwise conjoint analysis. This result seems to be contrary to what Revesz hypothesized. Cropper and Supramanian, looking at public goods, found a very small controllability effect, but a significant one. In a study by Jones-Lee et al., WTP for reduced risk of cancer was twice as high as WTP for reduced risk of death by heart disease, and three times as high as WTP for reduced risk of death by auto accident.

In a study that used a conjoint ranking, Strand found VSLs between $2.5 and $6 million (with VSL for death from environmental causes > VSL for death from auto accidents > VSL for death from heart attack). The Strand result is similar to the Jones-Lee result, except that the auto and heart attack ordering is reversed. In an Italian study by Aimola, VSLs for different types of cancer were derived from a risk ranking exercise. The VSL associated with leukemia risk reduction was about four million dollars, and for lung cancer the VSL was $300,000. That might be consistent with the hypothesized effects of dread and controllability, Dr. Krupnick suggested, if people think that lung cancer is more controllable than leukemia (to the extent that they can avoid lung cancer by avoiding smoking).

Cookson looked at five types of death (from food poisoning, birth control pills, medical radiation, air pollution, and rail and car accidents), using a conjoint analysis. In this study, the VSL associated with death by air pollution is 50 percent greater than the VSL associated with food, rail, and car accidents (lumped together), and the VSL associated with those was larger than the VSL associated with medical radiation and birth control pill risks. They did some further testing on how people rated these various risks and found air pollution rates to be the lowest in controllability and voluntariness and the highest in dread. This supports the general conclusion in the risk qualities literature. Dr. Krupnick pointed out, however, that the VSLs in this study are very large. He hypothesized that this is because the denominator on the risk change was 2.5 million (i.e., the risk reduction people were asked to value was 1 in 2.5 million) and that people cannot understand a risk change like that.

On private versus public goods: Dr. Krupnick suggested that the only way one can make comparisons is if the private good is nested in the description of the public good, in which case the public good will have an altruism component that the private good won=t have. In this case, the expectation would be that the public good would be valued more than the private good. Without this nesting, researchers get into problems. Dr. Krupnick suggested this is what happened in the study by Johannesson et al. In that study, people were asked their WTP for a

private safety increase, which would result from adding a safety device to their cars. They found VSLs ranging from $4.5 million to $9 million. Then they asked people how much they'd be willing to pay in taxes for a change in roadway configuration. The VSLs from this ranged from $2.6 million to $7.4 million. Dr. Krupnick suggested that in this case the private and public goods were not nested in any useful way. Because of this the researchers ended up with a range of VSL for the public safety increase that was less than and overlapping the VSL for the private safety increase.

The Strand study, which isn't published yet, is better at that nesting, he said, and it does find the VSL for private risk reductions for heart disease ($1.2 - $2.5 million) to be less than or equal to that for a public program to reduce risks of heart disease ($2.5 million). In that study, they actually ask people what fraction of their answer depends on altruism, and they find that it's about 70 percent.

Dr. Krupnick noted that altruism is not necessarily related to publicness, citing Mark Dickie's comments (earlier in the workshop) about one's WTP for a product that might help one's child or a relative. The literature is pretty clear, he said, that people are willing to pay more for their children than for themselves, and there are some papers that suggest that some people are willing to pay more for a relative than for themselves.

On the issue of futurity: Dr. Krupnick noted that this issue comes up in their U.S. and Canada work, in which they are talking about reducing risks of death in the future. This isn't a willingness to accept issue, he noted, this is a WTP issue. Both discounting and the possibility that you won't be around to experience any benefits of a risk reduction in the future should lead to a lower WTP for a risk reduction that's in the future, or a lower VSL in the future, than one in the present, assuming you would have to pay for both of those (the future risk reduction and the present risk reduction) in the present.

He noted that Morris and Hammett have some interesting papers on this. They ask for WTP for a vaccine today that would be effective starting at age 60, and they get a median WTP of $361. Then they ask (a different group) for WTP for a vaccine that would be effective at age 70, and they find a lower WTP, of $285. They compute the implied discount rates and find a negative discount rate . Then they try this **B** this was in a risk reduction context **B** They also estimate the WTP using a life expectancy context (rather than a risk reduction context), and get somewhat stronger results. The WTP was about 50 percent greater for the nearer-term risk reduction than the further term.

Carson and Mitchell recently re-released a trihalomethane study in which the risk reduction is a 4 in 10,000 reduction in cancer risk with a 25-year latency, for which they got a VSL of between $600,000 and $800,000. This is consistent with results for more generalized risk reduction of about this size for non-specified (i.e., not cancer) risk.

On the effect of age: Depending on assumptions, WTP as a function of age can either be an inverted U-shape or falling with age. There is a useful distinction between how the respondents' ages affect their choices and how, for a public good, the ages of those who are

helped by the program affects the respondents= choices. Johannesson et al. find that respondent age doesn=t affect choices. Strand finds that, in the public context, older respondents have lower WTP. Carson and Mitchell find the same pattern, that WTP is lower for the older group, in the private context. Morris and Hammett find no age effect. Dr. Krupnick and his colleagues get mixed results. With regard to the effect of the ages of those being helped, they find that people seem to favor saving the lives of younger people over older people in a public program.

On the effect of the health status of the respondent: This is conceptually unclear, he said. The impact of the health status of the respondent on WTP could go in either direction. The literature looks at the effect of health status on WTP for current and for future risk reductions. The new Strand study finds no effect of health status on WTP for current risk reductions. Looking at future risk reductions, Morris and Hammett find that WTP is greater when the quality of life at 65 years old is expected to be higher. Dr. Krupnick noted that he and his colleagues found the same thing -- if you think that your life is going to be better in the future when you=re going to experience the risk reduction, you=re willing to pay more.

Turning to their own U.S. and Canada CV surveys, Dr. Krupnick noted that they also have survey results in from Japan and Korea, and they are field testing surveys in Italy, France, and England. They plan to eventually put all seven studies (from the five locations noted above plus Canada and the U.S.) together and see what can be learned from them. Dr. Krupnick acknowledged Paul DeCivita and Dave Steve from Health Canada, who enabled them to field test their survey in Canada, and the EPA=s Star Grant program for the U.S. work.

The goals of the Canada and U.S. surveys were to state the risks and risk changes to the respondents as clearly as possible (and to try to teach them if they were having trouble understanding the concepts), to test for comprehension, and to elicit WTP for contemporaneous or immediate risk reductions, as well as for future risk reductions. They tried to include people in Canada up to age 75 and in the United States up to any age. They made sure respondents understood that in their daily lives they spend money to reduce their risk of death. They kept their private good and the risk reduction delivery system quite abstract and set up the survey to test for external scope.

The surveys were self-administered on a computer with a voice-over in the appropriate language. Towards the beginning of the survey, subjects are shown two grids of a thousand squares each, with a red square representing death. The two grids represent the baseline risks of two different people. To check subjects= comprehension, they ask a simple question such as: Which person is more likely to die in the next ten years? If they get this wrong (not many get it wrong, but some do), they teach them and ask them some other questions to get them used to the format. They also get them used to Abunching@ the risk, so that they can tell how large the risks are a bit easier. Risk reduction is shown by changing red squares to blue squares.

Dr. Krupnick noted that one of the key features of their survey is how they characterized risk reductions. They found that people cannot understand a risk change presented in units of more than one thousand, so they made their base denominator for the risk change one thousand. A risk reduction would be described as X in 1,000 risk reduction over a ten-year period to try to

deal with the risk comprehension issue. Dr. Krupnick expressed confidence that most people understood this.

The surveys had two Awaves,@ each of which had a certain ordering of risk reductions to be valued. Wave 1 was asked to value a 5 in 1,000 risk reduction over the next 10 years, then a 1 in 1,000 risk reduction over the next 10 years, and finally a 5 in 1,000 risk reduction starting at age 70 over 10 years. Wave 2 had the first two options in reverse order. The results show an insensitivity to the wave ordering.

Comparing the Canadian survey with the U.S. survey, Dr. Krupnick noted that the Canadian survey was done in person in Hamilton, Ontario, self-administered on a computer. The U.S. survey was carried out using Knowledge Networks, a Web TV system. Because of the limitations of the technology, the voice-overs are limited to the key questions. Sample sizes in the Canada survey were 630 for wave 1 and 300 for wave 2; in the U.S. both waves had 600 subjects. The health of sample subjects in the U.S. study was worse than in Canada. People participating in the Canadian study had to be ambulatory and reasonably vigorous, Dr. Krupnick supposed, to go to a central location in Hamilton, Ontario to take the survey. Because the U.S. study was done via the Internet, however, people could fill out the survey in their homes. This format therefore didn=t require that people be very healthy or ambulatory to participate. About a third of the sample were over 60, going up to 75 in Canada; in the U.S. study there were people in their 80s. The Canada survey was the Abase survey.@ Minor adjustments were made to it for the U.S. survey.

Dr. Krupnick next discussed the results of the U.S. and Canada studies. He described the percent of Ayes@ responses by bid value as the cleanest result. In the Canada study, as bid values increased from $100 (Canadian) to $1100, the percent of Ayes@ responses decreased from 49.25% down to 19.67% when the risk reduction was 1 in 1,000, and from 72.56% down to 26.28% when the risk reduction was 5 in 1,000. In the U.S. study, as bid values increased from $70 (U.S. dollars) to $725, the percent of Ayes@ responses decreased from 43.79% down to 12.89% when the risk reduction was 1 in 1,000, and from 72.86% down to 35.17% when the risk reduction was 5 in 1,000. Comparing the results from the Canada study to those from the U.S. study, he described the degree of replicability as Astartling,@ noting that the two studies were totally separate.

He next compared the results for contemporaneous risk reductions with those for future risk reductions in the U.S. Among people ages 40 to 60 in the U.S. study, WTP for a future risk reduction (of 5 in 1,000 over ten years) that would occur when they are 70 averaged $350. The 70-year-olds in the U.S. study were willing to pay an average $685 for the equivalent contemporaneous risk change. So the futurity of the risk reduction reduced WTP by quite a bit.

Comparing the Canadian results to the U.S. results requires making two adjustments: exchange rate and purchasing power parity. Including these adjustments, they found that the Canadian WTP, mean or median, was always lower than the U.S. WTP. The U.S. income is a little bit larger (considering both exchange rates and purchasing power parity) on average, about five to ten percent at most. Dr. Krupnick noted that this doesn=t explain the size of this difference

in results, which remains a question. The medians are always less than the means. Although the medians are the more robust statistic, they feel the means are more appropriate for policy purposes.

Summarizing the WTP results of the U.S. study, mean WTP for a contemporaneous risk reduction (of 5 in 1,000 over ten years) is $770, which implies a VSL between $1 million and $2 million. And the WTP for the equivalent future risk reduction is $350, which implies a VSL of about $700,000. Comparing those results to the results obtained for a risk reduction of one in 1,000 (WTP = $483), the insensitivity to scope becomes apparent. While $483 is significantly different than $770, it=s not proportional; the VSL implied by the WTP for a 1 in 1,000 risk reduction is $4.8 million, whereas the VSL implied by the WTP for a 5 in 1,000 risk reduction in between $1 and $2 million. Dr. Krupnick noted that that=s an issue.

Dr. Krupnick next discussed covariates, turning first to the variables that help explain variations in WTP for future risk reductions. They found that the more likely respondents think it is that they will survive to 70, the more they are willing to pay for risk reductions. The more they believe their health at 75 is going to be worse than it is now, the less they are willing to pay. Age has a small effect, although at an eight percent significance level in the U.S.

People who are more ill are willing to pay more. If a relative is sick respondents were willing to pay more (for a risk reduction for that relative), to six percent significance level in Canada. The income effect is positive. Other findings: in Canada WTP is flat as a function of age until age 70, and then falls by about a third at 70. In the U.S. they found no age effect. Subjects in the Canada study were not generally that sick, so they saw no effect of physical health on WTP for risk reductions, except for cancer, which was a positive effect. In the U.S. poor health raises VSL. Dr. Krupnick described the findings as Apretty robust.@

So what are the conclusions to be drawn? There does not appear to be a single VSL or range of VSLs. Instead, VSL is context-dependent, as Robin Keller discussed in her talk. Risk and population characteristics do affect VSL, although Dr. Krupnick acknowledged that the use of varied VSLs raises legal and ethical concerns. He stressed his opinion that we must move away from applying VSLs estimated in labor market or auto accident studies to environmental pollution-related risks, because it=s too much of a benefits transfer stretch. Insensitivity to the size of the risk change in CV studies, he noted, remains a big issue.

Finally, the lack of robustness in VSL work suggests the need for further research. More work on valuing risk reductions for children is needed. More work on altruism is needed. We still need to do more on the issue of communicating low probabilities and on using a life expectancy approach rather than a risk approach.

Discussion of Session I

Chris Dockins, US Environmental Protection Agency

I plan to address some portion of all four papers.

I will briefly remark on the two behavioral economics papers presented, respectively, by Dr.'s Kellor and Gregory. These remarks should be prefaced however with two comments. The findings from behavioral economics are yet to have a major impact on economic analysis at EPA, at least inasmuch as that practice is codified in the Agency's *Guidelines for Preparing Economic Analyses*. This has not gone unnoticed by researchers in the field. Earlier this year, in fact, Dr. Jack Knetsch contacted us on the issue and was kind enough to offer some initial readings as an introduction to recent behavioral research results.

This brings me to my second introductory point: I needed those readings. Like many economists at EPA my background is more firmly in the neoclassical tradition of the discipline. Although I am familiar Kahneman and Tversky's prospect theory, and some of the common heuristics, biases and difficulties in risk perception, behavioral economics more generally is a bit out of my field. Because of this I found the explanatory notes and charts in both of these papers highly useful. Much of what I will say may be similar to comments that neo-classical economists typically offer on behavioral work.

Comments on "Preferences for Environmental Outcomes: Consistent with Discounting Models or Not?" (presented by L. Robin Kellor)

First, a bit of an apology. Through some confluence of cyberfactors and other, equally mysterious forces, I have only the presentation itself as the basis for my comments. But, the bottom line from this research seems to be that declining sequences are preferred for money while constant or increasing sequences are preferred for health (own health), air quality and water quality.
In Dr. Kellor's impromptu experiment just a few minutes ago I found myself wondering "hmm...do I really want a declining sequence of environmental quality? What about my child?" It took a few seconds to realize my folly - I was assuming that we are starting from the status quo. While the quick questions a few minutes ago were not a controlled experiment it made me wonder about what people believe as they answer these questions.

I note that the sequences have a given mean, but what are people thinking about their current endowment of the commodity in question, and what are their expectations about their future endowments? Presumably, all of these sequence are in addition to an expected endowment of health, of money, of environmental quality. These endowments are sequences themselves. What do they look like? Is there a relationship between an expected baseline endowment and the increment provided in the experiment?

Because individuals are responding based on the marginal value of the sequences provided, perhaps these preferences are easily understood in conventional theory. If one must consume the

commodity provided in the particular time period (e.g., health) then its marginal value is dependent upon the baseline quantity at that time. This possibility is briefly noted in a side note on one of the slides presented in the context of health, but it would seem to merit greater attention. In short, it's not at all clear that responses are solely representing time preferences and not other factors.

Also, what matters for environmental policy are pairs - if not bundles - of sequences. This is what we typically face in a benefit cost analysis: a sequence of environmental quality, a sequence of monetary costs, and perhaps a separate sequence of risk reductions. How do people react when asked about preferences for bundles of sequences rather than viewing them in isolation? Does this force them to confront what they may admit later as "irrational" preferences? I'd be curious to hear.

A minor question: what do market commodities look like in these experiments. Aside from the monetary outcomes people are being asked about non-market goods. Is their unfamiliarity with thinking about such goods driving some of these results?

The second experiment in Dr. Kellor's presentation leaves me perplexed. I'm frankly stunned that people would opt to put off saving lives until a later date. But looking at the data reported, I am not so sure that the results make a strong case against conventional notions of discounting. The two choices that dominate the responses are steeply decreasing preferences and constant streams. The former is consistent with conventional discounting, as noted by the authors. The latter, a preference for a constant stream is at odds with conventional discounting, but would seem to be a cognitive default: give me the same thing every year. It certainly facilitates planning. How much of an issue is this? Perhaps reframing the question could address this point. For example, I can envision giving folks a screen of blocks representing a constant stream and then asking them to rearrange them into any shape they prefer by clicking and dragging, for example.

Comments on "Multiple Discount Rates: the Influence of Decision Context on Choices over Time," presented by Robin Gregory:

This research looks at 1) how framing options as gains or losses affects stated time preferences, and 2) examines the role of attributes of goods. First, let me say that I was quite sorry to see that "improvements in the office equipment of government workers" as an example of a low-affect good and something that the public is not expected to be at all excited about. I note, however, that this is phrased as "state" workers in the actual survey question.

One difficulty with some of these experiments is that they are framed as questions of public choice rather than own-welfare. This is always a concern for the applicability of results in a benefit-cost framework because there is no reason to expect *a priori* that preferences in a public choice setting would be systematically associated with particular preferences for own-welfare.

The paper notes on page six that we need a better understanding of factors that underlie and

contribute to implied discount rates: "...an increased emphasis on explanatory mechanisms is necessary." This is absolute true, especially if behavioral findings and context-dependent results are to inform policy and be incorporated into formal policy analysis at places like EPA.

Consider this. The last revision of the EPA's economics *Guidelines* was underway when I arrived at the Agency in 1996 and the final draft was not published until 2000. Anyone who has read the document may have noticed that while it includes a great deal of information, it contains only two numerical recommendations: use 3% and 7% for discount rates, and use a value of statistical life of about $6 million (in year 2000 dollars). Both of these fields (discounting and valuing mortality risk) are the subject of a large and extensive literature yet it still took quite a bit of time and effort to arrive at numerical conclusions in the Guidelines. I raise this point to suggest that even if the explanatory mechanisms have been explored in detail there may be significant practical difficulties in codifying a portfolio of context-specific time preference indicators or discount rates. Of course, without such work it is virtually impossible to include them regularly in applied policy analysis.

The results of the research presented here suggests that generating a predictive model of these kinds of preferences requires more data than previously thought. The fact that characteristics and context may matter more than the broad "type" of good (e.g. environmental) creates a new information need: the various characteristics of the commodity must be clearly defined. If each commodity is a unique vector of characteristics must we then define preferences over all of these characteristic combinations? Can this vector of characteristics be collapsed into a meaningful index? These kinds of questions need to answered before applied policy analysis can make greater use of the behavioral findings.

Comments on "Parents' Valuation of Latent Health Risks to Their Children," presented by Mark Dickie:

The essential structure for looking at children's health risks is nice, although it would be interesting to extend and complicate the household structure. Exploring perceived risk is a real strength because ultimately we want to know the information set under which individuals are making decisions. "Latent" risks in a 1-period model is somewhat difficult to grasp and more should be done with the issue of time, both in the model and the survey design.

Additional comments on particular subjects:

On Risk Perception

When I saw the results that parents assess risks to themselves as greater than those facing their child I thought that the paper's explanations made the most sense, especially the observation that parents may have a much better notion of the long term damage of sun exposure than their own parents did. Also, most of the parents in your sample must have been adolescents at least when sun screen came into common use in the 1980's.

But, of course, I began wondering what else could be happening here. One idea is that delayed risks are perceived as being smaller. Skin cancer doesn't even begin to appear until at least the late teens, meaning that parents have a positive current probability of skin cancer while their children have zero probability for several more years. This is offset by the fact that some of the risk for parents is already behind them, but I began to wonder if perhaps "under-perception" is increasing with time. This implies a sort of discount rate for perceived risk.

The National Cancer Institute's SEER data base provides information on the age-specific cancers, including melanoma. It's not exactly the measure we need because it is incidence per 100,000 person years and not a probability conditional upon survival, but it's convenient. Using the time-profile from these data one can estimate a sort of "present value of risk" for a 36 year old (average from your survey) and for a 7 year old (middling age of kids in your survey). With no discounting children have a greater lifetime probability of melanoma. But if risks are perceived as if they are discounted at rates of about 1 to 2.5 percent I found adult-child ratios similar to what parents were reporting in the survey.

Okay, so this may simply be a statistical fluke, but I found it interesting. At a minimum it seems that further consideration should be given to the effect of timing - perceived timing, actually - on perceived magnitude of risk.

Also, I don't suppose we can dismiss the "good parent" hypothesis under which parents will tend to report that their children, of course, are safer than they themselves were - or currently are.

On the model

It seemed odd to me to think of lifetime risks without a time element given that there is a zero chance of the event for the first 15 years of life and an increasing annual chance thereafter. Add to that the fact that you have two individuals at different points on this time-risk line, and it seems that aggregating across time to model change in lifetime risk is not sufficient to explore changes in the probability of cancer.

(As an aside, I wasn't sure what a lifetime supply of the product means in this case. Parents can only directly affect their children's risks while the children are dependent - for convenience, say this is eighteen. The annual v. lifetime expenditure problem is addressed in the estimation, but "lifetime" means something different for the child and the adult in this case. This is probably a small point, but, again, it goes to being more explicit in the treatment of time.)

In the work presented in this session by Dr. Krupnick, for example, both the contemporaneous and deferred risk reductions are reductions in lifetime risk (conditioned on survival), but the alternatives clearly have different value. For skin cancer it seems reasonable that the parent would enjoy the reduction sooner than would the child, as noted above.

In part, and setting aside statistical significance for now, this is what would be striking about a unitary marginal rate of substitution in this case. Such a finding would really mean that parents,

at the margin, are willing to trade a change in more immediate risk to themselves to secure an equal, but more-deferred risk reduction for their child. Depending on the timing difference between the two risks, it could imply a strong parental preference for children's health over their own at the margin if the two were contemporaneous.

Some Policy Notes

From a consumer's perspective - as an EPA analyst charged with using benefit transfer to estimate the benefits of policies - the fact that the empirical work doesn't separate mortality and morbidity limits its applicability. Skin cancer outcomes are a compound lottery: there's a probability of it occurring and then a subsequent probability of death. We need to either understand individual risk perceptions of the compound lottery (probability of skin cancer and probability of death) or to simplify the problem by eliminating one stage of this lottery. The second alternative is simpler, and makes the results clean for policy analysis, but it avoids interesting questions. Do people think that melanoma is more fatal than it is? Do they think it will be more or less fatal for their children? Presumably, given trends in cancer treatment, parents would think that the consequences for their children would be less severe than for themselves. In any case, the work could use some refinement along these lines.

Understanding the marginal rate of substitution between adult and child health could be very useful for policy. If a broad cross-section of studies reveals the difference to be consistent and robust - or even only robust within particular types of health end points - it could be a great aid for analysts using benefit transfer to estimate children's benefits from adult WTP to reduce own-risk. At a minimum, it would provide more substance for a qualitative discussion of the differences in value between changes in adult and children's risk.

Comments on "The Willingness to pay for Mortality Risk Reductions: A Comparison of the United States and Canada," presented by Alan Krupnick:

I have relatively few comments on this paper, in part because I have seen related work presented at other events and don't wish to reiterate comments offered in those forums. Most of these comments have been positive, and for good reason. This is a complete, well-done survey on risk reduction preferences.

An interesting result from the survey is the insignificance of age in the estimated WTP function for the U.S., even for those who are aged 70 or older, which is counter to the robust significance found in the Canadian data. Obviously, this is a question of particular interest in that economic analysis of the benefits of air quality improvements, particularly particulate matter. It merits additional consideration.

The survey really lacks a context for the risk reduction, which was a conscious and defensible design choice. It is somewhat striking to see it presented here in the very session in which others have argued that value is highly context-dependent. A useful next step of this kind of survey would be to test the impact of contextual differences.

It would also be valuable to see fuller treatment of WTP for future risk reductions because this issue is of major consequence for policies affecting cancer risks. It is given short shrift at the end of the paper - in part because the survey was not designed to focus on this tradeoff. Still, the implicit discount rate should be included in the presentation. Simply back-calculating a discount rate that would generate the same median WTP ratios as those presented in Table 12 suggests a Canadian discount rate (10%) that is almost twice that in the U.S.(5%). While this is a crude calculation, such disparity deserves more attention. It should be noted, though, that both rates are broadly consistent with financial discount rates. In this respect the finding would not be markedly different from other work on time preferences for health improvements.

Discussion of Session IV

Ted Gayer, Georgetown University

I very much enjoyed all four of these papers. They are all very carefully designed, and they address interesting research questions. I should point out that I didn't have much time to read the four papers and prepare comments, so I apologize in advance if my comments misrepresent their papers in any way.

Instead of trying to synthesize all the studies, I'll just share my comments one paper at a time. I'll start with the Keller study.

Keller, et al.

Before commenting on the specifics of the study, I want to confess to an unscientific tendency that I had while reading their paper. In fairness to myself, I believe many other physical and social scientists have the same tendency. Ostensibly, scientific progress is made through a process of falsification. That is, we test hypotheses and discard those hypotheses that are refuted by the empirical evidence. However, when a test yields a result that falsifies a cherished hypothesis, we sometimes take this as evidence that the *empirical test itself* must be incorrect. This leads to an infinite regress, in which a test that doesn't support a hypothesis is rejected as a bad test and re-done until the result supports the hypothesis. Not a very scientific process. I admit to doing something like this when reading the Keller paper.

They find evidence that people demonstrate a negative discount rate for environmental and health goods. This result didn't make any sense to me, so I quickly went about looking for what I thought must be wrong with the empirical test. I'll first

share some comments about their experiment, and then I'll talk about some of the implications of their results.

[Show slide]

First off, when comparing their survey for monetary gains to health and environmental gains, I thought the metric wasn't analogous. For the environmental and health measures, they use a scale from "worse" to "better," whereas the monetary choices were just in dollars gained. Therefore, for the environmental and health responses, they may be conflating discrepancies in WTP and WTA in a way that doesn't occur in the financial tradeoff question. I wonder if the results would differ if they measured from baseline up, instead of on both sides of the baseline.

What concerned me more was whether the respondents were seeing ongoing trends in the environmental and health choices. I know they told the respondents that the benefits go away after five or fifty years, but when I look at this picture I see a *trend*, in which benefits persist. I think this is especially the case when asking about the environment. After the environment gets better and better (or worse and worse) year after year, do respondents really believe that there is a sudden return to year zero quality? The question is whether the respondents prefer to defer environmental benefits or whether they view deferring the benefits as protecting the environment over the long run, even after the time frame examined. One possible way of partially addressing this problem would be to extend the bar charts for many years, with the future years all at the baseline.

I also wondered what the respondents knew about the sequence of costs across the different categories. Did the respondents who preferred deferred benefits think that they were also deferring costs? Did they think the costs were the same across the categories?

I want to jump to the Gregory et al. paper since the policy implications of both these papers are similar.

Gregory, et al.

In the Gregory paper, they acknowledge the possibility that tests of time preferences might conflate two different factors: 1) the disparity between WTP and WTA and 2) people's preferences for trading off present and future outcomes.

Among other things, they find that people prefer paying today for benefits tomorrow instead of paying tomorrow for benefits today, *even when the former has a b-c ratio less than one*. As was my concern with the Keller paper, for the environmental product (endangered species), I think deferring the benefits is preferred in part because these benefits persist *past* the respondents' lifetimes. I also found it confusing to compare removing and adding species from the endangered lists, especially since people are thinking about *extinction*, which is irrevocable. If I've read their results correctly, they find that people prefer protecting species tomorrow instead of today, *even when this means that fewer species will be protected*. Do the respondents really understand this?

Unlike the Keller paper, they find that the preference for deferring benefits exists for both environmental goods *and for money*. This really had me wondering whether this reflected people's preferences or their misunderstanding of the tradeoffs involved. All

the inter-temporal transactions that people actually make suggest that they don't prefer monetary benefits tomorrow over monetary benefits today.

I think the problem I'm having in general is making sense of discount rates that differ depending on context. The confusion stems from the economic practice of monetizing benefits in terms of willingness to pay. Both papers find that when assessing inter-temporal tradeoffs of certain goods (such as environmental benefits), people place a greater value on the future than when assessing inter-temporal tradeoffs of other goods (such as money). However, if we think of environmental benefits in terms of WTP, then we have a clearly unsustainable arbitrage opportunity. By defining benefits as WTP, the papers' results would suggest that people are willing to pay more for a future benefit than they are willing to pay for the same benefit today. Here comes the arbitrage: You pay me what your willingness to pay is for the current environmental benefit, and I'll promise you the future benefit (which you value more highly). I take your money, then lend it on the credit market (perhaps even to you) and receive a greater rate of return. I can pay off what I owe you in the future environmental benefit and have money left over in my pocket. Something is strange here. I point this out not to discredit their findings, but only to point out that there's some inconsistency between the contextual discrepancy in discount rates and the common practice of benefit estimation. And this inconsistency could have great policy implications.

What's particularly striking about both papers' results is that they hold for relatively short time periods. My impression has been that for short time horizons (less than 40 years or so), most economists and policy analysts accept that future benefits and costs should be discounted using the opportunity cost of capital. The debate has more

frequently been about how to discount over the long term. Using a constant discount rate for long time horizons leads to the uncomfortable implication that even very large benefits in the distant future are discounted to next to nothing. But now we have a finding suggesting a negative discount rate, which to me leads to an equally uncomfortable implication in which extremely small benefits explode in magnitude when they accrue in the distant future. What's more, the negative discount rate presents a time inconsistency problem when formulating policies. It implies that you want to push environmental programs into the future. But when the future arrives, you want to push the programs further into the future yet again. The program never takes place.

I now turn to the paper by Dickie and Gerking.

Dickie and Gerking:

Among other things, this paper estimates the determinants of parents' perceptions of their child's skin cancer risk, and they find that parents appear to rely heavily on their estimate of their own risk in estimating the risk to their child. However, parents don't consider such things as the child's complexion or whether the child has freckles or dangerous moles. The authors say that this "supports the notion that parents form beliefs about the child's risk through the lens of their own risk and do not explicitly account for the child's own risk factors." They also find that "if the child had ever used sunscreen, parents lowered their risk estimate." Now, as we all know, the difficulty with these conclusions is the endogeneity of both the parents' perceptions of their own risks and the child's use of sunscreen. They mention this endogeneity in the paper, but I would encourage them to more clearly discuss how they go about identifying the effects of these

variables on the parents' perceptions of the child's risk. It's not clear to me what would make for good exogenous instruments for these variables. I can think of nothing that would correlate with parents' perceptions of their own risk that would also be orthogonal to unobservable determinants of the perceived risk to the child. For the sunscreen measure, I thought that a possible exogenous instrument would be the price of sunscreen, but I couldn't find this variable in the first-step equation estimates listed in the appendix.

I had the same concern with the estimation of parents' willingness to pay for sunscreen. They find little evidence that changes in the parents' perceptions of their own risk or risk to their child have an effect on willingness to pay for sunscreen. Again, they state that the analysis allows for the simultaneity of sunscreen expenditure and perceived risk change, but it wasn't clear to me how they account for this. Looking at their first-stage results, I couldn't figure out which variables are correlated with either the parent's or the child's risk change and which do not directly influence the willingness to pay for sunscreen.

I think their study and their results are extremely interesting, so I would only suggest that they give more specifics about how they are identifying the causal impacts that they discuss. At the very least, I would like to know what their exogenous instruments are and whether their first-stage regressions pass an F-test of the joint significance of these instruments. Given that their first-stage results don't look strong, and that they have a relatively small sample, there is potential for substantial bias towards the OLS estimates in their results. I almost think it would be better for them to present the OLS results instead of the 3SLS results, since this way the potential biases are more transparent to the reader.

Which brings me to the final paper by Alberini, Krupnick, et al.

Alberini, Krupnick, Cropper, Simon, Cook

Their study uses an extremely well designed contingent valuation survey for both the US and Canada to provide an empirical assessment of the effects of age and health on the WTP for risk reductions. The policy implications of this issue are clear: to the extent that WTP for risk reduction vary by age or health status, then efficient policy would also vary accordingly. While this makes economic sense, I admit to being somewhat uncomfortable with this potential policy of valuing the benefits to the elderly or sick by less than we value these benefits to others. My sense is that the authors are similarly uncomfortable with this, since whenever they refer to this policy in the paper they revert to the passive voice. In fact, I think this leads them to downplay their results. They find that the VOSL does diminish for people over 70 in both samples, though it isn't significant in the US sample due to large standard errors. I think this is more than "limited empirical support," which is what they say.

There's not much for me to critique methodologically about this paper. The only thing that gave me pause was that I kept picturing my great-aunt taking this rather elaborate survey. My great-aunt is one of those life-long Democrats living in Florida who mistakenly voted for Pat Buchanan in the last election. I would feel more confident in their results if they could convince me that the people over 70 who took their survey understood it. In other words, they could show the age breakdowns of those people who failed the probability test and choice questions, those who admitted to having a poor understanding of the concept of probability in the debriefing, those who did not believe

the baseline risk figures, those who doubted the effectiveness of the product, those who voiced concern about possible side effects of the product, and those who indicated they that were not willing to pay anything for the product. To the extent that these tendencies varied by age, their results could be misleading.

The final small comment I had was about their third criteria for consistency. They claim that WTP should be near-proportional to the size of the risk reduction. I thought that, given the commonly assumed shape of individuals' willingness to pay functions, we would expect WTP to be less than proportional for larger changes in risk, which is exactly what they find. In all likelihood I'm missing something here, but at the very least it would be good to have it briefly explained in the paper.

I hope all the presenters find my comments useful, and I'm grateful to have had the opportunity to discuss them. Thank you.

Question and Answer Period for Session IV

Glenn Harrison, of the University of South Carolina, said he would like to raise the issue of the distinction between an individual discount rate and a social discount rate. This is a theme, he noted, that was raised on the first day of the workshop, when they talked about individual willingness to pay and social willingness to pay. It is critical, he said, that we keep those two concepts straight. He said he suspects that the subjects saw some of the streams that were offered in Robin Keller's experiments as a social discount rate question, and perhaps applied an individual discount rate to the income streams. That then leads, he said, to the very important point that Tom Shelling made (in the context of global warming) -- that very often what we call discount rate issues are not – they are really inter-generational equity issues, and should be addressed as such.

Robin Gregory responded that in the work they are doing now, they are using eight or ten scales, and among those are scales that they borrowed from some of the work by experimental economists Harrison was talking about, to get at some of these equity questions – fairness over generations, inter-generational equity, etc. They now have some correlations, he said, of some of the gain/loss questions, with scales such as what Harrison was talking about. He noted that Harrison's comment was a good one.

Robin Keller added that, for their air quality and water quality outcome sequences, they frame it as recommendations to be made to one's congressperson (or something like that), so it is framed in a social context.

Ted Miller, of the Pacific Institute for Research and Evaluation, commented that he believed the first experiment that Robin Keller talked about told us a lot about people's preferences but didn't tell us anything about discount rates. He noted that the dose-response relationship for pollution is non-linear, so having a small constant level is probably a lot safer than having something that goes to extremes. He suggested that the same thing may be true when it comes to health – it is probably a lot better to be a little bit sick for a long time than to be a lot sick for some period of time and then healthier for another period. He said he would rather get up every morning knowing that he is going to feel better today than yesterday than get up knowing with certainty that he is going to feel worse today than yesterday -- and that is really the choices that were offered in Keller's experiment.

Robin Keller said she definitely agreed that if you ask people about air quality level or water quality level, those often really are proxy attributes for something that you care a lot about, and we may not have very good models yet to translate it into health.

Nick Bouwes, of the EPA, commented that some of the results that seem to be inconsistent with economic theory really did not strike him as being inconsistent at all. He said we need to solicit more background information from the respondents to provide more perspective on our interpretation of the results. For example, regarding the responses on the environment, if one considers that property rights belong to the existing generation, he said, then

we would probably think that we have an obligation to provide a level of quality of the environment to upcoming generations. Regarding the responses to some of the financial questions, he gave his own life as an illustration – in retrospect, he said, it is probably better that his income was lower when he was younger, because his marginal propensity to save then was about zero. He needed the greater income flow, he said, at a middle stage of his life when he had kids. He gave as a final example of background information on respondents that would be easy to get and could be important in interpreting results, such as the person's profession and retirement program. If you are working for the government, he noted, the last three years are going to be the basis of your retirement program for the rest of your life.

Robin Keller agreed with the issue that extra assumptions could be put in. They did try to counteract some assumptions about where you are starting and to not extrapolate past the future. In a real problem domain, she noted, the researcher must be very careful to understand what people's concerns were and include those into the modeling.

Trish Koman, of the EPA, focused on the questions of making decisions in the face of uncertainty. She noted that the degree of certainty about things decision makers must address makes a difference. For example, getting a return on an investment where it is a contract and you know what you are going to get, is different from making decisions about less certain things, such as future beach improvement. She asked the panelists to comment on how the change in profile of uncertainty plays in their research.

Robin Keller responded that in the studies she presented there was no uncertainty explicitly put into the sequences. There have been some studies, she noted, primarily on money, that explicitly give gambles over money, with gains or losses, and then elicit interest rates or discount rates. But she said that for now they are not doing that.

Robin Gregory said that they were adding uncertainty into some of their work. One of the consequences of not including uncertainties is that if people feel that there are different amounts of uncertainty across choices, or if they feel they have different levels of control over the uncertainty, then what is being interpreted as discount rates will be confounded with that ability to seemingly control the uncertainty over time. Therefore, he said, uncertainty is an important element and definitely one that has to be looked at.

Tom Crocker, of the University of Wyoming, agreed with Ted Miller that rationality is an institutional phenomenon and not an individual phenomenon. He said he would be curious, with respect to the work of both Robin Keller and Robin Gregory, about what would happen to their results if they arbitraged their respondents and then went back and put them in the black box in which they were originally placed. In his own work with Jay Shogren and a doctoral student, Tod Cherry, using CVM, he said they got results similar in a broad scope to what Keller and Gregory obtained. However, when they arbitraged their subjects, and then went back and put them in the "black box of CVM" again, they found that there was a rationality spillover. He suggested that this would be an interesting thing for Keller and Gregory to do in their work.

Robin Gregory responded that they have found differences between the large sample test, where people got a piece of paper and had to fill in their responses, and the small groups of three or five people, which involved discussions and feedback to individuals of the consequences of their choices. He suggested that the question of what is the preferred environment in which to elicit responses, to get informed responses from people, has interesting policy implications. In many cases, he said, it is different from what researchers are currently doing.

Robin Keller spoke to the money pump idea. She gave as an example an experiment in which people are given choices about a sequence of meals – French dinners and dinners at McDonald's. The question is, how do you want to spread out your meals that you are going to have special certificates for? Taking a step back, she said, we might consider the possibility that for some of these kinds of attributes, in this case the eating experience, there may be preference for spreading. There may be preference for variety. And, although you might be able to adjust them a little bit by paying people to adjust to a behavior you would like, those kinds of preferences might not necessarily really reflect whatever their actual preferences would be.

Deborah Frisch, of the National Science Foundation, noted first that a consistent theme of this research seems to be that, for discount rates and the value of a life, for which we would like to have a single, consistent answer, we don't have one. That is the bad news, she noted, both for standard economic theory and from a policy perspective, she said. Second, she commented on Ted Gayer's attempt to "do mental gymnastics to try to explain seemingly irrational behavior with rational explanations." She complimented him on his efforts, but noted the irony that he prefaced his talk by admitting that he was being irrational because he was wedded to standard economic theory and would work hard to "fend off this empirical evidence."

Ted Gayer responded, saying that all he meant was that we always face the empirically very difficult if not impossible task of trying to disentangle people's preferences from their misconceptions, and what he was trying to do is to make sense of people's responses. If policy is based on people's misconceptions rather than their actual preferences, he said, we are going to get very different policies and ultimately we might get the wrong policy.

Alan Krupnick commented that, with the exception of the insensitivity to scope, which does conflict with the life cycle theory, he does not find the other findings that were discussed troublesome to economic theory. The more general point that VSLs may vary by context or by more detailed population characteristics or risk characteristics, he noted, is not a problem from an economics perspective. It is a problem for policymakers, he said, who may feel uncomfortable using different VSLs in different situations.

Bryan Hubbell, of the EPA, asked Alan Krupnick a question concerning the issue of the proportionality between the risk reduction [offered to people in CV surveys] and the willingness to pay. In Krupnick's survey, he noted, they used a risk reduction of one in 1,000 over ten years. Because of that, he said, in order to get the number that EPA currently uses, which is about $6 million, you actually have to have a willingness to pay somewhere between $3,000 and $4,000 over the ten-year period. He expressed concern that when you get to that level you will actually

cause budget constraints to kick in.

Alan Krupnick acknowledged that he was also concerned about that. The way one avoids running into these budget constraints, he said, is by increasing the denominator [of the risk reduction being offered]. But when you do that, he said, people don't understand what you are talking about. He said they designed the bids to embrace EPA's figures, but the budget constraint issue inevitably follows.

Kerry Smith, of North Carolina State University, had a couple of comments and a question. First, he noted that the price of a commodity will vary (citing literature that suggested that, all else held constant, the ratio of maximum to minimum price for the same commodity can be six to one). Therefore, he said, there is no reason to expect that, where there is less opportunity for arbitrage, we would not see differences in VSLs if these were prices. Second, with regard to Bryan Hubbell's comment on the binding effect of income on the VSL, he said that if we estimate a willingness to pay relationship, we should then go back to the preference function and reevaluate the VSL at the comparable point to make the comparison that Bryan Hubbell would like. We don't do that, he noted, because we leave the willingness to pay functions as reduced forms, as opposed to structural, but there is no reason why we could not if we collected enough information. The third comment and question focused on the fact that researchers generally try to separate valuations for mortality risk changes from those for morbidity risk changes, when we know that most deaths are not "clean kills" – i.e., that there are terrible situations that precede them, and that is probably the way most people think about them. He asked why researchers do that.

Alan Krupnick replied that they considered broadening out into morbidity, but were not up to the task. Now that they feel like they have a handle on mortality, he said, going to the morbidity component might be a reasonable next step.

Glenn Harrison commented that the question is, what do the subjects have in mind?

Alan Krupnick said that they asked people about whether they thought of other benefits, to themselves and then to others, and there were a fraction of people who thought about the morbidity benefits to themselves. They used that, plus other debriefing questions, to see how the VSLs or willingness to pay vary by their responses – and morbidity benefits make a difference. If you take that into account, he said, you get a higher VSL. But they did not ask respondents what fraction of their answer dealt with morbidity, because they do not think that is a meaningful way to do it.