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

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DO THE "NEAR" ELDERLY VALUE MORTALITY RISKS DIFFERENTLY?

Presented by V. Kerry Smith, North Carolina State University
Co-Authored with Hyun Kim and Donald H. Taylor, Jr.

Summarization

Dr. Smith described their joint research as a traditional analysis of the job risk/wage tradeoffs underlying the estimation of the value of a statistical life, but with a new data set, the Health and Retirement Survey. These data have not been used for this purpose in the past. The Health and Retirement Survey (HRS) is a survey of individuals who were between 51 and 61 in 1992, and their spouses or primary partners in that year. While the individuals who were recruited into the HRS sample were between 51 and 61 in 1992, their spouses or partners span a wider age range. The Smith et al. study derived estimates of the value of a statistical life from a traditional hedonic wage model, estimated first with the responses of individuals who were surveyed in 1992 (wave 1), and then with the responses of individuals surveyed in 1994 (wave 2).

Dr. Smith initially presented the results developed using a simple wage hedonic model, in which the log of wage is a function of BLS job risk, gender, race, years of education, and occupation categories. Although the bulk of the individuals in both the wave 1 and wave 2 samples were between 51 and 60 (because of the nature of the HRS), the age of individuals in their sample ranged from 26 to over 71, because it included the partners of the individuals recruited into the HRS sample. Applying the simple wage model only to men working at an hourly wage in wave 1, the VSL estimate they developed was $6.5 million in 1999 dollars (p-value = 0.032). Specializing this estimate to all men in wave 1, the implied VSL from this wage model is $5.3 million (p-value = 0.123). The corresponding VSLs for wave 2 are $6.1 million (0.025) and $6.6 million (0.048), respectively. Thus, both the data and the model framework provide benchmark results that correspond well with the literature on VSLs.

Dr. Smith noted that the HRS has a number of interesting features in the survey, one of which is that it has very detailed health records. Another interesting feature is a question that tried to gauge the individual's relative risk aversion – the inverse of risk tolerance. From these data one can estimate a set of values for risk reductions that are indexed by risk tolerance and by age category. Dr. Smith showed the VSLs they estimated from the HRS data specific to different age category and risk tolerance combinations, noting that the ones he was showing were those that would be judged to be statistically significant at approximately a ten percent level. The age categories were 51-55, 56-60, and 61-65. The risk tolerance codes were 3 and 4. He pointed out that none of these VSL estimates were below the "overall norm" for VSL (characterized by the $6.5 million for wave 1 and $6.1 million for wave 2). They were all above, and in some cases substantially above.

The conclusion, Dr. Smith noted, is that there is no reason to believe, on the basis of the existing evidence, that the "near elderly"would accept a lower compensation to accept a risk than would a 35-year-old. They would demand higher incremental compensation.

Dr. Smith began with the basic structure for the VSL calculation, in which the individual is maximizing expected utility, using an expected utility model, where there is some utility of death, U^D, and some utility of being alive, U^A, accepting the simple formulation of a static expected utility model. This leads to a kind of marginal rate of substitution in ex ante terms, he said, that is going to be sensitive to how we characterize these utilities and how we characterize the expected marginal utility of income or wealth. This is what we are estimating when we develop a hedonic wage equation.

If we introduce time into this process, and in particular the fact that these risk changes can take place over a person's lifetime, Johansson's work (in the *Journal of Health Economics*, 2001) offers a simple characterization of an optimal control model in which at time τ we look forward over an infinite time horizon (in the Johansson model), and we are maximizing a time-separable expected utility function. The survivor function in the model is the likelihood that you will continue to survive, conditional on the probability of having survived to time τ. The change in capital or assets at time t is a function of income at time t, consumption at time t, and any payment that is made at time t for a change in the survival probability at some point in this optimal program.

Dr. Smith noted that, in the Johansson model, to simplify the expression associated with how age affects the value of a statistical life, one has to make the assumption that if an action is taken to change the probability of surviving, at any point in the time profile, it does not change your optimal consumption profile. He noted that assumption does not make sense, but that it is the only assumption that will allow you to be able to simplify Johansson's exceedingly complex, inherently inter-temporal model, and reduce it to the simple static model.

Dr. Smith led the workshop through the following exercise: take what a person at time τ is willing to pay for some change in his survivor function. Divide it by the size of the change measured appropriately. And then multiply the result by the remaining years that he has left in present value terms. This ought to be the change in the monetized value of continuing life as viewed from time τ. This is like a marginal utility of income along the optimal profile. The only way you can do this, he said, is if you can move the utility of consumption outside of the optimization process and assume that the consumption profile does not change as you change the probabilities of survival – i.e., that the consumption profile does not change as you change risk. Citing changes over time in what he himself would be willing to accept for risk changes, Dr. Smith said he does not believe that the consumption profile does not change as you change risk of premature death.

He then returned to the Health and Retirement Survey. The HRS is a panel study that began in 1992, in which people are surveyed every two years. There are about 12,000 individuals, in 7,600 households, in the survey as of 1992. Five waves are nearly available. Four are available in the public domain; a fifth is coming online very soon. In the Smith et al.

study they looked only at waves 1 and 2.

The goals of the HRS are principally to understand why the "near elderly" retire. What are the health considerations, what are the financial considerations, what are the factors that might cause these individuals to retire? It is a very detailed survey on health, labor market participation, financial information, and it is all downloadable from the University of Michigan's website.

Dr. Smith and his coauthors examined the HRS data from the perspective of traditional labor market models (which had not been done before). To do this, they had to "specialize" the survey, and impose a selection effect. First, they considered only the people who are working. (Dr. Smith commented that it is hard to get a wage tradeoff for the people who are not working.) They looked at selection models, which did not seem to be particularly important once they took into account demographics, so they did not adjust for selection effects. Also, they only used individuals who are paid by the hour.

The average hourly wage rate of the sub-sample they chose from the survey is almost $10 in wave 1 and a little over $10 in wave 2. The average hours worked per week is 37.10 in wave 1 and 36.72 in wave 2. Dr. Smith then showed the sample age distribution for both waves. Ages range from 26 to over 71 (recall that those selected between ages 51 and 61 could have partners of ages outside that range). He noted that he would not be able to say much about the people over 65, because the sample size drops off very rapidly at that point; there were only 38 people in wave 1 and 97 people in wave 2 over 65.

The risk tolerance question in the HRS, a double-bounded CV type question, is as follows: Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your (family) income and a 50-50 chance that it will cut your (family) income by a third. Would you take the new job?

If the respondent answers "yes" to this question, then in a subsequent question, a third is changed to one half; if the respondent answers "no" to the question, then in a subsequent question a third is changed to 20 percent. These two values are then used to derive an interval estimate of the coefficient of relative risk aversion.

Dr. Smith showed a crosstab of risk tolerance class by age, using the categories of risk tolerance index provided in the survey, based on the responses to these questions. A chi square test showed that attitudes toward risk change with age. Therefore we can not assume that these attitudes are invariant to age.

Next, Dr. Smith showed the simple wage hedonic models they estimated, separately for waves 1 and 2, in which wage is a function of BLS job risk (per 10,000 employees), gender, race, years of education, and, in some models, occupation. The models were estimated for all hourly workers, then for males, because this is a frequent focus of the wage hedonic literature.

Dr. Smith pointed out that the BLS job risk coefficient becomes significant only when the model takes account of occupational fixed effects.

The next step was to add to the simple wage hedonic models a series of categorical (dummy) variables that interact both the age class and the risk tolerance category with the job risk. This was done to allow them to look in the most flexible way they could at the change in the marginal rate of substitution they are trying to estimate as they look at these observable features of heterogeneity. The occupational fixed effects were included in these models as well.

Dr. Smith then compared the VSLs that result from the simple wage hedonic models with those that come out of the models with heterogeneity in risk compensation (i.e., the models that include categorical variables crossing age class and risk tolerance category with job risk). The simple model, that does not include age or risk tolerance and their interactions with job risk, produces results (presented in the beginning of his talk) that look exactly like what is in the literature. The results for specific combinations of age category (using categories 51-55, 56-60, and 61-65) and risk tolerance, in contrast, are much larger (ranging from $9.4 million to $25.5 million).

One question that is routinely asked in these circumstances, he noted, is: Do individuals really know their job risks? The following longevity question, asked of HRS respondents (largely as a test of their cognitive functioning abilities, rather than with an objective of linking it to any risk assessment) is relevant here: On a scale of zero to ten or zero to 100, what is the likelihood that you will live to 75 years or older? This question is asked in each wave of the questionnaire. Dr. Smith used this longevity question and other questions on the health survey to try to answer the original question, do people really know their job risks? He noted that there was a negative and significant effect of job risk on longevity expectations – that is, people with higher job risks have lower expectations of living to 75 years or older. This supports the hypothesis that people do have a good sense of their job risks. The relationship between other health factors (e.g., whether the person is a smoker; whether he has angina or has ever had a heart attack) and longevity expectations in the HRS data similarly support the notion that people do have a reasonable idea of the risks they face.

Another source of support for the hypothesis comes from the data on people who died during the course of the HRS survey. Dr. Smith asked the rhetorical question: What about the people who die? Did they know it was coming? He took the sample of individuals who died before the wave four interviews and looked at their answers to the longevity question in waves one, two, and three. He found a slight downward trend in their average assessment of longevity, the odds that they will live.

Dr. Smith also examined the wage tradeoffs accepted by the people who subsequently died by the time of the next panel interview. He then took those who died and interacted that coefficient with the risk, hypothesizing that their marginal rate of substitution ought to be different. According to the "dead anyway" hypothesis, they should expect greater compensation, and this is what he found. Looking at a series of other factors that might be associated with attitudes toward risk and heterogeneity, he found some of those do matter, and they matter differently by age and risk tolerance threshold, which is what one would expect.

The VSLs of people in wave 2 who had died by wave 3, which Dr. Smith presented by age-risk tolerance class, were all much larger than the normal values seen in the literature. They ranged from $14.4 million (1999$) to $56.0 million (1999$).

Dr. Smith said, in conclusion, that "the book is still open on what the elderly do in valuing risk," but that he was not prepared to accept, at least for the near elderly, that they are willing to accept compensation to accept risk at a level that is in fact lower than what the average person would accept.

What are the next steps? One next step would be to consider job market transitions. One of the difficulties in any revealed preference investigation that is associated with older people, Dr. Smith suggested, is that in many cases they are no longer working, or they make the retirement decision as well as the decision about the number of hours to work, and that is tied up in our risk analysis. Our hedonic models are not tied to labor supply models because we assume a person takes a job. Dr. Smith suggested that we ought to rethink this. He cited some work that he has done with Subhrendu Pattanayak and George Van Houtven, in which they took some labor supply models and tried to calculate the VSLs that are implied by them. A possible next step is integrating the labor supply modeling with the hedonic modeling, particularly at job market transitions.

Other next steps: We need to consider the possible endogeneity of risk, as Tom Crocker and Jay Shogren have noted. Selection effects are also important, and certainly among the near elderly, we have to consider whether they understand the risk tradeoffs as our models hypothesize they do and determine if their willingness to accept compensation for risk varies with cognitive performance.

Age and the Valuation of Risk Reduction: An Examination of Spending on Bicycle Safety Helmets

--Working Paper*--

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**Age and the Valuation of Risk Reduction:
An Examination of Spending on Bicycle Safety Helmets**

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Introduction

Improving children's health has recently become a priority objective for federal policy makers. In 1997, Executive Order (E.O.) 13045 directed policy makers to examine and reduce health and safety risks to children. Previous executive orders, including E.O. 12866, require major rules issued by a federal agency to be assessed through benefit-cost analyses. To measure the benefits of policies that target children's health, estimates of the economic value of reducing childhood risks are needed. While the economics literature contains many estimates of values of reducing health and safety risks to adults, it contains only a handful for children. Thus, for practical applications, policy analysts routinely transfer to child populations, values estimated for adults. The appropriateness of these transfers is questionable (Dockins et al, forthcoming). Researchers are currently asking whether a risk reduction of the same character and size should be valued differently when experienced by adults as compared to children.

Many of the estimates of adult health and safety values have been derived via hedonic wage analyses. For obvious reasons, this methodology is not viable for analysts focused on children or for analysts seeking insight regarding the differences between adults and children. A valuation alternative that does hold promise, however, is analysis of safety product markets.

Of particular promise is the bicycle safety helmet market, for several reasons. A bike helmet is a personal safety product; that is, helmet ownership is generally assigned to a single individual, and not to a family or some other group which would render it impossible to assign the benefits of the safety product to one person. In addition, bike helmets are owned by young and old alike leaving open the possibility of discerning a relationship between age and spending on safety. This paper takes advantage of these desirable attributes of the bicycle helmet market by examining the relationship between consumer spending on bicycle safety helmets and the age of the helmet wearer, as well as other socioeconomic, policy and helmet attribute variables. We estimate a Tobit model and convert the coefficient on age to a measure of the effect of age on the value of a statistical life (VSL).

We rely on data gathered by a telephone survey as part of the most recent National Survey on Recreation and the Environment. Respondents to the survey modules of interest can be separated into two groups: parents who report having a child age 5 to 14 who had bicycled within the previous 12 months, and adults age 19 and over who report having bicycled themselves within that same time frame. For these respondents, we regress the amount they report having spent on a bicycle safety helmet on the age and gender of the bicyclist, household income, race, a policy variable that indicates the perceived existence of a local helmet law, an estimate of the reduction in risk bestowed by the helmet and finally on the importance to the purchaser of the helmet's appearance. We then convert price into VSL and convert the estimated coefficients into the marginal effect on VSL. We find that relative to what adults pay for themselves, parents pay a premium to protect their children but that as the child ages, parents' spending declines. For adults, we find that VSL increases with age until age 32 at which point it declines until age 51 when it begins a gradual upturn.

Previously in the economics literature, analyses of safety product markets have lacked price data and have based estimates of the value of risk reduction on estimates of implicit values (and amounts) of time (Blomquist 1979 and 1991; Blomquist, Miller and Levy 1996; Carlin and Sandy 1991). Other product market analyses estimate risk reduction values based on highly aggregated product prices (Dardis 1980; Garbacz 1989; Jenkins, Owens and Wiggins 2001). The current paper analyzes consumer level data on bicycle helmet expenditures. To our knowledge, analysis of such detailed expenditure data is unprecedented in the safety product market literature.

As mentioned, in order to estimate how consumer WTP for risk reduction varies with the age of the beneficiary requires the capability to identify the age of the beneficiary. Previous analyses have examined spending on safety products that benefit an entire household -- smoke detectors (Dardis 1980, Garbacz 1989) and automobile size (Mount et al 2000) -- or that benefit only children or only adults -- car safety seats and motorcycle helmets (Carlin and Sandy 1991; Blomquist 1991; Blomquist, Miller and Levy 1996). Our analysis is unique in that bicycle safety helmets are used by all age groups but are purchased for specific individuals. This allows us to estimate a coefficient that measures the impact of aging throughout the middle years of childhood and into adulthood.

The choice of whose preferences to rely upon to determine the value of childhood risk reductions is an important one. Dockins, et al (forthcoming) suggests that the parental perspective is advantageous for multiple reasons.[1] This paper examines spending on child bicycle helmets as reported by parents. Also reported by parents are the variables used to determine VSL such as the expected lifespan of the helmet and the percent of bike-riding-time a child's helmet was expected to be worn. Thus, for children's health, we estimate a parent-determined VSL. We estimate an adult VSL with responses adults reported for themselves.

Data Description

The primary data source for this work is the 2000 National Survey on Recreation and the Environment (NSRE), conducted by the U.S. Department of Agriculture's Forest Service. The NSRE is a random-digit-dialed phone survey of U.S. residents over age 16. The survey collected information from the American public on demographics, participation in a multitude of outdoor activities, and opinions concerning environmental and natural resource issues. The overall survey was comprised of 11 versions. Each version included a common module on demographics and participation in outdoor activities, as well as modules collecting more detailed information pertaining to several specific outdoor activities or special interest topics.

The NSRE modules relevant for this paper asked respondents questions related to

[1] Four possible perspectives for valuing children's risk reductions are suggested by Dockins et al. (forthcoming): that of society, the child, adult-as-child, and parent.

bicycling, especially regarding bicycle helmet purchases and use. These modules were asked from July 2000 to March 2001. The common module contained a question asking if the respondent had done any type of bicycling during the past 12 months. In the NSRE versions containing the bicycle helmet modules, respondents were either asked a series of questions related to their own bicycle helmet purchasing decisions (adult module) or, if the respondent had a bike riding child between the ages of 5 and 14, questions related to purchasing decisions for that child's bicycle helmet (child module). Respondents were asked about the amount of bike riding they (or their child) did, their beliefs regarding the existence of helmet laws, the price they or another family member paid for their (or their child's) helmet, the factors influencing their choice of helmet, their (or their child's) expected helmet use patterns at the time of purchase and a question to determine if the respondent would have changed their helmet purchase decision after being given accurate information on the risk reduction provided by helmets.

In order to maximize the number of responses to the bicycle helmet modules subject to a constraint on the length of each interview and because of the anticipated difficulty contacting respondents with bike riding children of an appropriate age, most of the respondents were asked the child module first. The first question in the child module asked if the respondent has a bike riding child between the ages of 5 and 14. An affirmative answer to that question led to the remaining questions in the children's bike helmet module. If the respondent did not have any bike riding children of an appropriate age, the questions in the adult bike helmet module were asked. A concern that we were not getting responses to the adult questions from any parents who had bike riding children led to approximately 100 interviews in which respondents with bike riding children were also asked the adult questions.

There were 10,009 observations in versions 5 and 7 of the NSRE.[2] After eliminating observations for respondents who did not ride a bicycle or have a bike riding child between the ages of 5 and 14[3], the sample was pared down to 1,984 parent respondents and 1,334 adult respondents. Observations with missing data values for variables included in our regression analysis were eliminated, as were observations where the respondent (or her child) had a helmet, but the helmet was not purchased by herself or an immediate family member.[4] In addition, we eliminated those observations with a "don't know" answer to the helmet law question for this study. If a respondent doesn't know whether there is a helmet law or not, then the existence of a

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[2]Versions 5 and 7 contain the adult and child bicycle helmet modules.

[3]Observations were also eliminated from the data set if income was greater than $12 million (this eliminated the few income observations that were greater than 3 standard deviations from the mean); if the respondent answered that his or her helmet would last over 50 years; and for the child questions, if the parent age minus the child's age was less than 15.

[4]In this situation, respondents were not asked further helmet questions because it is unlikely they would have known the helmet purchase price or other factors that went into the purchase decision.

law would not have affected his helmet purchasing decision. Most of the missing values were household income or the respondent's belief regarding helmet laws. The adult observations were missing relatively more helmet law values than the child observations. This may be due to the fact that there are more helmet laws aimed specifically at children than there are laws that apply to adults. In addition, helmet education campaigns are almost exclusively geared towards children and therefore parents might be more aware of helmet laws applicable to their children than adults are aware of helmet laws applicable to themselves.

The final data set used for our analysis includes 950 child observations and 448 adult observations. Of the 950 child observations, 847 (89.2%) were helmet purchasers, while 223 (49.8%) of the 448 adult observations were purchasers. These numbers are similar to a 1999 U.S. Consumer Product Safety Commission (CPSC, 1999) survey that found 84% of bike riding children under 16 and 45% of bike riding adults own a helmet. Means and standard deviations of the data we use for our study are summarized in Table 1.

Relative to the U.S. population in general, the bike riding population as portrayed by the study sample is more likely to be male, more likely to be white and has a higher income. The sample has slightly more males (53.3%) than the U.S. population (49.1%) and more respondents categorize themselves as white in our sample (87.9%) than the U.S. population does (75.1%) (U.S. Census Bureau, 2001a). The mean household income in our sample is $65,743, while the mean household income of the U.S. population as a whole is only $55,253 (U.S. Census Bureau, 2001b). The helmet owners in our sample have a higher mean household income ($70,155) than those who do not own a helmet ($51,351).

About 12% of the U.S. population is covered by state or local helmet laws (BHSI, 2001). All 20 of the state laws are specific only to children and 30 of the 83 local laws apply to all ages, with the others being specific only to children. Therefore it is interesting to note that 63% of the respondents in our child sample said that there was a law in their community or state requiring children to wear bicycle helmets, while 26% of the respondents in the adult sample said they thought there was a helmet law geared towards adults in their state or community.[5] People may believe that a helmet law exists in their community when they are exposed to a helmet education campaign. For example, about a year ago, McDonald's Corporation ran a national campaign encouraging helmet use for children and adults. Whether the respondents are correct in their knowledge of helmet laws in their community or not, it is their perception of the law that will drive their helmet purchasing decisions.

On average, adults in our sample spent over $10 more on their own helmets ($36.61) than parents in our sample spent on helmets for their children ($25.49). Respondents to our adult questions spent anywhere from $5 to $150 while respondents to the child questions spent from $1 to $259 on helmets for their children. For comparison, the average retail price of 12 adult

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[5]If a respondent doesn't know if there is a helmet law, then the existence of a law would not have affected his helmet purchasing decision.

helmets tested by Consumer Reports, was $65.42, while the average retail price of the 8 youth helmets tested was $31.75 (Consumer Reports, 1999).

The federal safety standard for bicycle helmets (U.S. CPSC, 1998) ensures that all bicycle helmets manufactured after March 10, 1999 must meet a minimum level of safety. It is unlikely that manufacturers would create helmets that go too far beyond this standard. To make a helmet safer than the federal standard would require additional cost to the manufacturer, but also more weight and size to the helmet, making it less likely to be bought or worn (U.S. CPSC, 1998). Even though helmets themselves do not differ significantly in their levels of protection, different levels of risk-taking behavior or exposure to risk during riding will cause individuals to face different risk reductions provided by their helmets. Because the CDC (2001) reports annual pedal cycle deaths by age, race and gender, we were able to assign individuals a fatal risk reduction that varies according to their age category, race and gender.[6] We use the CDC data along with data on the percent of the population riding bikes and percent of riders wearing helmets (Sacks et al. 1996; Bolen, Kresnow and Sacks 1998); the percentage of deaths preventable by wearing a helmet (Thompson, Rivara, and Thompson 1996); and our data on the percent of time individuals expect to wear their helmets to create the fatal risk reduction variable.

In the adult bike helmet and child bike helmet NSRE modules, several questions were asked about how important certain helmet characteristics were in the respondent's helmet purchase decision. The characteristics were: weight, ventilation, texture of chin strap, overall comfort, color, and overall appearance. Respondents were asked to rate each characteristic on a scale from 1 to 5, with 1 being not at all important and 5 being very important. For the individual comfort characteristics (weight, ventilation, and texture of chin strap) and especially for the overall comfort characteristic most of the respondents (98 percent) rated them as important (answering 3, 4, or 5). This lack of variation led us to omit these variables from our econometric analysis. The appearance variables (color and overall appearance) offered much greater variation. Thus we include in our analysis an indicator variable for the importance of overall appearance which equals 1 if response was 3, 4, or 5. We chose to include the overall appearance variable instead of the color variable because it captured more of the aspects of appearance that may be important to people than just color.

In order to gain some minimal assurance that helmet expenditures reflect a lower bound of consumer willingness to pay for fatality risk reduction, we asked respondents to the child questions the following (respondents to the adult questions were asked a similar question),

> *Biking is a popular but potentially risky activity. Without bicycle helmets, 7 in every 1 million child bike riders would die each year from a head injury. Now suppose the only benefit from wearing a bike helmet is that your child's risk of death from head injury declines to 2 in one million, with no change in his or her*

[6] For the child observations, we assume that the race of the child is the same as the race of the respondent.

risk of non-fatal injury, would you still have purchased your child's helmet at the price you paid?

The risk reduction described within this question is the actual average fatality risk reduction provided by helmet use. A negative response to this question would indicate that the fatality risk reduction offered by helmets, by itself, is not enough to warrant the helmet expenditures undertaken. This might be because the respondent had been under the impression that a bicycle helmet provides more fatality risk reduction than it actually does or that injury protection must be offered in addition to fatal risk reduction to have made the purchase worthwhile. An affirmative answer gives some indication that the helmet purchaser was willing to pay at least the price of the helmet to gain just the fatality risk reduction.

Only 130 respondents (43 adult, 87 child) answered this question because the question was added to the two NSRE modules after the survey had already started and it was only asked of those who had purchased a helmet. Of those that answered, 90.8 percent (40 adult, 78 child) answered yes, 4.6 percent answered no (2 adult, 4 child), and 4.6 percent refused or answered "don't know."

Estimation Strategy and Results

Our primary objective is to determine the relationship between age and safety expenditures. We hypothesize that bicycle safety helmet expenditures depend on the age of the helmet wearer as well as the wearer's gender; race; household income; whether the respondent believes there is a law requiring helmet use; the risk reduction enjoyed by the helmet wearer; the importance to the purchaser of helmet appearance; and the number of years the purchaser expected the helmet to last. For observations representing spending on a child's helmet, the purchaser and respondent are a parent while the helmet wearer is a child. For observations representing spending on an adult's helmet, both the purchaser/respondent and wearer are the same individual.

We combine data for helmet purchasers and non-purchasers. For the non-purchasers, helmet spending equals zero. To accommodate this truncation at zero, we wished to conduct a Tobit analysis. Unfortunately, for the helmet non-purchasers, we had no information on their opinions regarding the importance of helmet appearance nor on the number of years they might expect a helmet to last. As a remedy, we predicted the opinions and expectations of these respondents, based upon the responses of the helmet purchasers, via a process termed conditional mean imputation.[7] We also predicted values for these same variables when their values were missing for helmet purchasers. There were missing values for the appearance variable for eleven of the 847 purchasers. For the expected lifespan variable, 147 of the 847 purchasers had missing values.

7For an explanation of conditional mean imputation, see Little and Rubin (1987).

Specifically, with data for the helmet purchasers who had non-missing values,[8] we estimated a logit equation with the indicator variable that identifies whether or not the respondent believed the appearance of the helmet was important as dependent variable. We selected seven socioeconomic variables, two of which are not included in the primary spending equations,[9] as independent variables. Similarly, we estimated an equation to predict expected helmet lifespan via ordinary least squares, again as a function of the same seven socioeconomic variables. We examined the means and ranges of these seven variables and confirmed that the values for non-purchasers were within or not too far out of the range that represented purchasers. We used the coefficients estimated via the logit and OLS equations to predict values for the appearance and lifespan variables for the helmet non-purchasers. For the appearance variable, the prediction is always zero; for the lifespan variable the mean number of years predicted is 2.71 for children and 6.75 for adults. We combined these predicted values for the non-purchasers (and for the purchasers who had missing values), with the actual values for the helmet purchasers, to conduct a Tobit analysis of helmet spending.

The relationship between safety spending and age is potentially a complicated one. There is reason to suspect that the relationship is different during childhood than during adulthood. One reason is that the childhood values are determined by a third party (a parent), while the adult values are self determined. In addition, based on previous research we suspect that the age of a child affects a parent's WTP for risk reduction differently than the age of oneself affects an adult's WTP for risk reduction. Specifically, Jenkins, Owens and Wiggins (2001) estimate childhood VSLs that suggest that parents' valuation of risk reduction might decline with parents' gradual detachment from a child as the youngster ages and grows more independent. This suggests that a child's age might vary negatively with parental WTP for risk reduction.

Previous studies that have focused on adult populations have estimated nonlinear relationships between age and values of risk reduction. Rowe et al. (1995) examines three studies that estimate VSL for adults and that either explicitly or implicitly control for age. The review concludes that estimates of adult VSL increase until around age 40 at which point they decline. However the rate at which VSL changes differs according to the study.

In addition to age affecting helmet expenditures differently for adults and children, so too might other independent variables such as whether a respondent believes there is a law requiring helmet usage.[10] Parents might be more prone to respond to a law governing usage among

8The data was for the helmet purchasers who had non-missing values for the variable being predicted.

9The two not included are indicator variables for whether the respondent completed highschool and college.

10On the other hand, other variables might not affect helmet expenditures differently for children childhood bicyclists than adults would be to a law requiring helmet wearing for adults. Adults might be more responsive to concerns about appearance regarding their own helmet than parents are to concerns regarding the appearance of their child's helmet. This potential for important differences led us to estimate separate equations for child and adult observations. To accommodate the possibility that adult age interacts nonlinearly with spending on risk reduction, we include squared and cubed versions of the age variable for adults along with adult age itself. The child equation includes a single age variable.

Table 2 presents the results of the Tobit regression analyses for children and adults. These results indicate the significance and direction of each variable's effect on bicycle-safety-helmet spending. Table 2 does not indicate the magnitude of each variable's effect. To determine magnitudes, we use the estimated Tobit model coefficients to calculate the marginal effects of the independent variables. These are reported in Table 3 for the significant variables.

The Effect of Age

Age is significant and negative in the child equation. The age of the children in our sample varies between 5 and 14. As a child ages through these middle years of childhood, helmet spending by parents gradually declines. The mean price paid for a child helmet among helmet purchasers is approximately $25.00. Including the 11 percent of parents who report not purchasing a helmet, this values declines slightly to $23.00. Ceteris paribus, each additional year of age has a marginal effect on helmet spending of negative $0.40. This finding supports the suggestion in Jenkins, Owens and Wiggins (2001) that as a child ages at least through middle childhood, parents' valuation of risk reduction declines, perhaps because of the natural transference of responsibility for health and safety over to the child.

We find a non-linear relationship between adult age and price paid for a bicycle helmet. Age, age squared and age cubed are all significant in the adult equation. The coefficients for age and age cubed are positive, the one for age squared is negative. The age range of adults in our sample is 20 to 59. Helmet expenditures increase with age until age 32 where they reach a maximum, then turn down again until age 51, at which point they begin to rise again. Similar to the research summarized by Rowe, et al.(1995) we find a hump shaped relationship between age and valuation of risk reduction. However, our peak occurs at a younger age than 40, and at higher ages we find that valuation turns up again. A possible explanation for why it turns back up is that the "near elderly" are particularly interested in reducing risks from physical injury. While our equation does control for the reduction in fatal risks bestowed by helmets, this does not account for length of recovery times for non-fatal injuries. The near elderly might well require more time to recuperate and thus might value the reduction in non-fatal risks bestowed by helmets more than younger people.

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and adults, in which case child and adult observations should be pooled and the pooled equation should include separate interaction terms representing child age and adult age along with the other independent variables. We conducted a log liklihood test and found no reason to pool the adult and child data.

Socioeconomic Variables

For both children and adults, the indicator variable for male is negative and significant. Its marginal effect for both is approximately $10.00, quite large relative to the average helmet expenditures of $37.00 among adult helmet purchasers or $25.00 among parent purchasers. These findings support the traditional view that males are more willing to undertake physical risks.

We find no important cultural distinction between whites and other races regarding helmet expenditures. The coefficient for the indicator variable for the race categorization, white, is not significant for either adults or children.

As expected, we find that spending on helmets varies positively and significantly with household income. The marginal effect of income is quite small, although the effect on parental spending is larger than on adult spending. An increase in household income of $10,000 increases parental spending on a child's helmet by $0.20. That same change in income increases adult spending on a helmet for self by only $0.04.

Risk Reduction

The reduction in risk from wearing a bicycle helmet has a significant and positive effect on helmet spending for both the child and adult equations. The risk reduction bestowed by a helmet varies according to gender, race and age of the helmet wearer, not according to helmet design. Adults who face a greater risk of fatal head injury, and parents of children who face greater risk, spend more on helmets. The magnitude of the response is remarkably similar for adults purchasing for self and parents purchasing for a child. An increase in risk reduction of 1/1,000,000 leads to an increase in helmet spending of $2.50 for both groups. This gives a marginal value of statistical life for both adults and children of $2.5 million. As an example, consider a family with a bike-riding child whose risk increases by 1/1,000,000 as he grows older and undertakes more distant, lengthier bicycle trips. This results in a corresponding increase of $2.50 in spending on a bicycle helmet.

While the marginal effect of an increase in risk reduction is the same for adults and children, the baseline amount of risk reduction experienced by these two subpopulations is different -- approximately 4/1,000,000 for children and 3/1,000,000 for adults. Thus, we can draw no immediate conclusions regarding the relative magnitude of VSL for children versus adults, except to say that the values are probably similar.

The Importance of Appearance

The coefficients estimated for the appearance variables are positive and significant in the adult and child equations. The marginal effect on parental spending is $10.00 while the effect on adult spending is $19.00. These are very high effects relative to the mean child and adult helmet expenditures. Both parents and adults are willing to spend substantially more on helmets when they consider the appearance of the helmet to be important.

Expected Helmet Lifespan and Helmet Laws

The number of years respondents expected a helmet to last is insignificant in both equations. This suggests that other factors override expected lifespan in determining the amount to spend on a helmet.

The indicator variable for whether the respondent believed there was a law requiring helmet use is also insignificant in both equations. This finding is surprising in a model with non-purchasers pooled with purchasers. Again, apparently, other factors dominate in consumers' decisions regarding how much to spend on a helmet.

Conclusion and Policy Implications

This paper offers several important results for policymakers and economists. First is the finding that the price paid for a helmet is significantly affected by the amount of risk reduction experienced by wearing a helmet. This paints a portrait of consumers as more knowledgeable regarding risk than is frequently assumed by economists. This finding is even stronger given that the Consumer Product Safety Commission applies a uniform safety standard to all bicycle safety helmets, regardless of the age or other characteristics of the intended wearer (U.S. CPSC 1998). In other words, consumers do not select a helmet by examining labels and comparing reductions in risk across helmet models. The variation in the risk reduction offered by helmets comes exclusively from behavior patterns of the wearer or from the wearer's exposure to risk. These behavior patterns and exposures are captured in our data by variables such as the percent of time the helmet is expected to be worn and the race, age and gender of the wearer, all of which are reflected by the risk reduction variable.

The differences in risk produced by behavior patterns or exposures are subtle compared to differences that can be overtly communicated via a label. That this obscure risk information is being observed and put to use by consumers suggests that, in general, the efforts of policy makers to improve the public's access to risk information are worthwhile.

Another important set of conclusions are those regarding the relationship between safety valuation and age. We find that during the middle years of childhood, parental valuation of risk reduction experienced by their own children declines gradually. For adults, valuation of risk reduction increases between ages 20 and 32 then declines until age 51 at which point it increases again. Ours is the first paper, of which we are aware, to estimate a relationship between safety spending and child age. The finding supports the notion that as children grow independent, parents' valuation of risk reduction declines, perhaps because of the natural transference of responsibility for health and safety over to the child.

Our conclusions regarding the relationship between adult age and safety spending are similar to conclusions reached by previous research except that we find the value of risk reduction begins to increase again for adults who are in their early 50s. As explained previously this might simply reflect a greater aversion to non-fatal physical injury by the near elderly than by younger adults. However, it might also reflect a greater aversion by the near elderly to fatal physical injury. There is an abundance of anecdotal evidence that the elderly take greater precautions to avoid accidents than younger adults do. For example, elderly drivers are often portrayed as overly cautious. It seems possible that this sub-population of older individuals might truly value risk reduction more. At the very least, that they might value injury risk reduction more than younger individuals seems plausible. The implications for policy makers are apparent. Assigning lower VSLs to elderly populations, whether explicitly or implicitly, might well not be correct.

To compare valuation of adult risk reduction to parental valuation of childhood risk reduction, we can convert the average prices paid for child and adult helmets into estimates of average VSL. Likewise we can convert the marginal effect of age into the marginal effect on VSL. We do this by dividing an annualized version of the dependent variable[11] and the marginal effect of age[12] by the mean reduction in annual risk of fatal head injury that was expected at the time of helmet purchase. We divide by

$$R = \sum_{i=1}^{n} (R_i T_i) / n \qquad (1)$$

where R_i is the annual reduction in the risk of fatal injury experienced by the i^{th} wearer, T_i is the proportion of bike-riding-time that the helmet purchaser expects the helmet to be worn, and n is the sample size. Recall that the CDC reports annual head-injury deaths from bicycle accidents by age category, gender and race. Thus R_i varies by age category, gender and race. Assuming that the reason for purchasing a helmet is to reduce fatal injury only,[13] dividing by R converts the annualized price of a bike helmet to a lower bound value of statistical life (VSL) and converts the marginal effect of age on price into the effect on VSL.

These conversions generate VSL estimates of $1.1 million for adult helmet purchasers ($0.9 million for purchasers and non-purchasers together) and $1.9 million for parent purchasers

11We annualize the dependent variable by multiplying by $r/\{1 - 1/(1+r)^t\}$ where r is the interest rate and t is the average expected helmet lifespan,

12Adjusted by the same factor as the dependent variable.

13The NSRE survey gathers evidence that respondents would not wish to reverse their helmet purchase even if the only benefit conferred by a helmet was to reduce fatality risk by the average actual risk reduction conferred by a helmet. Please see the discussion under Data Description.

of child helmets ($1.8 million for parent purchasers and non-purchasers combined). The absolute values of these estimates are quite low as holds true for most estimates of VSL from safety product market studies. Perhaps more relevant are the relative values of the adult estimate compared to the child one. The adult value is approximately 60 percent of the child one despite that the average price paid for an adult helmet is much higher. This derives mainly from the higher expected helmet lifespan among adults. As the child ages through middle childhood, the estimated effect on parent-determined VSL is rather small. It declines by approximately $30,000 per year of age. The suggestion for policy makers is that parents might well value risk reductions enjoyed by their children more than adults value risk reductions to themselves.

In sum, we find that valuation of risk reduction is sensitive to the age of the risk recipient. Future research should explore the sensitivity of valuation to age for risks other than bicycle head injury. The nature and timing of the risk could well affect the interaction between age and valuation. One would certainly suspect that reductions in risks whose consequences are experienced after a time lag, would be valued less by the elderly whose odds of ever experiencing the consequences are lower. Our conclusions are most relevant to risks that pose immediate consequences, as in bicycle accidents.

References

Bicycle Helmet Safety Institute, "Mandatory Helmet Laws", last revised October 16, 2001. (http://www.bhsi.org/mandator.htm) accessed on 10/23/01.

Blomquist, Glenn. 1979. "Value of Life Saving: Implications of Consumption Activity," *Journal of Political Economy*, 87:540-558.

Blomquist, Glenn. 1991. "Motorist Use of Safety Equipment: Expected Benefits or Risk Incompetence?" *Journal of Risk and Uncertainty*, 4:135-152.

Blomquist, Glenn C., Ted R. Miller, and David T. Levy. 1996. "Values of Risk Reduction Implied by Motorist Use of Protection Equipment: New Evidence from Different Populations." *Journal of Transport Economics and Policy*, January 1996.

Bolen, J., M. Kresnow, and J. Sacks. 1998. "Reported Bicycle Helmet Use Among Adults in the United States," *Archives of Family Medicine* 7:72-77.

Carlin, P. and R. Sandy. 1991. "Estimating the Implicit Value of a Young Child's Life," *Southern Economic Journal*, 58:186-202.

Consumer Reports Online, "Head Cases", June 1999. (http://www.consumerreports.org/main/detail.jsp?CONTENT%3C%3Ecnt_id=34975&FOLDER%3C%3Efolder_id=34843&bmUID=1004378401378) accessed on 9/19/01.

Dardis, R. 1980. "The Value of a Life: New Evidence from the Marketplace," *American Economic Review*, 70:1077-1082.

Dockins, Chris, Robin R. Jenkins, Nicole Owens, Nathalie B. Simon and Lanelle Bembenek Wiggins. Forthcoming. "Valuation of Childhood Risk Reduction: The Importance of Age, Risk Preferences and Perspective," *Risk Analysis*.

Garbacz, C. 1989. "Smoke Detector Effectiveness and the Value of Saving a Life," *Economics Letters*, 31:281-286.

Jenkins, Robin R., Nicole Owens and Lanelle Bembenek Wiggins. 2001. "Valuing Reduced Risks to Children: The Case of Bicycle Safety Helmets," *Contemporary Economic Policy*, 19(4):397-408.

Little, Roderick J.A. and Donald B. Rubin. 1987. Statistical Analysis with Missing Data, New York: John Wiley & Sons.

Mount, T. W. Schulze, W. Weng, H. Kim and L. Chestnut. 2000. "Valuing Reduced Risk for Households with Children or the Retired," presented at the American Economics Association

Annual Convention, Boston MA.

Rowe, R.D., C.M. Lang, L.G. Chestnut, D. Latimer, D. Rae, S.M. Bernow and D. White. 1995. The New York Electricity Externality Study, Oceana Publications, Dobbs Ferry, New York.

Sacks, J., P. Holmgreen, S. Smith, and D. Sosin. 1991. "Bicycle-associated Head Injuries and Deaths in the United States from 1984 through 1988: How Many Are Preventable." *JAMA* 266:3016-3018.

Sacks, J., M. Kresnow, B. Houston, and J. Russell 1994. "Bicycle Helmet Use among American Children." *Injury Prevention* 2:258-262.

U.S. Consumer Product Safety Commission. 1998. "16 CFR Part 1203: Safety Standard for Bicycle Helmets; Final Rule." *Federal Register*, vol. 63, no. 46, pp. 11711-11747 (March 10, 1998).

U.S. Consumer Product Safety Commission. 1999. "National Bike Helmet Use Survey." (http://www.cpsc.gov/library/helmet.html) accessed on 9/18/01.

U.S. Census Bureau. 2001a. "U.S. Population Estimates by Age, Sex, Race, and Hispanic Origin: 1980-1999." (http://www.census.gov/population/estimates/nation/natdoc_rl.txt) accessed on 8/1/01.

U.S. Census Bureau. 2001b. "Profile of Selected Economic Characteristics: 2000." (http://factfinder.census.gov/servlet/QTTable?ds_name=ACS_C2SS_EST_G00_&geo_id=01000US&qr_name=ACS_C2SS_EST_G00_QT03) accessed on 10/24/01.

U.S. Centers for Disease Control and Prevention. 2001. "Injury Mortality Reports-Pedal Cyclist Traffic-Related Deaths and Rates Per 100,000: 1994-1997." (www.cdc.gov/ncipc/data/us9794/Mvpctr.htm) accessed on 8/1/01.

Table 1
Means (Standard Deviations) of Data for Bicycle Riders

	Children N = 950 (unless otherwise noted)	**Adults** N = 448 (unless otherwise noted)
Age	9.6411 (2.9453)	39.1295 (10.8828)
Gender (male = 1)	0.5337 (0.4991)	0.5313 (0.4996)
Race (white = 1)	0.8726 (0.3336)	0.8929 (0.3096)
Household Income ($1000)	61.0596 (48.7451)	75.6746 (330.0045)
Helmet Law (yes =1)	0.6263 (0.4840)	0.2567 (0.4373)

***Helmet Purchase Price**	25.4911 (22.9159) N = 847	36.614 (23.284) N = 223
***Expected Lifespan** (years)	3.0429 (2.33) N = 700	6.574 (4.4385) N = 155
***Percent of Time Expected to be Worn**	0.9229 (0.1837) N = 847	0.8554 (0.2375) N = 223
Risk Reduction (1/1,000,000)	4.3052 (3.3116)	3.3464 (4.2902)
***Appearance**	0.7141 (0.4521) N = 836	0.6712 (0.4708) N = 222

(*includes only purchasers with no missing values)

Table 2
Econometrics Results for Tobit Model

	Children	**Adults**
Variable		
Constant	9.2045** (4.0198)	-177.08** (83.243)

Table 2 **Econometrics Results for Tobit Model**		
	Children	**Adults**
Variable		
Age	-0.51299* (0.29093)	13.196* (6.8723)
Age Squared		-0.3343* (0.18195)
Age Cubed		0.0027* (0.0015)
Male	-12.467*** (2.6849)	-24.469*** (5.3904)
White	1.5356 (2.4223)	-5.4496 (5.3721)
Household Income ($1000)	0.03193** (0.01623)	0.00726* (0.00434)
Risk Reduction (1/1,000,000)	3.0753*** (0.4327)	5.0926*** (0.60211)
Appearance	11.969*** (1.718)	37.758*** (3.7426)
Expected Lifespan (years)	-0.54068 (0.39211)	0.50214 (0.56213)
Helmet Law	1.1383 (1.7016)	1.0436 (3.8287)
Number of observations	950	448
Log Likelihood	-3963.414	-1164.544

Standard error reported in ( ).
* = significant at 90%level of confidence
** = significant at 95% level of confidence
*** = significant at 99% level of confidence

Table 3
Marginal Effects of Significant Variables

	Children	**Adults**
Variable		
Constant	7.4289	-90.507
Age	-0.4140	6.7446
Age Squared		-0.1709
Age Cubed		0.00137
Male	-10.062	-12.506
Income (1000s)	0.02577	0.00371

Risk Reduction (1/1,000,000)	2.4821	2.6029
Appearance	9.6605	19.299

Smoking Parents' Valuations of Own and Children's Health
--Working Paper*--

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*Smoking Parents' Valuations of Own and Children's Health**

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ABSTRACT

This paper uses data from the 1991 National Maternal and Infant Health Survey (NMIHS) to estimate propositions derived from a model of intrahousehold allocation, wherein parents engage in a consumption activity (smoking) that produces own utility, while generating environmental tobacco smoke (ETS) that harms their child's health. We find a statistically significant negative association between sample parents' assessed health of their child and that child's daily exposure to ETS. Estimated annual parental willingness-to-pay (WTP) for a one percent reduction in their child's daily ETS exposure ranges from $8.29 to $11.01 for the subsample of NMIHS parents who smoke. WTP estimates for respondent parent and young child health status further imply that smoking parents on average value their child's health roughly twice as much as they value their own health.

I. INTRODUCTION

Except insofar as it reduces household resources available to invest in a child, the 'child development' influence of parents' own consumption in its various commodity-specific forms has been little studied in economics. Yet parents freely engage in many activities that give them direct or indirect utility, while simultaneously producing incidental effects that spill over to affect their children's well-being. Thus, for example, a parent may drink alcohol excessively and subsequently abuse or neglect their child (Markowitz and Grossman, 1998); or, by renovating and improving the appearance of their residence, the parent removes lead paint from the home, thereby reducing their child's health risks (Agee and Crocker, 1996).[1]

In this paper, we examine parents' choices to smoke and the effect these choices have upon their own health plus the health of their children. In particular, we estimate smoking parents' substitution rates between own consumption and own health, between own consumption and their children's home exposure to environmental tobacco smoke (ETS), and between own health and own children's health. Our household production model presumes that smoking parents self-assess the potential harm of smoking—to themselves and their children—and then balance these assessments with the own utility of smoking. The structure we assign to the parents' decision problem allows us to assess all of the abovementioned tradeoffs within the confines of a single study. We focus solely on parents who currently smoke because of recent evidence that smokers make different health and safety risk-wealth tradeoffs than do non-smokers. Smokers appear to have idiosyncratic preference structures which affect both the supply and the demand sides of the markets in which they participate (Viscusi and Hersch, 2001).

Information on the health risks that U.S. federal health protection agencies believe ETS poses to the general population has been available and widely dispensed since the mid 1980's (U.S.

Surgeon General, 1986). Included is information on an assortment of child-specific diseases and functional limitations, including respiratory infections, aggravated asthma, and neonatal death (U.S. Environmental Protection Agency, 1992). People, including smokers, are thought to understand, even exaggerate, the health hazards of smoking and ETS (Viscusi, 1992; Rovira et al., 2000), and not to evaluate the consequences of smoking myopically (Chaloupka, 1991). Public concerns about the health and aesthetic impacts of ETS have been expressed in widespread legal and voluntary restrictions on smoking in public places and in private worksites outside the home. No one knows whether these restrictions have increased smoking in the home as smokers try to compensate for their loss of access to nonhousehold venues.[2] A clearer understanding of the consequences for children of the various public smoking policies may be obtained with a better grasp of the tradeoffs smoking parents are willing to make between home smoking and their children's health.

The following section develops a basic model of household production and ETS exposure. Section III translates derivations from this model into an empirically implementable form. A fourth section describes the data we employ, while empirical results are presented in Section V. We conclude that the smoking parents in our sample value their young children's health more that they value their own health.

II. FAMILY HEALTH AND ETS EXPOSURE

Consider a household with unified preferences where paternalistic parents (denoted by t) derive utility, U_t, from a vector of consumption and/or leisure activities, z_t, and from their own and their children's health service flows, H_t and H_{t+1} (t+1 denotes children):

(1) $$U_t \equiv U_t(z_t, H_t, H_{t+1}),$$

where $U_t(\cdot)$ is quasi-concave and twice differentiable. Parents have symmetric concerns over their children, as is commonly assumed (Wilhelm, 1996). So as to remove fertility decisions from the problem, expression (1) presumes family size to be predetermined.

A child's flow of health services, H_{t+1}, varies with parents' choices of child-specific, health-related commodities, h_{t+1}, and the child's exposure to ETS, d_{t+1}, according to

$$H_{t+1} \equiv H_{t+1}(h_{t+1}, d_{t+1}(x_t, f); y_{t+1}), \tag{2}$$

where $H_{t+1}(\cdot)$ is twice differentiable and concave. Child ETS exposure varies with parental smoking, x_t, and the number, f, of other household members who currently smoke. The vector y_{t+1} accounts for predetermined health stock characteristics, observed and unobserved, which shape children's health. We presume $d_{t+1}(\cdot)$ to be shared in common amongst siblings. Own parental health is determined in similar fashion:

$$H_t \equiv H_t(h_t, x_t, f; y_t). \tag{3}$$

Parents' personal consumption activities are produced using a vector of inputs, c_t, an element of which may be cigarettes, x_t, using a personal consumption activity function, $z_t(c_t)$, where $z_t' > 0$, and $z_t'' < 0$.

Finally, households face an income constraint written as the sum of expenditures on consumption and family health commodities,

$$Y_t = c_t p_c + (h_t + h_{t+1}) p_h, \tag{4}$$

where Y_t is household income, and p_c and p_h are column vectors of market prices. Solving expression (4) for c_t and substituting along with (2) and (3) into (1), the parents' objective is to maximize

$$U_t(z_t([Y_t - (h_t + h_{t+1}) p_h] p_c^{-1}), H_t(\cdot), H_{t+1}(\cdot)) \tag{5}$$

over h_t, h_{t+1}, and x_t. Parents' optimal choices satisfy the first order conditions:

$$\frac{\partial U_t}{\partial z_t} z_t' \, p_c^{-1} = \frac{\partial U_t}{\partial H_t} \frac{\partial H_t}{\partial h_t} p_h^{-1}, \tag{6}$$

$$\frac{\partial U_t}{\partial z_t} z_t' \, p_c^{-1} = \frac{\partial U_t}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial h_{t+1}} p_h^{-1}, \tag{7}$$

and

$$\frac{\partial U_t / \partial H_t}{\partial U_t / \partial H_{t+1}} \equiv s = -\frac{\dfrac{\partial H_{t+1}}{\partial d_{t+1}} \dfrac{\partial d_{t+1}}{\partial x_t}}{\dfrac{\partial H_t}{\partial x_t}}. \tag{8}$$

Expressions (6) and (7) state the familiar proposition that, at the optimum, adults will seek to equate their marginal utilities of consumption activities and health commodities across family members. Expression (8) further states that parents who smoke will choose a level of cigarette consumption that equates s , their substitution rate between own and children's health, to the ratio of marginal health effects of cigarette consumption upon their children and upon themselves. Substituting (6) and (7) into (8) and rearranging terms yields

$$s = -\frac{\dfrac{\partial H_{t+1}}{\partial d_{t+1}} \dfrac{\partial d_{t+1}}{\partial x_t}}{\dfrac{\partial H_t}{\partial x_t}} = \frac{\partial H_{t+1} / \partial h_{t+1}}{\partial H_t / \partial h_t}, \tag{9}$$

which shows that parents will seek to balance the relative (perceived) health impacts of all health-related commodities upon themselves and their children in accordance with their preferred substitution rate, s .

Simultaneous solution of (6) through (8) yields demand functions x_t^*, h_t^*, and h_{t+1}^*, which solve the implicit function

$$F(p_h, p_c, y_t, y_{t+1}, Y_t; U_t^*) \tag{10}$$

$$\equiv U_t(z_t([Y_t - (h_t^* + h_{t+1}^*)p_h]p_c^{-1}), H_t(\cdot), H_{t+1}(\cdot)) - U_t^* = 0,$$

where U_t^* denotes maximum parental utility given family income, Y_t, and health attributes, y_t and y_{t+1}. Applying the Implicit Function Rule to (10) and substituting from (7), parents' marginal valuation of an exogenous improvement in their child's health is defined as the tradeoff between family income and the marginal improvement:

$$\frac{dY_t}{dH_{t+1}} = -p_c \frac{\partial U_t / \partial H_{t+1}}{(\partial U_t / \partial z_t) z_t'} = -p_h / (\partial H_{t+1} / \partial h_{t+1}^*). \tag{11}$$

Also, if the child's health improves due to an exogenous decrease in ETS exposure, expression (11) expands to

$$\frac{dY_t}{dd_{t+1}} = -p_h \frac{\partial H_{t+1} / \partial d_{t+1}}{\partial H_{t+1} / \partial h_{t+1}^*}. \tag{12}$$

Dividing (11) into the adult marginal valuation of own-health gives the relationship between adult marginal valuations of own health and children's health

$$\frac{dY_t / dH_t}{dY_t / dH_{t+1}} = s, \tag{13}$$

i.e., the utility substitution rate as given in expression (9).

III. EMPIRICAL APPLICATION

Expression (13) together with expressions (9) and (12) show that observed data on adult expenditures on health, smoking behaviors, and adult and child ETS dose-response relationships enable one to assess parental valuations of own health and child health improvements, and health-enhancing reductions in home ETS exposures. Empirical implementation requires estimation of a system of demand equations for adult and child health and related inputs that allow cross-price effects among goods and health inputs to be distinguished from the effects of price-induced input consumption changes upon health states. However, identification of such a system requires either that structural health input demand equations be specified with a number of exogenous variables sufficient to disentangle health production relationships from adult preference orderings, or that within-household, cross-person restrictions on demand functions be employed.

The household production literature (e.g., Rosenzweig and Schultz, 1983) emphasizes that technical or biological processes together with prices and income condition input selection by parents in their health production activities. Thus if the impacts of exogenous changes in H_{t+1} or d_{t+1} are to be estimated, simple correlations between inputs and health outcomes cannot be used to determine causality. That is, unbiased estimates of family health technological relationships such as those derived in Section II must be obtained from a behavioral model in which health inputs are themselves endogenous. To account for heterogeneity in the production of adult and child health, we propose the following expressions:

$$\ln H_t = \ln A + e \ln \hat{h}_t + f \ln \hat{x}_t + e_t \ln \hat{f} \qquad (14)$$

and

$$\ln H_{t+1} = \ln B + g \ln \hat{h}_{t+1} + g_{t+1} \ln \hat{d}_{t+1}, \qquad (15)$$

represent adult and child health status as perceived by the parent, and

$$\ln \hat{d}_{t+1} = \ln S_{t+1} + k \ln \hat{x}_t + e_{t+1} \ln \hat{f}, \qquad (16)$$

represents child exposures to ETS (A, B, and S_{t+1} are technological parameters).[3]

Using $\frac{\partial H_{t+1} / \partial h_{t+1}}{\partial H_t / \partial h_t} = -\frac{\partial H_{t+1} / \partial x_t}{\partial H_t / \partial x_t}$ from expressions (8) and (9) together with expressions (14)-

(16) to obtain $\hat{h}_t = \frac{ekg_{t+1}}{fg}\hat{h}_{t+1}$, parental valuations of own and child health improvements and ETS exposure reductions can be consistently estimated using the following six-equation system: a modified form of expression (14):

$$\ln H_t = (\ln A + e\ln\frac{ekg_{t+1}}{fg}) + e\ln\hat{h}_{t+1} + f\ln\hat{x}_t + e_t\ln\hat{f}, \qquad (17)$$

together with expressions (15) and (16), and three endogenous variates, $\hat{x}_t$, $\hat{h}_{t+1}$, and $\hat{f}$, which we specify as log-linear functions of exogenous prices, income, and other family and community characteristics. Our empirical strategy thus proceeds by obtaining first-stage estimates of $\hat{x}_t$, $\hat{h}_{t+1}$, and $\hat{f}$, and then applying the fitted values of these variates to estimate (17) and (16), followed by (15).

IV. DATA AND MODEL SPECIFICATION

Our data comes from the National Maternal and Infant Health Survey (NMIHS; National Center for Health Statistics, 1991). The NMIHS is a nationally representative longitudinal sample for studying the development of young children, effects of low birth weight, use of WIC foods and AFDC, child nutrition, child care, and environmental hazard exposures. The general sample, which consists of 8,285 respondents, nearly all of whom are women, provides a nationally representative body of information on such covariates as respondent-assessed child and adult health status, parents' use of pediatric care including out-of-pocket costs net of insurance (as well as other barriers to care), and health-related behaviors in the home. Every subject child in the sample is three years old. Of special interest here is the respondent parent's (and other adults') consumption of tobacco products and their assessment of their child's home exposure to ETS.

Table 1 presents variables and descriptive statistics we use to estimate our five-equation system. While no data on prices are available, the survey does provide information on respondents' states of residence, enabling us to merge state-level price and other exogenous health variables with individual data. Excluding all subjects with missing data, the sample size is 5,631. A total of 1533 (roughly 27 percent) of these respondents are smokers.

The respondent's assessments of own health, H_t, and the subject child's health, H_{t+1}, each measured on a one-to-five scale (poor = 1; excellent = 5), are used to indicate overall health status. We assume that any idiosyncratic errors respondents make in their subjective assessments of objective health states and in the positioning of the scale thresholds have zero means, and are independent of the explanatory variables we employ. Home exposure to ETS, d_{t+1}, is defined as the respondent-estimated number of hours per day the subject child is exposed to ETS.[4] Endogenous variables posited to have direct effects on adult and child health and exposures are: x_t, the number of cigarettes per day smoked by the respondent; h_{t+1}, the respondent's annual out-of-pocket expenditures (excluding insurance payments) for the subject child's health care; and f, the number of household members other than the respondent who also smoke.

Each health status and demand equation in the system includes as exogenous or predetermined covariates the respondent's education, martial status, and age. In addition, the adult health status equation includes a measure of each respondent's psychological stress or depression (CESD-Scale) at the time of the interview. The child health status equation includes a measure of the respondent's assessment of the subject child's development status (DENVER) at the time of the interview. In Table 2, the demand equations also include dummy variables for whether or not the household has or had problems other than cost in gaining access to medical care for the child in the previous year, whether or not the subject child has had an accident requiring medical care in the past year, whether or not the household participates in the Aid for Families with Dependent Children (AFDC) program, and the subject child's gender. Measures of the number of serious and nonserious health problems the child had in the past year,[5] and trichotomous variables indicative of the child's insurance coverage and of its race also appear in these demand equations. Since every sample child is three years old, child age is excluded. However, we include birthweight as a predetermined, post-natal covariate to represent the child's endowment effect, or potential for increased current expenditures on child health. Measures of parents' education and occupational prestige, and household income are intended to capture parents' knowledge of the health consequences of smoking, and to purchase medical care. Finally, we have augmented the set of exogenous variables in the Table 2 demand equations by collecting and merging state-level information on cigarette prices (including state and federal excise taxes), available health facilities, and public expenditures on health.

V. EMPIRICAL RESULTS

Table 3 reports log-linear estimates of h_{t+1} and f using a standard tobit estimator, and x_t using a tobit estimator with sample selection. Following Heckman (1979), the tobit model subject to sample selection uses a first-stage probit estimate of the respondent's probability of smoking to calibrate the second-stage tobit estimate of x_t. As in Lahiri and Song (1999), the probit selection equation in Table 2 specifies smoking choice as a function of marital status, occupation, and education; however, we include age and race, as well as regional dummy variables to control for socio-geographical differences in smoking choice. Table 3 shows that respondents' schooling and prestige of the spouse's occupation emerge as statistically significant influences upon daily cigarette consumption; the positive signs attached to these covariates contrast somewhat with other more recent findings in the cigarette demand literature (see, e.g., Chaloupka and Warner, 1999), which suggest that cigarettes are trending toward inferior good status. Otherwise, the results of the cigarette consumption equation accord reasonably with the smoking demand literature. For instance, respondent stress and depression and the number of household children are associated with increased cigarette consumption. Similarly, the significance of $MSTAT_1$, $MSTAT_2$, and $RACE_2$ suggest that blacks (whites/other) are below (above) average cigarette consumers, and that respondents who are currently married (never married/divorced/separated) are below (above) average consumers. Cigarette consumption declines with cigarette price.[6]

The number of smokers other than the respondent, f, varies positively with the receipt of AFDC, respondent depression and stress, and income. Smoker numbers fall with respondent age and education, and in married households with more health insurance. Though not significant at conventional levels, the negative coefficient attached to cigarette price suggests that smoker numbers fall as cigarette prices rise.

Table 3 h_{t+1} estimates indicate increasing respondent expenditures for child health as perceived child health problems increase, and as respondent education, occupational prestige, and household income increase. Married respondents with higher copay insurance who reside in medically underserved states also tend to spend more. Lesser spending on child health is found in households with more children, who receive AFDC, or who reside in states with higher public health care spending.

Table 4 provides tobit estimates of the child ETS exposure equation, d_{t+1}, and of the structural health service flow production functions, H_{t+1} and H_t. Predicted quantities from the Table 3 demand expressions $\hat{x}_t$ and $\hat{f}$ are used to estimate the ETS exposure equation. As Table 4 shows, we use the entire sample of 5,631 respondents to obtain fitted estimates of $\hat{d}_{t+1}$, a zero lower bound variate that is observed in all homes, including those with zero smokers. However, because our present focus is on smokers who, as in previous studies, appear to make different health and safety risk-wealth tradeoffs than do nonsmokers (Viscusi and Hersch, 2001), and because we acknowledge this unique tradeoff by invoking first order condition (8) to specify H_t in expression (17) (this condition is unobserved for nonsmokers), we use a tobit model with sample selection to obtain our final-stage estimates of H_t and H_{t+1}.[7]

Table 4 shows that children's ETS exposure durations are strongly and positively associated with respondents' cigarette consumption and to the number of other smokers in the household. In turn, tobit estimates for H_{t+1} indicate a strong negative association between ETS exposure duration and respondent-assessed child health status. Similarly, respondents' utility maximizing cigarette consumption significantly reduces perceived own health status, H_t, though it appears the number of other smokers in the household does not affect this perception.

A number of other insights emerge from Table 4, including the respondent's education and depression/stress score, and the child's development score as significant associates of the respondent's perceptions of own and child health status. Married respondents perceive child health service flows to be better than average, but being married doesn't necessarily mean that respondents' perceptions of own health will be better. Race appears to have little or no affect on respondents' assessments of child and own health status; however, occupational prestige of the respondent and her spouse impart a weakly positive affect on own health status.

Household utility maximizing expenditures on health care have a negative but statistically nonsignificant impact on own health perception, and a negative and highly significant effect on respondent perception of child health. Zweiful and Breyer (1997, pp. 60-62), among others, obtain a similar result. The literature posits two explanations. First, since h_{t+1} refers only to medical expenditures in the past year, these expenditures may not have produced, at the time of the NMIHS survey, the parents' utility maximizing flow of child health services. Observations on the child health service flow consequences of these expenditures are thus censored if the parent believes the health problems that initially induced the expenditures persist.

A second plausible explanation calls for the assumption that medical expenditures result in instantaneous attainment of parents' desired child health service flows. As Grossman (1999) points out, an increase in the shadow price of health service flows arising from an exogenous decline in the health stock may simultaneously reduce the quantity of flows demanded, and increase the quantity of health inputs demanded. If medical expenditures and a better health stock are substitutes with positive marginal products in the provision of health service flows, an exogenous decline in the stock of health raises both the marginal utility consequences of medical expenditures and the marginal disutility, via the budget constraint, of these same expenditures. When utility dominates, medical expenditures increase as the stock of health decreases.

Table 5 presents smoking respondents' estimated annual willingness-to-pay for a perceived increase in own and child health service flows, and for reductions in child exposures to home ETS. Computations are based upon model expressions (11) through (13). The first column in the table provides estimates for all respondents who are smokers, and columns two and three provide estimates for subsamples of light and heavy smokers. On average, sample smokers reveal an annual willingness-to-pay of $494.48 for a 10 percent increase in perceived health status of their child.[8] Columns two and three show that parents' valuations of child health increase (decrease) for heavy (light) smokers. In row two, the average respondent's annual willingness-to-pay for a 1 percent decrease in daily ETS exposure comes to $10.12. Similar to the pattern in row one, parents' valuations tend to increase with their child's (potential) baseline exposure level. The last two rows in Table 5 supply figures on adult valuations of own health. In row four, adults on average are willing-to-pay $198.29 for a 10 percent increase in own health. Adult annual willingness-to-pay also increases as respondents' baseline risk levels increase. Row three provides mean marginal substitution rates between adult and child health, calculated in accordance with expression (9). These rates shed light on the apparent discrepancy between adult and child health valuations in Table 5; that is to say, this sample of 1533 adult smokers value a 10 percent improvement in their children's health roughly twice that of the same improvement in their own health.

VI. DISCUSSION

Technically correct methods to value non-market environmental goods are generally costly in money, time, and labor. Federal agencies responsible for benefits analyses of proposed rules or projects therefore often take refuge in measures of benefits of a presumptively like good with an unknown price. Desvousges et al. (1998) provide general criteria for evaluating the transferability of point estimates or of functions from existing benefits studies. These criteria are unequivocally statistical. One is asked to judge *a priori* whether or not studies from different settings possess characteristics sufficiently similar such that a common structure applies to each. If similarity is judged adequate, differences in existing studies are presumed to have been generated randomly, thus allowing application of statistical procedures to generate pooled estimates of parameters that can be extrapolated (transferred). Analytical considerations enter only in terms of judgments about the technical quality of the candidates for pooling.

Because adults do not resemble children either biologically or economically, the current federal agency practice of transferring unadjusted extant adult health benefits measures to children's health and safety issues is suspect—no matter the sophistication of the statistical techniques employed.[9] Moreover, the adult health benefits measures transferred usually fail to recognize that most adults belong to multiple person, liquidity constrained households where any particular adult has to trade off his well-being against the well-being of other household members. Internal household allocation and investment behaviors may amplify or temper the response an individual family member would otherwise make to an environmental change. The adult health measures currently employed for transfer purposes might therefore be biased in their own right because of considerable unobserved heterogeneity. Household arrangements differ widely among adult individuals. This paper embeds adults and their young children in the household. It is therefore able to derive a set of expressions that analytically link the values household adults attach to own health and safety, and the values they attach to child health and safety. Specification and estimation of the structure gives insight into how to adjust measures of household adults' own health valuations to produce measures of their valuations of own child health. At least for the case of endogenous (to the adult) environmental tobacco smoke, the estimates provided in this paper suggest the values adults who smoke attach to own health are, on average, a bit less than half the values these same adults attach to the health of their young children.

Table 1. Variable Descriptions and Sample Characteristics (N=5631)

Variable	*Definition*	*Sample Mean*	*Standard Deviation*
ACCESSPROB	Respondent has had problems gaining access to medical care for reasons other than the cost of care in the past year: 1=yes, 0=no.	0.0356	0.1853
ACCIDENT	Subject child has had an accident/injury requiring care in the past year: 1=yes, 0=no.	0.2137	0.4099
AFDC	Household receives Aid to Families with Dependent Children: 1=yes, 0=no.	0.2533	0.4349
AGE	Respondent's age in years.	28.6844	5.7471
BIRTHWT	Subject child's birth weight: 1=below normal, 2=slightly below normal, 3=normal or above normal.	2.6247	0.6761
CESD-Scale	Respondent's score on combined emotional stress and psychological depression questionnaire.	10.2451	9.0088
CHILDSEX	Subject child's gender: 1=male, 0=female.	0.505	0.50
CIGPRICE	State average price (1991 cents per pack including tax) of cigarettes of the respondent's residence.	175.99	16.874
$COPAY_1$	Proportion of subject child's doctor visits not covered by private or public insurance: 1=part, 0=all, -1=none.	-0.1305	0.023
$COPAY_2$	Proportion of subject child's doctor visits not covered by private or public insurance: 1=all, 0=part, -1=none.	-0.360	0.088
d_{t+1}	Number of hours per day the subject child is exposed to ETS at home.	3.1414	4.4084
DENVER	Subject child's Denver Developmental Score.	12.0255	2.9008
EDUCATION	Respondent's education in years completed.	12.6316	2.2625
HEALTH	State spending (100's of 1991 dollars) per capita on health care services of the respondent's residence.	83.9523	27.9218
H_t	Respondent's assessment of own health status: 5=excellent, 4=very good, 3=good, 2=fair, 1=poor.	3.8127	0.9857
H_{t+1}	Respondent's assessment of the subject child's health status: 5=excellent, 4=very good, 3=good, 2=fair, 1=poor.	4.2460	0.8962
h_{t+1}	Amount of out-of-pocket expenditures for the subject child's health care in 1991 dollars over the past year (excluding insurance payments).	184.32	393.54

Table 1. (Continued)

Variable	*Definition*	*Sample Mean*	*Standard Deviation*
INCOME	Annual household income before taxes: 1 = INCOME < $6,000, 2 = 6,000 ?INCOME < 8,000… 26= INCOME > 100,000.	14.1021	6.3575
MSTAT$_1$	Respondent's marital status: 1=never married, 0=married, -1=divorced, separated, widowed.	0.1381	0.6416
MSTAT$_2$	Respondent's marital status: 1=married, 0=never married, -1=divorced, separated, widowed.	0.4230	0.7326
NONSERIOUS	Number of nonserious health problems the subject child has/had in the past year.	1.1169	1.0638
NUMCHILD	Number of children currently living at home.	2.2609	1.3222
f	Number of others in the house (excluding the respondent) who currently smoke.	0.3844	0.7022
RACE$_1$	Respondent's race: 1=black, 0=white, -1=other.	0.4440	0.5621
RACE$_2$	Respondent's race: 1=white, 0=black, -1=other.	0.4525	0.5628
R-OCCUPATION	Respondent's occupation; prestige ranked by 1980 Census of Population: Index of Industries and Occupations, 1980 Edition.	373.3588	368.7287
R-SMOKES	Respondent smo kes: 1=yes, 0=no.	0.2722	0.4452
S-OCCUPATION	Respondent's spouse's occupation; prestige ranked by 1980 Census of Population: Index of Industries and Occupations, 1980 Edition.	267.5233	328.3592
SERIOUS	Number of serious health problems the subject child has/had.	0.6963	1.5690
UNDERSERVED	Percent of state population medically undeserved (1991 shortages of physicians and clinics) of the respondent's residence.	18.3354	5.9239
x_t	Number of cigarettes per day the respondent smokes.	3.7170	8.6916

Table 2. Probit selection equation for R-SMOKES (N=5631)

Independent Variable	Estimate	Asymptotic t-statistic
NORTHEAST	2.9521**	2.191
MIDDLE ATLANTIC	3.0085**	2.215
EAST NORTH CENTRAL	3.0575**	2.288
WEST NORTH CENTRAL	3.0779**	2.297
SOUTH ATLANTIC	2.8996**	2.180
EAST SOUTH CENTRAL	2.8857**	2.176
WEST SOUTH CENTRAL	2.9649**	2.200
MOUNTAIN	2.7456**	2.065
PACIFIC	2.8096**	2.057
ln(CIGPRICE)	-0.4273*	-1.714
ln(AGE)	0.4596**	4.507
ln(EDUCATION)	-1.0226**	-13.595
$MSTAT_1$	0.0860**	2.452
$MSTAT_2$	-0.2664**	-6.516
$RACE_1$	-0.1252**	-2.706
$RACE_2$	0.1965**	4.494
ln(R-OCCUPATION)	-0.0172**	-2.819
ln(S-OCCUPATION)	-0.0355**	-3.531
McKelvey-Zavoina (1975) R^2 for probit	0.401	

Table 3. Estimates of log-linear demand equations (N=5631)

Independent Variable	Dependent Variable[a]		
	$\ln(h_{t+1})$[b]	$\ln(f)$[b]	$\ln(x_t)$[c]
CONSTANT	1.410 (1.232)	4.1630** (4.144)	4.2125** (2.907)
ACCESSPROB	0.0714 (0.707)	0.1357 (1.579)	0.1230 (1.211)
ACCIDENT	0.1759** (3.767)	0.0456 (1.096)	0.0765 (1.594)
AFDC	-0.5611** (-7.368)	0.2031** (3.49)	0.0756 (1.255)
ln(AGE)	0.1018 (0.860)	-0.3350** (-3.324)	-0.1793 (-1.270)
ln(BIRTHWT)	-0.1639** (-2.846)	-0.0969** (-1.926)	0.0568 (1.059)
CHILDSEX	-0.0460 (-1.173)	0.0026 (0.077)	-0.0919** (-2.428)
ln(CESD-Scale)	0.0483** (2.025)	0.0808** (3.849)	0.0462** (2.050)
ln(CIGPRICE)	0.3407 (1.553)	-0.2995 (-1.560)	-0.4615* (-1.661)
$COPAY_1$	0.2092** (7.248)	-0.0408 (-1.494)	0.0048 (0.144)
$COPAY_2$	0.4507** (12.749)	0.0794** (2.388)	0.0125 (0.324)
ln(DENVER)	0.0642 (0.983)	0.0567 (0.948)	0.0296 (0.477)
ln(EDUCATION)	0.2139* (1.788)	-0.7812** (-7.751)	0.5289** (3.540)
ln(HEALTH)	-0.1676** (-2.621)	-0.0838 (-1.483)	0.0545 (0.768)
ln(INCOME)	0.2219** (4.791)	0.1045** (2.898)	0.0325 (0.900)
$MSTAT_1$	-0.1607** (-3.682)	-0.0013 (-0.037)	-0.0891** (-1.923)
$MSTAT_2$	0.1376** (2.896)	0.0965** (2.447)	0.1587** (2.717)

Table 3. (continued)

Independent Variable	**Dependent Variable**[a]		
	ln(h_{t+1})[b]	**ln(f)**[b]	**ln(x_t)**[c]
ln(NONSERIOUS)	0.2942** (7.129)	-0.0120 (-0.336)	-0.0265 (-0.550)
ln(NUMCHILD)	-0.2443** (-5.835)	-0.0047 (-0.133)	0.1054** (2.683)
$RACE_1$	-0.1249** (-2.752)	-0.0657* (-1.657)	-0.0170 (-0.278)
$RACE_2$	0.0555 (1.326)	-0.0661* (-1.773)	0.1444** (2.473)
ln(R-OCCUPATION)	0.0196** (2.775)	0.0083 (1.331)	0.0113 (1.260)
ln(S-OCCUPATION)	-0.0270** (-2.359)	0.0036 (0.373)	0.0377** (2.642)
ln(SERIOUS)	0.4294** (9.858)	-0.0128 (-0.329)	0.0204 (0.452)
ln(UNDERSERVED)	0.1363** (2.323)	-0.0595 (-1.157)	0.0713 (1.431)
Log of likelihood	-5553.87	-4224.14	-4767.13

[a]Asymptotic t-statistics in parentheses.
[b]Tobit estimates.
[c]Tobit model with sample selection.

**Significant at less than 5 percent.
* Significant at less than 10 percent.

Table 4. Tobit estimates of production functions for health and ETS exposure (N=5631)

Independent Variable	Dependent Variable[a]		
	$\ln(H_{t+1})$[b]	$\ln(H_t)$[b]	$\ln(d_{t+1})$[c]
CONSTANT	1.1232** (4.046)	1.8163** (5.480)	-0.9097** (24.598)
ln(AGE)	0.0389 (0.820)	-0.0375 (-0.533)	
ln(CESD-Scale)		-0.0257** (-2.852)	
CHILDSEX	0.0018 (0.121)		
$\ln(\hat{d}_{t+1})$	-0.1941** (-2.863)		
ln(DENVER)	0.1634** (8.643)		
ln(EDUCATION)	0.0555 (0.618)	0.2490** (2.606)	
$\ln(\hat{h}_{t+1})$	-0.0355** (-5.996)	-0.0046 (-1.256)	
$\mathbf{MSTAT_1}$	-0.0170 (-1.305)	-0.0225 (-1.131)	
$\mathbf{MSTAT_2}$	0.0469** (2.566)	-0.0634** (-2.015)	
$\ln(\hat{f})$		-0.0723 (-0.623)	1.0414** (7.005)
$\mathbf{RACE_1}$	-0.0186 (-0.961)	0.0212 (0.727)	
$\mathbf{RACE_2}$	0.0297 (1.555)	-0.0285 (-0.814)	
ln(R-OCCUPATION)	0.0042 (1.416)	0.0072* (1.851)	
ln(S-OCCUPATION)	-0.0002 (-0.043)	0.0151* (1.651)	
$\ln(\hat{x}_t)$		-0.3646** (-4.254)	0.5933** (16.403)
Log of likelihood	-3340.07	-3343.88	-6362.73

[a]Asymptotic t-statistics in parentheses.
[b]Tobit model with sample selection.
[c]Tobit estimates.

**Significant at less than 5 percent.
* Significant at less than 10 percent.

Table 5. Willingness to pay and substitution rate estimates for respondent parents who smoke

Model Derivation	***Sample Mean N=1533***	***Mean for Light Smokers[a] N=510***	***Mean for Heavy Smokers[a] N=107***
Respondent willingness to pay to increase own child's health status by 10 percent	\$494.48	405.21	537.77
Respondent willingness to pay to reduce own child's daily exposure to ETS by 1 percent	\$10.12	8.29	11.01
Respondent MRS between own health and child health: $\dfrac{\partial U_t / \partial H_t}{\partial U_t / H_{t+1}}$	0.401	0.393	0.431
Respondent willingness to pay to increase own health status by 10 percent	\$198.29	159.25	231.78

[a]Light smoking is defined as 1-9 cigarettes per day; heavy smoking is 25 or more cigarettes per day (1989 Surgeon General's Report: Reducing the Health Consequences of Smoking, 25 Years of Progress).

REFERENCES

Agee, M.D., and T.D. Crocker (1994), " Parental and Social Valuations of Child Health Information," Journal of Public Economics 55:89-105.

Becker, G.S. (1962), "Investments in Human Capital: A Theoretical Analysis," Journal of Political Economy 70:Part 2, 9-39.

Behrman, J.R. (1997), "Intrahousehold Distribution and the Family," in M.R. Rosenzweig and O. Stark, eds., The Handbook of Population and Family Economics, New York, NY: Elsevier Science.

Browning, M. (1992), "Children and Household Behaviors," Journal of Economic Literature 30: 1434-1475.

Carlin, P.S., and R. Sandy (1991), "Estimating the Implicit Value of a Young Child's Life," Southern Economic Journal 58: 186-202.

Chaloupka, F.J. (1991), "Rational Addictive Behavior and Cigarette Smoking," Journal of Political Economy 99: 722-742.

Chaloupka, F.J., and K.E. Warner (1999), The Economics of Smoking, Working Paper 7047, National Bureau of Economic Research, Cambridge, MA.

Cimons, M. (2001), "Huge Drop Seen in Secondhand Smoke Levels," Los Angeles Times, March 22, 2001.

Desvousges, W.H., F.R. Johnson, and H.S. Banghaf, (1998) Environmental Policy Analysis with Limited Information: Principles and Applications of the Transfer Method, Aldershot, U.K.: Edward Edgar.

Grossman, M. (1999), The Human Capital Model of the Demand for Health, Working Paper 7078, National Bureau of Economic Research, Cambridge, MA.

Grossman, M., and T.J. Joyce (1990), "Unobservables, Pregnancy Resolutions, and Birth Weight Production Functions in New York City," Journal of Political Economy 98: 983-1007.

Heckman, J.J. (1979), "Sample Selection Bias as a Specification Error," Econometrica 47: 153-161.

Kuchler, F., and E. Golan (1999), Assigning Values to Life: Comparing Methods for Valuing Health, Agriculture Economics Report No. 784, Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Lahiri, K., and J.G. Song (1999), "Testing for Normality in a Probit Model with Double Selection," Economics Letters 65: 33-39.

Lee, L., M.R. Rosenzweig, and M.M. Pitt (1997), "The Effects of Improved Nutrition, Sanitation, and Water Quality on Child Health in High-Mortality Populations," Journal of Econometrics 77: 209-235.

Liu, J.T., J.K. Hammitt, J.D. Wang, and J.L. Liu (2000), "Mother's Willingness-to-Pay for Her Own and Her Child's Health: A Contingent Valuation Study in Taiwan," Health Economics 9: 319-326.

Markowittz, S., and M. Grossman (1998), "Alcohol Regulation and Domestic Violence Towards Children," Contemporary Economic Policy 16:309-320.

McKelvey, R.D., and W. Zavonia (1975), "A Statistical Model for the Analysis of Ordinal Level Dependent Variables," Journal of Mathematical Sociology 4: 103-120.

National Center for Health Statistics, (1991) The National Maternal and Infant Health Survey Washington, DC: Department of Health and Human Services.

Pagan, A., and F. Vella (1989), "Diagnostic Tests for Models Based on Individual Data: A Survey," Journal of Applied Econometrics 4: S29-S59.

Rosenzweig, M., and T.P. Schultz (1983), "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs and Their Effects on Birth Weight," Journal of Political Economy 91:723-746.

Rosenzweig, M., and T.P. Schultz (1988), "The Stability of Household Production Technology: A Replication," Journal of Human Resources 23: 535-549.

Rovira, J., W.K. Viscusi, F. Antonanzas, J. Costa, W. Hart, and I. Carvallo (2000), Smoking Risks in Spain: Part II – Perceptions of Environmental Tobacco Smoke Externalities, Discussion Paper No. 305, John M. Olin Center for Law, Economics, and Business, Harvard University, Cambridge, MA.

Spengler, J.D., D.W. Dockery, W.G. Turner, J.M. Wolfson. And B. G. Ferris, Jr. (1987), "Long-Term Measurements of Respirable Sulfates and Particles Inside and Outside Homes," Atmospheric Environment 15:23-30.

U.S. Environmental Protection Agency (1992), Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders, EPA/600/6-90/006F, Washington, DC: U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency (2000), Guidelines for Preparing Economic Analyses, EPA 240-R-00-003, Washington, DC: U.S. Environmental Protection Agency.

U.S. Surgeon General (1986), The Health Consequences of Involuntary Smoking, Washington, DC: U.S. Government Printing Office.

Viscusi, W.K. (1992), Smoking: Making the Risky Decision, Cambridge, MA: Harvard University Press.

Viscusi, W.K., and J. Hersch (2001), "Cigarette Smokers as Job Risk Takers," The Review of Economics and Statistics 83: 269-280.

Viscusi, W.K., W. Magat, and J. Huber (1987), "An Investigation of the Rationality of Consumer Valuations of Multiple Health Risks," Rand Journal of Economics 18: 465-479.

Wilhelm, M.O. (1996), "Bequest Behaviors and the Effects of Hiers' Earnings: Testing The Altruistic Model of Bequest," The American Economic Review 86: 874-892.

Zweiful, P., and F. Breyer (1997), The Economics of Health, New York, NY: Oxford University Press.

ENDNOTES

[1] In addition to these text citations, a near exhaustive listing of parental influences analyzed via commodity-specific choices would include Carlin and Sandy (1991) on restraint devices in automobiles, Liu et al. (2000) on mothers' choices between self-protection and child-protection from respiratory infection, Grossman and Joyce (1990) and Rosenzweig and Schultz (1983, 1988) on mothers' prenatal care choices, and Viscusi and coauthors (1987) on child health risks from parental uses of household pesticides. Studies that approach child investment via the effects of parental decisions upon household budgets are numerous. See Behrman (1997) and Browning (1992) for reviews.

[2] Cimons (2001) reports that the U.S. Centers for Disease Control and Prevention find that exposures of nonsmokers to ETS dropped more than 75 percent in the 1990's. But the Centers also note that nonsmoking children and teenagers now have higher levels of the chemical cotnine (a byproduct of tobacco) in their systems than do adults. This finding is consistent with increased ETS exposures of children in their homes.

[3] Here we omit y_t and y_{t+1} for notational convenience.

[4] Spengler et al. (1987) find cigarette smoke to be the major source of indoor air pollution, contributing an average of an additional 20 ug/m $^{-3}$ to indoor concentrations for each active smoker in the household. By comparison, an average baseline level of 21.1 ug/m $^{-3}$ of suspended particulates was found in nonsmoking households.

[5] The variable SERIOUS sums together the respondent's 1=yes, 0=no responses as to whether or not the subject child has or had any of the following more serious health problems: deafness or other hearing problem, delayed speech, sight problems, food or other allergies, asthma, chronic respiratory or lung problems, chronic heart condition, sickle cell anemia, spinal bifida, eating or swallowing problems, developmental delay or other mental problems, epilepsy, convulsions, seizures, chronic orthopedic or bone problems, cerebral palsy, brain hydrocephalus or hemorrhage, neuromuscular problems, upper respiratory problems, gastrointestinal or rectal problems, hernias, urological/testicular/kidney problems, and other serious or acute health problems. The variable NONSERIOUS sums together the respondent's yes/no responses to less serious child ailments within the past 30 days: stomach flu, diarrhea, ear infection, cold or runny nose, tonsillitis, cough/fever/croup, skin infection, food allergy, head lice or other parasites or worms.

[6] Our price elasticity of demand estimate (-0.46) for cigarettes is very close to what Chaloupka and Warner (1999, p. 5) say is the consensus estimate of –0.40. Similarly, our smoking participation price elasticity estimate of –0.43 lies within the range of adult estimates appearing in the recent literature.

[7] As evident from the above discussion, normality plays a key role in the identification and estimation of our structural system, making it critical to determine how accurate the normality assumption is. There appears to be little in the literature about checking the validity of this

assumption (Lee et al., 1997, and Lahiri and Song, 1999, provide some more recent examples of this test). Pagan and Vella (1989) describe and implement a number of conditional moment-based specification tests for the tobit model. Among their tests are tests for normality of disturbances in the standard tobit model, and for the tobit model with sample selection. For each of our tobit specifications, including those for x_t, H_t, and H_{t+1} based upon the probit selection equation in Table 2, test statistics consistently fail to reject the null hypothesis of normality of disturbances.

[8] Table 5 calculations are for a nonmarginal increase in child health status above the sample mean. To calculate willingness-to-pay, we use expressions (11) and (15). Since our empirical specification of (15) uses data on parents' *expenditures* on child health, the derivative $(\partial H_{t+1} / \partial \hat{h}_{t+1})^{-1} = \dfrac{\hat{h}_{t+1}}{gH_{t+1}}$ from (15) gives us an estimate of parents' marginal willingness-to-pay in expression (11). Thus, defining $\overline{H}_{t+1}$ as the sample mean of child health status (i.e., for the 1533 sample of smoking parents), parents' willingness-to-pay for a 10 percent increase in status is: $\int_{\overline{H}_{t+1}}^{(1+.1)\overline{H}_{t+1}} \dfrac{\hat{h}_{t+1}}{gH_{t+1}} dH_{t+1}$.

[9] See, for example, the benefit measure transfer procedures proposed in Kuchler and Golan (1999) and in U.S. Environmental Protection Agency (2000).

What Do Organic Baby Food Purchases Tell Us About Parental Values for Reductions in Risks to Children's Health?
--Working Paper*--

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WHAT DO ORGANIC BABY FOOD PURCHASES TELL US ABOUT PARENTAL VALUES FOR REDUCTIONS IN RISKS TO CHILDREN'S HEALTH?

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I. INTRODUCTION

Estimates of the value of a statistical life are used in the conduct of benefit-cost analyses to provide policy makers with useful information regarding competing government programs. Although these estimates abound in the economics literature, they are for the most part derived for adult populations facing relatively immediate fatal risks. Current benefit assessment practices generally consist of transferring such estimates to evaluate diverse risk reduction programs, many of which reduce risks with significant latency periods that may or may not end in death, as well as programs affecting individuals of all ages. Recent research has begun to derive age-specific value of statistical life estimates, as well as estimates for valuing health risk reductions. Few estimates exist, however, for valuing reductions in health or safety risks to children. This paper contributes to the literature by estimating the value of lifetime cancer risk reductions (a specific type of health risk) for babies through the dollar-risk tradeoffs make by

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parents.[15]

Most value of statistical life (VSL) estimates are based on hedonic wage-risk studies using labor market data.[16] This methodology involves examining the wage and risk combinations accepted by workers in different jobs to learn about the values associated with fatal risks. Two features of these estimates are worth noting. First, the risks accounted for in the labor market studies are usually relatively immediate accidental deaths that occur on the job (e.g., fall from a construction site, auto accident). There are, of course, other types of risks that individuals face outside of occupational death risk, including non-fatal and health risks. In fact, many environmental policies seek to reduce health risks (e.g., cancer from contaminated water, asthma from air pollution). There is no basis for assuming, however, that all risks are valued equally. For example, a reduction in risk of cancer death may be valued higher than a reduction in the risk of dying from a fall because of the dread and morbidity associated with the cancer. Transferring values from immediate death risks to those with a latency period may be flawed.

Second, studies on individuals who are of working age do not necessarily capture trade-offs made by (or for, in the case of children) individuals who are not of working age, such as children. Studies have hypothesized regarding the relationship between adult and children VSL estimates, however no definitive empirical conclusions have emerged (Dockins, et al., forthcoming). Therefore, transferring values derived for adult populations to policies affecting children may result in flawed outcomes, if in fact values differ according to the age.

We seek to address these two issues, the nature of risks and age, simultaneously by

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[15] We refer to the primary care giver for the baby as a parent, recognizing that other adults could be acting in this capacity (e.g., grandparent, foster parent).

[16] VSL estimates are also derived via stated preference and averting behavior studies.

calculating the value of a lifetime cancer risk from exposure during the first year of life using dollar-risk tradeoff decisions made by parents. Several studies have valued fatal risks to children, but to the best of our knowledge our estimate is the first to focus on cancer risks to babies.

In order to calculate this value we use a product market, or averting behavior study with a hedonic price function. Product market studies examine the dollar-risk tradeoffs made in the purchase of consumer goods with risk reduction features. By examining these decisions we can infer the values associated with the risk reduction offered by a particular product.

The baby food market presents a unique opportunity for such analysis because it offers a product targeted to the specific age group of interest and is available in both conventional and organic varieties. Organic baby food is free from pesticide residues, which are known carcinogens. By purchasing organic baby food parents are revealing information about the value they place on the risk reductions conferred by organic baby food. We combine a hedonic study on the premium paid for the organic feature of baby food with an exposure study on cancer risks from pesticide consumption to calculate the value of a cancer risk reduction from exposure in the first year of life, hereafter called the value of a statistical cancer (VSC).

The remainder of this paper is as follows. Section II discusses the children's health valuation literature. Section III presents the conceptual model for using the baby food market to derive values for cancer risk reductions. Sections IV and V present the data and analysis used to estimate the VSC. Our valuation estimate is provided in section VI and concluding comments are in section VII.

II. VALUING RISKS TO CHILDREN

Although our focus is on a more narrow population and risk category, namely babies less than 12 months old and cancer risks, the literature on the broader category of children and other risk reductions offers insights into the methodology we use and results we might expect from our study. Valuing children's risks is arguably more difficult than valuing risks to adults because children typically do not make their own decisions regarding dollar-risk tradeoffs. Of the two feasible techniques to value children's risks (stated preference and product market studies), almost all of the existing studies on children use a product market methodology.

One of the first product market studies applicable to valuing children's lives was conducted by Carlin and Sandy (1991). They calculate a child-specific VSL estimate from information on child car safety seat usage and the associated risk reductions from using a car seat. Using data from a survey conducted at safety check points in 10 Indiana cities they estimate the marginal cost of car safety seats for children under the age of 5. They combine these results with published data on automobile related deaths for children in safety seats and for those who were not riding in a safety seat. The reduction in deaths due to safety seats is calculated as the difference between these two values. This information allows them to calculate a child VSL estimate equal to $870,046.[17]

Jenkins, Owens, and Wiggins (2001) calculate age-specific VSL estimates for school age children and adults using information on bicycle safety helmets. They estimate the average price of a bicycle helmet for three age groups (ages 5 to 9, 10 to 14, and 20 to 59) based on published data. They couple this information with published risk reduction information for each age group

[17] Unless otherwise noted all dollar values are presented in $2001.

to calculate age-specific VSL estimates. Specifically, based on various assumptions regarding the use of the helmet, the estimate for ages 5 to 9 range from $1.4 million to $3.0 million, for ages 10 to 14 the estimates range from $1.2 million to $2.9 million, and for ages 20 to 59 the range is $2.2 to $4.4 million. While these values differ greatly from those calculated by Carlin and Sandy (1991), both studies provide estimates within the ranges published for adults.

Several other studies examine valuation estimates related to children, yielding additional insight into VSL estimates. Mount, et al. (2000) model decisions regarding automobile purchases using an intra-household allocation model. They use data on the safety characteristics of specific automobiles, uses of the automobiles (e.g., work, leisure), and information on seating arrangements within the vehicle to calculate household VSL estimates for three household types. The households with children yield a VSL estimate of $3.6 million, compared to $3.0 million and $3.5 million for households with no children and elderly households, respectively. It is not possible to apportion these values to the members of the household, but the households with children yield the highest (though not necessarily statistically significant) estimates.

Attempts at eliciting VSL estimates through survey techniques are also very few in number. Liu, et al. (2000) use a contingent valuation survey to value reductions in the risk of a common cold. Specifically, they elicit willingness to pay values from mothers to reduce their child's chance of suffering from a cold, as well as the mothers' willingness to pay to reduce their own chances of contracting the same illness. They find that the median willingness to pay to reduce the child's chance of catching a cold is $66, compared to $43 for the mother's willingness to pay to avoid her own cold.

While these studies offer some insight into child specific valuation estimates, the literature on children's health valuation is still very much in its infancy, making it difficult to draw definitive comparisons between published studies. Nonetheless, these studies form a basis for establishing a set of valuation estimates specific for children.

III. PESTICIDES, HEALTH RISKS, AND VALUATION

As mentioned earlier, we use the baby food market to learn about the dollar-risk tradeoffs parents make with regard to their babies. Most parents purchase jarred baby food for their baby as a convenient method for introducing solid, or table food, although some parents may opt for making their own baby food using food grinders or mashers. Within the baby food market parents make certain choices. These choices include the brand and flavor of food, as well as whether it is a certified organic variety or not.

The organic component of baby food deserves further discussion. While the food supply in the United States is considered safe, it is the primary means for exposure to pesticides for most of the population. Pesticides are used in most farms (organic being the exception) to reduce the exposure of crops to insects and weeds that can destroy a crop through infestation. By applying pesticides, either topically or to the soil, crop yields increase. However, pesticides can also have an adverse impact on human health, causing cancer, as well as nervous system and reproductive damage (National Research Council, 1993). The Environmental Protection Agency (EPA) regulates approximately 600 pesticides by setting tolerances, or legal limits for allowable pesticide residues on foods. While these limits are set to minimize risks, residues can remain on the harvested crops. In fact, Kuchler, et al. (1996) report detection rates between 40% to 60%

for a variety of fruits and vegetables commonly consumed in the average U.S. diet.[18]

For individuals concerned with the health risks associated with pesticide intake, organic foods offers a natural alternative. Organic foods, baby food being no exception, are defined as foods grown in the absence of pesticides. The U.S. Department of Agriculture accredits groups with the ability to certify organic producers (Federal Register 65, 2000). Producers of organic baby food, as well as any other organic foods, must adhere to the standards set forth in this rule, which include farming and handling practices. Therefore, for parents who are concerned about the cancer risks from pesticide residues in conventional baby food, organic baby food is an alternative. We infer values associated with the lifetime health risk reductions for babies from these purchase decisions.

We formally model the relationship between the baby food purchase decision and health risk reduction by following a model introduced by Portney (1981) to derive VSL estimates based on the purchase of homes with varying air quality. Portney (1981) provided a methodology, which can be called "hedonic method with averting behavior" (Freeman, 1993), for inferring the value of a statistical life from the choices individuals make regarding housing location. Individuals are able to "choose" an air quality standard through the location where they purchase a home. Air quality is known to impact health and therefore by purchasing a home in a particular area individuals reveal information about how they value mortality risk.[19] The issue in our study is ideal for the methodology proposed by Portney (1981).

Following the Portney (1981) model, we assume that preferences are separable in baby

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[18] Only 1% of the samples were above legal limits.

[19] Portney (1981) used data on pollution related deaths from SO_2 and particulate matter, thus deriving fatal risk estimates, as opposed to health risk estimates. The methodology still applies.

food characteristics. That is, the value of jarred baby food consists of different components, including flavor, brand, and health. Parents are able to choose baby food with varying quantities of these characteristics. The well known hedonic relationship can be expressed as follows:

$$V_i = V(S_i, F_i, H_i, M_i) \tag{1}$$

where V_i is the value of the ith jar of baby food, S_i are store characteristics, F_i are characteristics of the baby food, H_i represents the health component of the baby food, and M_i include other factors, such as taste and production methods. Further, we assume the following:

$$H_i = H(O_i) \tag{2}$$

$$M_i = M(O_i) \tag{3}$$

where O_i is the organic characteristic of the baby food (whether it is an organic or conventional variety). We assume that $\partial H/\partial O>0$ and $\partial M/\partial O>0$.

Total differentiation of (1) with respect to O yields the following:

$$\frac{dV}{dO} = \frac{dV}{dS}\frac{dS}{dO} + \frac{dV}{dF}\frac{dF}{dO} + \frac{dV}{dH}\frac{dH}{dO} + \frac{dV}{dM}\frac{dM}{dO} \tag{4}$$

Similar to Portney (1981) we assume that store and food characteristics do not vary with the organic designation, which gives us the following:[20]

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[20] We discuss each of these sets of characteristics in more detail later, however, briefly, store characteristics include the type of store (e.g., convenience) and food characteristics include the type of food and size (e.g., stage 1 fruits). These characteristics do not vary with organic designation.

$$\frac{dV}{dO} = \frac{dV}{dH}\frac{dH}{dO} + \frac{dV}{dM}\frac{dM}{dO}. \qquad (5)$$

Equation 5 indicates that the value of the organic characteristic is composed of two parts. The first part of the right hand side of equation 5 is the value of the health component of the organic characteristic. This is the value parents place on the reduced cancer risk to their child from consuming pesticide-free baby food. The second part of the right hand side of equation 5 represents other values parents may derive from purchasing organic baby food, such as values for environment achieved through pesticide free farming practices. We ignore the latter part of equation 5. Since we attribute the entire price premium for organic baby food to improved health, we are likely to overestimate the health component of the organic characteristic. It is likely, however, that these other factors have a small impact on value, relative to the health component.

Finally, by rearranging terms we have the following equation for the value of a change in health:

$$\frac{dV}{dH} = \frac{dV/dO}{dH/dO}. \qquad (6)$$

That is, the value of a change in health risk from consuming organic baby food consists of the value of the organic characteristic of baby food (the numerator in equation 6) and the change in health risk associated with organic baby food (the denominator in equation 6). This is a well established equation for expressing values for environmental or health amenities.[21]

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[21] See Freeman (1993) for an extensive discussion.

IV. Value of Organic Characteristic

We estimate the value of the organic characteristic of baby food using the hedonic method. In order to estimate this equation we need data on baby food prices and characteristics. Our data collection effort is unique, but reliable. Baby food price and characteristic data were collected from 38 retail establishments in Raleigh, North Carolina during a three day period in February 2001. Stores were randomly selected from a list of all retail food establishments generated from current local on-line consumer yellow pages.[22] We stratified our sample across establishment type based on the distribution of food purchased by location for consumers in the U.S. (ERS, 2000). Although specific information is not available on the distribution of jarred baby food purchased by location, we use the ERS (2000) data as a basis for our stratification and reallocate the sample to more accurately reflect likely baby food venues.[23] Table 1 summarizes the distribution of establishments in our sample.

In the U.S. there are five major brands of baby food available at retail outlets: Beechnut, Gerber, Earth's Best, Heinz, and Organic Baby. Beechnut and Heinz offer conventional baby food only, Earth's Best and Organic Baby are exclusively organic baby foods, while Gerber offers both conventional and organic varieties. We are able to identify the value associated with the organic characteristic as distinct from values associated with brand itself because Gerber offers both conventional and organic baby food; the latter is commonly referred to by its line name, Tender Harvest.

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[22] The consumer yellow pages can be found at http://yp.yahoo.com, accessed on January 29, 2001.

[23] For example, specialty stores and mass merchandisers in Raleigh, North Carolina did not sell jarred baby food, while drug stores and baby super centers did sell baby food, but were not part of the ERS (2000) distribution. We re-stratified the sample accordingly.

Jarred baby food is also offered by stage (which relates to the age of the baby) and type. Generally, there are three stages within each brand.[24] Stage 1 baby food consists of simple, single flavor foods, such as peas or peaches that serve as a baby's first introduction to "solid" food. Stages 2 and 3 often combine flavors (e.g., blueberries and pears) and offer increasingly complex flavors by combining food groups (e.g., beef and pasta). We categorize baby food according to seven types: cereal, fruit, vegetable, fruit-vegetable combination, meat, dinner, dessert. The meat category consists of jars with single ingredients (e.g., beef), whereas the dinner category consists of more traditional dinner-like flavors (e.g., beef noodle dinner). The other categories are self-explanatory. There are a variety of flavors available within each stage and type. For example, common stage 2 flavors include, pears, plums with apples, and apple-blueberry. As price varies only rarely across flavors within a stage and type, we aggregate the jars within each stage, type, and brand to create the unit of observation. For example, Beechnut stage 1 fruits is an observation, as is Heinz stage 2 dinners.

We developed a template for each brand of baby food that allowed us to record the price of each observation, as well as the shelf space allocated to the observation and relevant store characteristics. This data collection effort is exhaustive and complete for all of the stores in our sample; we recorded data on all the baby food offered in each store. This effort resulted in 928 useable observations. Relevant variables are described in table 2 and descriptive statistics in table 3. In our sample, 139 (15 percent) of the observations are for organic baby food and 189 (85 percent) are for conventional baby food. We also include nine product characteristics in our model to capture features of baby food that may affect the price, as well as two store

[24] During this data collection effort, Gerber only offered organic vanities as stage 2. They have since introduced stages 1 and 3 organic baby food.

characteristics and the organic characteristic.

In order to estimate the value of the organic characteristic of baby food (the numerator in equation 6) we estimate a linear hedonic price equation. Because most of the variables in our analysis are dichotomous choice variables, our choice of functional form is limited. We estimate the price of an observation (jar of baby food) as a function of product characteristics, store characteristics, and the organic characteristic. The product and store characteristics serve as fixed effects that control for factors that may affect the price of baby food.

Table 4 presents the results from estimation of the hedonic equation. The dependent variable in the model is the price per jar of an observation. Recall that an observation is a type of food (e.g., fruit) within a stage, brand, and store. The flavors within each type (e.g., apples, pears) are aggregated. The model performs well, with an overall adjusted R^2 of 0.75. With the exception of the LABEL and ORG BABY variables, all variables are highly significant and of the expected sign.

Our prior expectations were that the various store types (e.g., large grocery stores, convenience stores) would be significant determinants of the price of baby food. However, we found this not to be the case. In fact, we regress price per jar on variables for all of the store types and find that the indicator variable for convenience stores (CONVENIENCE) is the only significant determinant of price. Therefore, we control for point of purchase in this manner and find that the per jar price of baby food is approximately $0.35 higher in convenience stores than in other venues. Similarly, meat products (MEAT) are the only category of baby food that is significant, with a $0.26 positive impact on the price per jar. We also find that stage 1 and 2 baby food (STAGE1 and STAGE2) has a significantly lower price than stage 3 baby food

(STAGE3).

Among the brands, we omit the Beech-Nut brand (BEECHNUT) and find that the prices of Gerber (GERBER) and Earth's Best (EARTHS BEST) baby food are approximately $0.04 and $0.07 higher than Beech-Nut, respectively, while the price of Heinz (HEINZ) baby food is approximately $0.03 lower. We find no significant difference between the price of Organic Baby (ORG BABY) and Beech-Nut. We find that the more square feet (SQFT) allocated to an observation (a proxy for the quantity sold) the lower the price by a significant, but very small amount. Surprisingly, we also find that baby food sold in multi-pack units (MULTI) is about $0.02 more per jar than baby food sold in individual units. We expected the opposite results, based on the notion of a volume discount for purchasing multiple jars. However, some of the non-traditional venues (e.g., department stores) only sold multi packs. We suspect that because these venues do not sell a large volume of food products in general, prices tend to be higher than in more traditional grocery stores. However, models that controlled for this venue did not affect the results.

Turning to the variable of ultimate interest, we find that the organic characteristic (ORGANIC) of baby food has a significant and positive effect on the price of baby food. The price premium for organic baby food is approximately $0.13 per jar, controlling for other characteristics that may influence price. That is, individuals are willing to pay approximately $0.13 more per jar of baby food for the organic designation.[25]

This value represents the premium *per jar*. It is necessary to convert this value into a

[25] We estimate several other models with different specifications, including a model where the dependent variable is the price per ounce and models by stage. The results and the organic premium are robust to these other specifications.

lifetime value to comport with our risk data, which will be discussed shortly.[26] Consumption of jarred baby food can vary depending on when table foods, as well as jarred foods, are introduced and tolerated. Some babies consume little jarred food once grasping skills are mastered while others consume baby food exclusively until after 12 months of age. The American Academy of Pediatrics (1998) recommends introducing solid food between ages 4 and 6 months, and that by 12 months most babies are able to consume regular table food. We assume a baby consumes an average of 600 jars of baby food in the first year (EWG, 1995).[27] Hence, the annual premium, or value of organic baby food is $78 ($0.13/jar * 600 jars). Next, we use results from an exposure study to estimate the cancer risk from pesticides in foods consumed.

V. Cancer Risks From Pesticide Exposure

The denominator in equation 6, $\partial H/\partial O$, represents the change in health risk from consuming organic foods. We measure this risk reduction by assuming that parents can eliminate their baby's lifetime cancer risk from pesticide exposure during the first year of life by feeding their baby organic baby food. That is, we assume that the organic diet eliminates all cancer risk from pesticide exposure. Our cancer risk estimate is taken from a study by Kuchler, Ralston, and Tomerlin (2000) who estimate a one-year cancer risk for babies less than 12 months old of 1.98 per 1,000,000. That is, the probability of contracting cancer in a lifetime, based on

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[26] As can be expected, it is impossible to estimate a *per jar* risk. Instead, risks are typically presented as annual or lifetime averages.

[27] Gerber and Beechnut estimate that a baby consumes 1100 jars of baby food (email communication, May 12, 2001 and May 15, 2001, respectively). This estimate assumes the baby consumes jarred food exclusively from the moment solid food is introduced. Casual observation of babies indicates that jarred baby food is rarely the exclusive source of food and results from focus groups reported in Maguire, Owens, and Simon (2001) confirm our beliefs that this estimate may be high. Therefore, we rely on the independent estimate provided by EWG, 1995.

pesticide consumption in the first 12 months of life is 0.00000198.

Kuchler, Ralston, and Tomerlin (2000) estimate a cancer risk as the product of dietary intake per body weight and a potency measure. The intake measure (dietary intake per body weight) is based on a total diet study conducted in the late 1970's (Kuchler, et al., 1996). This is a national study in which a sample of individuals reported their total food consumption over several consecutive days. The foods are broken down into raw components (e.g., a bowl of chicken soup is broken down into chicken, carrots, water, etc.). These components are used to create a "representative diet" based on average consumption patterns. The diet is then tested for pesticide residues. Detection of residues form the basis of the exposure to pesticides for the average individual; lifetime exposures are also calculated, assuming a life expectancy of 70 years. A baby's intake is assumed to be 1/70th of the lifetime intake.

The cancer "potency" data in the Kuchler, Ralston, and Tomerlin (2000) is taken from studies conducted by EPA. Potency is measured as "...tumors per milligram of compound ingested daily per kilogram of body weight, where a given level of intake occurs over a lifetime..." (Kuchler, et al., 2000, p. 11). Based on the exposure data from the total diet study and the EPA potency estimates, the one-year cancer risk from exposure to 16 pesticides with known carcinogenic properties is 1.98 per million for a baby under 12 months of age. This means that <u>over a lifetime</u> an individual has a 1.98/1,000,000 chance of contracting cancer from pesticides consumed in the first year of life.

Several items are worth noting about this estimate. The exposure data assumes that a baby's exposure is 1/70th of the lifetime exposure. Babies are known to consume more food per body weight than adults, in which case the exposure in the first year could be greater than in later years. Hence, we could be underestimating the actual risk. Also, exposure to pesticides in early years of life are likely to be more harmful than in later years due to the fact that babies have immature neurological systems that are more sensitive than more developed systems. Again, this implies that we could be underestimating actual risk. Finally, this risk measure is based on an older total diet study conducted in the late 1970's. Consumption patterns have likely changed over time. While Kuchler, et al. (2000) adjust the consumption data to reflect patterns observed in the late 1980's, reflecting greater consumption of fruits and vegetables, we do not have data on more recent consumption patterns. If consumption of fruits and vegetables has continued to rise, then we could also be underestimating risk by using older consumption data. Despite these limitations we assume that the overall cancer risk is reduced from 1.98/1,000,000 to zero through the consumption of organic baby food.

VI. VALUE ESTIMATION AND DISCUSSION

We combine the estimates derived from the hedonic price equation in section 4 with the cancer estimates from Kuchler, et al. (2000) discussed in section 5 to estimate equation 6, the value of a statistical cancer, or VSC, from exposure in the first year of life. Recall that the annual value of consuming organic baby food is $78. We assume that the cancer risk is reduced by 1.98/1,000,000 from this diet. Therefore, based on equation 6, the value of a statistical cancer from exposure in the first year of life is $39,000,000 (78/0.00000198). This figure, of course, assumes that a baby consumes organic baby food, exclusively. While this is unlikely to be the case in all households, if we assume that markets are competitive, then this figure represents the value of a *similar* risk reduction for this age group.

Previous research suggests that values for children are not necessarily equivalent to those estimated for adults. However, research has not found a consistent direction for the bias. That is, we are aware of studies that value risks to children as both higher and lower than average estimates for adults. Our estimate is significantly higher than other estimates for children in the literature. However, there are several reasons why this may be the case.

First, our estimate is for reduced lifetime *cancer* risk from exposure during the first year of life, rather than a reduced risk of an immediate *fatality*. It is interesting to note that the value of reduced lifetime cancer risk that we estimate is higher than most VSL estimates for immediate risk of death, even though the cancer risk may not be fatal. In many cases food and safety risks are perceived as involuntary and uncontrollable compared to accidental death. While the literature has yet to reach a consensus on this issue, some reports and empirical evidence suggest that willingness to pay for reductions in such risks are two to three times higher than reductions for risks that can be more easily controlled through safety precautions like wearing a bicycle helmet (e.g., Tolley, Kenkel, and Fabian, 1994; Revesz, 1999; UK Department of Health, 1999). In addition, the dread often associated with a cancer diagnosis may lead to higher estimates of willingness to pay for reduced cancer risks. Finally, cancer is often preceded by a long period of morbidity that is often associated with pain, as well as lengthy and intrusive medical procedures, suggesting that values for reducing this risk may be higher than those for immediate fatalities, in spite of the fact that one may survive cancer. These issues suggest that our VSC estimate of $39,000,000, while approximately 10 times higher than the next highest VSL estimate for children, may be reasonable.

One important limitation with many product market studies, ours being no exception, concerns the assumption that purchasers or users of the product being studied are fully informed about the risk reduction conferred by the product. Implicit in our analysis is the assumption that parents are fully informed about the reduction in their baby's lifetime cancer risk conferred by the use of organic baby food. We assume that parents are aware that they are purchasing some risk reduction through organic baby food, but the magnitude of this risk reduction could vary dramatically. Williams and Hammitt (2001) find that perceived risk of cancer from consumption of fresh produce tends to be significantly higher than scientifically estimated risks, and that buyers of organic products perceive these risks to be even higher as compared to buyers of conventional produce. Maguire, Owens, and Simon (2001) conduct focus groups with parents of young children and find that perceived risks from conventional jarred baby food tend to vary dramatically, but range from close to zero to more than 100/1,000,000.[28] If in fact perceived cancer risks from conventional baby foods are higher than scientific risks, then we will overestimate the VSC. In fact, the VSC estimate can vary significantly with a small change in the risk estimate. Barring additional data, the Kuchler, et al. (2000) estimate is the most reliable.

Children's health issues are receiving more attention as policy makers demand that analyses explicitly include impacts on children. As such, the lack of age-specific valuation estimates, particularly those dealing with health risks, is problematic for analysts. Our results provide insight into the value of a statistical cancer, an estimate that is unique in both the type of risk and age group of interest. We estimate a value of $39,000,000, which while high, could be plausible, given the involuntary nature of the risk and other caveats mentioned above. While this estimate is based on consumption of organic baby food, exclusively, assuming competitive

[28] Given the nature of the data the authors do not calculate an average perceived risk.

markets it is plausible to believe that this estimate applies to *similar* risk reductions. Nonetheless, given the unique nature of this estimate, it should be taken as an early effort to estimate the value of a statistical cancer from exposure in the first year of life.

Table 1: Distribution of Sample Data Across Venues	
Venue Type	**Percent of Sample**
Grocery store	71
Mass merchandiser	11
Convenience store	11
Drug store	5
Baby supercenter	2

Table 2: Variable Description	
Variable	**Description**
MEAT	= 1 if a meat product, = 0 otherwise
LABEL	= 1 if a special label within brand, = 0 otherwise
STAGE1	= 1 if a stage 1 product, = 0 otherwise
STAGE2	= 1 if a stage 2 product, = 0 otherwise
STAGE3	= 1 if a stage 3 product, = 0 otherwise
GERBER	= 1 if a Gerber product, = 0 otherwise
BEECHNUT	= 1 if a Beechnut product, = 0 otherwise
EARTHS BEST	= 1 if an Earth's Best product, = 0 otherwise
HEINZ	= 1 if a Heinz product, = 0 otherwise
ORG BABY	= 1 if an Organic Baby product, = 0 otherwise
MULTI	= 1 if sold in a multi-pack, = 0 otherwise
CONVENIENCE	= 1 if sold in a convenience store, = 0 otherwise
SQFT	number of square feet of shelf space
ORGANIC	= 1 if an organic product, = 0 otherwise

Table 3: Descriptive Statistics[1]			
Variable	**All Data**	**Organic**	**Conventional**
PRODUCT CHARACTERISTICS			
MEAT	0.05 (0.22)	n/a	0.06 (0.23)
LABEL	0.20 (0.40)	0.85 (0.36)	0.08 (0.27)
STAGE1	0.21 (0.41)	0.01 (0.12)	0.25 (0.43)
STAGE2	0.53 (0.50)	0.94 (0.25)	0.46 (0.50)
STAGE3	0.26 (0.44)	0.05 (0.22)	0.30 (0.46)
GERBER	0.54 (0.50)	0.85 (0.36)	0.49 (0.50)
BEECHNUT	0.37 (0.48)	n/a	0.44 (0.50)
HEINZ	0.06 (0.24)	n/a	0.07 (0.26)
EARTHS BEST	0.02 (0.14)	0.13 (0.34)	n/a
ORG BABY	0.003 (0.06)	0.02 (0.15)	n/a
MULTI	0.09 (0.28)	n/a	0.10 (0.30)
STORE CHARACTERISTICS			
CONVENIENCE	0.01 (0.11)	0.01 (0.08)	0.01 (0.11)
SQFT	1.24 (0.99)	0.94 (0.73)	1.29 (1.02)

ORGANIC CHARACTERISTIC			
ORGANIC	0.15	1.00	0.00
Observations	928	139	789

[1] Mean (standard deviation) displayed for each variable.

Table 4: Empirical Results[1]	
Variable	**Coefficient (standard error)**
Intercept	0.634** (0.005)
ORGANIC	0.131*** (0.010)
MEAT	0.262*** (0.009)
LABEL	0.007 (0.009)
STAGE1	-0.185*** (0.006)
STAGE2	-0.146*** (0.005)
GERBER	0.042*** (0.005)
HEINZ	-0.027*** (0.009)
EARTHS BEST	0.074*** (0.018)
ORG BABY	-0.020 (0.036)
MULTI	0.015** (0.008)
CONVENIENCE	0.345*** (0.019)
SQFT	-0.006** (0.002)
Adjusted R^2	0.7469
Observations	928

[1] Dependent variable is price per jar. Significance of coefficients is indicated as follows: *** = 99 percent level of significance, ** = 95 percent level of significance, and * = 90 percent level of significance.

References

Carlin, Paul S., and Robert Sandy. 1991. Estimating the Implicit Value of a Young Child's Life. *Southern Economic Journal* 58(1): 186-202.

Dockins, Chris, Robin R. Jenkins, Nicole Owens, Nathalie B. Simon, and Lanelle Bembenek Wiggins. Forthcoming. Valuation of Childhood Risk Reduction: The Importance of Age, Risk Preferences and Perspective. *Risk Analysis: An International Journal.*

Economic Research Service (ERS). 2000. Food CPI, prices, and Expenditures: Sales of Food at Home by Type of Outlet. http://www.ers.usda.gov/briefing/CPIFoodAndExpenditures/Data/table16.htm. Accessed Jan. 19, 2001.

Environmental Working Group (EWG). 1995. Pesticides in Baby Food. http://www.ewg.org/pub/home/Reports/Baby_Food/Baby_home.html. Accessed Jan. 19, 2001.

Federal Register. 2000. *National Organic Program; Final Rule.* December 21, 2000. Volume 65, number 246.

Freeman, A. Myrick, III. 1993. *The Measurement of Environmental and Resource Values: Theory and Methods*. Washington, D.C.: Resources for the Future.

Jenkins, Robin R., Nicole Owens, and Lanelle B. Wiggins. 2001. Valuing Reduced Risks to Children: The Case of Bicycle Safety Helmets. *Contemporary Economic Policy.*

Kuchler, F., K. Ralston, L. Unnevehr, R. Chadran. 1996. *Pesticide Residues: Reducing Dietary Risks.* U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report Number 728.

Kuchler, F., K. Ralston, J. R. Tomerlin. 2000. Do Health Benefits Explain the Price Premium for Organic Foods? *American Journal of Alternative Agriculture*, 15:9-18.

Liu, Jin-Tan, James K. Hammitt, Jung-Der Wang, and Jin-Long Liu. 2000. "Mother's Willingness to Pay for Her Own Child's Health: A Contingent Valuation Study in Taiwan." *Health Economics,* 9: 319-326.

Maguire, Kelly, Nicole Owens, and Nathalie Simon. 2001. A Summary of Focus Groups With Parents of Young Children. Internal Report, Environmental Protection Agency, National Center for Environmental Economics (October).

Mount, Timothy, William Schulze, Weifeng Weng, Hong Kim and Lauraine Chestnut. 2000. Valuing Reduced Risk for Households with Children or the Retired. Paper presented at the American Economics Association Annual Convention, Boston MA, January.

National Research Council. 1993. *Pesticides in the Diets of Infants and Children.* Washington, DC: National Academy Press.

Portney, Paul R. 1981. Housing Prices, Health Effects, and Valuing Reductions in Risk of Death. *Journal of Environmental Economics and Management* 8: 72-28.

Revesz, Richard. 1999. Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives. *Columbia Law Review*, 99(4).

Tolley, George, Donald Kenkel, and Robert Fabian. 1994. "State-of-the-Art Health Values." In Tolley, George, Donald Kenkel, and Robert Fabian (Editors). *Valuing Health for Policy: An Economic Approach*. University of Chicago Press (Chicago).

U.K Department of Health. 1999. "Economic Appraisal of the Health Effects of Air Pollution Report." http://www.doh.gov.uk/hef/airpol/ecomain.htm

Williams, Pamela and James Hammitt. 2001. "Perceived Risks of Conventional and Organic Produce: Pesticides, Pathogens and Natural Toxins." *Risk Analysis*, 21:319-330.

Discussion of Session V

Nishkam Agarwal, US EPA, Office of Pollution, Prevention, and Toxics

I begin by noting that I enjoyed reading all 4 of the papers presented this afternoon in Session V: Population Characteristics. The primary focus of the papers is on Age and its association as a factor influencing estimates of the Value of a Statistical Life (VSL).

This discussion is in three parts. The first part lays out the range of possibilities linking VSL with age, and attempt to put various disparate estimates of VSL together in one unified whole, accompanied by major caveats. The second part discusses implications of the research conducted for recent lead policy discussions within the Office of Pollution Prevention and Toxics (OPPT). The third part discusses briefly comments specific to each of the papers for this session.

I. Overall Context and General Observations

To better understand the overall context of these papers, the following matrix lays out the theoretical possibilities linking risk with the demographic characteristic of age. Estimations of VSL may exhibit uniqueness in each of the cells of this matrix.

MATRIX linking VSL and Age: Possibilities

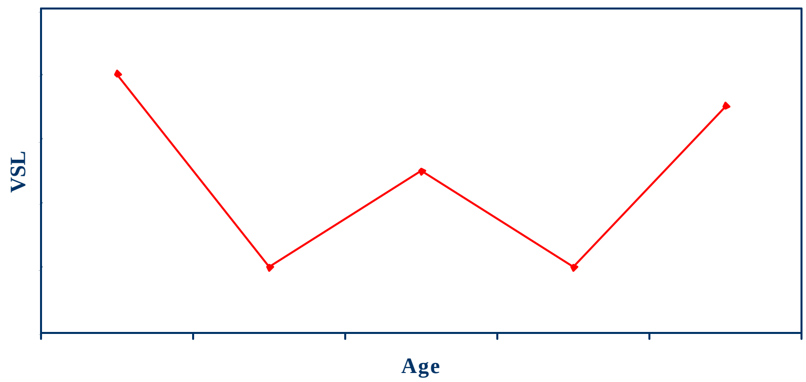
VSL and Age: Possibilities

	Mortality Risk		Morbidity Risk	
	No Latency	Yes Latency	No Latency	Yes Latency
Child		ETS	Helmets	Baby Food
Adult		ETS		
Elderly		Air Pollution		

Estimates of VSL and related discussions on VSL developed by the authors in the four papers of this session do not necessarily fit neatly within the confines of a single cell of the above matrix. The lines separating the cells are not "bright"; nevertheless, this matrix serves as a useful organizational tool to try to understand where various authors have attempted to tackle the issue of age in the estimation of VSLs.

To obtain a fuller picture of the interactions between VSL and age, one would need to fill in cells in the above matrix besides the ones tackled by the 4 papers of this session. Prior and ongoing work has targeted some of these cells. For example, the Maguire et. al. paper mentions (page 2 of that paper) that several studies exist for VSL estimates for the cell connecting children with low latency/mortality risk. It may be useful to compile all of the results to fill out the above matrix once we begin to get more confidence in their credibility. The following "W" curve may be considered an early attempt to put together in graphic form the relationship of VSL with age. All the usual caveats apply about the pitfalls of this attempt. No claim is being made that this type of curve is anything other than tentative.

The "W" Curve



Notice that the scale has been suppressed on both the axes of the above curve. This is deliberate in order to avoid the impression that the function is definitive. Also notice that adequate evidence may not exist as of now to draw a continuous curve. In a concrete exercise of this type, problems of comparing "apples and oranges" across disparate studies would also arise, namely, different baselines and different ceteris paribus variables.

Notwithstanding all of the caveats, it is proposed here that the four papers of this session are broadly and generally consistent with the contours of this curve. In particular, the Maguire et. al. paper helps to define the leftmost part of the curve, the Kerry Smith et. al. paper's results are linked to the rightmost part of the curve, and the other two papers provide useful information to fill out the middle section.

To understand this further, note that the Kerry Smith et. al. paper supports a gradual uptum of VSL estimates after age 51, while the Maguire et. al. paper supports a high estimate of the Value of a Statistical Cancer (VSC) for the very young. The latter paper does not discuss a relationship between VSC and VSL, but it would be difficult to imagine that these two concepts are not inter-related. The Agee/Crocker paper also supports a higher parental valuation for children's health than for own health, in fact they state that parental willingness-to-pay (WTP) estimates for respondent parent and young child health status imply that "smoking parents on average value their child's health roughly twice as much as they value their own health." These results emanate from a household production model which presumes that smoking parents self-assess the potential harm of smoking – to themselves and their children (via ETS) – and then trade-off these assessments with the own utility of smoking.

Finally the Jenkins et. al. paper advances several insights and hypotheses in the mid-section of the "W" curve. For example, this paper supports the initial downward slope from childhood to age 14 by advancing the hypothesis that "as children grow independent, parents' valuation of risk reduction (from wearing helmets) declines, perhaps because of the natural transference of responsibility for health and safety over to the child." The authors state further that:

"..during the middle years of childhood, parental valuation of risk reduction experienced by their own children declines gradually. For adults, valuation of risk reduction increases between ages 20 and 32 then declines until age 51 at which point it increases again."

Jenkins et. al. advance hypotheses for why the value of risk reduction begins to increase again for adults who are in their early 50s (the "near elderly" as described by Kerry Smith et. al.). These include greater aversion to non-fatal physical injury by the near elderly and the observation that elderly drivers are more cautious than younger drivers.

Needless to say, some of the above estimates, turning points and hypotheses are still on the drawing board, as the authors emphasize. If we were, however, to accept them in large measure, and ignore issues of estimate compatibility across studies, a curve resembling the "W" above may emerge. Much additional research would undoubtedly be useful.

II Implications of Research for Lead Policy Discussion in OPPT

In this section, I touch on the implications of this research for recent lead policy discussion in OPPT. As you know, lead policy discussions and rule-making have been at the forefront of OPPT work for the last several years. The Office of Management and Budget (OMB) has also engaged itself with EPA scientists and economists in related debates on a priority basis. One of the recent rules to garner such attention both within the EPA as well as between the EPA and OMB and other concerned Federal Agencies is Section 403 of the Toxic Substances Control Act (TSCA). This section was established by the Residential Lead-Based Paint Hazard Reduction Act of 1992, also known as Title X.

TSCA Section 403 requires that EPA promulgate regulations to "identify ... lead-based paint hazards, lead-contaminated dust and lead-contaminated soil" for purposes of other parts of Title X. The lead-based paint hazards addressed in the economic analysis associated with the rulemaking include residential hazards from deteriorated paint and contaminated dust and soil. These standards are central to OPPT lead policy since they apply directly to "target housing", that is, most housing in the United States constructed prior to 1978, and child-occupied facilities. In addition, various parties may also apply the standards to newer residences. The rule was published in the Federal Register in January 2001 after a serious analytical and policy exercise lead by OPPT, and an extensive debate involving the Agency with OMB and other concerned entities of the U. S. Government.

The benefit-cost analysis compares alternative candidate standards in terms of their normative net benefits. Net benefits are based on the benefits of risk reduction minus the costs of control activities needed to achieve the reduction in risk. The analysis calculates net benefits for a wide range of alternative standards, including the final Section 403 hazard levels.

The focus of the Section 403 regulation is on the protection of children's health. The household lead standards were chosen based on an analysis of the health risks to children. This aspect of the lead rule makes it particularly relevant to the present discussion of the linkages of demographic characteristics to VSL estimates.

Benefits of hazard control are calculated using estimates of "avoided" economic damages to children corresponding to avoided adverse health effects. The economic model defines "avoided" as the difference between the baseline scenario, which assumes no intervention activity and various intervention or ex post scenarios. Each of the scenarios assumes a different specification of lead hazard standards, and hence intervention activities. In the analysis, benefits are calculated for children whose exposure to lead is reduced for the period from birth to age six.

These avoided economic damages include reductions in IQ, plus increased educational and medical costs connected with high levels of exposure. In each case, the economic value is a proxy for society's willingness to pay (WTP) to avoid the health effect. The economic analysis had to resort to this analytical cost-of-illness (COI) approach since little reliable information is available on society's WTP to pay to avoid cognitive impairment or IQ loss associated with lead exposure. Therefore, as stated above, the analysis focused on three primary economic consequences of increased blood levels that could be valued using COI techniques, namely, decreased expected lifetime earnings, increased educational resources expended, and costs of increased medical intervention associated with several critical blood lead levels requiring follow-up monitoring and/or specific medical intervention.

Details of the economic benefit estimates are provided in the EPA report entitled "Economic Analysis of Toxic Substances Control Act Section 403: Lead-based Paint Hazard Standards", dated December 21, 2000. Suffice it to note here that changes in IQ levels make up the vase majority of benefits in this analysis. The economic value of avoiding lost IQ points is approximated by using an estimate of the foregone lifetime income due to IQ point loss. The estimated value per IQ point lost is $8,346 (1995 dollars). Details of the increased educational resources expended as well as the costs of medical intervention are found in the above-mentioned report.

With regard to the implications of the current research on demographic characteristics, several points should be noted. First, we do not yet have a concrete framework linking the WTP and COI approaches. To the extent that children's VSL based on the WTP approach may need revision, the COI methodology will remain insulated from these revisions. Theoretically, however, it is hard to see how absolute benefit estimates in the Section 403 analysis would not be impacted if the WTP approach had been utilized.

Second, and most importantly, even if the WTP approach had been used in the economic analysis, it is not clear that revised VSL estimates for children would have had a major implication for lead hazard option selection in OPPT. This is because the policy makers would be interested not in absolute net benefits of each of the candidate hazard standards, but rather in the relative net benefits which allows for the establishment of a ranking of the various standards. If changes in absolute net benefits are approximately uniform across candidate options (i.e., if there are no significant changes in <u>relative</u> net benefits across candidate options), there would be minimal change in these rankings which are the main item of interest to senior policy makers in the 403 context. The jury is still out as to whether relative net benefits would indeed by impacted by revisions to the age-based VSL estimates. Sensitivity runs of the Section 403 model may help to shed light on this issue.

III Specific Comments

The Kerry Smith et. al. paper was motivated in part by the EPA's retrospective analysis of the benefits and costs of air pollution regulations which has focused specific attention on older adults. The authors state and conclude that

"..those questioning the EPA's estimates as too high argue the benefit transfer procedures used to adapt VSL estimates to fit the policy circumstances should adjust for the difference in the discounted loss of life expectancy in the two age groups. Much of the current policy discussion has suggested that such adjustments should be made. Our results indicate this conclusion is not warranted based on the actual tradeoffs older adults make in accepting job-related risks."

Reiterating this point later, the authors claim that their ".. estimates offer good reasons to reconsider efforts to adjust down the VSL estimates used to evaluate the benefits from risk reductions experienced by older adults," and that their ".. findings provide no reason to conclude the value of statistical life estimates used for adults up to age 60 should be reduced from consensus estimates in the literature."

The retrospective benefit-cost analysis of the Clean Air Act (CAA) identifies at least 5 potential sources of bias introduced by relying on wage-risk studies to derive an estimate of the WTP to reduce air pollution-related mortality risk. Assuming that the Kerry Smith et. al. paper settles the controversy of the direction of bias for age, we are left with 4 other sources of bias. The Clean Air Act report admits that three of these, namely, degree of risk aversion, voluntary versus involuntary risks, and catastrophic versus protracted death, likely involve downward bias. This leaves the income/wealth bias still unresolved. The CAA report acknowledges that factors exist which may bias the WTP estimate either upwards or downwards. The following lengthy quote from that report, dated October 1997, page 49, admits this:

"There is substantial evidence that the income elasticity of WTP for health risk reductions is positive (although there is uncertainty about the exact value of this elasticity). Individuals with higher incomes (or greater wealth) should, then, be willing to pay more to reduce risk, all else equal, than individuals with lower incomes or wealth. The comparison between the (actual and potential) income or wealth of the workers in the wage-risk studies versus that of the population of individuals most likely to be affected by changes in pollution concentrations, however, is unclear. One could argue that because the elderly are relatively wealthy, the affected population is also wealthier, on average, than are the wage-risk study subjects, who tend to be middle-aged (on average) blue-collar workers. On the other hand, the workers in the wage-risk studies will have potentially more years remaining in which to acquire streams of income from future earnings. In addition, it is possible that among the elderly it is largely the poor elderly who are most vulnerable to air pollution-related mortality risk (e.g., because of generally poorer health care). *On net, the potential income comparison is unclear.*" (Italics added)

To conduct a rigorous investigation of this bias, one should separate out the income and wealth effects if possible. The overall conclusions of the Kerry Smith et. al. paper would become more certain vis-a-vis the net effect of all major sources of bias in the CAA report when some of these additional factors have been incorporated.

In terms of the implications of the Kerry Smith et. al. paper for rule-making under Lead Section 403 as described above, one notes that adult benefits were not quantified in the economic analysis. The Kerry Smith et. al. paper reinforces the need to bring adult benefits into the analysis. Given, however, that we looked at rankings of hazard standards, the issue is whether the percentage of adults in the affected categories of housing varied with the hazard standard. To the extent this did not or may not happen, neglecting adults in the quantified benefits analysis does not necessarily change the rankings of the candidate hazard options, and thus does not bias the choices from an economic standpoint for senior decision makers in OPPT.

On another point, the Kerry Smith et. al. paper analyzes the near-elderly and not the elderly. The authors do, however, hypothesize that "there is little reason to expect abrupt changes in people's risk/money tradeoffs beginning at age 65." Although this hypothesis seems defensible, further investigation may be worthwhile.

Finally, it may be useful to present some further details of the econometric estimation procedure used in the analysis, in particular any tests of specification the authors may have performed in pursuit of the chosen estimators.

The Agee/Crocker paper raises the interesting possibility of attempting to estimate society's WTP to avoid cognitive impairment from lead and other toxics. Several issues are involved here which analytically distinguish the case of environmental tobacco smoke (ETS) from lead exposure, including the observation that ETS is an act of commission while lead exposure to children is more an act of "omission", the disease associated with ETS is more "visible" compared to the IQ-related impacts of lead exposure, and parental values relating to "cerebral" attributes may not mirror those relating to respiratory or other health-outcomes associated with ETS, thereby influencing WTP estimates. Further research would be most useful.

The Jenkins et. al. paper brings out an important point about the usefulness of analyzing the impact of the nature and timing of risk for the age-valuation interaction. From a policy perspective, this is crucial. For example, risks with immediate consequences (bicycle helmets) are qualitatively different from risks that involve latency periods as with lead and other toxics. As the authors point out, one would suspect that reductions in risks whose consequences are experienced with a time lag (i.e. latency) would be valued less by the elderly whose odds of ever experiencing the consequences are lower. Further investigations would be invaluable to study risks with latency periods, and their impact on the age-VSL relationship.

With respect to the Maguire et. al. paper, it is important to note that their estimate of VSC is extremely sensitive to assumptions about the elements of their equation 6 which equates the value of a change in health risk from consuming organic baby food with the ratio of the value of the organic characteristics of baby food to the change in health risk associated with organic baby food. Specifically, the crucial elements of equation 6 are the price differential for organic versus non-organic baby food, the number of jars consumed in the first year, and the marginal change in health risk from consuming organic food. Since the VSC estimate of $39 million is so sensitive to assumptions about these elements, it may be useful to conduct a sensitivity analysis. The credibility of their result could be further enhanced by building perhaps a confidence interval around their point estimate of VSC.

Discussion of Session V

Carol Mansfield, RTI International

Taken together, the four papers provide estimates of the value of a statistical life (VSL) at different points in life and the difference between parents' valuation of their own health versus their children's.

The estimates from both Crocker and Agee and Jenkins, Owens and Wiggins suggest that parents willingness-to-pay (WTP) for their child's health is about double their WTP for their own health.

Maguire, Owens and Simon estimate the value to parents of reducing their child's lifetime risk of cancer from food consumed during the first year of life to be about $39 million.

Smith, Kim and Taylor estimate that the VSL does not decline as one reaches "near elderly" status -- and it may increase.

Although it is hard to directly compare the estimates, together these articles suggest that VSL is high for young children, may decrease as the child ages (based on parents' WTP), then increases until about age 32, declines until age 50 and then may be flat or increasing (based on an individuals own WTP).

These papers and the pattern of changing VSL though one's lifetime raise many interesting questions about how to calculate and interpret VSL measures.

How should we think about a child's VSL? How does the transition for dependence to independence take place and what does it imply about VSL? Parents are WTP for their child's wellbeing, but as the child ages parents may expect children to contribute to their own safety (by following rules about when, where and how to their bike, for example). Thus parents may reduce their own spending on their children's health, but expect the child to increase his or her contribution – so total household WTP remains constant. But as children age, they develop their own preferences for risk, and they gradually become more independent. What bargains do parents and children reach about risk and how should we think about VSL during this transition? At what point (if ever?) are parents' no longer WTP more for their children's health than for their own? We need household or multigenerational models can help explore these issues.

Different risks may imply different VSL's, so context matters.

If risk preferences change, as Smith et al. imply, why do they change?

What is the full cost of a "risk" and how should it be measured? If the elderly take longer to recuperate from an accident or suffer more side effects, then we would expect their WTP to be higher than a young person's to avoid a particular accident. However, using the probability of death as the measure of "risk" does not capture side effects and recuperation periods, so it looks like the elderly are WTP more to avoid the same level of risk.

Where do the middle-aged fit in? Do they have a lower VSL than the young or the old – or are we leaving something out? Children place a value on having their parents avoid risks; the elderly value their adult children both because they love them and because they may need care in later years. What does this imply for policy makers?

Let me make a few comments on the specific papers now.

"Do the Near Elderly Value Mortality Risks Differently?" Smith, Kim, and Taylor

In this paper, the authors estimate VSL from hedonic wage regressions for a sample of older workers (people in their 50's and early 60's) and find VSL's that are comparable to those estimated elsewhere for younger people. They conclude that VSL does not decline for the "near elderly" as is sometimes assumed. The survey data includes a question meant to capture risk tolerance, and when this risk tolerance factor is used as a variable, VSL actually increases above the levels estimated for younger workers.

The authors suggest that risk preferences may change as people age. It is also possible that older people are more "educated consumers" of risk – they understand risk better after living so many years and death is a more concrete concept. Thus, a specific job-related risk may be a different commodity for older workers than for younger workers.

It would be interesting to run hedonic wage regression for people aged 20-50 years and include the risk tolerance variable – perhaps one would estimate higher VSL's for younger people too.

"Age and the Valuation of Risk Reduction: An Examination of Spending on Bicycle Helmets" Jenkins, Owens, and Wiggins

This paper raises interesting issues, which I discussed in general above, about the degree to which parents observed payments for the safety of their children reflect their total WTP. Is parents' WTP declining gradually as children age, as implied by their spending on helmets, or do parents require children to bear some of the burden of providing for their own safety, or are children asserting their own preferences as they age?

The authors found that adults increase spending on helmets until age 32 and then reduce spending until age 51, at which point it may increase again. I would be interested in the type of riding people do during these years and their perceived need for a helmet. Are people riding less? Are they riding more safely? If adults with small children (perhaps in their 30's?) ride with their children at slow speeds on paved trails, they may not feel the need for a helmet.

One question I had was about how to interpret spending on helmets and whether a tobit model is appropriate. Since all helmets are assumed to provide the same level of safety, people who want safety only would buy the cheapest helmet. If people buy more expensive helmets, it must be because they are looking for other features such as comfort or appearance. Presumably, the significant coefficient on risk in the tobit model comes from the difference between people who buy helmets and those who do not, but it should not explain why people who decide to buy a helmet buy a more expensive helmet. Thus the tobit model, which combines the decision to buy the helmet with the decision about how to spend, may not be appropriate. Instead the authors might like to consider one of the selection or hurdle models that treat the decision to buy or not separate from the decision about how much to spend. It might also be nice to include a diagram showing which part of WTP they are using to calculate the VSL given that they use average helmet price for people who purchased helmets.

In the regressions, I wondered why the authors excluded people from the sample who did not know if there was a helmet law in their community, especially since the variable is insignificant in the regressions. However, in their presentation the authors mentioned that they plan to include these people in later regressions.

"Smoking Parents' Valuations of Own and Children's Health" Crocker and Agee

This paper recognizes the interdependence between the decisions made by parents about their own activities and their children's health outcomes. Specifically, the authors develop a model of the mother's decision about how many cigarettes to smoke given the utility she derives from smoking, the impact of smoking on her own health and the impact of smoking on the health of her 3 year old. They find that the mothers are WTP about 2.5 times more to improve their children's health than to improve their own.

I liked the model and the approach, since there are many areas where a parent's actions indirectly affect their children. An interesting extension would be to incorporate the decision to quit (since everyone in the sample smoked) and to develop a model that included all children in the household, not just the 3-year-old. Finally, it would be interesting to look at a time series of smoking and household health over time. However, for that they would need a different data set.

The authors discuss that smokers seem to be different than nonsmokers in their attitudes towards health. Given that, I wondered how to generalize the results to the nonsmoking population.

It would also be nice to have more discussion about the results. The authors estimate that heavy smokers have a higher WTP for a 10% increase in their child's health than light smokers. But, heavy smokers' self-assessment of their child's health is lower than light smokers. How should we interpret this result? Similarly, WTP for a 10% improvement in the child's health in higher than for a similar improvement in the adult's health – but what is the baseline level of health in both groups?

Some other suggestions for more discussion in the paper include:

Based on the regression results, smokers did not think other smokers in the house affected their own health, but they did think additional smokers in the house affected their child's health.

Higher cigarette consumption is associated with higher levels of stress and more children in the household. But secondhand smoke is a "public good" in some ways, so if there are more children in the house, more people are negatively impacted by the mother's smoking.

Finally, it would be nice to have standard errors on the WTP values.

"What do Organic Baby Food Purchases Tell Us about Parental Values for Reductions to Risks in Children's Health?" Maguire, Owens, and Simon

In some ways, organic baby food is a perfect commodity, since no extra time or preparation is involved in feeding it to your child than normal baby food, and no one else in the household benefits.

My main concern about this paper is the level of risk that parents think they are avoiding with organic food. The authors use an estimate of risk based on a study of diet, pesticide residues and cancer risks. However, what they need is the parent's subjective estimate of risk. It is possible that people who are the strongest proponents of organic food perceive very high risks from eating nonorganic food, while people who do not buy organic food think nonorganic food poses no increased risk. The VSL would be smaller if the people buying organic food perceive a much higher risk from the food than that used in the study.

Parents may believe they are buying more than just reduced cancer risk from pesticides when they purchase organic baby food. Just as an aside, I thought Earth's Best had much better flavors than the nonorganic brands.

One interesting issue is what happens when the child starts eating table food? At least in our household, we bought organic baby food, but we do not generally buy other types of organic food. If parents are so concerned about the risk from pesticides in baby food, why aren't they equally concerned about table food – or does the extra time required to shop at different stores or prepare organic food make the cost of organic table food higher than the perceived benefits?

It would be interesting to observe eating patterns over time and over all the members of the household. It might provide some insights into why parents buy organic baby food how parents think about risks from organic and nonorganic food.

Question and Answer Period for Session V

Sandy Hoffman, of Resources for the Future, asked about the "W curve" that we are seeing over time and the household's budget constraint. She asked whether expenditures on life insurance in the middle years may substitute for expenditures on other kinds of risk reduction, suggesting that perhaps in those middle years one of the big concerns is the loss of income from a parent in a household with children. She also asked what the burden on the household budget looks like in those middle years. What other kinds of expenditures are having to be made (e.g., kids' clothing and schooling), and does that create a further constraint on the household's ability to pay for risk reduction? Finally, she commented that the National Institutes for Children's Health and Development, EPA, and CDC are in the midst of designing a longitudinal survey of children's environmental health, and that survey is something to keep an eye on.

Kerry Smith offered two comments on the income and wealth questions. First, he noted that we just have a point estimate of a marginal rate of substitution with the VSL, and that there should be a structural model whose parameters we can estimate that connects to the VSL, that defines the marginal rate of substitution. If we had such a model, he said, we would begin to resolve some of these issues – like the role of income and wealth. What is the role of other demographic characteristics of households and the factors that influence their ability to respond? Second, he noted that, even if we had reliable VSLs for different groups (e.g., for old people, young people, and intermediate people), we couldn't get away with using them in any policy situation. The only way we would ever use them, he suggested, is if we identified that there was one category or group that was the sensitive group, and that was the only group that was impacted by a particular regulation. Then we would use the value that was relevant for that group.

Following up on that point, Glenn Harrison, of the University of South Carolina, noted that there is a political constraint. People at EPA know that VSL can vary by age, by race, by a number of other factors. But they cannot use different numbers. Can we, however, still come up with a scalar that is a weighted average of group-specific VSLs, as was done in the Clean Air Act retrospective analysis, he asked. That is more a political question, he noted, but that is the issue of having a social willingness to pay that meets those constraints of equity.

Michael Hanemann, of the University of California, Berkeley, offered three comments. The first was in answer to the question concerning varying marginal rate of substitutions. He said the answer is that it is a result of the fact that in the expected utility model there are two outcomes, being alive or being dead, and the utility of a state is multiplied by the probability of being in that state. And so, not just the marginal utility, but the total utility is linear in the probability and is linear in the difference between being alive and dead. What we need, he suggested, is a utility function, for example, which is nonlinear in the mortality probability. And, all the evidence suggests that willingness to pay is not linear in probability. He addressed his next comments to the two EPA papers. First, he expressed the opinion that, analogous to expenditures on site visit in travel cost studies, expenditures on bicycle helmets is not a meaningful variable. If one person spends $50 for accommodations per night, for example, and the other person spends $100 a night, it tells us that one person wants to stay in a nice hotel and the other person wants to stay in a cheap hotel, but that does not tell us anything about the cost of going to the campground. What we should do, he said, is impute a standard price per site and ignore the actual data on expenditure on accommodation. Similarly, he said, it makes no difference how much people spend on bicycle helmets. First, it is a fixed cost, so it tells us nothing about how many days the helmet is worn. Second, the only behavioral signal is that somebody purchased a helmet or did not, but how much they spent on it may tell you nothing. He recommended that they disregard the information on expenditure and just focus on behavior which is zero or one. With regard to the other study on organic foods, he noted that the hedonic method falls apart if there is heterogeneity in preferences. The hedonic model works when you assume the price is such that all consumers are pretty much the same, and if the price were a little higher they would all flip from one quality level to another level. But where there are segmented markets [as there are in food markets], that does not happen. The fact that some people buy organic food tells you that it is worth that much to them, but it tells you nothing about the people who do not buy it. He added that people see more in organic food than the safety, so the EPA researchers may be attributing too much of the benefit to the reduced risk of cancer.

Robin Jenkins responded that when someone is buying a helmet, unlike a recreational visit, the only thing that they get from the helmet is improved safety. There is a continuous payment being made in terms of negative utility from wearing the helmet because it causes discomfort and because it looks unattractive – that is, people may be paying more for helmets that are more attractive in an effort to reduce the disutility that comes from using the helmets. They have tried to control for that, she said, with an appearance variable. However, she said, they are only concluding that the fact that the consumers are purchasing these helmets merely indicates that they at least were willing to spend that much to reduce the risk of death.

Michael Hanemann replied that it *is* analogous to the recreation site situation, that consumers are getting real characteristics (e.g., greater attractiveness of the helmet) if they spend more on the helmet, but that is not what the EPA researchers want to be measuring – in other words, they cannot attribute willingness to spend more on a helmet to the increased safety of the helmet.

Nicole Owens had two comments. First (in response to Michael Hanemann's comment), she said she thinks it is true that they do just have a value for people who purchase organic foods. They did find some evidence in their focus group, she said, that people who do not purchase organic food are purchasing risk reductions elsewhere. Second, in response to an earlier comment by Carol Mansfield, she noted that they do not deal at all with the transference of pesticides from breast milk. Finally, she noted that, in the bike helmet study, they asked a question concerning the percentage of time parents expected their child to wear his or her helmet. They use that in calculating the risk reduction variable.

Kerry Smith commented that, on the helmet issue, he agrees and disagrees with what Michael Hanemann and Glenn Harrison said, in part because he thinks what they are calling for is not to throw out the helmet expenditure information, but rather to think about a more complete model. What Michael Hanemann probably had in mind, he suggested, was to model the amount of time or trips that the person or the child spends on the bike, jointly with the decision to buy the helmet, and to try to control for appearance and the rest of it.

Nick Bouwes, of the EPA, describing himself as a bikeaholic who logs from 3,500 to 5,000 miles a year, said the only consideration for him (in buying a helmet) is risk reduction. He asked Robin Jenkins what baseline is used for the miles variable and how she compensates for different mileage baselines? If he bikes anywhere from 3,500 to 5,000 miles, he asked, is his risk going up? And if his expenditure is the same as that of somebody who is getting much less risk reduction, does that mean his VSL will compute as less than theirs?

Robin Jenkins responded that their risk reduction numbers come from fatality data reported by the CDC, and right now they do not take into account the number of days that the bicyclist rides, although that was on their to do list.

Nick Bouwes noted that that probably would be a reflection of the skill level and the commitment to biking. He suggested that mileage may be a better indicator than number of days. He suggested that they do an online survey with the committed bicyclists at EPA (there is a directory kept of them). He said he suspects that they will find that the other helmet variables are less significant than risk reduction.

Reed Johnson, of Research Triangle Institute, (referring back to Michael Hanemann's comments on utility functions), said he is not sure it is necessary to model a discontinuous utility function with respect to life and death. There are states of living, he noted, that many people would rate as worse than death, so it may be that there is a continuum of quality of life, of which death is maybe not even the endpoint. He suggested that maybe we use a more conventional, flexible form of utility.

Jack Wells, of the Department of Transportation, wanted to pick up on Carol Mansfield's question about when parental altruism towards their children stops being the case. He also wanted the panelists to address the general belief that taking account of altruism is a form of double counting. If I value my life at a million dollars, he said, and my mother values my life at a million dollars and my father values my life at half a million dollars, why isn't the total value of my life $2.5 million?

Tom Crocker responded that the exercise they undertook gave no information on how parental altruism would change as the children's ages change. With regard to your parents' valuation, your mother, your father, he said, it depends on what kind of model you wish to build.

Kerry Smith noted that there is not double counting if the commodity that is being valued by your parents is a risk reduction to you. There is double counting, he said, if the commodity that is being valued is an increase in your utility or expected utility.

Ted Miller, of the Pacific Institute for Research and Evaluation, commented that the people he knows who buy organic baby food and organic food generally seem to be much more worried about attention deficit disorder risks to their kids than latent cancer risks. He also suggested that the EPA researchers consider using five-year age ranges instead of cubic variables.

Nicole Owens agreed that one of the risks associated with purchasing or consuming conventional baby food is attention deficit disorder. She noted, however, that not one parent in their focus groups ever mentioned this concern. They mentioned cancer specifically, she said, and then a general notion of health risk. She also said they would try the five-year increment.

Ted Miller noted that you hear a lot about hypersensitivity and organics if you shop in organic food stores.

Glenn Harrison asked the authors of the organic food study three questions. First, did they control for whether it was a first child or a later child? Secondly, did they control for the period of nursing? If you contact people in the La Leche League, he said, they'll tell you that nursing a good substitute for things such as organics. And thirdly, did they control for smoking in the household?

Nicole Owens responded that the short answer to each of Harrison's questions is "no." To come up with the premium, they just went to grocery stores. The risk reduction data was from research published by USDA. They do not have any individual level data at this point, she said, so they cannot control for birth order of the child. If they go forward with a survey, she said, they would want to take into account the things Harrison mentioned.

Rich Ready, of Penn State University, commented that in the bicycle helmet study, they should think in terms of a "helmetless survival function," – how long the child has not had a helmet and how long the child has had a helmet, and not just focus on the age of the child at the time of the interview. A 14-year-old who does not have a helmet probably did not have a helmet when he was 12 or 10, either, he noted. And conversely, a 14-year-old who does have a helmet probably had it at an earlier age.

Robin Jenkins replied that it is possible that during the time at which respondents received the phone call the helmet had been lost, or the child had been in a wreck and therefore the helmet was no longer useful, and they had not had time to replace it. She said they might be able to figure out a reasonable way to make some assumptions to take this into account.

Laura Taylor, of Georgia State University, commented (in response to Michael Hanemann's comment) that with bicycle helmets an increased price is associated with increased quality and increased safety. So unlike in the recreation studies, there is probably a connection between price and safety. Robin Jenkins commented here that there is not. Taylor said she was talking about people's perceptions. If increased quality is associated with increased price, and if you have an uninformed consumer, she said, then that is what is relevant.

Glenn Harrison noted that if you are trying to get a kid to wear a helmet, you buy a cool helmet that is comfortable so they are happy to wear it. They will just get into the habit of wearing it. So you will pay extra, he said, but you get more for it.