Valuing Environmental Health Risk Reductions to Children

PROCEEDINGS OF

SESSION IV-AM: AGE-SPECIFIC VALUE OF STATISTICAL LIFE ESTIMATES

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Session IV-AM: Age-Specific Value of Statistical Life Estimates

Valuation of Cancer Risk in Children and Adults in Minnesota

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presented by Chris Dockins

In Minnesota, there is some expectation among health policy professionals that "negligible risk" may soon be defined more stringently for cancer risks that affect children, resulting in standards for cancer risk setting of 1 in a million rather than the current level of 1 in 100,000. How exactly such standards could be effected in practice is a difficult question, and it is possible that the de facto outcome of this type of policy change would be a 1 in a million negligible risk standard for virtually all contaminants in an effort to protect children.

Faced with the possible need to assess the merits of this approach the Minnesota Department of Health (MDH) asked EPA for information on recent or ongoing work that could answer questions about the extent of risk avoidance, especially cancer risk, that the public believes is appropriate for adults and children. The economics literature is quite sparse in the areas of children's health valuation and cancer risk valuation generally and as such currently contains little guidance on this question. To fully address this issue requires assessment of at least two largely unaddressed sources of heterogeneity in risk valuation: age (or, more specifically, adult/child status) and cancer.

Surprisingly, given the current crises faced by state governments across the country, the MDH secured state funding to investigate these questions with an eye toward developing a survey of state residents. After learning that EPA's National Center for Environmental Economics (NCEE) and Office of Children's Health Protection (OCHP) had an ongoing interest in promoting work in this field, MDH approached EPA for technical consultation regarding survey development on these issues. After a series of meeting in which we each presented our existing work on valuation and children's health and identified mutual research interests, we resolved to develop a survey instrument that would address the following questions:

- How do public preferences compare with private preferences for risk reduction
- How do Minnesota residents perceive and value lifetime or long-term cancer risks
- What generally are the public and private preferences in Minnesota for reduced risks of dying from cancer as an adult from (1) child exposure and (2) adult exposure?
- How does the length of the latency period affect valuation estimates for cancer risk reductions? Does this vary between adult exposures and child exposures?

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[1] The opinions expressed in this paper are those of the authors and do not necessarily represent the US EPA. Also, this work is being developed in consultation with a consortium of government analysts and academicians in Minnesota, including: Pamela Shubat, Chuck Stroebel, and Amy Lockheart at the Minnesota Department of Health (MDH); Pat Welle at Bemidji State University; Andy Klemer at the University of Minnesota-Duluth; and Becky Judge, St. Olaf College.

We began by holding a series of focus groups in order to understand some fundamental perceptions and concerns about environmental cancer risks in Minnesota. These focus groups included parents and non-parents, and sought to represent a general cross-section of the adult population in the state. Because about half of the state population live in the greater Minneapolis-St. Paul metropolitan area, we held four of the eight focus groups we conducted in that area with the remaining four groups held in the cities of Mankato, Rochester, Duluth, and Bemidji. The locations outside of the twin-cities area were chosen to capture regional variation in risk attitudes and perceptions. In particular, Mankato was chosen because of the heavy agriculture industry in the area, while Duluth was chosen because of its size and role as a shipping port and industrial center. Bemidji was chosen as representative of the northern portion of the state which is dominated by lakes and recreational opportunities. The area around Bemidji also has a relatively large Native American population. Finally, Rochester is one of the three largest cities in Minnesota and was chosen to be representative of the state to the southeast of the twin cities.

Distinct materials were developed to guide the discussion in each focus group and these materials evolved over time.[2] In general, we developed scenarios to address both public and private "goods" that would reduce carcinogenic exposure to adults and children. These exposures would cause cancer with a latency period. We began by testing scenarios for risk reductions that were based on specific contaminants (e.g., benzene) and specific types of cancer (e.g, brain cancer and kidney cancer). Further, in an attempt to separate risk reduction possibilities for adults and children we initially focused on scenarios with separate exposures and policies for adults and children. For example, some hypothetical situations considered policies targeted narrowly at reducing exposure to carcinogens in schools, which would primarily, but not exclusively, affect children.

Because MDH and NCEE wanted to focus on long-term cancer risks, we initially presented focus groups with a presentation of lifetime cancer risks including detailed information on the when risks were reduced. In their most complex form this information was presented as distributions of risk over a lifetime based on data from the National Cancer Institutes SEER database. We also presented separate displays of magnitude of lifetime risk reduction accompanied by stylized displays of the distribution of the reduction over time.

What did the focus groups tell us? First, any scenario that involved public risk reduction paid for through a tax mechanism was rejected. The size and distribution of state taxes is simply too sensitive a topic to be included in the hypothetical scenario. Interestingly, however, when public interventions are portrayed as a rise in prices for associated commodities, food prices, for example, there was little rejection of the policies based on payment mechanism.

Local issues played a key role in the perceptions of environmental policies to reduce cancer risk. In Duluth, for example, residents were keenly aware of surface water quality and

[2]In keeping with Paper Work Reduction Act requirements, no more than 9 people participated in each of our focus group discussions. Topics and materials developed to guide discussions varied across focus groups.

could even recall specific state recommendations on fish consumption. The presence of a Superfund site near Bemidji seemed to increase the respondents sensitivity to environmental cancer risks in that area, while Mankato's concern for programs that might target pesticides reflected the region's economic reliance on agriculture.

We also found that respondents demanded more information on background mortality risks before responding to choice questions about cancer risk reductions. In fact, we modified the draft questions to explicitly account for non-cancer mortality risk to satisfy these concerns. Respondents also had difficulty linking specific exposure scenarios with specific cancers and other illnesses. Further, when the proposed risk reduction scenario required modification to existing systems in their home (e.g., installation of air filters), respondents required additional information on current risk levels before proceeding.

Finally, very initial responses suggest that there is little sensitivity to the timing of risk reductions associated with children's exposures to environmental carcinogens. This is perhaps not surprising considering there is a minimum of 30 years before childhood exposures become manifest in cancer outcomes. If choices for children's risk reduction reflect standard discounting assumptions then the difference in a risk reduction 40 years hence from one 50 years hence is small in present value terms. On the other hand, insensitivity to timing could simply reflect that parents are considering only whether the child will receive a risk reduction at any time, regardless of the time or magnitude. Additional interviews are necessary to determine how adults are considering long term risks to children.

So, where are we now? We have found that respondents accept our framing the scenario in terms of persistent environmental carcinogens in food as the source of environmental cancer risk and risk reduction. Also, respondents seem to accept distinguishing public and private programs by whether a testing program is optional (labeled foods at a premium price) or mandatory (all foods at an increased price). Risk reductions to adults vs. children are distinguished by whether the testing programs focus on contaminants primarily associated with (1) long-term cancer risks from child exposure, or (2) cancer risks from adult exposure. We have loosely correlated these with cancer initiators and cancer promoters, respectively.

Our risk communication devices are based on the grids recently developed and used by others in the literature (Alberini, et al.; Krupnick, et al.; Corso, et al.; Cameron and DeShazo). These grids include cancer and non-cancer mortality risks typically over a 20-year time period in order to respond to MDH's interest in views of lifetime cancer risks. We plan to experiment with animation to convey the timing and magnitude of risk reductions in additional cognitive interviews.

We anticipate continuing with survey development in the coming months. If all continues to go well, MDH will have the option of implementing their survey as early as summer 2004.

THE EFFECTS OF AGE AND FAMILY STATUS ON THE VALUE OF STATISTICAL LIFE:
EVIDENCE FROM THE AUTOMOBILE MARKET AND A NATIONAL SURVEY OF AUTOMOBILE USE

by

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Research Strategy

We develop a theoretical model in which automobile safety is shown to be a family public good where the marginal cost of purchasing and operating a safer automobile is set equal to the usage-weighted sum of the values of statistical life (VSL) of family members.

Using this theoretical result we can estimate the VSL for different family members (children, adults and seniors) by collecting primary data on automobile usage by family members that is combined with secondary data from both the automobile market and the FARS data set on automobile accidents.

An important issue that has clouded the potential reliability of the VSL obtained from estimated hedonic price functions for automobiles (that include risk of death) is that prior studies have shown what appears to be a positive correlation between fuel consumption and the price of automobiles rather than the expected negative correlation since people should be willing to pay less for cars with poor fuel economy (See Atkinson and Halvorsen, 1990, and Dreyfus and Viscusi, 1995). Our theoretical work provides a possible explanation that also suggests a revised estimation procedure.

Theory: Fuel Consumption

To begin, we address the problem of fuel consumption by considering the case of a single individual (buyer) with no family who may, or may not, survive for a single period. We then consider the choice of fuel consumption by makers.

The Buyer's Decision:

Let

c = consumption,
w = wage income,
r = risk of a fatal automobile accident per mile driven,
Π = probability of survival without automobile fatality risk,
Π-r = probability of survival with automobile fatality risk,
m = total miles driven
a = level of some other automobile attribute
P(r,a) = automobile price per mile driven (decreasing in r)
F*(r,a)) = fuel consumption per mile (increasing in r and a)
G = price of fuel
U(c,a,m) = strictly concave utility function.
Note: subscripts or primes denote derivatives where appropriate.

Note that we propose that the individual realizes that the fuel consumption of the car is itself a function of the attributes of the automobile. We will justify this proposal when we consider the manufacturer's decision below.

To abstract from the life cycle issues of owning and financing an automobile, we analyze the problem in terms of the annualized price per mile of owning the vehicle, P, without loss.

The buyer is assumed to maximize expected utility,

$$(\Pi - rm)U(c, a, m), \qquad (1)$$

where it is assumed that the death state provides no utility because the individual has no family, subject to the budget constraint,

$$(\Pi - rm)(w-c) - P(r,a)m - GF^*(r,a)m = 0. \qquad (2)$$

The optimal choice for r, risk per mile, is determined by

$$VSL = -(P_r + GF_r^*), \qquad (3)$$

where

$$VSL \equiv (U/U_c) + w - c. \qquad (4)$$

The optimal choice of the attribute, a, is determined by

$$U_a/U_c = m(P_a + GF_a^*) \quad (5)$$

The total miles driven, m, is determined by

$$U_m/U_c - rVSL - GF^* = P \quad (6)$$

<u>The Maker's Decision</u>

Competitive automobile manufactures will be forced to minimize the cost per mile of driving their automobiles including both the capital and fuel cost per mile of automobile life given the choice of other characteristics (r and a).

Consider the design problem of a particular manufacturer with a cost of production per mile of life for the cars that they offer of C(r,a,F). Given a particular choice of r and a by buyers, the maker is forced by competitive pressure to minimize the total cost per mile to buyers,

$$C(r,a,F) + GF. \quad (7)$$

The condition for optimal fuel consumption in the engineering design of the vehicle is then

$$-C_F = G. \quad (8)$$

This implies that there is an optimum fuel consumption F*(r,a) for any choice by consumers of r and a and the cost function relevant for the hedonic price solution for profit maximization over r and a by the maker is C*(r,a,F*(r,a)).

The maker faces a hedonic price function only defined in r and a, P(r,a), not fuel consumption which is optimized in the engineering design of the vehicle, and maximizes profits

$$P(r,a) - C^*(r,a,F^*(r,a))$$

with respect to a, implying

$$P_a = C_a^*, \quad (9)$$

and with respect to r, implying

$$P_r = C_r^*. \quad (10)$$

In summary, given G, the price of fuel, the choice of F will be made by the automobile maker since fuel usage will be optimized by makers for any combination of attributes chosen by consumers. Consumers and makers are faced with a hedonic price function P(r,a) which is the envelope curve of the cost tradeoffs for makers and value tradeoffs for consumers between attributes. Buyers face a pre-optimized choice of fuel consumption, F*(r,a), for each level of attributes that they choose in their purchase decision.

If these arguments are correct, the appropriate procedure is to estimate F*(r,a) and P(r,a) and use (3) above to estimate the VSL for the individual from these relationships and the price of gasoline, G.

The VSL for Family Members

The model developed above can be extended to a family setting by using the Nash cooperative bargaining between parents approach employed by McElroy and Horney (1981).

Let

- i = 1, 2,….,n denotes individual family members,
- i = 1 denotes the mother,
- i = 2 denotes the father,
- i = k = 3, …..,n denotes children,
- c_i = consumption of the ith family member,
- w_i = wage of family member i,
- r= automobile fatality risk per family member per mile,
- Π_i = probability of survival, excluding automobile fatality risk, of i,
- m = total vehicle miles driven
- m_i = total miles of driving for family member i
- P(r,a) = automobile price per mile driven,
- F*(r, a) = fuel consumption per mile driven,
- $U^k(c_k,a,m_k)$ = child's utility function,
- $U^i(c_i;\ldots, m_i,a,(\Pi_k\text{-}r)U^k(c_k,m_k),\ldots)$ = parent's utility function, and
- E^i = individual expected utility in separation (i = 1, 2).

In the Nash cooperative bargaining solution,

$$[(\Pi_1\text{-}rm_1)U^1 - E^1]\,[(\Pi_2\text{-}rm_2)U^2 - E^2], \qquad (11)$$

is maximized with respect to c_i, r, a, m, and m_i,
subject to the budget constraint,

$$\sum_{i=1}^{n} (\Pi_i\text{-}rm_i)\,(w_i - c_i) - (P - GF^*)m = 0, \qquad (12)$$

and constraints on the use of the car such as,

$m - m_i \geq 0 \qquad i = 1,\ldots, n$

so that no individual family member can ride more miles than the car itself travels, and

$m_1 + m_2 - m_{12} - m_k \geq 0 \qquad k = 3,\ldots, n$

so that no child can ride more miles than the parents can collectively drive the child. Note that, to avoid pointless complication of the model, m_{12} is taken to be a constant.

The resulting conditions for choosing the level of automobile risk and miles driven imply that the individual VSLs of family members all take the form:

$$VSL_i \equiv U^i/U^i_c + w_i - c_i \qquad i = 1,\ldots,n. \qquad (13)$$

The choice of automobile risk, r, is determined by

$$\sum_{i=1}^{n} k_i VSL_i = -(P_r + GF_r^*) \qquad (14)$$

where usage weights for the vehicle for each family member are defined as $k_i = m_i/m$.

Estimation Strategy

Since available measures of vehicle safety are affected by selection bias (more dangerous drivers are attracted to Corvettes and safer drivers to minivans) the FARS data set was used to estimate vehicle risk for vehicles in the sample for a standard driver. This corrected risk is used in estimating the hedonic vehicle price function.

Hedonic vehicle price and separate fuel consumption equations were estimated to calculate the per mile cost of reducing risk for vehicles purely as a function of vehicle (not driver) attributes. This allows estimation of the rhs of equation (14).

Since data were not available on m_i and m, we conducted a national survey to obtain the necessary information to allow estimation of the VSL for children, adults, and seniors using equation (14).

Because m_i and m are endogenous variables in a system of simultaneous first order conditions, a two-stage procedure is required to obtain consistent estimates using equation (14). In the first stage, reduced-form equations for m_i and m are estimated using appropriate exogenous variables. The predicted m_i and m that are uncorrelated with the residuals in equation (14) are then used as instrumental variables for m_i and m to obtain consistent estimates of the VSL for children, adults and seniors.

Survey Design and Implementation

The survey consisted of two parts, a telephone screening survey used to develop an appropriate sample and collect information on usage, followed by a mail survey used to collect subjective probability measures.

Both the telephone and mail surveys were extensively pre-tested and revised prior to implementing a pilot aimed at 80 households to formally test the telephone/mail survey methodology.

The purpose of the telephone survey was to identify appropriate households and to obtain data on automobile usage that was judged too difficult for respondents to fill out themselves in a mail survey.

Both the telephone and the mail survey were developed following Donald Dillman's Tailored Design Method (1999).

The telephone survey:

- Determined if a household met the requirements for the sampling.

- Asked for detailed information on automobiles owned or leased by the household and elicits information on the residents' ages and relationships.

- Elicited the total mileage driven and percentage of miles that each member of the household rides in each of the three most driven cars. Needless to say, these are difficult questions and necessitated a personal telephone interview with trained interviewers.

- Employed a random digit-dialing sample of 8519 telephone numbers from Sample Survey Inc. (Note that random digit dialing produces a large number of non-household, disconnected, or ineligible numbers for household surveys.)

- Was implemented between July 1 and August 5, 2001 and employed a minimum of 13 attempts to reach each telephone number.

The overall response rate was 40%. This produced 1,235 completed interviews. Of these, 926 or 75% agreed to participate in the mail survey.

The follow-up mail survey:

- Was titled "WHAT ARE YOUR VIEWS ON AUTO SAFETY," and shows a picture of a family next to a Ford Windstar (thanks to Ford for granting permission to use the photo).

- Thanks the respondent and repeats the information on the most, second most and third most driven automobiles.

- Asks about insurance and repair costs and features of each of the vehicles.

- Collects subjective risk information from respondents that requires use of risk ladders and asks for a subjective risk assessment of having a fatal accident (compared to the average driver in the same type of automobile) for the respondent, for a child's risk of dying relative to an adult's risk in a serious automobile accident and for their perceived risk of the safety of the vehicles that they drive.

The mail survey was sent in waves from July 6, 2001 to August 6, 2001. The survey packet included a letter, a $5 cash incentive, the 12-page survey booklet, and a post-paid return envelope. The overall response rate after multiple contacts including reminder phone calls for the mail survey was 74% with 625 completed surveys, exceeding the initial target of 600.

Estimating the Components of the VSL Model

Vehicle Risk (Step 1):

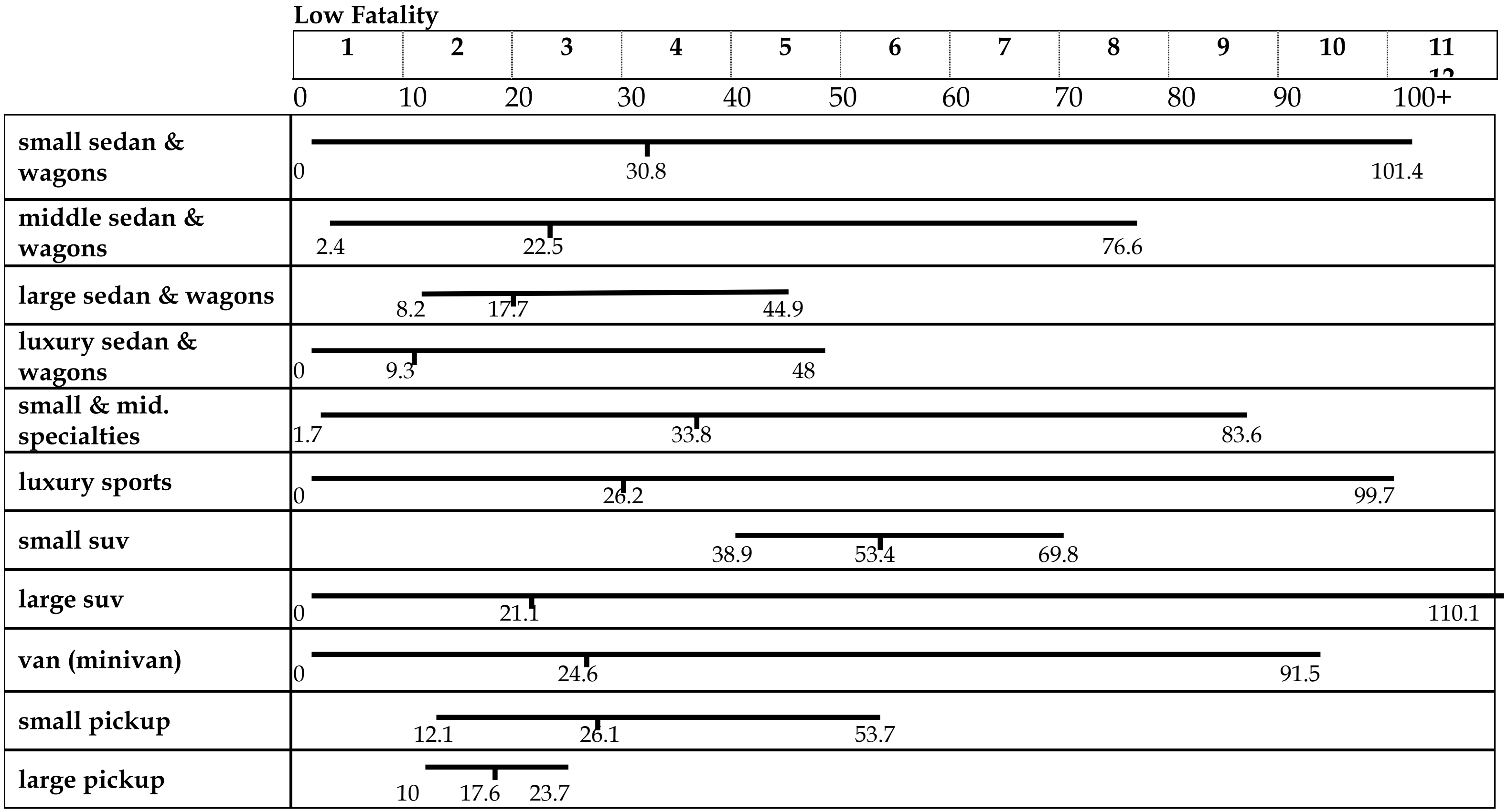
Data from the Fatal Accident Reporting Service (FARS) and National Personal Transportation Survey (NPTS) were used to estimate the driver independent risk of vehicles. This analysis has been presented in full in a report to the EPA (Environmental Protection Agency) and a research paper.

This risk was determined by the probabilities of having different types of accidents (one-vehicle, two-vehicle and multi-vehicle), and the probabilities that the occupants will survive in these accidents. All of these probabilities are functions of the vehicle's characteristics and the characteristics of the driver and the occupants.

The safety rating of each type of vehicle is computed using the same set of characteristics for the driver and the occupants.

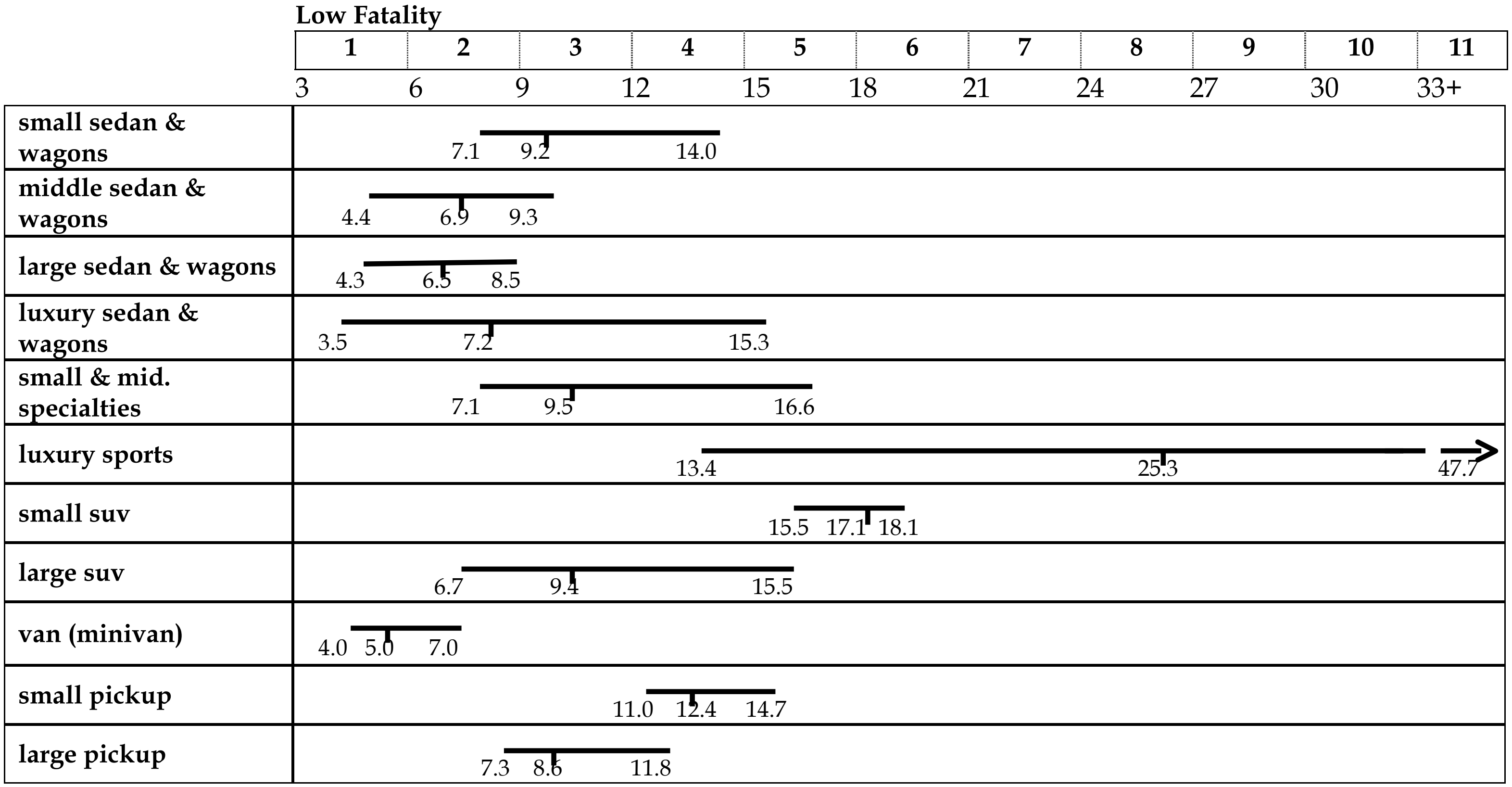
The safety rating used in the hedonic models for each type of vehicle was computed under the assumption that there are two adults in each vehicle who drive 14,000 miles in a year. The effect of making this assumption (as shown in the standardized risk scales) is that some vehicles, which have high-observed rates of fatalities, such as pickup trucks, have lower predicted rates of fatalities. The reason is that the specified occupants are more safety conscious (e.g. by wearing seat belts) than the typical behavior of the actual occupants in the fatality data.

Unadjusted Scales for the Risk of Mortality



Note: The scale is based on the observed total fatalities in year 1996-1997 per 100,000 vehicles (1995 model year) on road per 10,000 miles driven (average annual miles driven is 13989 miles).

Standardized Scales for the Risk of Mortality



Note: The scale is based on predicted total fatalities per 100,000 vehicles (1995 model year) per 10,000 miles driven with 2 occupants.

Hedonic Models (Step 2):

Parameter Estimates for the Hedonic Equations

Variable	Model A Estimated Coefficient	t ratio	Model B Estimated Coefficient	t ratio
Dependent	Fe_city		P_{auto}	
Constant	2.5689	14.13	7.7174	25.45
Value Retained	0.0549	3.35	0.4594	11.10
Mortality Rate	0.0258	1.99	-0.0690	-3.53
Injury Rate	0.0330	4.01	-0.0161	-1.31
Reliability Rating	0.0170	5.05	0.0617	5.23
Acceleration	-0.2290	-8.04	0.6014	13.99
Traditional Styling	-0.2786	-5.21	0.6035	7.56
Class2	-0.1873	-16.56	0.2426	14.34
Class3	-0.2751	-14.69	0.3734	13.28
Class4	-0.2852	-19.29	0.6752	29.76
Class5	-0.6397	-37.47	0.8127	31.94
Class6	-0.4846	-24.84	0.6558	22.67
Class7	-0.4352	-27.49	0.3398	14.31
Year91			0.1137	6.31
Year92			0.2100	10.53
Year93			0.2977	13.16
Year94			0.3880	15.30
Year95			0.4474	16.14
Ford	0.0347	1.90	-0.0972	-3.58
GM	0.0334	1.94	-0.0879	-3.44
Chrysler	0.0196	1.12	-0.1148	-4.43
Germany	-0.0562	-2.84	0.1489	5.05
Japan	0.0470	2.73	-0.0430	-1.71
MB	-0.0078	-0.33	0.5237	14.89
R^2	0.7626		0.8996	

Estimating VSL by Age Group and Household Type (Step 3):

Note that the simple one car model can be easily extended to multiple vehicles if the last car purchased is the most-driven, newest vehicle and is chosen subject to the constraint of prior vehicle purchases.

In the case of multiple vehicles, the allocation of driving miles across family members and vehicles is endogenous and reduced form equations must be used to predict this allocation and miles ridden and driven.

Thus, our estimates of the VSL for family members uses the optimizing condition for the risk level choice for the most-driven vehicle since other, now non-optimal, vehicles may be retained in a family fleet because of transactions costs.

Three typical family groups own most of the total 783 vehicles used in the analysis:

1) PA: pure adults family (424 vehicles);
2) AK: family with both kids and adults (267 vehicles);
3) PS: pure senior family (57 vehicles).

To address possible income effects on the VSL, we divide families into three types:

1) Low income family: Per Capita Income<=$15000;
2) Middle income family: $15000<Per Capita Income<=$37500;
3) High income family: Per Capita Income>$37500.

Three no intercept OLS regressions were run, one for each of three family groups. (If we run regressions with intercepts, the intercepts are insignificant).

The average ages for adults, seniors and kids in our data set are 39.8, 74.2 and 7.8 respectively, so the value for each group can be interpreted as the average VSL for that age.

The estimated results are inconsistent with the simple discounted present value of life-year model.

The estimated results without intercepts are shown in the following table:

Estimated VSL for Families

Family Type	Income Type	Sample Size	Person Type*	VSL (million)	t value
PA	Low	67	Adult low	6.81	9.37
	Middle	188	Adult middle	6.07	13.63
	High	169	Adult high	7.27	14.88
AK	Low	133	Adult low	3.36	8.36
			Kid low	2.54	3.64
	Middle	120	Adult middle	3.79	8.96
			Kid middle	5.12	6.46
	High	14	Adult high	-	-
			Kid high	-	-
PS	Low	9	Senior low	7.67	4.60
	Middle	31	Senior middle	8.42	6.85
	High	17	Senior high	8.25	3.35

Note:

1. *Person Type is Defined as:
   Adult low: adults from low-income families;
   Adult middle: adults from middle-income families;
   Adult high: adults from high-income families;
   Kid low: kids from low-income families;
   Kid middle: kids from middle-income families;
   Kid high: kids from high-income families;
   Senior low: seniors from low-income families;
   Senior middle: seniors from middle-income families;
   Senior high: seniors from high-income families.
2. –means insufficient sample size to obtain reliable estimates.

<u>Fragility</u>

It should be noted that the analysis so far has omitted an important effect that has not previously been considered, fragility. Seniors are, on average, more fragile than adults and kids are, on average, less fragile than adults. From the mail survey data, people's perception of the likelihood of a 70-year-old person dying compared to an average adult when involved in a serious accident is about 39% higher. For children, the survey data shows that the perception of the likelihood of a 8-year-old child dying compared to an average adult when involved in a serious accident is about 12% lower.

Pooling the data for the different income groups and adjusting for fragility does imply that, with the exception of parents facing the financial stress of raising children, that the VSL for kids, adults without kids, and seniors follows the humped shaped pattern predicted by theory.

Fragility Adjusted VSL ($million) by Family Group

Age Group	Fragility Unadjusted VSL	Fragility Adjusted VSL
Kids(AK)	3.63	4.13
Adults(AK)	3.72	3.72
Adults(PA)	6.62	6.62
Seniors(PS)	8.44	6.07

Income Elasticity Measurements

Income elasticities can be obtained by assuming that

VSL=a+b(Y-averageY), and estimating:

$$MC_{risk} = (a_{kids} + b_{kids}\,(Y\text{-average}Y))(M_{kid}/TVM) + (a_{adults} + b_{adults}\,(Y\text{-average}Y))(M_{adult}/TVM + (a_{senior} + b_{senior}\,(Y\text{-average}Y))(M_{senior}/(TVM)$$

Note that the estimated coefficients for the constant term, a, are estimates of the VSL for average per-capita income by person by family type and the income elasticity at this point is: b(averageY)/a.

The very low income elasticities (0-.33) obtained in this study suggest that utility may depend on many things other than money income. Recent research on the psychology of happiness suggests that income plays a relatively minor role compared to family, friends, and work satisfaction.

Income Elasticity Estimates

Family Type	Sample Size	Per Capita Income	Person	a (million)	t value	b	t value	elasticity
PA	424	40776	Adult	6.67	22.28	18.19	2.05	0.111
AK	267	18709	Adult	3.59	12.25	0.62	-0.02	-0.003
AK	267	18709	Kid	3.64	6.80	65.08	1.14	0.335
PS	57	26462	Senior	8.18	8.97	7.97	0.14	0.026

Income elasticities are obtained by assuming that VSL=a+b(Y-averageY), and estimating:

MC_{risk} =(a_{kids} + b_{kids} (Y-averageY))(M_{kid}/TVM)
+(a_{adults} + b_{adults} (Y-averageY))(M_{adult}/TVM
+ (a_{senior} + b_{senior} (Y-averageY))(M_{senior}/(TVM)

Note that the estimated coefficients for the constant term, a, are estimates of the VSL for average per-capita income by person by family type and the income elasticity at this point is: b(averageY)/a.

Draft - Do Not Quote or Cite

Willingness to Pay for Reduced Accident Risk for Children: Inferences from the Demand for Bicycle Safety Helmets

Robin R. Jenkins
Nicole Owens
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Abstract: This paper develops a household production model in which parents produce bicycling safety for their children. Using data from the National Survey on Recreation and the Environment, via a random utility model, we estimate conditional indirect utility as a function of bike safety and infer WTP for reduced risk of fatal and non-fatal head injury. We estimate parental values for reducing biking risks faced by their children. We obtain estimates of parental values for children that include a VSL of $9.5 million and a VSI of $7.0 million.

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1. Introduction

Improving children's health is a relatively new federal priority. The Clinton Administration's Executive Order (E.O.) 13045 directs policy makers to examine and reduce health and safety risks to children. This directive has led to a new need for more accurate measures of the benefits of policies that improve children's health; more specifically, for better estimates of the economic value of reducing childhood risks. To date, the economics literature contains only a handful (albeit a growing handful) of such estimates, whereas it contains a multitude of estimated values of reducing risks to adults. Thus for policy applications, at present, analysts must choose between two practical but conceptually lacking alternatives for child health values. The first is to rely on estimates of the medical costs associated with an illness. The second is to transfer estimates of willingness-to-pay (WTP) for risk reductions estimated for adults to child populations.

The first approach has been labeled "cost-of-illness" and usually involves estimates of direct medical expenditures and of the more indirect cost due to lost work time (or for children, future lost work time). Conceptually, the cost-of-illness approach simply measures ex post costs and does not attempt to measure the loss in utility due to pain and suffering or the costs of any averting behaviors that individuals have taken to prevent an illness. Some consider a cost-of-illness estimate to be a lower bound estimate of WTP because it fails to account for many effects of disease, such as lost leisure time or pain and suffering (Harrington and Portney 1987; Berger et al. 1987). Others suggest that cost-of-illness might exaggerate risk values since in some cases the cost of averting behaviors that prevent a medical condition can be far less than the ex post costs of treatment (insert cite). Economists widely recognize that the preferred measure to assess the benefits of federal policy is to estimate WTP for ex ante risk reduction rather than using cost-of-illness estimates (U.S. EPA 2000).

Due to a lack of WTP estimates for children, at present analysts routinely transfer WTP estimates for adult risk reductions to child populations. The appropriateness of these transfers is questionable (Dockins et al. 2002; Agee and Crocker 2003). Researchers are currently asking whether a risk reduction of the same character and size should be valued differently when experienced by children as compared to adults. This paper is a first step in shedding light on this issue by estimating parental values for reducing the risk of a bicycle injury to their children. In a future paper, the authors will estimate adult values for reducing the same risk to themselves and compare the values.

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 helmet market. A bike helmet is a personal safety product whose ownership is generally assigned to a single individual, 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 willingness-to-pay for safety. This paper and future work will take advantage of these desirable attributes of the bicycle helmet market by examining households' purchase decisions regarding helmets for adults and children. We develop a household production model in which adults produce bicycling safety for themselves or parents produce it for their children. Via a random utility model, we estimate conditional indirect utility as a function of bike safety and infer WTP for reduced risk of fatal and non-fatal head injury. We estimate parental values for reducing biking risks faced by their children and, in the future, we will estimate adult values for reducing their own risks.

Data were obtained from a telephone survey that was part of the most recent National Survey on Recreation and the Environment. Respondents 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 20 to 59 who report having bicycled themselves within that same time frame. In addition to socioeconomic information, we have information on the amount of bike-riding, the perception of helmet laws, the importance of helmet features and the price paid for the helmet. Data on the risk of bicycling is obtained from the Centers for Disease Control (CDC) and varies according to age, gender and race.

Previously in the economics literature, analyses of safety product markets have estimated the value of risk reduction by assuming that the marginal benefit of risk reducing activities equates with their marginal cost. These papers have lacked price information and have based estimates of the value of risk reduction solely on estimates of implicit values (and amounts) of time and/or on estimates of monetized dis-utility (Blomquist 1979 and 1991; Blomquist, Miller and Levy 1996; Carlin and Sandy 1991). Other product market analyses estimate lower bound values of risk reduction based directly on highly aggregated product prices (Dardis 1980; Garbacz 1989; Jenkins, Owens and Wiggins 2001). The current paper adopts a different approach, one developed outside the safety product literature. Dickie and Gerking (1991) and Agee and Crocker (1996) develop household production models in which utility depends upon health or risk of family members. The household makes many unobserved choices regarding the production of health or risk but there is one observable discrete choice, such as whether or not to purchase medical care. The probability of the discrete choice is estimated via a random utility model with which welfare effects can be computed (Small and Rosen 1981). For the current paper, the discrete choice is whether or not to purchase a helmet.

To estimate how consumer WTP for risk reduction varies with the age of the beneficiary requires an ability to discern 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 separately the WTP for bicycle safety for children and adults.

The choice of whose preferences to rely upon to determine the value of childhood risk reductions is an important one. Dockins et al (2002) suggests that the parental perspective is advantageous for multiple reasons.[1] The current paper examines parental decisions regarding bicycle safety, specifically regarding the purchase of a child bicycle helmet. Also reported by parents are other variables in the demand function for helmets, such as the perception of helmet laws and the amount of time a child spends riding. Thus, for children's safety, we estimate a parent-determined WTP.

The following sections of the paper develop a model of household production and then translate propositions from the model into empirically testable form. We describe the data that we analyze and the tentative results that we obtain via a logit model of the purchase decision.

2. Household Production Model

This section presents a household production model of utility from which we derive the compensated demand for bicycle safety helmets. The household perspective is chosen in order to represent helmet purchase decisions made by parents for their children. However, the model can be easily adjusted to represent adults making decisions only for themselves, without explicit consideration of children. The model will illuminate the important underlying variables in the discrete choice decision of whether or not to purchase a helmet. The model also provides structure for the estimation of risk valuation. We derive from the model an equation to represent adult willingness to pay for own risk reduction as well as parental willingness to pay for child risk reduction. This section draws heavily from household production and random utility models developed by Dickie and Gerking (1991), Agee and Crocker (1996) and Agee, Crocker and Shogren (2001), which in turn drew from Small and Rosen (1981).

Parents derive utility, U_p, from consumption of commodities and activities, Z_p, produced for themselves, and from the risk they perceive themselves as facing by riding a bicycle, R_p. Parents also derive utility from commodities and activities, Z_c, produced for each of their $i = 1, ..., n$ children and from the risk they perceive their children face, R_c, from bicycling. If we represent a single-period, two-generation family in which children's utility is additive to parents' utility but separable, then:

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[1]Four possible perspectives for valuing children's risk reductions are suggested by Dockins et al. (2002): that of society, the child, adult-as-child, and parent.

$$U_p = u_p(Z_p, R_p) + \sum_{i=1}^{n} \alpha_{pi}(\gamma)u_{ci}(Z_{ci}, R_{ci}), \qquad (1)$$

where $U'_z \geq 0$ and $U'_R < 0$. $U_p(.)$ is quasi-concave and increasing in at least some of the Z's, and is finite whenever some of the Z's are zero (Small and Rosen 1981). Parents combine their time, effort and market good purchases to produce child-related commodities, Z_c. The u_p and u_c functions differ because children and their parents experience their environments differently. The multiplier $\alpha_{pi}(.)$ converts child i's utility into his parents' utility and depends on γ which represents family characteristics that affect the conversion of childhood utility into parental utility.

Parents also combine their time, effort and market purchases to affect the level of risk, R, faced by themselves and their children from riding bicycles:

$$R_j\left(D_j, H_j, b_j, \gamma\right)_{j=p,c} \qquad (2)$$

where D represents the amount of time spent riding a bicycle, H represents the use of a bicycle safety helmet, b is the level of risk per unit of riding time, assuming no helmet-wearing, that is expected for the rider and varies according to the risk taking behavior of the individual, and γ represents any family characteristics, such as parents' educations, which may influence risk perception. As mentioned already, helmets are unique in their ability to reduce by significant proportions the risks of injury and death from bicycling. Spending on helmets produces nothing of value other than reductions in R.

Let q denote a vector of market prices for commodities and activities; t denote a vector of parental time inputs, and t_s denote time spent away from paid work. Then the parental income constraint can be written as a sum of expenditures on own and children's consumption,

$$Y_p = r_p Z_p + r_{hp} H_p + \sum_i \left(r_{ci} Z_{ci} + r_{hci} H_{ci}\right) \qquad (3)$$

where $r_j = (q_j + wt_j)$; $j = p, c, hp, hc$; and $w = Y_p/(T-t_s)$ so that parents' income, Y_p, determines their opportunity cost of time, w. Parents choose t_j, R_p, Z_p, R_c and Z_c to maximize total utility in (1) subject to (2) and (3).

Assume that parental WTP is the largest income that parents must forego after a reduction in expected risk, to maintain ex ante expected utility. Parental WTP estimates the value to the household of a reduction in the level of risk, b, that the rider is expected to face. Let $V_p(.)$ denote the parents' indirect utility function from the above utility maximization problem.

Given the properties of expression (1), $V_p(.)$ is continuous and strictly increasing in household income, Y_p, and thus can be inverted to find the expenditure function, $e[.]$, satisfying

$$U_P = V_p\left(r, D, b, \gamma; e\left[r, D, b, \gamma\right]\right). \qquad (4)$$

Differentiating (4) with respect to b yields adults' or parents' marginal willingness to pay for a reduction in the expected riskiness in either their own or their child's bike riding activity.

$$MWTP_b \equiv \partial e / \partial b = -(1/\lambda)\partial V_p / \partial b, \qquad (5)$$

where $\lambda \equiv \partial V_p / \partial Y_p$ is the marginal utility of income.

Expression (5) portrays parents' marginal disutility of the expected risk of bicycling converted to monetary units via the marginal utility of income. In general, this measure is empirically intractable because actual utility levels are not observed. However, an empirical representation is available via a discrete choice model of the decision to purchase a bicycle helmet.

The household production model portrayed in (1) through (5) can be adjusted to represent adults making decisions for themselves without explicit consideration of children by assuming $Z_{ci} = 0$ and $R_{ci} = 0$ for all i.

3. Empirical Model

A parent's decision to purchase a helmet or not is a discrete choice based upon information about the risk reduction provided by helmets. Let $\bar{v}_H$ denote the maximum attainable expected utility if a helmet is purchased and let $\bar{v}_O$ denote the maximum attainable expected utility if a helmet is not purchased. For households characterized by b and γ, the choice to purchase a helmet or not is made by comparing these two expected utility levels, given income, Y_p, and a wage-price vector, $r = (w, q)$:

$$\begin{aligned} H &= 1 \text{ if } \bar{v}_H - \bar{v}_O > 0 \\ H &= 0 \text{ otherwise.} \end{aligned} \qquad (6)$$

The utility difference is specified econometrically as

$$\bar{v}_H(.) - \bar{v}_o(.) = X'\beta + \varepsilon \qquad (7)$$

where X is a vector whose first element is unity and whose remaining elements measure arguments of the conditional utility function in (4), β is a parameter vector and ε is a random error component. The probability of purchasing a safety helmet, conditional on ε, is

$$\Pr(H = 1) = F(X'\beta + \varepsilon), \qquad (8)$$

where $H = 1$ if a helmet is purchased and 0 otherwise, and $F(.)$ is the symmetric distribution of V conditional on ε.

Let $\overline{X}'\hat{\beta}$ be the inner product of explanatory variables and estimated coefficients, with each explanatory variable except risk set equal to its sample mean. Assume that ε is distributed standard logistic and note that bicycle expenditures are a small part of the family budget. Then, following Small and Rosen (1981) if the compensated demand for a bicycle helmet is approximated by its Marshallian counterpart, parents' $MWTP_b$ in expression (5) is approximated by

$$MWTP_b = -(\hat{\beta}_b / \hat{\lambda}) F(\overline{X}'\hat{\beta}), \qquad (9)$$

where $\hat{\beta}_b$ is the estimated coefficient for risk, $\hat{\lambda}$ is the estimated marginal utility of income, $F(.)$ is the standard logistic cumulative distribution function and $F(\overline{X}'\hat{\beta})$ is the estimated probability of purchasing a helmet.

Helmets seem essential to reducing the risk of head injury from bicycle riding thus the concern shown by Bockstael and McConnell (1983) that (9) will yield an incomplete measure of the true $MWTP_b$ in (5) is lessened.

4. 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. Other data we relied upon includes income and population data from the U.S. Census Bureau, weather data from the National Climatic Data Center, and pedal cycle injury and death statistics from the Centers for Disease Control and Prevention (CDC).

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. Between July 2000 and July 2001, the NSRE asked respondents questions related to bicycling, especially regarding bicycle helmet purchases and use. 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.

The initial data set included 15,010 observations.[2] After eliminating observations for respondents who did not ride a bicycle in the past year or have a bike riding child between the ages of 5 and 14[3], the samples contained 2,463 respondents with a bike riding child between the ages of 5 and 14, and 1,493 adult respondents who rode bikes themselves. 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 order not to lose those observations where

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[2]The data set comes from versions 5, 7, and 9 of the NSRE which contain the adult and child bicycle helmet modules.

[3]Observations were eliminated from the data set if income was greater than $4 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; if the respondent was less than 19 years old; 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

household income was the only relevant variable that was missing, we used data from the 2000 Census[5] to create a proxy income variable. Proxy income is equal to the median family income by race for the zip code in which the respondent lives. If the respondent lived alone or in a house with roommates, proxy income is equal to the mean individual income by race for his or her zip code. The final data set used for our analysis includes 1,984 child observations and 941 adult observations. Means and standard deviations of the data for children are summarized in Table 1.

Of the 1,984 child observations, 89.5% were helmet purchasers. These numbers are similar to a 1999 U.S. Consumer Product Safety Commission (U.S. CPSC 1999) survey that found 84% of bike riding children under 16 own a helmet.

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. Interestingly, 52% of the respondents in our child sample said that there was a law in their community or state requiring children to wear bicycle helmets and 17% said they did not know whether there was a law applicable to children. People may believe that a helmet law exists in their community when they are exposed to a helmet education campaign. For example, 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.

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. The CDC reports annual pedal cycle deaths and injuries by age, race, and gender. We combine this data with information on population and the percent of population that rides a bicycle in order to assign a fatal and non-fatal risk measure to each individual in our sample that is equal to the average for that individual's age-gender-race

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purchase decision.

[5]Data was obtained from Census 2000 Summary File 1 and Census 2000 Summary File 3 (http://www.census.gov/main/www/cen2000.html - accessed May - June 2003).

group.[6]

5. Empirical Implementation

We estimate a purchase equations representing parents' purchases of helmets for children. The indirect utility function in (4) suggests that the purchase decision depends on a variety of variables including the wages of the family and the price of the helmet. We combine these two variables and include in the equation one variable measuring household income less the helmet price. To measure the amount of time spent riding, *D*, we include a variable indicating the number of days ridden by the bicycler during the previous 30 days. Since the prevailing weather during the month in which the survey was administered would influence the number of days a bicyclist might ride, we also include the average temperature during that month and a term that interacts avidity with temperature. We include separately both the rate of death and the rate of injury to measure the risk of bicycling. To represent the attributes of families, γ, that either affect the conversion of childhood utility into adult utility or affect risk perception we include a variety of socioeconomic information: age, gender, race and education of the bicycler and/or his parents. (For the child equation we substitute parent's education for rider's education and we include an indicator variable for whether the parent respondent rode. For age, we include both the parent's age and the child's.) Finally, we include two indicator variables that indicate whether the respondent believed that there was a helmet law requiring use or whether the respondent was unsure.

Table 2 presents the results of four logit models of the decision to purchase a helmet for children and adults. The first column gives the primary results. The sign of the coefficient on the child's age is positive, in agreement with the burgeoning consensus among studies targeted at children that parent's valuation of risk reduction varies inversely with child age (Agee and Crocker 2003). The suggestion is that as a child ages through middle childhood, the probability that a bike helmet will be purchased for him declines. Similarly, parents of male children are less likely to purchase a helmet. This could indicate a greater parental acceptance of risky behaviors undertaken by boys compared to girls or undertaken by older children compared to younger ones. Alternatively, parents of boys and older children might have lower expectations regarding their children's compliance with parental wishes for the child to wear a helmet. Parents would naturally be reluctant to purchase a helmet that they believe it will not be worn.

The probability that a helmet will be purchased for a child increases if the respondent believed there was a law requiring helmet usage or if the respondent was unsure about the presence of a helmet law. This finding bodes well for the recent dramatic increase in popularity of helmet laws for youngsters. Parents really are responding to such laws. However, parents

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

also respond positively to uncertainty about the existence of a law.

As expected, greater household income positively affects the probability that a parent will purchase a helmet for her child as does greater education level. The indicator variables for black and white race are significant and negative. Relative to households of other races (Asian, Pacific Islander, American Indian and others) these households are less likely to purchase a helmet for their child. The indicator variable for whether or not the parent rides a bike is significant and positive suggesting a greater awareness of bike safety issues by parents who themselves bike.

A parent's age is not correlated with the probability of purchasing a helmet. The indicator variable for whether or not the parent rides a bike is significant and positive suggesting a greater awareness of bike safety issues by parents who themselves bike. As expected, the rate of death and injury faced by the child as a consequence of bicycling is positively and significantly associated with the probability of purchasing a child's helmet.

In addition to the primary model described above, we estimate three additional logit models. To check the sensitivity of the results to the rather rough measure of avidity represented by the number of days ridden and the temperature variables, we re-run the logit and omit those three variables in specification (2), and omit just the two temperature variables in specification (3). The results are robust. Finally, we wished to include measures of the importance to the respondent of the helmet's appearance and comfort level. We include two variables indicating whether the respondent believed these features of the helmet were important in specification (4) and find that neither is significant, nor does their inclusion alter substantially the coefficients estimated for the remaining variables.[7]

Our principal purpose is to approximate parental WTP for child risk reduction. To do this we estimate for each respondent the percentage change in income necessary to keep utility constant when bicycling risk is reduced by one percent. This is achieved by evaluating equation (9) and converting to percentage terms. For specification (1) the resulting values of statistical life and injury for children are $9.5 million and $7 million, respectively. These estimates vary between $8.9 and $9.9 million for VSL and $7 and 8.4 million for VSI among the four specifications.

6. Discussion

These estimates of VSL for children are higher than most VSL estimates reported in the

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[7]The appearance and comfort variables are constructed with responses to questions in the survey regarding the importance of comfort and appearance and with the days ridden variable thus we omit direct measures of days ridden and temperature from specification (4).

literature for adults. A good summary estimate of a set of high quality, policy relevant adult VSL studies is provided by the EPA. To analyse proposed regulations, EPA relies on a VSL estimate of approximately $6 million (in 2000 dollars). This estimate was derived by fitting a Weibull distribution to 26 adult VSL studies (21 that use the hedonic wage method and five that examine stated preferences). The suggestion is that parents value reductions in risk to their children by more than adults value reductions in risk to themselves. However, this suggestion is made with caution since there are important differences between the nature of the risk being examined and the valuation estimation methodology in the current study compared to the adult studies. In the future, we plan to estimate adult willingness to pay for reductions in bicycle risk and will more confidently make direct comparisons to our estimates for children.

Our VSL estimates for children are quite high relative to the two values for children found in the published literature: between $0.75 million (Carlin and Sandy 1991) and $4.0 million (Jenkins, Owens and Wiggins 2001)[8] However, these two studies were examinations of direct time and/or money expenditures on safety products. So, again the methodology is different enough to suggest caution in making comparisons.

To get an idea of the relative magnitude of the VSI estimates, we gathered information about the medical costs of non-fatal bicycle injuries in the U.S. A review of hospital discharge data in Washington state (1989-1991) found that treatment for nonfatal bicycle injuries among children ages 14 and under costs an average of $218,000 per injured child (Bicycle Helmet Safety Institute 2003). A cost of illness (COI) estimate would add to these direct costs, such indirect costs as the value of the parent's lost work time from caring for the sick child and the value of future lost wages due to any brain injury or long term debilitating injury to the child. Even after accounting for these indirect costs, the COI of non-fatal bicycle injury would be far less than our VSI estimates. Dickie and Gerking (1991) also obtain estimates of WTP that are higher than corresponding medical costs. Using a similar model and empirical method as in the current paper, the estimates of WTP for ozone control turn out to be about double the medical expenses associated with treating respiratory illness that is associated with ozone pollution. While the magnitude of the difference is much smaller, these findings and ours give examples when estimates of WTP are substantially higher than comparable COI estimates. The unmonetized costs such as pain-and-suffering might be the explanation.

On the other hand, the opposite is suggested by the WTP estimates inferred from demand functions for chelation therapy to reduce child lead burdens. Agee and Crocker (1996) estimate parental WTP for a 1 percent reduction in child lead burden as falling between $11 and $104. Lutter (1994) converts these WTP estimates into estimates of the value of a lost IQ point and obtains values that range from $1,100 to $1,900. Lutter compares these parental WTP estimates

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[8]These estimates are in 1997 dollars. The estimate for Jenkins, Owens and Wiggins (2001) is the upper limit of a range beginning at $1.1 million.

to government COI estimates of lost income due to lowered IQ and finds the latter to be much higher, approximately $8,800 per lost IQ point.

Dockins et al. (2002) attribute this difference to the fact that the WTP estimates represent the parental viewpoint while the COI estimates represent a lower bound of what a child should be WTP him or herself (if lending constraints were relaxed). Our own paper suggests that parental WTP for children is actually much higher than COI. The nature of the risks being valued by the two studies is quite different. Children with high body burdens of lead exhibit long-term cognitive and adaptive behavior deficits. In the short term, effects include hyperactivity, poor attention and learning problems. Risks of bicycling include catastrophic brain injury, concussion and contusion. A second important difference between the two studies is the education and income levels of parents in the study sample. Parents in the Agee and Crocker (1996) study had an average education level of 11 years and an average income of only $17,000 (1985 dollars). Almost 70 percent of our sample went to college and they earn an average of $60,000 (2000 dollars). Thus the Agee and Crocker paper examined a risk that imposes intangible effects, the most devastating of which are in the distant future, and estimated the WTP to reduce this risk among relatively low income parents. The current paper examines a risk that poses a dramatic immediate physical threat and estimates WTP among relatively high income parents. In light of these difference, the larger gap between WTP and COI for non-fatal bicycle injury is easier to understand.

In a future version of this paper, we will estimate a logit equation representing adult's helmet purchase decision for self. This will enable us to compare values of risk of the same nature and similar magnitude for children and adults.

Table 1
Means of Variables for Child Bicyclists
(Standard deviations are in parentheses)

	children (n=1984)
Own	0.895 (0.307)
Age	9.513 (2.871)
Parent's Age	38.855 (7.650)
Male	0.534 (0.499)
Helmet Law - Yes	0.519 (0.500)
Helmet Law - Don't Know	0.171 (0.377)
Household Income Minus Price($1000)	58.247 (39.635)
Black	0.088 (0.284)
White	0.887 (0.316)
Parent Rides	0.583 (0.493)
Highschool	0.284 (0.451)
College	0.671 (0.470)
Days Ridden	11.008 (10.937)

Fatal Head Injury Risk	5.300 E-6 (3.669 E-6)
Non-Fatal Head Injury Risk	3.083 E-3 (1.488 E-3)
Monthly Mean High Temperature (degrees)	62.413 (20.974)

Table 2 Econometrics Results for Logit Model of Purchase Decision for Child				
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Constant	1.225 (1.030)	0.573 (0.913)	0.898 (0.958)	0.338 (0.924)
Age	-0.122** (0.048)	-0.093** (0.045)	-0.120** (0.046)	-0.082* (0.046)
Parent's Age	0.014 (0.012)	0.021* (0.011)	0.020* (0.011)	0.019* (0.011)
Male	-1.848** (0.735)	-1.858*** (0.694)	-1.942*** (0.715)	-1.900*** (0.699)
Helmet Law - Yes	1.905*** (0.195)	1.877*** (0.183)	1.866*** (0.188)	1.887*** (0.184)
Helmet Law - Don't Know	1.012*** (0.224)	0.946*** (0.208)	0.896*** (0.212)	0.956*** (0.209)
Household Income Minus Price ($1000)	0.01*** (0.003)	0.01*** (0.003)	0.01*** (0.003)	0.01*** (0.003)
Black	-2.578** (1.035)	-2.882*** (0.976)	-3.00*** (1.002)	-2.802*** (0.972)
White	-1.528* (0.882)	-1.903** (0.828)	-1.912** (0.853)	-1.823** (0.828)
Parent Rides	0.631*** (0.164)	0.551*** (0.154)	0.570*** (0.158)	0.540*** (0.155)
Highschool	0.764** (0.319)	0.673** (0.297)	0.815*** (0.304)	0.712** (0.302)
College	1.303*** (0.323)	1.247*** (0.298)	1.298*** (0.305)	1.301*** (0.304)
Fatal Head Injury Risk	199886** (82924)	195097** (78693)	210878*** (80635)	189992** (79207)
Non-Fatal Head Injury Risk	254.2** (129.4)	286** (122.4)	276.3** (125.2)	305.9** (123.1)

Table 2 **Econometrics Results for Logit Model of Purchase Decision for Child**				
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Days Ridden	-0.016 (0.027)		-0.001 (0.007)	
Temp	-0.009* (0.005)			
Days Ridden * Temp	0.0003 (0.0004)			
Appearance Factor				9.810 (863.3)
Comfort Factor				13.398 (825.1)
Number of observations	1984	2159	2103	2114
Likelihood Ratio	232.724	238.397	233.163	247.622

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Valuing Environmental Health Risk Reductions to Children Workshop
Session IV Discussant Comments: Age-Specific Value of Statistical Life Estimates

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October 21, 2003

The two papers presented in this session provide empirical evidence using revealed preference methods to estimate to values associated with risk reductions to children. Thus far, we have heard presentations regarding theory and conceptual models that may be used to determine how children's health risk reductions can be valued and whose preferences should be used to elicit such values. Today, we are turning our attention to empirical applications.

In terms of policy, while EPA does not currently use age adjustments in our formal benefit-cost analyses, the research in this area can help inform policy decisions by providing information on how children's risks are valued relative to risks to adults. Such information can be used to prioritize decisions and highlight areas where new decisions might be needed regarding risk reductions.

Both the automobile and bicycle helmet studies presented in this session rely on revealed preference methods in which the analyst examines trade-offs between price and risk, or risk reduction, for a market good to infer how people might value the risk reduction. As we know, our traditional tools for valuation are often difficult to apply to children who do not control a budget and may or may not behave in a rational manner. In addition, there may be issues associated with asking a parent their willingness to pay for their own child in a stated preference study because of the emotions associated with that question. Product market studies, such as those presented in this session, hold promise because we can explore what parents spend on safety for their children, thus using real market transactions by the decision-maker to infer values.

In Bill Schulze's paper the "good" is an automobile, or more specifically, automobile safety. The idea is that children ride in cars that have various safety ratings. By looking at the choices parents make with regards to car purchases and time spent in the car the authors infer values of a statistical life for a child, as well as other family members.

They use a Nash cooperative bargaining model to motivate the decision-making, where investments in safety are a function of parent and child utility. They then conduct a telephone/mail survey where they ask people about the kinds of cars they drive and how many miles each member of the household spends in each car. This information is combined with safety ratings for the various cars to infer VSLs for adults, children, and various types of households.

The good in this study is well-defined and there is very accurate and detailed information regarding the safety of automobiles. Unfortunately, people likely value their cars for more than just safety. When deciding what car to purchase safety is likely to be a factor, along with comfort, fuel economy, and type. If these features of the car purchase decision are not carefully controlled then the authors may be over-estimating the VSL by attributing all of the spending to safety.

In the bike helmet study, the "good" is a bicycle helmet, which is used to protect against fatal risks and non-fatal injuries. The authors use a household production model to motivate the decision-making and a telephone survey where people are asked how much money they spent on a helmet and other information regarding its use. They combine this information with death and injury data to estimate a value of a statistical life and injury to a child.

The good in this study is also well-defined. In fact, the primary purpose of the good is safety for a specific member of the household. For these reasons it is not necessary to tease out the usage by various family members, as in the automobile study or with other goods that are jointly consumed. In addition, because the primary purpose of the good is safety it is plausible to attribute most, if not all, of the spending to risk reduction. While some of the spending may be for comfort and style, it is probably difficult, if not impossible to tease out these individual effects.

Turning now to the results. In the automobile study the authors estimate a variety of VSLs. I focus on the adult-child comparisons because these are most relevant for policy and comparable to the bicycle helmet study. The authors find comparable results for both the adult and child VSLs when they aggregate across income groups - both estimates are around $5 million. In terms of policy analysis, the results at the aggregate level, which is what we would be most likely to use in a benefit-cost analysis, may be somewhat comforting in that applying one value to all individuals comports with their results.

In the bicycle helmet study the authors estimate a VSL and a VSI - or value of a statistical injury - for children. They plan to add similar results for adults in the future. Their VSL for a child in about $9.5 million, or double the results found in the automobile study. This creates a problem for the policy analyst who must decide how to use this information. Here we have two results, both for fatal, immediate risks, both involving decisions made from the parental perspective, and one result is double the other. While we do not know if these differences are statistically significant, there may be reasons why we would expect them to differ in magnitude.

In the automobile study the parent may feel a certain amount of control over the risk reduction. That is, the parent probably drives more safely when the child is in the car - or believes that he or she is a better driver than others on the road, in general. The parent may avoid particularly dangerous traveling situations, such as avoiding the roads when there is heavy traffic or rain. By taking these precautionary measures the parent may feel a certain amount of control over the risk and is not using the car, exclusively, to mitigate the risk associated with driving. These alternative behaviors are not reflected in the analysis and therefore may result in a lower VSL estimate than if they were included.

On the other hand, the parent may feel little or no control over the child on his or her bicycle. This is likely to vary somewhat with age. For smaller children the parent may accompany the child on the bike, maintaining control over the types of trails used and how fast or reckless the child rides. However, as the child gets older and becomes more independent with bike-riding, the parent loses some control - or transfers some of it to the child - and the bicycle helmet is the only safety feature that remains from the parent's perspective. Hence, the bicycle helmet might represent all of the mitigating behavior that is used, in which case the VSL estimated might be higher than in situations where the parent has other options.

Turning to the value of a statistical injury estimated in the bicycle helmet study. The authors estimate a value of approximately $7.0 million, which is almost as high as the VSL estimated and much higher than expected. It is likely the case that the parent is buying protection from serious injuries associated with a cycling accident, as opposed to cuts and scrapes - injuries that could potentially be very debilitating and painful. These serious injuries could be devastating and therefore may in fact carry a value that nears that associated with death.

In terms of contribution to the literature, both of theses studies provide much needed estimates of risk reductions to children. Currently, only a few estimates exist and it is useful to add to this literature as we build our understanding of these values. In the automobile study, it would be useful to have estimates for morbidity, which can be calculated given the data used in the paper.

In terms of applications to policy, analysts are very often interested in how results can be applied in a benefit transfer context. OMB has stated that estimates should only be transferred when the context in the study parallels the policy question. Many of the environmental policies at EPA deal with risks that have a long latency period, which may or may not ultimately end in death. In these cases it may not be appropriate to use estimates for fatal, immediate deaths in policies where there is a long latency period. The authors should address how their results may be used in a policy context given that the nature of the risks in these studies may differ from those used in environmental policy.

In summary, both studies provide much needed estimates for how people value risks to children. Even if the context does not mimic that found in many environmental policies, these studies are a step in furthering our understanding of how we might value risks to children, in general.

Summary of Q&A Discussion Following Session IV-AM

Anna Alberini (University of Maryland) opened by asking for "Just a clarification from Nicole Owens and Lanelle Wiggins–How did you calculate the baseline risks that you used in your regressions?"

Nicole Owens (EPA NCEE) responded that "the CDC has data on the number of people that were either killed or injured as a result of biking. We adjust that to take into account the fact that people are wearing helmets, so for kids and adults the percentage is different, but eighty percent of kids out there are wearing helmets and we know how many of them died or were injured taking into account that helmet use. So we back out either the number that would be injured or would have died in the absence of helmet use and call that baseline risk."

Albernini followed up with, "But how does it vary across the respondents?–which is my original question."

Owens clarified by stating that the data is tabulated by age, race, and gender and, therefore, is not really a personal measure of risk.

Albernini closed by asking, "So, potentially there is correlation with age, which is also one of the regressors?" and Dr. Owens responded, "Yes."

Don Kenkel (Cornell University), addressing the researchers of the bicycle helmet study, observed that "your risk variable is just some kind of non-linear combination of other variables on your right hand side, so in some sense, you could question are you picking up the effect of risk versus the effect of quadratic interaction terms of those other variables . . ."

Nicole Owens (EPA NCEE) responded that they have "tried *really* hard to get a more individual measure of risk and so far it's been kind of unsuccessful." She said they had thought of implementing people's zip codes to help make some assumptions, but even that wouldn't provide information about "*where* they ride, whether it's urban or rural," so they still are left with the problem that the number they get from the CDC is categorized.

Lanelle Wiggins added that they also tried to include some notion of exposure by using the "days ridden" variable within the risk variable, but that had created some troubles also.

Al McGartland (EPA) said that the automobile market and bicycle helmet study presentations brought his thoughts back to yesterday's lunchtime talk and the issue of how kids deal with low-probability events or high-probability events. He asked if either of the research groups had "thought at all about *perceived* risk versus your measured objective risk and whether that might influence or put your results in perspective."

William Schulze (Cornell University) said that they "actually collected in the mail survey perceived risk information, and I used that for the fragility, so we've got at least the engineering risk, is what I call it, or the non-person-specific risk that we calculated from the FARS data set–we also have subjective risk from our survey that we haven't had a chance yet to utilize and compare the results both ways."

Lanelle Wiggins said they also had thought about that and in their survey had included a question designed to get at risk perception, something to the effect of, "If you knew that the helmet you purchased provided this much risk reduction, would you still have purchased it?" She concluded by saying that they are still trying to figure out an effective way to get at and use that information.

Robin Jenkins added, "I think Lanelle mentioned the NSRE was done over the phone, so we struggled a lot with the original questions we had for trying to ask people about their perceived risks, and you just can't explain that over the phone. It wasn't going very well, and then we also had no control over when the survey was implemented, so we came to give up that endeavor." She said she believes the NSRE is scheduled to be redone in 2005, which will present a new opportunity to try to gather that kind of information.

Barbara Kanninen asked Dr. Schulze whether he had explicitly accounted for family size in the automobile study model. In explaining why this would matter, she stated that current laws regarding air bags and child safety seats coupled with space issues eliminate the option of purchasing a safe Volvo stationwagon once you have three kids–they simply won't fit into what might be your vehicle of choice. She personally knows several families who, as soon as they had three kids, traded in their Volvo wagons for Ford minivans. She continued, "So, I was thinking, especially when you get to the multinomial choice models, that might be a place where you can really account for that, because basically, choice hasn't changed. They, of course, I think are very much thinking of safety, but they also don't have some of the safe cars available to them anymore."

Picking up on a related issue, Dr. Kanninen said, "I'm not a family economist, so maybe I'm out on a limb here, but–depending on the size of your family, if you have one kid versus five kids, at some point when you've got a lot of kids you have to sort of mentally think of them as a pack. They're sort of not individuals any more–it's like mentally, financially, emotionally, everything–you're dealing with *the kids*. And so I was kind of wondering if when it comes to decision-making, especially when it comes to the pocketbook, do families with single children actually value that one child a lot more than if you divided that five-kid family into five? . . . So, to use an inappropriate term, there might be sort of like almost "diminishing marginal returns" to a family who has more kids, and I wondered if that might come out of this model as well."

Dr. Schulze replied that although he fully agrees with Dr. Kanninen's first comment, he is reluctant to say much about what's going on with the kids and the parents. He added that the VSL switching that goes on between kids and adults in the lower income and middle income groups (with kids worth less than adults in the lower income group, and adults worth less than kids in the middle income group) is something he doesn't fully understand. He also commented regarding "the fact that parents' values are so low relative to families which you don't have children in, so something strange is going on here, and I don't want to claim that I understand it." He agreed that a multinomial model would probably be a productive way to move forward "along with adding some additional explanatory variables that we have collected . . . we know there are broken homes and things like that." In closing, he reiterated that "there's a lot more work that needs to be done with the data that we collected, and anything I would say would be very speculative. I already speculated a little, but *I* don't understand it at this point."

Ted Bergstrom had this to say: "I don't do econometrics very often, but I'm used to seeing numbers with confidence intervals around them. Kelly Maguire remarked that she thought the differences between the bicycle helmet study and the car study values of child life were *big*. I didn't think they seemed so big, and I especially thought that neither of them seemed terribly reliable. I would guess that a responsible policy analysis would suggest that you should provide some confidence intervals."

After a long pause, Dr. Schulze drew laughter by responding simply "Yes." He was quick to add that one shouldn't be misled by a "t" of 14 on an estimate of VSL because an enormous amount of statistical machinery is behind that calculation, and he conceded, "You need someone smarter in statistics than I to construct a confidence interval." He went on to say, "You know, there are many questions about the functional forms we used to predict the allocation of miles, so I fully agree with that. What we know about the VSL is that it falls in a certain range, and that range is not unreasonable compared to the physical science estimates we get in the environment, where an order of magnitude is *great*. Well, we certainly know the order of magnitude, and there's not a lot of evidence that old people are worth a lot less than adults, and there's not any reliable evidence that we should value kids less, and EPA uses one number for everybody, and I don't see any support for changing that until we know a lot more. So, I think you're exactly right because of that confidence interval."

Ted Bergstrom then directed a similar question to the bicycle helmet researchers: "How about the bike study–have you got any notion about how confident you are in your numbers? Would you be surprised if you were off by a factor of 10 or even 5?"

Nicole Owens answered that early in the study they were actually getting estimates that were much, much higher and since they haven't calculated confidence intervals, they would not be surprised at all if they off by a factor of that much.

Robin Jenkins quickly added, "But we *can.* We *can* estimate them, so we will.

Charles Griffiths (U.S. EPA NCEE) directed his comments to Dr. Schultze, first stating that he would view thirteen telephone calls to a home with no response as a refusal. He cited the fact that many people use their caller ID function to screen calls and simply won't pick up if they don't recognize the caller.

Dr. Griffiths then made his main point by stating, "I was curious what the theoretical justification was for *miles* in the utility function. It seemed like an intermediate product– you would sort of *go* somewhere in the miles required to get something that's useful for the utility function. I noticed it was in the kid's utility function, too, and there I'd have trouble citing it–I mean you'd think it would be negative, but, you know, I gave my son a Gameboy and now he loves to ride in the car . . ."

He closed with this final question regarding econometrics: "I noticed in your model the omitted category was the high-income kids and child VSL. I assume that was done for econometric purposes, but my question is just: Does that force then the equation to implicitly assume the same VSL for the high-income because . . .?"

Dr. Schulze responded, "No, there were actually different coefficients–there wasn't a subscript working on them, so no–they could be different for each group."

He addressed the phone call comment by saying, "The thirteen calls–sure, who knows? It's just that you call a number thirteen times and it never gets a pick-up–you're right, it could be caller ID, but then they'd have to have been there . . . I don't know–who knows? My recommendation is forget telephone surveys, forget mail surveys, go to the web-based and you need to get some approval on a better approach. I certainly would not do this again–it's a very expensive, very inefficient way of collecting data. You know, it was the only thing available to us at the time. So, that's my position on that."

Dr. Schulze continued by asking, Dr. Griffiths: "In terms of your point about *miles* in the utility function, how many miles did you drive last year?" to which Dr. Griffiths answered, "10,000." Dr. Schulze concluded, "You must like driving–you spend a lot of money doing it. That's my answer. I mean, people do it–they like doing it. . . . We spend a major part of our life doing it, and I just didn't want to make the model more complicated." He acknowledged the point that "it actually is an intermediate good" but said that for simplicity's sake he "just dumped it in there." He closed by saying he didn't give it more attention because he didn't think that was where the theoretically interesting stuff was.

Ronnie Levin (U.S. EPA) opened by commenting that in her experience the utility of telephone surveys depends on what you're doing. She said, "We do a lot of targeted randoms and not random *digit* dialing, so when we're surveying sectors, we do a lot of surveys using the telephone, and it works very well."

Regarding the bicycle helmet study, Ms. Levin then asked, "In the CDC injury data, do they record whether the injuree was wearing a hemet?"

Nicole Owens answered that although that information was included in some "smaller surveys that observed hospital emergency room visits," the CDC doesn't collect those data.

Levin continued, saying that "injuries in most sports don't occur equally distributed across the population of participants, and so that may be something to further investigate. Now, the purchasing is happening by the *parent*, who is *not* the person who's actually exhibiting the risky behavior. But, again, going back to Al McGartland's comment that perceptions of what is risky behavior vary by age and sex–and so that's something else for us on the finessing of loose ends. But, I think it doesn't negate in any way the fact that I find the numbers remarkably similar, also."

Mary Evans (University of Tennessee) stated her interest in the issue of how decisions about *multiple* mortality risks are made. Addressing Dr. Schulze, she said, "You have this kind of inherent in your structure, where you have a baseline survival probability and you *assume* sort of an additive framework, so that risks just add on top of each other. I wonder if you could comment on how an alternative framework in which you have individuals confronting risks in a sequence–in other words, I have to *survive* some baseline risk in order to then be confronted with and ultimately deal with fatality risk– how that might change the way that you think about estimating VSL."

Dr. Schulze responded that he would need a blackboard to work through that explanation, and he borrowed a quote from his doctoral microeconomics professor, who claimed not to be "*smart* enough to do economic theory except using mathematics as a crutch." He said the question required "*real* thought" and a lot of figuring.

Evans commented that she and Kerry Smith "have done a little bit of work looking at that" and offered to speak with Dr. Schulze afterwards, to which he responded, "I would *love* that–it's even better if *I* don't have to do it."

Bryan Hubbell (U.S. EPA) addressed Lanelle Wiggins and Nicole Owens regarding his concern "about this issue of jointness in production: You're using the cost of the bicycle helmet somewhere in there–I couldn't figure exactly whether they have individual prices or not, but if you do have individual prices, there is this issue that you're producing this utility for your child by buying him a bicycle helmet that looks ugly. And they're also less likely to wear it. So, there are two things they're buying when they pay additional price for a helmet beyond what the minimum price might be to get an effective helmet. And if there's a systematic willingness to pay either to improve the child's utility because of the ugliness factor or to get them to increase their compliance behavior, that could affect your VSL in an upward fashion. Now, the compliance behavior–you may want that to be part of it, but you certainly don't want to include the child's willingness to pay or the parent's willingness to pay to reduce the child's disutility for appearance's sake into that VSL." Dr. Hubbell suggested finding some way to adjust the price of the bicycle helmet "to get rid of, or *net out*, this co-production of this other utility." As a related example, he cited the purchase of bottled water, where you're not just buying the safety–you're buying the taste and other things. He added that figuring out a way to pull that factor out might make the numbers more in line with some of the adult values.

Nicole Owens responded that the idea made sense but it was not something they had thought of.

Cristina McLaughlin (U.S. FDA) commented that she thought the use of temperature data in the bicycle helmet study was very creative and she asked whether they had also used that data to examine if temperature actually played a role in the decision to use the helmet.

Nicole Owens responded that the original intention was to predict days ridden as a function of temperature and precipitation. She said that they found that temperature was a significant factor: i.e., when it was warmer, kids rode more. The data also indicated that precipitation had no effect, but she stated that it was difficult to draw any really strong conclusions regarding this because the associated equation "was dismal."

T.J. Wyatt (U.S. EPA/OPP/Division of Biological and Economic Analysis) asked the presenters to comment on how they think the *absolute* cost of the risk mitigating decision plays into the estimate of VSL. He pointed out that "a helmet that costs 25 or 30 bucks seems like a fairly small expenditure to avoid risk, whereas an auto purchase would be a major commitment of resources, particularly for low-income families." He questioned to what extent they thought that might have something to do with the difference in magnitude of their estimates.

Lanelle Wiggins responded that they had thought about getting at that issue by trying to figure out how to measure the time it takes to use a helmet and somehow incorporate that into the price. She added that because of the way the model is currently structured, with the helmet price simply subtracted from income to reduce the amount available to spend on all other goods, it probably wouldn't change the results that much. She acknowledged, however, that it is an important point.

Dr. Schulze affirmed that "a single mom, newly divorced, and with a kid, might very well have a hard time getting auto financing, and that could be affecting our values, so that's a very good point."

Nicole Owens added that helmets, especially for kids, are very cheap and effective. People were asked how long they thought the helmets would last and their answers along with the prices of the helmets yielded an annualized price of the helmet somewhere around $6. She continued to say that combining this information with the risk data, it brings back Al McGartland's point about what is the risk that parents perceive. She closed by stating that it also might be that for $6 "you're almost buying yourself out of the uncertainty associated with what the specific to your kid might be" or you might feel better about the cost per use of a rarely used helmet.

Ted Bergstrom asked, "What is the reduction in the probability of the child dying as a function of having that [helmet]?"

Nicole Owens responded with the figure "2 million,"–the annualized price divided by the risk reduction for kids, yielding the estimated VSL.

Bergstrom continued, "So we're saying that all the parents who do *not* buy helmets, by your methodology, think their kids are worth *less* than $2 million. . . . How do you get to the $10 million statistic?" He asked whether that comes from all the extra paid for fancy helmets.

Robin Jenkins said that the paper they had written previously in fact did make it that simple–just looking at the price divided by the risk reduction. She clarified that the current study involves a household production model, in which the household is producing safety and the decision to purchase a helmet is really representing the indirect utility function of the household. So, the valuation is on risk–the model is designed to represent something *beyond* what you would get from such a simple calculation. She closed by saying, "So, I guess it's all embedded in the modeling–the fact that we've got this random utility model that's representing the conditional utility function."

Bergstrom said, "But somehow that seems to me it's producing something from nothing." He added that the data shows that there are a lot of people willing to pay at least $2 million for a statistical child's life, and he reiterated, "That's all you've got. And so now you've got a complicated model that produces $9 million. How can this be? I love magic, but . . . where's it coming from?"

Jenkins responded that "It's not really magic–it's just a representation of the household's decision that is trying to build into the equation other considerations about the valuation of safety . . ." When one of the participants clarified, "You're dividing by the marginal utility of money–you're not dividing by the price," she added, "Exactly–marginal utility of income."

Someone commented, "And if it's true that 90 percent of them are buying helmets, then the lower bound is $2 million but the mean is going to be up there . . ."

Jenkins added that the 2 million figure was just "off the top of their heads" and may not be right. She acknowledged that the "other paper" dealt with a higher value, closer to 4 million.

Owens clarified that the other figure was "the adult valuation . . ."

Scott Grosse (Centers for Disease Control and Prevention) asked whether any of the researchers had tried to calculate VSLs by parents' education levels and added that "There is a large literature suggesting that parental education leads to different valuations of children's health and investments in children's health, so it would be plausible that the VSL would differ by the education level."

William Schulze responded that their study represented "sort of a first look" at these data, and he affirmed that they did have information on that. Furthermore, he said that the parent education level is "exactly one of the variables that I hope to use to try to figure out what's going on with kids' and adults' relative values switching between income classes." He conjectured that the hypothesis that "lower-income families have lower education" levels might help explain the situation.
Nicole Owens explained that parent education was not factored into their equation, although it was significant, so the relationship remains to be explored.

Glenn Harrison (University of Central Florida) commented that listening to these study reports every couple of years always brings to mind the fact that "there are other sources of data that are extraordinarily rich that might be worth accessing, and it's the sort of thing an agency could do if they approach the right people." As one such source, he mentioned HMOs, "particularly Health Partners, based in Minnesota" as groups that engage in the collection of a lot of health-related data about cars, bike helmets, smoking, alcohol, etc. He continued by saying that "basically, they're collecting information from their target population about all sorts of risk factors" because they're interested in educating the people on the risks of obesity and all sorts of things and the interactions between them. The bottom line is they want to lower their own costs. Dr. Harrison explained that although these organizations are generally extremely reluctant to let others access their data, agencies can talk to them "and get cooperative agreements with some of these places." As an example, he said the CDC has negotiated such arrangements with some HMOs. He closed by testifying to the "incredible" quality and value of the data available from these groups because "they track everything else about these people as well."