

Utah State University

DigitalCommons@USU

All Graduate Theses and Dissertations

Graduate Studies

12-2008

Safety-Focused Altruism: Valuing the Lives of Others

Kevin Lee Brady
Utah State University

Follow this and additional works at: <https://digitalcommons.usu.edu/etd>



Part of the [Business Commons](#)

Recommended Citation

Brady, Kevin Lee, "Safety-Focused Altruism: Valuing the Lives of Others" (2008). *All Graduate Theses and Dissertations*. 223.

<https://digitalcommons.usu.edu/etd/223>

This Thesis is brought to you for free and open access by the Graduate Studies at DigitalCommons@USU. It has been accepted for inclusion in All Graduate Theses and Dissertations by an authorized administrator of DigitalCommons@USU. For more information, please contact digitalcommons@usu.edu.



SAFETY-FOCUSED ALTRUISM: VALUING THE LIVES OF OTHERS

by

Kevin L. Brady

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Applied Economics

Approved:

Paul M. Jakus
Major Professor

E. Bruce Godfrey
Committee Member

John E. Keith
Committee Member

Byron R. Burnham
Dean of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2008

Copyright © Kevin L. Brady 2008

All Rights Reserved

ABSTRACT

Safety-Focused Altruism: Valuing the Lives of Others

by

Kevin L. Brady, Master of Science

Utah State University, 2008

Major Professor: Dr. Paul M. Jakus

Department: Economics

The value of statistical life is an estimate of the monetary benefits of preventing an anonymous death. Society's willingness to pay to eliminate *private* health risks determines agencies' value-of-statistical-life estimates. Most estimates ignore society's willingness to pay to eliminate *others'* health risks. There are two possible reasons. First, altruism does not exist: Peter is not willing to pay to save Paul's life. The second possible reason is a bit more complicated. Certain economists argue that increasing benefit estimates to account for altruism involves double-counting.

The purpose of this thesis is to evaluate these possibilities. Accounting for altruism, it turns out, is not double-counting if altruism is paternalistic. Furthermore, I empirically demonstrate that people are willing to pay to reduce others' health risks. Thus, the two justifications for ignoring altruism are, seemingly, unfounded, which indicates that analysts should increase the value of statistical life to account for altruism.

(98 pages)

DEDICATION

To my wife, Heather

ACKNOWLEDGMENTS

There are three groups of people I wish to thank. First, my academic mentors – I could not have completed this thesis without Professor Paul Jakus. His ideas, assistance (especially with discrete choice modeling), and, most importantly, his data set facilitated the research contained herein. I also wish to thank Professors John Keith, Bruce Godfrey, Don Snyder, Arthur Caplan, and Dwight Israelsen of Utah State University and Kerry Hansen of Snow College for being great teachers and great examples.

Second, I wish to thank my financial supporters. My tuition waiver from the Graduate School and my research assistantship from the Utah Agricultural Experiment Station made the completion of my master's degree possible. I especially appreciate the freedom I received from former interim department head Dr. DeeVon Bailey. He allowed me to research whatever I wanted – within reason, of course.

Finally, I would not be where I am today – forgive the cliché – without those who have provided emotional support. My wife's help, kindness, love, and patience were invaluable throughout, as were her draft-reading and excellent cooking skills. In addition, I wish to thank my parents, Mark and Karin Brady, for passing on the love of learning.

Kevin L. Brady

CONTENTS

	Page
ABSTRACT.....	iii
DEDICATION.....	iv
ACKNOWLEDGMENTS	v
LIST OF TABLES	viii
CHAPTER	
I. INTRODUCTION.....	1
II. LITERATURE REVIEW AND THEORY	5
What Is a Life Worth?	5
Economic Value and the Value of Identified Lives.....	7
The Value of Statistical Life.....	8
Contemporary Value-of-Statistical-Life Estimates.....	13
Safety-focused Altruism and the Value of Statistical Life	17
The Absence of Altruism	22
Does Altruism Exist?	22
Is Altruism Safety-focused?	26
Implications for Cost-benefit Analysis	29
Theoretical Implications	30
Recent EPA Studies	34
III. STATED PREFERENCES	37
Contingent Valuation: A Brief History.....	37
Current Status of Stated Preferences Surveys.....	41
IV. EMPIRICAL ANALYSIS	45
Survey and Data	45
Survey	45

Summary Statistics	48
Models.....	51
Conditional Logit	51
Models 1 through 4	53
Welfare Measures: Conditional Logit	57
Results	59
Regression Results	59
WTP Estimates	64
Shortcomings and Future Suggested Research	67
V. CONCLUSION.....	70
REFERENCES	73
APPENDICES	80
Appendix A. Permission Letter from <i>Natural Resources Journal</i>	81
Appendix B. Jakus Survey	83

LIST OF TABLES

Table	Page
2.1 Significant Estimates of the Value of Statistical Life in the United States	14
2.2 U.S. Government Agency Estimates of the Value of Statistical Life	17
2.3 Jones-Lee's (1992) Recommended Altruism Adjustment Applied to Agency Value-of-Statistical-Life Estimates	33
3.1 Common Contingent Valuation Elicitation Methods	40
3.2 Sample Conjoint Analysis Choice Table for Public and Private Risk Reduction in Cache Valley	44
4.1 Program Selection Rate for Entire Sample and Income-revealing Subsample	48
4.2 Summary Statistics for Entire Sample and Income-revealing Subsample	49
4.3 Sample Data Setup for Conditional Logit Model with <i>NLOGIT</i> – Models 1 and 2	54
4.4 Sample Data Setup for Conditional Logit Model with <i>NLOGIT</i> and Income Dummies – Model 3	56
4.5 Regression Results for Models 1, 2, and 3	60
4.6 Regression Results for Model 4	62
4.7 Marginal Utilities Evaluated at Mean Sample Statistics – Model 4	63
4.8 Estimates of WTP for Program A, Program B, and Altruistic Risk Reduction – \$'s per Month	65
4.9 Estimates of Disparity Between Private and Public WTP Applied to Agency Value-of-Statistical-Life Estimates	68

CHAPTER 1

INTRODUCTION¹

Many government policies prevent deaths. The Consumer Product Safety Commission's (CPSC) regulation of space heaters, for example, saves 63 lives annually; the Environmental Protection Agency's (EPA) management of asbestos saves ten lives (Morall, 2003). According to a recent EPA study (1999a), 90 percent of the Clean Air Act's benefits are prevented deaths. Life-saving programs are desirable. Resources are, however, limited. It is impossible to avoid all accidental deaths.

How do government agencies determine the amount to spend on life-saving programs? Most agencies rely on the value of statistical life. Value-of-statistical-life estimates approximate the dollar value of preventing a single death. Such estimates vary across government agencies. EPA (2000) spends up to \$6.1 million to prevent one expected death. CPSC spends \$5 million (Heinzerling, 2000).

Most risk reduction programs entail uncertainty and anonymity. For instance, it is impossible to know whose lives – or how many lives – are prolonged through air quality improvements. As a result, the cost-benefit analysis (CBA) of general safety improvements requires knowledge of the value of unidentified or statistical death prevention.

In neoclassical economics, the value of an action is equal to society's willingness to pay (WTP) for that action. The value of statistical life approximates society's WTP to prevent anonymous deaths.

¹ Much of the information that appears in Chapters 1, 2, and 5 of this thesis is scheduled to be published in an essay, "The Value of Human Life: A Case for Altruism," in a forthcoming issue of *Natural Resources Journal*. The journal granted permission to reprint the quoted text. Appendix A contains the permission letter.

Policymakers use value-of-statistical-life estimates to value risk reductions that are primarily *public*. These estimates are based on numerous risk studies. Most of these studies, however, derive WTP only for reductions in *private* risks. Hence, in practice, policymakers value public risk reduction programs with private WTP estimates.² This is a subtle but important point. The current approach ignores altruism and adopts one of two implicit assumptions: either there is no disparity between WTP for reductions in private and public risks, or the gap is inconsequential. Throughout, these two assumptions are referred to as the anti-altruism assumptions.

The first assumption implies that people are not willing to pay to improve the safety of others, including family members and friends. This supposition is excessively parochial. Altruism exists if “personal welfare is affected by at least one other person’s well-being” (Altruism, 1992, p. 14). Parents demonstrate altruism when they help their children cross the street, grandparents when they offer gifts to their posterity. People are concerned with the welfare of those they know. Are people similarly concerned with the welfare of anonymous persons? Chapter 2 discusses this question, and Chapter 4 provides an answer.

The second anti-altruism assumption, the idea that policymakers should ignore altruism even if it exists, also deserves attention. Bergstrom (1982) and Milgrom (1993) argued that both altruists’ WTP and non-altruists’ WTP for public safety improvements are equivalent. Thus, they claimed, policymakers should ignore altruism in risk valuation. Nevertheless, as noted below, their theories rely on a restrictive definition of

² By way of definition, public risk reductions, such as improvements in air quality, apply to everyone within a population, including the payer; private risk reductions, such as seat belts, affect only the direct consumer. Thus, public risk reductions are public goods, and private risk reductions are private goods. Moreover, altruistic risk reductions apply to others, but not directly to the payer. Thus, public risk reductions differ from altruistic in that public risk reductions also include the payer.

altruism. In short, they assumed that altruism is non-paternalistic – that is, Peter’s welfare is affected by what Paul values, not by what Peter feels Paul *should* value.³ A paternalistic altruist, on the other hand, attempts to maximize others’ well-being as she perceives it, not as self-perceived by the affected individuals.

As it stands, one person’s WTP to prevent another’s death does not influence government spending on safety improvements. Is this approach correct? Should policymakers adjust the value of statistical life to incorporate altruistic concerns? As demonstrated below, if both anti-altruism assumptions are false, society’s WTP for reductions in public risks, rather than its WTP for private reductions, should determine the value of statistical life, and policymakers should increase this value to account for altruism. These questions are crucial, for they influence decisions that prevent actual deaths. EPA (1999a) estimates that the Clean Air Act, for example, will save *at least* 23,000 lives in 2010 – roughly 1 percent of non-accidental deaths in the United States – and the value of statistical life influences whether policymakers implement specific provisions of the Act.

The objectives of this thesis are twofold. First, Chapter 2 presents a broad theoretical examination of both anti-altruism assumptions. Significant empirical and theoretical evidence casts doubt on the validity of these assumptions. People, it seems, are altruistic, and their altruism tends to be paternalistic. This indicates that policymakers should indeed increase the value of statistical to account for altruism.

³ Thaler and Sunstein define paternalism as Peter influencing Paul to make the decision Paul would make if he possessed “complete information, unlimited cognitive abilities, and no lack of willpower” (2003, p. 175). My definition of paternalism is slightly different. I define paternalism as Peter influencing Paul’s choices to maximize Paul’s welfare as Peter perceives it. When giving a drunkard a loaf of bread instead of, say, two dollars, I behave paternalistically, for I attempt to increase the drunkard’s welfare as I perceive it, even though the drunkard may actually prefer two dollars.

The second objective of this study is to provide an empirical estimate of the difference between private and public WTP values. Chapter 3 outlines the contingent valuation survey method, which Jakus (1992) used to measure attitudes toward private and public risk reductions.

Chapter 4 outlines Jakus's survey. Over 950 Pennsylvania and Maryland residents participated in the study, which Jakus designed primarily to measure consumers' WTP to reduce Gypsy Moth infestations. The study also recorded respondents' attitudes toward water-borne carcinogens. The survey informed participants that they could select either a private or a public program to remove harmful substances from drinking water. In the hypothetical scenario, the public risk reduction program eliminates harmful substances at the central pump and treatment plant. With the private program, the local water utility installs a filtration device at each participating household.

As demonstrated in Chapter 4, the data yield an empirical estimate of the disparity between private and public WTP values. According to the results presented below, WTP for public risk reduction – which includes private risk reduction and altruistic risk reduction – is 120 to 210 percent greater than WTP solely for private risk reduction.

CHAPTER 2

LITERATURE REVIEW AND THEORY

In this chapter, the first section “What is a Life Worth?” provides a brief evaluation of historical attempts to value life, including current efforts involving the value of statistical life. It also examines contemporary value-of-statistical-life meta-analysis studies and explains how various government agencies have used these studies in CBA. The second section “Safety-focused Altruism and the Value of Statistical Life” develops a mathematical proof demonstrating that the value of statistical life is greater under the assumption of paternalistic altruism than under the assumption of pure self-interest. The third section “The Absence of Altruism” reviews literature and evidence on the existence of altruism and explores its potential role in determining the value of life. Finally, as mentioned in the Introduction, if altruism is paternalistically focused on improvements in others’ safety, policymakers should increase value-of-statistical-life estimates. The fourth section “Implications for Cost-benefit Analysis” demonstrates this concept and explores the implications for CBA.

What Is a Life Worth?

In the 1930s, government agencies proposed numerous federal projects, largely as a result of Roosevelt’s New Deal (Prest and Turvey, 1965). Cost-benefit analysis (CBA) soon became popular, especially for water-related developments. Within a few decades, many federal and state agencies, as well as Congress, began to require full analyses prior to approving major government actions (Sunstein, 2004). Multiple U.S. presidents, including Presidents Carter, Reagan, and Clinton, issued executive orders urging federal

agencies to weigh costs and benefits before making major programming decisions (see Exec. Order No. 12,044 [1978], Exec. Order No. 12,291 [1981], and Exec. Order No. 12,866 [1993], respectively).

CBA is a tool that compares the expected costs and benefits stemming from an action (or non-action). Analysts convert benefits and costs estimates into dollars, a common unit of measurement. If total benefits exceed costs, the project has positive net benefits. Such projects are feasible. In many cases, however, benefits and costs are not readily expressed in dollars and cents.

As noted above, countless government programs prevent premature deaths. EPA's National Ambient Air Quality Standard (NAAQS), for example, establishes acceptable air quality levels throughout the United States (U.S. EPA, 2008a). NAAQS forces polluters to reduce their emissions of potentially lethal toxins, such as PM_{2.5}. By tightening PM_{2.5} standards 20 percent over the next decade,⁴ EPA will prevent up to 7,100 premature deaths *per year*. Nevertheless, tighter air quality standards impose costs on activities that produce PM_{2.5}, including automobile operation and power generation. In evaluating such actions, cost-benefit analysts typically assign an explicit value to the benefits of premature death prevention. Otherwise, they implicitly assign it a value of zero. The value of human life is, understandably, difficult to quantify.

Until the 1960s, the discounted sum of expected earnings served as an estimate of the value of life (Rice and Cooper, 1967). Although such estimates are still used for compensation in wrongful death lawsuits (Lewis and Bowles, 2006; Bowles et al., 2005),

⁴ A 20 percent reduction would imply that permissible PM_{2.5} levels are lowered from the current standard of 0.84 parts per million to 0.65 parts per million.

economists realized that valuing life according to future earnings does not coordinate with the standard economic concept of value (Mishan, 1971).

Economic Value and the Value of Identified Lives

In neoclassical economic theory, WTP determines the value or benefits of an action. The economic value of John Doe's life is the sum of society's WTP to prevent his death. Valuing *actual* lives using the WTP approach is difficult and, perhaps, meaningless. How much are people willing to pay to prevent their children's deaths? Most parents would forfeit everything they own. Alternatively, how much must people be paid to accept death? For most, a suitable number does not exist.⁵ The irreversibility of death makes it difficult to value. Some economists feel that life should not be valued holistically (Viscusi, 1992). Indeed, current life-valuation attempts pursue a piecemeal approach. Fromm first proposed this method in 1965.

Fromm argued that lives could be valued by examining behaviors towards small changes in risk: "[Because people] expose themselves to danger in their avocations...for personal gain...[they] implicitly assign a value to their lives" (p. 193). According to Fromm's example, if the probability of dying on a commercial airplane is 1.7 in 1,000,000, and passengers are willing to pay \$0.68 to eliminate this risk, they value their lives at \$400,000.⁶

Fromm's claim notwithstanding, this approach cannot value specific lives because it requires the spurious assumption that people regard symmetric risk reductions equally, regardless of initial risk levels. In reality, WTP varies according to the quantity of risk

⁵ This coordinates with Hanemann's (1991) theory of infinite willingness to accept bids under conditions of no substitutability.

⁶ $\$0.68 / 0.0000017 = \$400,000$.

and baseline risk levels (Alberini, 2005). Though a person will pay \$100 for a 0.01 percent risk reduction, she may not pay \$200 for a 0.02 percent reduction; the additional 0.01 percent reduction may be worth more or less than \$100. As Mishan later noted, “The implied assumption of linearity, which has it that a man who accepts \$100,000 for an assignment offering him a four-to-one chance of survival will agree to go to certain death for \$500,000, is implausible, to say the least” (1971, p. 691). In fact, Fromm himself (1968) later criticized another economist for relying on the same mistaken assumption. (He did not, however, acknowledge that he had committed the same error three years prior.) This method cannot value *identified* lives. Nevertheless, economists have successfully used this approach to value *unidentified*, or statistical, lives.

The Value of Statistical Life

Risk mitigation policies prevent deaths that are anonymous, at least *ex ante*. EPA cannot identify the 7,100 lives it expects to save lives through tighter air quality standards (2008a). This knowledge might be available *ex post*, but such information is not accessible as decisions are made. Mitchell and Carson stated, “The principle of consumer sovereignty suggests that policymakers should attempt to implement the current desires of the public – clearly an objective with an *ex ante* perspective” (1989, p. 30). According to this viewpoint, the value of preventing unidentified deaths, not the value of preventing any specific person’s death, is relevant to decisions concerning generalized safety improvements.

Reductions in wide-ranging mortality risks result in reductions in anonymous deaths. Therefore, if it is possible to determine society’s WTP for risk reductions, it is possible to estimate the benefits of reductions in anonymous deaths. This is the purpose

of the value of statistical life, which “is the rate at which individuals are prepared to trade off income for risk reductions” (Alberini, 2005, p. 784). The value of statistical life is society’ equilibrium income-risk exchange rate. It does not, strictly speaking, define the benefits of preventing a single death; it merely provides an estimate. Emphasizing this point, Sunstein recently stated, “there is no ‘value of a statistical life’; there are only values for the reduction of statistical risks” (2004, p. 392).

The standard value-of-statistical-life derivation follows Alberini’s (2005) expected utility approach. Let EU_i be the expected utility of Person i and p_i his probability of death. EU_i is a quasi-concave, twice differentiable function. Further, let $U_i(M_i)$ be the utility of Person i associated with income M_i if he is living and $V_i(M_i)$ the utility of income if he is dead:

$$EU_i = (1 - p_i) \cdot U_i(M_i) + p_i \cdot V_i(M_i). \quad (2.1)$$

Both $U_i(M_i)$ and $V_i(M_i)$ are quasi-concave, twice differentiable utility functions.

Assuming that the post-mortality utility of income is zero, expected utility can be restated in the following manner:

$$EU_i = (1 - p_i) \cdot U_i(M_i). \quad (2.2)$$

Implicit differentiation of income with respect to the change in overall death risk yields the following value of statistical life VSL_i :

$$VSL_i = \left| \frac{dM_i}{dp_i} \right| = \frac{U_i}{(1 - p_i) \cdot dU_i/dM_i}. \quad (2.3)$$

That is, the value of statistical life is the ratio of total utility to the product of one minus the probability of death and the marginal utility of income. According to Equation 2.3, the value of statistical life is a function of the probability of mortality and income.⁷

Three implications of the preceding equations should be emphasized. First, in Equation 2.3, the relationship between the value of statistical life and income is positive. Although, by assumption, $dU_i/dM_i > 0$, $d^2U_i/dM_i^2 \leq 0$; thus $\partial VSL_i/\partial M_i \geq 0$. Nearly all risk studies confirm this implication (Viscusi, 1992; Brady, 2008). EPA (2008b) accordingly adjusts the value of statistical to account for expected income growth.

Second, the relationship between the value of statistical life and the overall probability of death is positive; that is, $\partial VSL_i/\partial p_i > 0$. In CBA, policymakers typically ignore initial risk levels. Although this tendency is undesirable, most government programs deal with remote mortality risks. For this reason, Viscusi (1992) argued that analysts should only use the value-of-statistical-life to estimate the benefits of small changes in minute death probabilities. Still, the implications of ignoring baseline risk levels in the application of the value of statistical life have yet to be fully investigated.

Finally, Equation 2.1 posits that expected utility is exclusively a function of income and the private probability of death. The well-being of others does not influence expected welfare. By using empirical estimates of Equation 2.3 to value potential losses of life, policymakers do not account for people's WTP to prevent others' deaths and, therefore, implicitly accept the anti-altruism assumptions mentioned in the Introduction, i.e., either altruism does not exist, or it should be ignored. The implications of these assumptions are discussed more fully later in this chapter.

⁷ The value of statistical life is also a function of utility. Nevertheless, in this model, utility is solely function of income.

It is, of course, impossible to directly measure utility, which Equation 2.3 requires. In practice, therefore, policymakers estimate the value of statistical life using estimates of society's WTP (or willingness to accept [WTA]) income for discrete decreases (or increases) in the probability of death (Alberini, 2005):

$$VSL_i \approx \frac{WTP_i}{|\Delta p_i|}. \quad (2.4)$$

Knowledge of WTP for safety improvements is necessary to calculate the value of statistical life. In a recent study, participants stated they were willing to pay \$1,589.46 for a 0.05 percent reduction in the probability of death (Alberini et al., 2006). The estimated value of statistical life was, accordingly, \$3.179 million.⁸ Estimates of WTP for mortality risk reductions play a crucial role in determining the value of statistical life. How do practitioners determine society's WTP for safety improvements? Do these values reflect WTP for private or public risk reductions?

There are four primary methods for calculating risk-related WTP (Alberini, 2005). Most WTP estimates only reveal attitudes toward private risk reductions.

Compensating wage studies (e.g., Moore and Viscusi, 1988; Smith, 1979; Dorman, 1996) and contingent valuation (e.g., Alberini et al., 2006; Brady, 2008; Corso et al., 2001; Hammitt and Graham, 1999) are the most commonly used WTP elicitation methods.⁹ The wage differential approach determines the amount of income necessary to convince workers to accept increased on-the-job health risks. Elephant handlers at the Philadelphia Zoo receive an extra \$1,000 per year because of the dangerous nature of their work (Viscusi, 1992). Adam Smith, the father of economics, is the progenitor of the

⁸ \$1,589.46 / 0.0005 ≈ \$3.179 million.

⁹ According to Alberini (2005), other WTP elicitation methods include behavioral studies (e.g., the opportunity cost of wearing seat belts compared with the corresponding risk reduction) and other hedonic studies (e.g., the added cost of air-bags compared with the risk reduction).

wage differential approach: “The whole of the advantages and disadvantages of the different employments of labor and stock must, in the same neighborhood, be either perfectly equal or continually tending to equality” (1776/1937, p. 99). That is, if certain jobs have disagreeable characteristics, employers must compensate workers. Negative job characteristics can include anything, such as high health risks. Researchers use econometric techniques to analyze wage rates and thereby determine WTP for safety improvements (e.g., Moore and Viscusi, 1988).

Nevertheless, wage differential WTP and WTA bids only reveal attitudes towards changes in private health risks. When deciding whether to engage in risky jobs, workers must determine if the offered wage rate is sufficient to compensate them for changes in their probability of death. Workers’ decisions to accept or reject risky job offers do not reveal information about their WTP to reduce their spouses’ or children’s probability of death.¹⁰

Contingent valuation studies, on the other hand, are capable of revealing preferences toward public risks (Johansson, 1994).¹¹ Still, in most studies, survey administrators urge respondents to consider only private risks. In a recent study, for example, researchers directed participants to “report information about their WTP for...risk reductions,” instructing respondents “to think of [the] risk as their own” (Alberini et al., 2006, p. 235).

Government agencies primarily use these *private* WTP estimates – which are derived with the wage differential approach or contingent valuation – to compute the

¹⁰ As Professor Paul Jakus pointed out, workers in high-risk jobs presumably consider their family when deciding whether to take risky jobs. The trade-off, however, occurs between workers’ private probability of death and their income.

¹¹ I discuss the use of contingent valuation studies more fully in Chapter 3.

value of statistical life and thereby determine the benefits of *public* risk reductions.

Peter's WTP to prevent Paul's death does not affect the value government agencies place on death prevention. To demonstrate this point, it may be useful to examine the origins of common value-of-statistical-life estimates.

Contemporary Value-of-Statistical-Life Estimates

Literature. – As noted above, although Fromm's (1965) proposed methodology cannot value actual human lives, economists quickly recognized that it can value statistical lives. In the 1970s, numerous value-of-statistical-life estimates appeared. Smith (1974) conducted the first successful value-of-statistical-life wage differential study, Acton (1973) the first successful contingent valuation analysis (Viscusi, 1992). The two studies, however, produced very different results.

Smith (1974) conducted his study in response to regulations arising from the Occupational Safety and Health Act of 1970 (OSH Act). Smith argued that an injury tax could replace the command-and-control method promoted by OSH Act. The injury tax would rely on estimates of workers' WTP to eliminate on-the-job health risks, which Smith computed using data on new hires in 1971. According to Smith's results, the value of statistical life is \$9.5 million (in 2000 dollars).¹² Table 2.1 provides a summary of this and other value-of-statistical-life estimates.

Acton's (1973) estimate is much lower. Acton sent students door-to-door to ask residents of Boston how much they would be willing to pay for better ambulance services. The implied value of life was only \$130,000. Nevertheless, the sample was

¹² In this section, all value-of-statistical-life estimates are reported in 2000 dollars.

Table 2.1*Significant Estimates of the Value of Statistical Life in the United States*

Study	Value-of- Statistical-Life Estimates Reviewed	Value of Statistical Life (<i>millions</i> \$)	Dollar Year	Value of Statistical Life (<i>millions</i> 2000\$)
Acton (1973)	1	0.1	1990	0.13
Smith (1974)	1	7.2	1990	9.5
Moore and Viscusi (1988)	1	6.0 -- 6.8 0.18 (life year)	1986	9.4 -- 10.7 0.28 (life year)
Fisher et al. (1989)	21	1.6 -- 8.5	1986	2.5 -- 13.4
Miller (1990)	47	2.2	1988	3.2
Viscusi (1993)	44	3 -- 7 (mean)	1990	4 -- 9.2 (mean)
Blaeij et al. (2003)	30	4.4	1997	4.7
Viscusi and Aldy (2003)	44 --- 46	5.5 -- 7.6	2000	5.5 -- 7.6
Kochi et al. (2006)	197	5.4	2000	5.4

likely too small to be reliable – only 36 responses were deemed viable – and the contingent valuation survey was poorly constructed (Viscusi, 1992).

Many of the studies conducted thereafter have found value-of-statistical-life estimates in the range of \$4 to \$9 million (Viscusi, 1993). In 1988, Moore and Viscusi furthered the value-of-statistical-life theory by proposing a new concept: the value of statistical life *years*. They argue that government agencies should seek to maximize the discounted sum of saved life years rather than lives. Moore and Viscusi estimated that the value of a statistical life year is \$280,000. The implications of their argument are controversial. According to their approach, government agencies should value unidentified young adults more highly than unidentified elderly people. Advocates for the elderly have, for obvious reasons, rejected this approach (Ackerman and Heizerling, 2004).

Over the past two decades, a number of meta-analyses have attempted to explain variations in value-of-statistical-life estimates. Miller (1990), for example, analyzed 47 studies and found a mean value-of-statistical-life of \$3.2 million. Viscusi (1993) found a mean of \$6.6 million, Blaeij et al. (2003) a mean of \$4.7. Kochi et al.'s (2006) study is the most complete and recent meta-analysis. They reviewed nearly 200 value-of-statistical-life estimates, producing a mean value of statistical life of \$5.4 million.

Agency Estimates. – The Department of Transportation's (DOT) estimate of the value of statistical life relies on Miller's 1990 study. Prior to adopting Miller's estimate, DOT valued saved lives at \$1.5 million (U.S. DOT, 1993). The Federal Aviation Administration (FAA) used this estimate as late as 1990 (Sunstein, 2004). DOT issued a memorandum in 1993 mandating that future CBAs must use Miller's life-valuation estimate. DOT has updated the mandated value of statistical life to account for inflation (U.S. DOT, 2002). In 2002, DOT set the value of statistical life at \$3.0, which is the

value still in use at the present. Table 2.2 provides a summary of agencies' estimate of the value of statistical life.

EPA's value-of-statistical estimate is based on Viscusi's 1993 study. As noted in Table 2.1, Viscusi examined 44 value-of-statistical-life studies, calculating a mean of \$6.6 million. EPA's estimate relies on 26 of the 44 studies (2000). Of the 26 studies, 21 are wage differential studies and five are contingent valuation surveys. The mean of these studies is \$4.8 million (in 1990 dollars). Therefore, "EPA recommends a central estimate of \$4.8 million (1990\$), updated [to account for inflation] to the base year of the analysis" (U.S. EPA, 2000, p. 90). Adjusted for inflation, the 26 studies provide a mean value-of-statistical-life of \$6.1 million. Accordingly, recent EPA studies attribute roughly \$6 million to the value of unidentified death prevention (Sunstein, 2004). Moreover, the Federal Food and Drug Administration's (FDA) value-of-statistical-life is comparable to EPA's estimate (U.S. FDA, 2004). Other major government agencies similarly value statistical lives in the range of \$5 to 6 million (Sunstein, 2004).

These agency estimates largely rely on wage differential and contingent valuation studies, which, as noted above, both yield estimates of private WTP values. Thus, one person's WTP to prevent another's death *does not* influence agencies' value-of-statistical-life estimates. This is only justifiable if either anti-altruism assumption is correct; that is, either people are not willing to pay to reduce the probability of others' death, i.e., altruism does not exist, or policymakers should ignore such WTP values. If both anti-altruism assumptions are false, agencies' current value-of-statistical-life estimates are not accurate approximations of the value of anonymous death prevention.

Table 2.2*U.S. Government Agency Estimates of the Value of Statistical Life*

Agency	Source	Value (<i>millions \$</i>)*
CPSC	Heinzerling (2000)	5
Department of Agriculture (DOA)	Sunstein (2004)	4.8
DOT	U.S. DOT (2002)	3
EPA	U.S. EPA (2000)	4.8 (1990\$), updated to relevant year
FDA	U.S. FDA (2004)	5 -- 6.5
FAA	Sunstein (2004)	1.5 -- 3
Office of Management and Budget (OMB)	Sunstein (2004)	5

* *Note* : For many agencies, the value of statistical life is not fixed (Sunstein, 2004).

This is demonstrated in the next section. Then, in the following section, the anti-altruism assumptions are evaluated.

Safety-focused Altruism and the Value of Statistical Life

In Equations 2.1 through 2.3, the value of statistical life is derived under the assumption that expected utility is a function of personal income and the private

probability of death. Bergstrom (1982) demonstrated that if altruism is neutral – that is, Peter’s utility is a non-decreasing, direct function of Paul’s utility function – Equation 2.3 is still the proper value-of-statistical-life definition.¹³ What if Peter’s altruism is biased so certain improvements in Paul’s welfare affect Peter’s utility function more drastically than other improvements? In this section, the value of statistical life is derived under the assumption that others’ private health risks affect Peter’s utility, but changes in others’ non-health-related determinants of utility do not.

Equation 2.2 is modified to allow safety-focused altruism. Person 1’s expected utility is therefore a function of his personal death risk p_1 , personal consumption c_1 , and n persons’ death probability, where n is the number of people in society:

$$EU_1 = (1 - p_1) \cdot U_1(c_1, p_2, \dots, p_n). \quad (2.5)$$

U_1 is a non-increasing function of p_2 through p_n . That is, others’ probability of death *can* affect Person 1’s utility.

Person 1 faces an income constraint of M_1 , which can be spent on consumption or safety improvements:

$$M_1 = c_1 + TWTP_1(p_1, \dots, p_n), \quad (2.6)$$

where $TWTP_1(p_1, \dots, p_n)$ is Person 1’s total willingness to pay to reduce mortality risks.

By definition, the value of statistical is $VSL = |dM/dp|$. Thus, from Equation 2.6,

$$VSL = \left| \sum_{i=1}^n \partial TWTP_1 / \partial p_i \right| \text{ because } \left| \sum_{i=1}^n \partial M_1 / \partial p_i \right| = \left| \sum_{i=1}^n \partial TWTP_1 / \partial p_i \right|.$$

Setting up the Lagrangean,

$$\ell = (1 - p_1) \cdot U_1(c_1, p_2, \dots, p_n) + \lambda \cdot (M_1 - c_1 - TWTP_1(p_1, \dots, p_n)) \quad (2.7)$$

¹³ The following is a pure altruist’s expected utility function, where n is the number of people in society:
 $EU_1 = (1 - p_1) \cdot U_1(M_1, U_2, \dots, U_n) + p_1 \cdot V_1(M_1, U_2, \dots, U_n).$

yields the following first-order conditions, where λ is the Lagrangean multiplier:

$$\ell_{c_1} = (1 - p_1) \cdot \partial U_1 / \partial c_1 - \lambda = 0$$

$$\ell_{p_1} = -U_1 - \lambda \cdot \partial TWTP_1 / \partial p_1 = 0$$

$$\ell_{p_2} = (1 - p_1) \cdot \partial U_1 / \partial p_2 - \lambda \cdot \partial TWTP_1 / \partial p_2 = 0$$

...

$$\ell_{p_n} = (1 - p_1) \cdot \partial U_1 / \partial p_n - \lambda \cdot \partial TWTP_1 / \partial p_n = 0.$$

Person 1's altruism-adjusted value of statistical life is the sum of his WTP for an improvement in everyone's safety. Solving for $\partial TWTP_1 / \partial p_i$ in each first-order condition, ℓ_{p_1} through ℓ_{p_n} , and summing the first-order conditions yields the following equation for the value-of-statistical-life:

$$\begin{aligned} VSL_1 &= \left| \sum_{i=1}^n \partial TWTP_1 / \partial p_i \right| = \left| (-U_1 + (1 - p_1) \cdot [\partial U_1 / \partial p_2 + \dots \partial U_1 / \partial p_n]) / \lambda \right| \\ &= \left| -U_1 + (1 - p_1) \cdot \sum_{i=2}^n \partial U_1 / \partial p_i \right| / \lambda. \end{aligned}$$

From ℓ_{c_1} ,

$$\lambda = (1 - p_1) \cdot \partial U_1 / \partial c_1.$$

Therefore,

$$VSL_1 = \left| \frac{-U_1}{(1 - p_1) \cdot \partial U_1 / \partial c_1} + \frac{\sum_{i=2}^n \partial U_1 / \partial p_i}{\partial U_1 / \partial c_1} \right|. \quad (2.8)$$

$\frac{\sum_{i=2}^n \partial U_1 / \partial p_i}{\partial U_1 / \partial c_1}$ is simply Person 1's marginal rate of substitution of changes in all other

persons' probability of death for income (MRS_{pM}).¹⁴ In this model, if others' death risks

do *not* affect Person 1's utility, $MRS_{pM} = 0$, and $VSL_1 = \frac{U_1}{(1 - p_1) \cdot \partial U_1 / \partial c_1}$, which yields

the value of statistical life outlined in Equation 2.3.

If, on the other hand, Person 1 is a safety-focused altruist, $\frac{\sum_{i=2}^n \partial U_1 / \partial p_i}{\partial U_1 / \partial c_1} < 0$ and

VSL_1 is greater under the assumption of safety-focused altruism (Equation 2.8) than under the assumption of no altruism (Equation 2.3). This proves the assertion that value of statistical life is greater if people are safety-focused altruists. As noted above, Jones-Lee (1992) estimated that Equation 2.8 is 10 to 40 percent larger than Equation 2.3.

Because utility levels are not directly observable, it is impossible to exactly estimate Equation 2.8, just as it is impossible to precisely estimate Equation 2.3.

Practitioners can nonetheless estimate the altruism-adjusted value of statistical (VSL_1^A) with Equation 2.9:

$$VSL_1^A \approx \frac{WTP_1^1}{|\Delta p_1|} + \frac{WTP_1^2}{|\Delta p_2|} + \dots + \frac{WTP_1^n}{|\Delta p_n|} = \sum_{i=1}^n \frac{WTP_1^i}{|\Delta p_i|}, \quad (2.9)$$

where WTP_1^i is Person 1's WTP to reduce Person i 's probability of death by Δp_i .

Thus, to compute Person 1's altruism-adjusted value of statistical life in practice, economists sum Person 1's WTP for reductions in all persons' probability of death, including his own probability of death. It is likely impossible to estimate WTP for

¹⁴ In this model, the marginal utility of consumption spending is simply the marginal utility of income. Also, in the notation MRS_{pM} , p is all other persons' probability of death, and M is personal income.

reductions in *all* affected persons' probability of death with revealed preferences, but it is possible with a properly worded contingent valuation study (Johansson, 1994).

This section indicates that policymakers should increase the value of statistical life if people are indeed safety-focused altruists. What is a practical approximation of the necessary adjustment? Equation 2.9 (the practical estimate of the altruism-adjusted value of statistical life) exceeds Equation 2.4 (the practical estimate of the non-adjusted value of statistical life) by $\sum_{i=2}^n \frac{WTP_1^i}{|\Delta p_i|}$, which is Person 1's WTP for altruistic risk reduction.

Equation 2.8 (the theoretical estimate of the altruism-adjusted value of statistical life) exceeds Equation 2.4 (the theoretical estimate of the non-adjusted value of statistical life)

by MRS_{pM} . Therefore, $\sum_{i=2}^n \frac{WTP_1^i}{|\Delta p_i|}$ is a practical approximation of MRS_{pM} , the necessary adjustment to the value of statistical life to account for safety-focused altruism.

In summary, various assumptions about the nature of altruism influence the value of statistical life. If people are egotists or neutral altruists, Equation 2.3 is the proper value of statistical life. If, on the other hand, people are safety-focused or paternalistic altruists, Equation 2.8, is the proper value of statistical life.¹⁵ Therefore, the value of statistical life depends on the nature of altruism. The next section evaluates the nature of altruism by reviewing available evidence. As demonstrated below, strong evidence indicates that people are safety-focused altruists, implying that the Equation 2.8 is the actual value of statistical life.

¹⁵ Of course, these are limiting cases, and people may be partly safety-focused and partly neutral altruists. In this situation, Jones-Lee (1992) demonstrated that the value of statistical is still greater than if people are strictly neutral altruists.

The Absence of Altruism

Although altruism does not play a role in determining the value of statistical life, I am not the first writer to note its absence. Mishan (1971) observed that the value of a person's life is equal to her private WTP to prevent her own death *plus* all others' WTP to prevent her death. Twenty years later, Viscusi (1992) commented, "[t]he extent and implications of altruistic concerns have yet to be estimated properly" (1992, p. 21). At the time of Viscusi's comment, researchers began to seriously investigate the role of altruism in the value of life (see Jones-Lee [1992] and Johansson [1994]). Nevertheless, their results have not been incorporated into policy decisions. A decade later, Ackerman and Heinzerling asked the following critical question: "How much is it worth to you to prevent the death of an unknown person far away?...The answer cannot be deduced solely from your attitudes toward risks to yourself" (2004, p. 9-70).

Does Altruism Exist?

Heuristic Observations. – Anecdotal evidence suggests that people are willing to sacrifice to prevent the deaths of others. In August 2007, six miners were trapped in a partial cave-in at the Crandall Canyon Mine in Emery County, Utah (Frosh and Lee, 2007). Because communications were cut off, mine operators did not know if those in the mine had survived the initial collapse. Many people sacrificed time and money in a heroic effort to save the miners. Unfortunately, these attempts were ultimately unsuccessful, and three additional rescue workers perished. Those involved in the rescue efforts knew the identity of the miners who were trapped. The rescue workers displayed a conspicuous WTP to prevent their deaths.

Similarly, parents accept lower salaries in exchange for medical insurance benefits that extend to their children. It seems unreasonable to suggest that parents' welfare is not affected by the well-being of their children. As noted above, however, most risk reduction policies prevent the deaths of persons that are unknown. Thus, the willingness-to-sacrifice displayed by rescue workers and affectionate parents, both of whom have an *ex post* perspective, does not provide a relevant estimate of the value of unidentified death prevention, nor does it demonstrate that people are indeed willing to pay for risk reductions enjoyed by unknown persons. The following question is therefore appropriate in the context of public policy: Does altruism exist even if it is impossible to identify whose deaths, if any, will be prevented through risk reduction programs?

Americans donated over 15 million units of blood in 2004 (Whitaker and Sullivan, 2005). Most people give one unit of blood per donation. Americans therefore donated blood on approximately 15 million occasions in 2004. Of these donations, only 132,000 were designated for specific patients; all others were made without knowledge of the eventual beneficiary. Although the motivation for donating blood may be complex (Schwartz, 1973), anonymous blood donations provide a clear answer to the previous question. People *are* willing to pay to prevent the premature death of other individuals, even if such individuals remain unidentified. Still, much of the existing empirical data is conflicting; some results are entirely paradoxical.

Empirical Evidence. – If altruism exists, consumers' WTP for public safety improvements should exceed their WTP for equivalent private improvements. That is, WTP for altruistic risk reduction (risk reduction that solely affects others) should be positive. A group of economists recently examined 96 empirical estimates of WTP, most

of which were elicited using contingent valuation surveys (Blaeij et al., 2003).

According to their study, consumers are willing to pay *more* for private risk reductions than public reductions. These results imply that, given the choice between (a) safety improvements that strictly apply to the individual, and (b) equivalent improvements that apply to the individual and all others (including family members and friends), the average person would select the former. In other words, people are misanthropists, not altruists. Individual welfare increases as others' experience an increased risk of death! There are a few possible explanations for this counterintuitive empirical result.

First, respondents who stated their WTP for risk reduction as a private good are not the same participants who expressed WTP for risk reduction as a public good. In fact, private and public risk surveys may bear little resemblance to one another. It is therefore questionable whether the WTP values are directly comparable. After all, "Small changes in question wording... sometimes cause significant changes in survey responses" (Hanemann, 1994, p. 26). This does not, however, explain similar disparities in studies where participants received near-identical surveys. Improper survey design may also lead to paradoxical results.

Researchers should urge survey participants to *endogenously* consider public risks. If participants do not apply the implications of risks to themselves, WTP bids may be vastly understated. Most of the surveys analyzed by Blaeij et al. (2003) fail in this regard. For example, in another recent study, Hultkrantz et al. (2006) explicitly stated that private risk programs would decrease the participants' probability of dying. The same researchers equivocally explained the effects of the public risk reduction program; they did not encourage participants to apply the effects of the risk reduction to

themselves. Respondents may have therefore considered the public program primarily as an altruistic safety improvement. If this is the case, the sum of private and public WTP values more accurately reflects the altruism-adjusted value of life.

The original group of economists proposed a final explanation: WTP for public risk reduction is subject to the free-rider effect (Blaeijs et al., 2003). That is, consumers may strategically understate their true WTP if they expect others to also pay. In such cases, *stated* public WTP values do not equal *actual* WTP values, and the comparison of private and public WTP numbers is illegitimate.

Researchers can eliminate these sources of bias through proper survey design. As expected, studies that mitigate these problems yield empirical evidence supporting the existence of altruism.

Araña and León (2002) recently surveyed 700 households to determine their WTP for reductions in the probability of acquiring influenza. The sample was split into two groups. One group stated WTP for a flu vaccine – a private risk reduction; the other group stated WTP for a policy that reduces the overall probability of acquiring flu – a public risk reduction. Both absolute levels of risk reduction were equivalent. Researchers corrected the first problem because the surveys were identical, aside from the specific risk reduction question. Also, the survey explicitly instructed participants to endogenously consider public risk reductions. Furthermore, the researchers took steps to mitigate potential free-rider biases. The researchers eliminated all three problems mentioned above. Their results meet expectations. On average, respondents were willing to pay 14 to 24 percent *more* for public morbidity reductions than private morbidity

reductions. These results confirm common intuition: altruism exists. Should policymakers disregard it?

Is Altruism Safety-focused?

Theory. – As noted in the Introduction, Bergstrom (1982) cogently argued policymakers should ignore altruistic concerns. Although consumers are willing to pay to improve others' safety, policymaker should not increase safety expenditures. According to Bergstrom's model, if the value of statistical life is increased to compensate for altruistic concerns, taxes must be homogenously raised to pay for greater risk-reduction expenditures. The tax increase, however, lowers overall welfare: "If the benefits to Peter of the extra public safety must include Peter's valuation of increased safety for Paul, then the costs to Peter of the taxes that pay for the increased safety must include Peter's regrets for Paul's reduced consumption" (Bergstrom, 1982, p. 17). If taxes are raised to pay for Peter's altruism, Paul is no longer able to purchase as many goods; hence Paul's overall welfare decreases. Therefore, the existence of altruism *does not* imply that agencies should increase their estimates of the value of statistical life. According to this model, optimal risk expenditure levels are independent of altruistic concerns. Milgrom (1993) later corroborated this assertion.¹⁶

In Bergstrom's model, Person *i*'s utility is represented in the following form,

$$U_i = U_i(p_1 \cdot U_1(c_1), \dots, p_n \cdot U_n(c_n)),$$

where U_i is a non-decreasing function of each argument and an increasing function of $p_i \cdot U_i(c_i)$ and p_i is Person *i*'s probability of survival and c_i is his wealth. Suppose that the allocation $(p_1^P, c_1^P, \dots, p_n^P, c_n^P)$ is Pareto optimal. This allocation would also be optimal if

¹⁶ I comment further on Milgrom's argument in the final section of this chapter.

each person is selfish and has the following utility function: $p_i \cdot U_i(c_i)$. Bergstrom demonstrated this by positing another allocation $(p_1^2, c_1^2, \dots, p_n^2, c_n^2)$ such that $p_i^2 \cdot U_i(c_i^2) \geq p_i^p \cdot U_i(c_i^p)$ “for all i with strict inequality for some i ” (p. 17). This would imply the following:

$$U_i(p_1^2 \cdot U_1(c_1^2), \dots, p_n^2 \cdot U_n(c_n^2)) \geq U_i(p_1^p \cdot U_1(c_1^p), \dots, p_n^p \cdot U_n(c_n^p)),$$

“for all i with strict inequality for some i . But this is impossible since the allocation $(p_1^p, c_1^p, \dots, p_n^p, c_n^p)$ was assumed to be Pareto optimal” (p. 17).

Nevertheless, these arguments rely on a questionable assumption concerning the nature of altruism, namely that it is neutral. Neutral altruism implies that Peter’s welfare is affected by Paul’s well-being as Paul perceives it, not as Peter perceives it.

Jones-Lee (1991) expanded Bergstrom’s model by allowing safety-focused altruism, a form of paternalistic altruism. Altruism is safety-focused if “[Peter’s] concern for [Paul’s] welfare is solely related to [Paul’s] safety and not to other determinants of [Paul’s] well-being” (Jones-Lee, 1991, pp. 213-4). In this case, Peter’s well-being increases when Paul enjoys greater safety, but it may remain unaffected when Paul’s income grows. A safety-focused altruist would have the following utility function: $U_i = U_i(p_i \cdot U_i(c_i), p_1, \dots, p_n)$. With this formulation of Person i ’s utility, Bergstrom’s proof does not hold.

Jones-Lee demonstrated that *if altruism is entirely safety focused, it is not only appropriate but necessary to include the full amount of people’s WTP for others’ safety in the valuation of statistical lives*. Accordingly, current value-of-life estimates are inadequate. Jones-Lee (1992) later demonstrated that the degree to which one person’s WTP for another’s safety should affect risk expenditure decisions depends on the

likelihood that altruism deviates from neutrality. He further estimated that the altruism-adjusted value of statistical life is 10 to 40 percent greater than the value used in current policy analyses. This theoretical estimate contains the 14 to 24 percent range found by economists Araña and León (2002).

Bergstrom's (1982) and Jones-Lee's (1991, 1992) conflicting models beg the question: Is altruism neutral or safety-focused? The former implies that policymakers should ignore altruism, the latter that policymakers should increase the value of statistical life to account for it. According to Arrow (1963), altruism is probably safety-focused: "The taste for improving the health of others appears to be stronger than for improving other aspects of their welfare" (p. 954). Government welfare programs may offer some additional insight.

Empirical Evidence. – If altruism tends to be neutral, one would expect society to pursue aid programs that offer cash payments, for recipients would be free to spend aid money however they please, thereby maximizing personal welfare *as perceived by recipients*. If, on the other hand, altruism is paternalistic, society would pursue spending programs that increase recipients' welfare *as perceived by society at large*. In 2002, cash payments constituted less than 10 percent of total aid given to families (Currie, 2008). According to Currie, most government welfare spending instead focused on "Medicaid, food stamps, public housing, school nutrition programs (the National School Lunch and the School Breakfast programs), [and] WIC (Supplemental Nutrition for Women, Infants, and Children)..." (pp. 196-7). Because welfare programs center on health and nutrition, current spending levels seem to indicate that altruism is safety-focused. A new empirical study strengthens this proposition.

Jacobsson et al. (2007) conducted a simple survey to test the nature of altruism. The researchers queried 360 students, informing participants they could donate either money or nicotine patches to a poor diabetes patient. According to the hypothetical scenario, the patient's WTP for nicotine patches was less than the market price. The respondents knew that the patient preferred cash payments to nicotine patches. Thus, "A pure altruist will...always prefer to donate money," which maximizes the patient's welfare, "whereas a [safety-focused] altruist may prefer to donate nicotine patches," which improves the patient's health (p. 765). Ninety percent of participants offered to donate nicotine patches instead of money. The students apparently attempted to improve the patient's health rather than maximize his overall welfare. Their results provide strong support for the notion that altruism is safety-focused.

In summary, significant evidence contradicts the anti-altruism assumptions mentioned in the Introduction. Not only does altruism seem to exist, but it tends to be safety-focused.

Implications for Cost-benefit Analysis

The above arguments suggest that policymakers should not ignore altruism in risk analysis because many people are safety-focused altruists. The value of statistical life of a safety-focused altruist exceeds the value of statistical life of a neutral altruist by MRS_{pM} , the marginal rate of substitution of changes in all other persons' probability of death for income. Should policymakers increase the value of statistical life by MRS_{pM} in CBA? That is, which equations, Equations 2.3 and 2.4 or Equations 2.8 and 2.9, should define the value of statistical life in CBA?

This section demonstrates that Equation 2.9, not Equation 2.4, is the value of statistical life that practitioners should use in CBA (assuming that people are safety-focused altruists). Moreover, this section shows that the failure to account for altruistic concerns can have a substantive impact on which safety programs are deemed tenable.

Theoretical Implications

Pure Altruism in CBA. – Milgrom (1993) argued that policymakers should ignore altruistic values in CBA. He felt that “counting one person’s WTP for another’s happiness in a benefit-cost calculation amounts to a double (or triple or...) counting of the beneficiary’s benefits” (p. 420). Milgrom corroborated Bergstrom’s (1982) contention that economists should not adjust the value of statistical life to account for altruism – that is, they should ignore MRS_{pM} . Although altruism exists, Milgrom acknowledged, policymakers should use $WTP_1 / |\Delta p_1|$ (Equation 2.4) in CBA, not $\sum WTP_1^i / |\Delta p_i|$ (Equation 2.9).

To demonstrate his point, Milgrom presented a simple example. A local municipality wishes to offer a public good. Paul receives \$100 of benefit from the public good, minus the amount C_a he must pay for it. Paul’s change in utility ΔU_a can be represented as follows:

$$\Delta U_a = \$100 - C_a. \quad (2.10)$$

Peter receives \$50 of benefit from the public good, minus the amount C_e he must pay for it. Furthermore, Peter’s utility increases as Paul’s utility increases at the rate of one half, for Peter is an altruist:

$$\Delta U_e = \$50 + 1/2 \cdot \Delta U_a - C_e. \quad (2.11)$$

Peter and Paul's total WTP is equal to \$200 (from Equations 2.10 and 2.11).

Policymakers would accordingly implement the public good if its total cost C is less than \$200. Nevertheless, for the public good to be economically feasible, Milgrom imposed the condition that both Paul's and Peter's welfare must not decrease ($C_a \leq \$100$ and $C_e \leq \$50 + 1/2 \cdot \Delta U_a = \$100 + 1/2 \cdot C_a$) and C must not exceed the amounts Peter and Paul pay for it ($C \leq C_a + C_e$).¹⁷ Therefore, the total cost of the public must not exceed \$150. Why? $C \leq C_a + C_e \leq \$100 + 1/2 \cdot C_a$, and $C_a \leq \$100$, so $\$100 + 1/2 \cdot C_a \leq \150 ; consequently, $C \leq \$150$.

If the total cost of the public good is between \$150 and \$200, policymakers will accept the project because total WTP exceeds total costs, but the implementation of the good would not constitute a potential Pareto improvement because, as demonstrated in the previous paragraph, costs cannot exceed \$150.

Following the presentation of this example, Milgrom concluded that the inclusion of altruistic values in CBA "leads to false conclusions" (p. 421).

Paternalistic (Safety-focused) Altruism in CBA. – Milgrom assumed that Peter is a neutral altruist because Peter's utility is a direct function of Paul's utility (Equation 2.11). What if Peter is instead a paternalistic altruist, so Peter's utility changes as Paul's access to the public good varies but remains unaffected by changes in his income? This section demonstrates that accounting for paternalistic altruism, such as safety-focused altruism, does not lead to "false conclusions."

It is assumed that Paul, as before, is purely self-interested, so $\Delta U_a = \$100 - C_a$.

Peter, on the other hand, is a paternalistic altruist. His utility is a function of Paul's

¹⁷ Actually, the project can still be economically feasible if one person's utility decreases as long as the other's utility increases sufficiently to enable a potential compensation. I am, however, outlining Milgrom's example as he presented it.

valuation of the public good. Peter's utility now increases at the rate of one half of Paul's valuation of the public good, instead of increasing as Paul's utility grows.

$$\Delta U_e = \$50 + 1/2 \cdot WTP_a - C_e = \$50 + 1/2 \cdot \$100 - C_e = \$100 - C_e. \quad (2.12)$$

Therefore, Paul's valuation of the public good WTP_a affects Peter's utility, but decreases in Paul's income do not affect Peter's utility.

Total WTP is \$200 (from Equations 2.10 and 2.12), implying that cost-benefit analysts should accept the program if total costs are no greater than \$200 (this is the same as before). This proof also imposes Milgrom's condition: both Paul's and Peter's welfare must not decrease ($C_a \leq \$100$ and $C_e \leq \$100$) and C must not exceed the amounts Peter and Paul pay for it ($C \leq C_a + C_e$). Accordingly, $C \leq C_a + C_e$, and $C_e \leq \$100$, and $C_a \leq \$100$, so $C \leq \$200$. In this case, the public good is economically feasible as long as costs do not exceed \$200, which is also the total amount Peter and Paul are willing to pay for it. This modified example indicates that it is appropriate to include paternalistic altruism values in CBA. (For related but more formal proofs, see Johansson [1992] and McConnell [1997]).

If people are indeed safety-focused altruists (as Arrow [1963], Jacobsson et al. [2007], and others have argued), policymakers should value each prevented death according to the altruism-adjusted value of statistical life (Equation 2.8). MRS_{pM} should be added to each value-of-statistical-life estimate.

As mentioned before, Jones-Lee (1992) argued that the altruism-adjusted value of statistical life is 10 to 40 percent greater than current estimates. This recommended increase implies that EPA's value of statistical life should be \$6.7 to \$8.5 million, not \$6.1 million. Table 2.3 shows the effects of increasing value-of-statistical-life on current

Table 2.3

Jones-Lee's (1992) Recommended Altruism Adjustment Applied to Agency Value-of-Statistical-Life Estimates

Agency	Source	Value (millions \$)*	Adjusted Value - 10% (millions \$)	Adjusted Value - 40% (millions \$)
CPSC	Heinzerling (2000)	5	5.5	7.0
DOA	Sunstein (2004)	4.8	5.3	6.7
DOT	U.S. DOT (2002)	3	3.3	4.2
EPA	U.S. EPA (2000)	4.8 (1990\$), updated to relevant year	5.3	6.7
FDA	U.S. FDA (2004)	5 -- 6.5	5.5 -- 7.2	7 -- 9.1
FAA	Sunstein (2004)	1.5 -- 3	1.7 -- 3.3	2.1 -- 4.2
OMB	Sunstein (2004)	5	5.5	7.0

* *Note* : For many agencies, the value of statistical life is not fixed (Sunstein, 2004).

government agencies' estimates. The next section demonstrates that the failure to account for safety-focused altruism influences which safety programs policymakers implement and the number of deaths thereby prevented.

Recent EPA Studies

According to Gowdy, “CBA drives the environmental policy recommendations of most economists” (2004, p. 241), despite the protests of many (e.g., Randall, 1999). Value-of-statistical-life estimates, which affect expected costs and benefits, heavily influence policymakers’ attitudes towards various life-saving programs. It is therefore important to know the true value of anonymous death prevention.

This section analyzes two recent EPA studies. These particular CBA reports were selected for their distinct qualities. First, both studies examine programs that reduce mortality levels. EPA’s estimate of the value of statistical life plays an important role in each analysis. Second, both studies fail CBA in certain regions or under certain assumptions. As noted above, Araña and León (2002) and Jones-Lee (1992) performed studies suggesting that the altruism-adjusted value of life is 10 to 40 percent greater than the value currently used by government agencies. This section briefly – and somewhat crudely – reevaluates the expected of both programs using this adjustment for altruism. The intent is to demonstrate that the absence of altruism is not arbitrary. It can have a substantive impact on which programs are labeled economically feasible.

Clean Air Act, Section 126. – In standard economics, external diseconomies are activities that impose costs on someone other than the producer (Buchanan and Stubblebine, 1962). Pollution is a classic example. Unless polluters are liable for the costs of contaminated air and water or recipients are able to pay polluters to reduce emissions (if polluters possess the property right), harmful emissions impose external diseconomies on those who desire a clean environment. Power plants often emit harmful pollutants. One such pollutant is nitrogen-oxide (NO_x), a harmful toxin that causes lung

damage (U.S. EPA, 1999b). Once released into the ozone, NO_x can travel via wind to adjoining areas. Congress, through the Clean Air Act, has attempted to mitigate this external diseconomy by establishing ambient NO_x standards.

Several Northeastern states recently filed a petition with EPA, charging that pollution produced in neighboring areas prevented the petitioning states from achieving acceptable NO_x levels (U.S. EPA, 1999b). Section 126 of the Clean Air Act was drafted in response to this petition. EPA later analyzed the efficacy of Section 126 by performing a CBA study. According to EPA's results, roughly 80 percent of compliance benefits are reductions in mortality risks (U.S. EPA, 1999c). In fact, EPA estimated that full compliance could save 200 lives per year. EPA compared costs and benefits using two methods: the value-of-statistical-life approach and the value-of-statistical-life-years approach. The latter approach, which Moore and Viscusi proposed in 1988, is similar to the standard method discussed throughout. The implications of altruism equally apply to both methods. With the standard approach, EPA estimated that the program yields positive net benefits of \$200 million. With the alternative approach, however, EPA determined that the program yields *negative* net benefits of \$300 million. If policymakers accept the alternative approach, they must conclude that the program is economically infeasible.

Nevertheless, if policymakers increase expected benefits by 43 percent, net benefits are *positive* under both approaches (U.S. EPA 1999b). This adjustment for altruism does not significantly differ from Jones-Lee's upper-end recommendation of 40 percent. In this study, the neglect of altruism could have led policymakers to reject an economically desirable program. Because EPA performed this CBA *ex post*, the results

did not affect the decision to enact Section 126. Had policymakers been able to consult the study in advance, it is possible they would have rejected Section 126 and thereby unduly allowed 200 premature deaths per year.

September 2006 Adjustment in PM_{2.5} Standards. – On September 21, 2006, EPA adjusted ambient PM_{2.5} standards (U.S. EPA, 2006a). According to scientific experts, this adjustment will prevent 1,200 to 24,000 deaths. Full attainment is expected to yield \$18 to \$22 billion net benefits – the variation depends on the discount rate (U.S. EPA, 2006c). EPA separated the results into three geographical areas: East, West, and California. Net benefits are positive in California and Eastern states, but *negative* in Western states (excluding California). Although EPA estimated that tighter standards could prevent 100 to 1,400 deaths in the West (U.S. EPA, 2006b), regional costs exceed benefits by \$20 to \$100 million. This implies that EPA should not enforce tighter standards in the West. Nevertheless, if EPA increases its estimate of benefits by 2.5 to 15 percent to account for altruism, net benefits are universally positive, even in the Western region. As with the previous example, the failure to consider altruism determines whether analysts label this regulation as efficient or inefficient. The decision to consider or ignore altruism continues to have a substantive impact on which projects government agencies pursue.

CHAPTER 3

STATED PREFERENCES¹⁸

Researchers have derived many value-of-statistical-life estimates using contingent valuation, a stated preferences method. Furthermore, the Jakus (1992) study outlined and analyzed in Chapter 4 is a contingent valuation study. Many of the arguments presented herein rely on the efficacy of stated preferences studies. In this chapter, I review the status of contingent valuation and other stated preferences welfare measurements. As mentioned below, stated preferences studies are becoming increasingly popular and accepted in the academic community.

Contingent Valuation: A Brief History

Economists use CBA as a tool to compare the expected costs and benefits of potential projects. Both costs and benefits are stated in dollars. If benefits exceed costs, the project is feasible. In analyzing the efficiency of building a municipal stadium, for example, analysts would compare the costs (construction costs, opportunity cost of land and capital, etc.) with the benefits (expected ticket and vending sales, rental revenues, etc.). For many projects, however, benefits and costs are not readily expressed in dollars. With the stadium, loud crowds and bright lights might annoy those on neighboring properties and therefore impose costs. How do researchers assign a dollar value to these costs? One answer is contingent valuation.¹⁹

¹⁸ This section draws on Mitchell and Carson (1989).

¹⁹ It might be possible to estimate these costs using a hedonic approach. Nevertheless, it would be difficult to disentangle the costs of bright lights and loud noise from the added value of being close to the stadium because nuisance costs and proximity benefits would be highly collinear in a regression analysis.

In 1947, responding to the question, “How...can demand schedules for collective extra-market goods be obtained?”, Ciriacy-Wantrup proposed the following:

Individuals...may be asked how much money they are willing to pay for successive additional quantities of a collective extra-market good. The choices offered relate to quantities consumed by all members of a social group...The results correspond to a market-demand schedule. For purposes of public policy this schedule may be regarded as a marginal social-revenue schedule. In combination with a corresponding cost schedule the socially desirable supply of the collective extra-market good can be determined. (p. 1189, emphasis added)

Ciriacy-Wantrup argued that researchers could estimate consumers’ valuation of non-market (or extra-market) goods by simply asking them how much they are willing to pay for such goods. Ciriacy-Wantrup further advocated this valuation method in his seminal work *Resource Conservation: Economics and Policies* (1952). This survey or interview valuation technique later became known as contingent valuation. Contingent valuation “attempts to elicit consumer valuations of goods and services which are not usually traded in markets” (Contingent Valuation, 1992, p. 80).

As part of his Ph.D. dissertation, Davis (1963) conducted the first known contingent valuation study to estimate the benefits of outdoor recreation in Maine. He received 121 responses and felt that they were “economically consistent.” In the 1960s and 1970s, contingent valuation became increasingly popular. As mentioned in Chapter 2, Acton’s (1973) door-to-door heart disease study was the first attempt to measure WTP for risk reduction with a contingent valuation study. Researchers have conducted hundreds of safety-related contingent valuation studies since the early 1970s.

According to Mitchell and Carson (1989), contingent valuation interviews or surveys consist of three parts:

1. A detailed description of the good(s) being valued and the hypothetical circumstance under which it is made available to the respondent...

2. Questions which elicit the respondents' willingness to pay for the good(s) being valued...
3. Questions about respondents characteristics (for example, age, income), their preferences relevant to the good(s) being valued, and their use of the good(s). (p. 3)

Researchers have developed a number of techniques to elicit WTP responses.

Table 3.1 outlines four prominent methods. Each elicitation technique has strengths and weaknesses. *Open-ended surveys*, for example, require respondents to directly state the maximum amount they would be willing to pay for the offered good (e.g., Mitchell and Carson, 1986; Brady, 2008). Theoretically, this should provide a very accurate estimate of WTP. In practice, however, many respondents are unable to choose a value without assistance. Open-ended contingent valuation studies produce an abnormally large number of protest bids, i.e., respondents claim they are not willing to pay anything for the offered good, despite indicating they value it.

Dichotomous choice surveys, or discrete choice surveys, simulate market decisions. Survey participants receive offers that they can either accept at the given price or reject. The market simulation alleviates the consumers' burden by simplifying options. Still, a number of statistical assumptions, which may or may not be accurate, are necessary to calculate WTP from discrete data (these are discussed in Chapter 4). Furthermore, dichotomous choice surveys do not yield complete WTP distributions; the extreme right tail of the distribution remains unknown. Despite its weaknesses, the dichotomous choice surveys are, perhaps, the most common elicitation method.

Davis (1963) used the *iterative bidding game* method in his original contingent valuation survey. Similar to the dichotomous choice method, participants receive an initial bid that can be accepted or rejected. If accepted, respondents receive higher bids,

Table 3.1*Common Contingent Valuation Elicitation Methods*

	Open-ended	Discrete
Single Question	Open-ended/Direct	Dichotomous Choice
Multiple Questions	Iterative Bidding Game	Dichotomous Choice (with follow-up)

Adapted from Mitchell and Carson (1989)

if rejected, lower bids. This continues until respondents arrive at maximum WTP. This approach seems to be an improvement over the previous two methods because it simulates market decisions and provides a complete picture of WTP distributions. Nevertheless, this method yields biased WTP bids. The initial bid has a rooting effect (Mitchell and Carson, 1989), causing respondents to bid abnormally high if the initial bid is greater than WTP and abnormally low if the initial bid is less than WTP.

Finally, the *dichotomous choice with follow-up* approach is similar to the bidding game, except respondents receive only one follow-up offer. This mitigates some of the effects of rooting, but not all. This method is more efficient but also more biased than the standard dichotomous choice method. The efficiency gains may or may not offset the bias.

Aside from difficulties in eliciting WTP responses that match actual preferences, there are a number of methodological problems with contingent valuation (Mitchell and Carson, 1989). First, consumers may provide unrealistic offers if they seek to impact

government decisions. A person may offer an extremely high WTP if she realizes it will affect the decision to preserve wildlife, for example. Conversely, she may offer a low WTP bid if she expects others to fund the program, creating the free-rider problem (as mentioned in Chapter 2, this may be one of the reasons many public risk surveys have yielded low WTP estimates [Blaeijs et al., 2003]). Also, consumers are sensitive to the payment method. A person may state that she is willing to pay more for pure water if she pays for the cleanup through her utility bill rather than through a tax increase. Presenting non-controversial payment vehicles is important in survey design. Many other contingent valuation problems can be mitigated through well designed surveys.

McCloskey notes that many "...economists are extremely hostile towards questionnaires and other self-descriptions" (1983, p. 514). Even today, many economists question the validity of contingent valuation responses.

Current Status of Stated Preferences Surveys

On March 24, 1989, the *Exxon Valdez* oil spill occurred off the coast of Alaska, sending millions of gallons of crude oil into the sea. A local jury determined that Exxon was liable for the damage costs.²⁰ Many of the costs, such as lost fishing production or reduced tourism, are relatively easy to calculate. Other costs, such as the U.S. citizens' distress over the environmental disaster and the loss of wildlife, cannot be calculated with market data. The National Oceanic and Atmosphere Administration (NOAA) assembled a team of blue-ribbon economists and social scientists to determine if the contingent valuation method can produce reliable damage estimates. The panel, led by Nobel

²⁰ The initial award was set at \$5.2 billion, but Exxon has repeatedly appealed the jury's decision (Mears, 2007).

laureate Kenneth Arrow, detailed their findings in the influential NOAA report (Arrow et al., 1993). The panel concluded that “a well-conducted CV study provides” is “adequately reliable” (p. 44) for use in damage assessment. Furthermore, they listed a number of recommendations for future contingent valuation studies. These recommendations include maximizing response rates, pretesting surveys, using personal interviews, favoring conservative WTP estimates over WTA estimates, relying on referendum format elicitation methods, i.e., dichotomous choice, and presenting multiple follow-up questions to determine if the bid was a true expression of WTP. According to the panel, the “burden of proof” (p. 63) to demonstrate the validity of responses rests on the economic researchers that implement the study.

Shortly after the release of the NOAA panel’s assessment, Diamond and Hausman (1994) stated, “contingent valuation surveys do not measure the preferences they attempt to measure” (p. 46). Their criticism focused on the inconsistency of past studies. Although, they acknowledged, “It is impossible to conclude definitely that surveys with new methods...will not pass internal consistency tests,” they “do not see much hope for success” (p. 63).

Hanemann (1994), in defending contingent valuation from Diamond and Hausman’s attack, conceded that many past contingent valuation studies have been internally inconsistent. He argued, however, that most of these studies were poorly designed. He felt that well designed surveys produces values comparable to revealed preferences studies. Bishop and Heberlein (1990), for example, used a contingent valuation survey to estimate hunters’ WTP for deer-hunting licenses. They estimated that

WTP was \$35. The population's actual WTP was \$31. The \$4 difference is statistically insignificant.

Contingent valuation studies allow economists to value goods and services that could not be otherwise valued. These studies are therefore important to CBA, which requires a full evaluation of costs and benefits. According to Portney, "Whether the economics profession likes it or not, it seems inevitable...that contingent valuation methods are going to play a role in public policy formulation" (1994, p. 16). Although many economists still remain suspicious, contingent valuation studies are regularly used in policy analysis and court decisions.

Over the past decade, many economists have shifted their attention to conjoint analysis, a modified version of contingent valuation. (These studies are sometimes called choice experiments.) In conjoint studies, consumers receive a number of offers, each with specific attributes and prices (Álvarez-Farizo and Hanley, 2002). Table 3.2 displays a sample conjoint questionnaire dealing with public and private risk reduction.

Consumers can accept one of the offers or reject all of them. Consumers' choices more fully simulate market decisions by highlighting tradeoffs. These surveys also allow economists to measure the value of specific attributes. Conjoint analyses have grown in popularity since the 1990s (Boyle et al., 2001).

Table 3.2

Sample Conjoint Analysis Choice Table for Public and Private Risk Reduction in Cache Valley

	<i>Option 1 - Oral Vaccination</i>	<i>Option 2 - Public Information Program</i>	<i>Option 3 - Neither</i>
<i>Effect on your health:</i>	My personal risk of dying from influenza and pneumonia would decrease by 50%.	My personal risk of dying from influenza and pneumonia would decrease by 50%.	N/A
<i>Effect on community health:</i>	N/A - My decision to receive the vaccine would not affect others' death risk.	My family, neighbors, friends, and all other residents of Cache Valley would face a 50% lower probability of dying from influenza and pneumonia, which would prevent roughly 9 deaths per year.	N/A
<i>Cost:</i>	I would prefer to pay { \$10, \$20, \$30 \$50, \$100 } for the oral vaccination.	I would prefer to pay { \$20, \$30, \$50, \$100, \$200 } for local authorities to implement the public information program.	I am not willing to pay the stated amount for either program.
<i>Please select one option:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

CHAPTER 4

EMPIRICAL ANALYSIS

The second objective of this thesis is to provide an empirical estimate of the difference between private and public safety WTP values. Jakus (1992) used a contingent valuation survey to measure over 500 respondents' attitudes towards risks in drinking water.²¹ Though more research is certainly warranted, analysis of the data reveals a positive disparity between private and public WTP, which suggests that policymakers should increase the value of statistical life to account for altruism – assuming, of course, that altruism is paternalistically safety-focused.

The first section “Survey and Data” outlines and explains the Jakus study, detailing the WTP question and providing summary statistics. The second section “Model” presents the conditional logit model and demonstrates how econometric coefficients can be used to derive welfare measures from discrete data sets. The final section “Results” presents the results of the econometric models and derives estimates of WTP for public and private risk reduction. It also outlines possible weaknesses in the analysis and discusses future suggested research.

Survey and Data

Survey

In 1991, as part of his Ph.D. dissertation, Professor Paul Jakus conducted a contingent valuation study designed to evaluate attitudes toward pest control. The contingent valuation study followed a telephone-mail-telephone approach. Respondents

²¹ Appendix B contains the survey in its entirety.

resided in ten counties: two in Maryland and eight in Pennsylvania.²² Participants were selected using random digit dial. In total, 962 of 1928 persons contacted (49.9 percent) completed the first survey, which is the survey analyzed in this chapter. Fewer respondents (559) agreed to participate in the second-round interview, and even fewer (436) actually completed the second-round survey.

Although the primary purpose of the surveys was to estimate household WTP to eliminate pest infestations, the first-round telephone survey contained a few questions that measure consumers' WTP to eliminate health risks. Furthermore, the survey differentiates between private and public health risks, so, presumably, data analysis could yield an empirical estimate of the disparity between private and public risk WTP values. The survey conjointly posed the risk reduction questions. The survey asked the 962 first-round respondents if their "drinking water [was] provided by [their] own private well or a city, town or private company water system that is piped to [their] home" (Jakus, 1992, p. 324). Of the 962 total respondents, 552 indicated that they received their water from the local municipality. These 552 respondents were presented the following scenario:

According to the Environmental Protection Agency, some places have small amounts of substances in their drinking water that may cause cancer. Although the risk is low, the agency recommends that these towns or cities undertake one of two types of programs.

Program A has the local water utility install equipment to remove substances at the central pumping and treatment plant. Because the cost of this program may be high for some towns, an alternative plan is Program B. Under this program, the local water utility would install a filtration device in each home that agrees to participate. Each household would decide if they wanted the system and would receive filters monthly. Each program would eliminate the substances from drinking water and make it safe.

If Program A (the central system) had added (\$2 \$8 \$5 \$15 \$25 \$40) to your monthly water bill and Program B (the private system) had an added cost of (\$15 \$20 \$25 \$30 \$35 \$60), which would you prefer? (p. 324)

²² Pennsylvania counties included Bedford, Cumberland, Franklin, Fulton, Huntingdon, Juniata, Mifflin, and Perry. Maryland counties included Frederick and Montgomery.

Respondents could select Program A at the given cost, Program B at the given cost, or neither. Because the respondents faced a discrete choice, it is necessary to use the tools developed for analyzing non-continuous choices to calculate WTP. These tools, as well as the models required to examine simultaneous choices, are outlined in the next section. Although Jakus (1992) used parts of the data for his dissertation, the responses to the risk reduction scenario were never analyzed.

Bids on Program A should reveal attitudes toward public risk reduction, which is the sum of private and altruistic risk reduction; bids on Program B should reveal attitudes toward strictly private risk reduction. If participants are altruists, WTP for Program A should exceed WTP for Program B. In total, 330 respondents selected Program A, the public risk reduction, 72 selected Program B, the private risk reduction, and 150 did not select either program. In the next section, multiple models are presented for analyzing this data. Some of the models require information on income. Of the 552 respondents, 116 were unwilling to divulge yearly income or other important demographic information. Of the 436 income-revealing respondents, 266 chose Program A, 61 chose Program B, and 109 chose neither. Selection rates for both samples are displayed in Table 4.1.

One feature of this survey is of particular interest. While past studies have provided estimates of the disparity between private and public WTP, most studies have followed the split-sample approach. That is, one group of respondents bids on public risk reduction, and the other group bids on private risk reduction. As noted above, these studies yield conflicting results. Araña and León (2002) found that respondents are willing to pay more for *public* risk reduction, and Hultkrantz et al. (2006) found that

Table 4.1*Program Selection Rate for Entire Sample and Income-revealing Subsample*

	Entire Sample	Income-revealing Subsample	Difference
Program A (Public)	330 59.8%	266 61.0%	64 -1.2%
Program B (Private)	72 13.0%	61 14.0%	11 -1.0%
Neither	150 27.2%	109 25.0%	41 2.2%
Total	552	436	116

respondents are willing to pay more for *private* risk reduction (which is surprising because public risk reduction comprises private risk reduction and altruistic risk reduction; Hultkrantz et al.'s results therefore indicate that WTP for altruistic risk reduction is negative). To my knowledge, the Jakus study is the only survey that has simultaneously presented both private and public risk reduction options to respondents. Furthermore, the questionnaire design coincides with the referendum-format suggested by the NOAA panel (Arrow et al., 1993). Summary statistics are provided in the next section.

Summary Statistics

Summary statistics are presented in Table 4.2. The samples' mean income and years-of-education estimates were calculated from the midpoint of the range selected by

Table 4.2*Summary Statistics for Entire Sample and Income-revealing Subsample*

	Sample <i>n</i> =552	Income-revealing Subsample <i>n</i> =436	Population ¹
Income <i>standard deviation (s.d.)</i>		\$42,193.18 25740.56	\$42,386.21
Male <i>s.d.</i>	42.6% 0.49	44.5% 0.50	48.5%
Caucasian <i>s.d.</i>	92.8% 0.26	91.9% 0.27	86.3%
African American <i>s.d.</i>	3.6% 0.19	4.0% 0.20	7.6%
Renter <i>s.d.</i>	25.0% 0.43	26.1% 0.44	29.5%
Age <i>s.d.</i>	42.5 16.01	41.9 16.05	35.2
High School Graduate <i>s.d.</i>	89.4% 0.31	88.6% 0.32	76.2%
Years of School <i>s.d.</i>	13.7 2.85	13.6 2.88	
Environmentally Concerned <i>s.d.</i>	72.5% 0.45	72.3% 0.45	
Confidence in Program <i>s.d.</i>	91.3% 0.28	91.4% 0.28	

¹ Sources: Jakus (1992); U.S. Bureau of the Census (1990)

respondents.²³ The survey told respondents to indicate whether they are very, somewhat, or not at all concerned about environmental quality. As noted in Table 4.2, about 72 percent of respondents indicated they are either very or somewhat concerned about environmental quality.

Those who selected either Program A or B were later asked whether they felt that the selected program would be effective in eliminating carcinogens from drinking water. In both samples, over 90 percent of respondents were confident in the efficacy of the selected program. This increases the credibility of the WTP bids. It is unknown, however, whether doubt influenced those who did not select either program because only those respondents who selected Program A or B answered this question.

Furthermore, as noted in Table 4.2, sample demographics approximate population demographics in the 10 Pennsylvania and Maryland counties. All sample statistics are within one standard deviation of population statistics. It does appear, though, that the random digit dial selected participants who were more likely to be female, older, and Caucasian than the overall population. Members of the sample were also more likely to own their own home and have a high school degree. This is unsurprising because older, highly-educated homeowners were, presumably, more likely to own a telephone than the overall population. Also, the surveyors may have spoken with an unusually high number of females simply because more females were home at the time of the call. Average income is remarkably similar for both the income-revealing subsample and the overall population.

²³ Those who indicated an income range of greater than \$80,000 were assigned an income value of \$100,000; those who indicated they had completed graduate work were assigned a value of 18 years of completed school. The results are not sensitive to these assumptions.

Models

As noted in Chapter 4, discrete choices are familiar to respondents. Discrete choice contingent valuation questions are therefore easier for respondents to answer than open-ended WTP questions. In modern society, little bartering occurs. Consumers instead face discrete decisions. On a daily basis, people decide if a gallon of gasoline is worth, say, four dollars. Consumers can either take the offered product at the given price or reject both the good and the price. Discrete responses in contingent valuation studies do not, however, yield measures of WTP as readily as open-ended responses. This is a difficulty of the referendum method advocated by Arrow et al. (1993). As demonstrated below, it is possible to calculate WTP from discrete data with a few statistical assumptions. These assumptions and models are later used to analyze the responses to Jakus's (1992) questionnaire.

Conditional Logit

Nobel laureate McFadden (1974) developed the method for modeling and analyzing discrete choice.²⁴ In the model, consumer n has the following random, indirect utility function:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \forall j, \quad (4.1)$$

where U_{nj} is the utility consumer n receives from alternative j . The utility function is treated as a random function, as designated by the error term, ε_{nj} . Because it is impossible to capture all variables that lead consumers to choose some option over other alternatives, the error term accounts for researcher ignorance. V_{nj} is, therefore, a function

²⁴ Daniel McFadden won the Nobel Prize for his contributions to the econometrics analysis of discrete choices.

of the observable attributes of alternative j , the price of alternative j , income, and other demographic characteristics. Assuming that each ε_{nj} is an independently and identically distributed extreme value, McFadden (1974) demonstrated that the probability consumer n will select option i from J alternatives is equal to

$$P_{ni} = \frac{\exp(V_{ni})}{\sum_j \exp(V_{nj})}. \quad (4.2)$$

That is, the probability that consumer n will select option i is equal to the exponential of the utility of option i divided by the sum of the exponential of the utility of all alternatives, including option i . This is the conditional logit model.

The deterministic portion of utility is generally modeled as a linear function, so $V_{nj} = \beta_{njI} \cdot x_{njI} + \dots + \beta_{nja} \cdot x_{nja} + \beta_{nM} \cdot M_{nj}$, where a is the number of attributes of alternative j , x represents the various attributes, and M_{nj} is the income of consumer n after selecting option j . The absolute value of β_{nM} is therefore the marginal utility of income. This function is often represented in vector notation, $V_{nj} = \beta' \cdot x_{nj}$ (Train, 2003); therefore,

$$P_{ni} = \frac{\exp(\beta' x_{ni})}{\sum_j \exp(\beta' x_{nj})}. \quad (4.3)$$

The parameters $\beta_I, \dots, \beta_a, \beta_M$, can be estimated by maximizing the log-likelihood function (Train, 2003). As Greene (2008) demonstrated, demographic characteristics cancel out in converting deterministic utility V into the conditional model. In the basic conditional logit model, utility is simply a function of alternative attributes and price, which is sometimes written as income minus price.

Models 1 through 4

There are many ways to use the conditional logit model to analyze contingent valuation data. This section outlines four models that are later used to estimate WTP for public and private risk reduction using data acquired through the Jakus survey. Models 1 and 2 are the least sophisticated. Models 3 and 4 expand on the simple model to account for demographic characteristics.

Model 1 is the basic conditional logit model for all 552 observations, where each observation has three choices – Program A, Program B, or neither – and each choice is defined by cost, provision of private risk reduction, and provision of altruistic risk reduction. Program A, the central system, provides altruistic and private risk reduction. Program B, the private system, provides only private risk reduction. The deterministic portion V of the representative utility function for Model 1 accounts for these three variables:

$$V_j = \alpha_1 \cdot \text{altruistic}_j + \alpha_2 \cdot \text{private}_j + \alpha_3 \cdot \text{price}_j, \quad (4.4)$$

where private_j is a dummy variable for private risk reduction, altruistic_j is a dummy variable for altruistic risk reduction, and price_j is the offered monthly price for alternative j . The absolute value of α_3 is the mean marginal utility of income for all observations.

Data setup requirements vary across econometric software packages. In Greene's *NLOGIT* (2002), for example, each observation appears on multiple rows, and each choice is assigned a single rows. Sample data setup for the Jakus survey in *NLOGIT* is shown in Table 4.3.

As noted above, more sophisticated models require knowledge of each respondent's income. Model 2, then, is the basic conditional logit model for the 436

Table 4.3*Sample Data Setup for Conditional Logit Model with NLOGIT - Models 1 and 2*

	Selection Variable	Cost	Altruistic Risk Reduction	Private Risk Reduction
Program A	0	2	1	1
Program B	0	15	0	1
Neither	1	0	0	0
Program A	0	15	1	1
Program B	1	30	0	1
Neither	0	0	0	0
Program A	1	40	1	1
Program B	0	60	0	1
Neither	0	0	0	0

income-reporting observations.²⁵ The representative random utility function is the same for both Model 1 and Model 2 (Equation 4.4). The purpose of the second model is to measure whether results change significantly after dropping the 116 non-income-revealing observations.

As mentioned above, Greene (2008) demonstrated that demographic variables fall out of conditional logit models upon estimation. The conditional logit model can estimate coefficients only for variables that change across choices. Still, Greene showed that it is possible to account for demographic characteristics and other constant variables by taking the product of a column of some constant variable and a dummy column for all but one of the choices.²⁶ Model 3 uses columns of dummy variables to account for race,

²⁵ In total, 111 respondents failed to provide income information. The other five observations were removed for failing to provide other important demographic information.

²⁶ One choice must be excluded to prevent perfect multicollinearity.

income, homeowner status, age, education, environmental concern, and perception of risk. The representative utility function for Model 3 differs from the utility function in Models 1 and 2:

$$V_{nj} = \alpha_1 \cdot altruistic_j + \alpha_2 \cdot private_j + \alpha_3 \cdot price_j + \alpha_4 \cdot A \cdot income_n + \alpha_5 \cdot B \cdot income_n + \dots + \alpha_{z-1} \cdot A \cdot Age_n + \alpha_z \cdot B \cdot Age_n, \quad (4.5)$$

where A and B are the columns of dummy variables corresponding to choices A, the public program, and B, the private program, $income_n$ is the income of consumer n , age_n is the age of consumer n , and α_4 through α_z are the coefficients corresponding to consumer n 's individual characteristics. Sample data setup for three observations with two dummy income columns is displayed in Table 4.4.

One advantage of this model is that it allows unique WTP estimates for each observation, thereby providing more information on the distribution of WTP values. Still, as with Models 1 and 2, Model 3 estimates the sample's mean marginal utility of income, which is the absolute value of α_3 (Equation 4.5), but it does not yield a unique estimate of the marginal utility of income for each respondent.

Model 4 also accounts for demographic characteristics and is similar to the model developed by Morey et al. (2002):

$$V_{nj} = (b_1 + b_2 \cdot college_n + b_3 \cdot age_n + b_4 \cdot non - Cauc._n) \cdot price_j + (b_5 + b_6 \cdot rent_n + b_7 \cdot pollutionperc._n + b_8 \cdot environ._n) \cdot altruistic_j + (b_9 + b_{10} \cdot rent_n + b_{11} \cdot pollutionperc._n + b_{12} \cdot environ._n) \cdot private_j + b_{13} \cdot A \cdot income_n + b_{14} \cdot B \cdot income_n, \quad (4.6)$$

Table 4.4

Sample Data Setup for Conditional Logit Model with NLOGIT and Income Dummies - Model 3

	Selection Variable	Cost	Altruistic Risk Reduction	Private Risk Reduction	Income Dummy 1	Income Dummy 2
Program A	0	2	1	1	45000	0
Program B	0	15	0	1	0	45000
Neither	1	0	0	0	0	0
Program A	0	15	1	1	100000	0
Program B	1	30	0	1	0	100000
Neither	0	0	0	0	0	0
Program A	1	40	1	1	75000	0
Program B	0	60	0	1	0	75000
Neither	0	0	0	0	0	0

where $college_n$ is a dummy variable indicating graduation from college, $non-Cauc.n$ indicates non-Caucasian ethnicity, $rent_n$ indicates rental status, $pollutionperc.n$ indicates perception of carcinogens in drinking water, and $environ.n$ indicates that the respondent is concerned with environmental quality. Similar to Model 3, Model 4 accounts for income through choice interaction variables.²⁷

This model assumes that age, race, and education influence consumer n 's marginal utility of income, and homeowner status, risk perception, and environmental concern influence willingness to bid on public and private risk reduction. The parameter $\beta_{1n} = (b_1 + b_2 \cdot college_n + b_3 \cdot age_n + b_4 \cdot non - Cauc.n)$ is consumer n 's marginal utility of

²⁷ Morey et al. (2002) wrote the price variable as income minus price, and there were no income-choice interaction variables. When the price variable was written as income minus price in Model 4, *NLOGIT* was unable to converge on log likelihood maximizing coefficients, possibly because the offered price constituted a small portion of income for most respondents.

income, which is unique for each respondent. Model 4 also provides unique estimates of the marginal utility of private and altruistic risk reduction. Model 4, then, offers the most complete estimates of the marginal utility of income and, by extension, WTP.

Welfare Measures: Conditional Logit

Small and Rosen (1981) demonstrated that it is possible to derive measures of WTP with the coefficients estimated from conditional logit models. The value for WTP is:

$$WTP_n = (\ln \sum_j \exp(V_{nj}^*) - \ln \sum_j \exp(V_{nj}^0)) \cdot 1/\beta_{1n} . \quad (4.7)$$

where V_{nj}^* is consumer n 's utility after the change in the choice set, V_{nj}^0 is her utility prior to the change, and β_{1n} is her marginal utility of income. This is the log-sum formula.

According to Morey et al., if “the marginal utility of money is a step function of income,...there is no choice over alternatives once the state is specified, and...the policies considered have small welfare effects” (2002, p. 173), consumer n 's WTP to move from the status quo to alternative j is simply the ratio of alternative j 's attribute coefficients to consumer n 's marginal utility of income. Thus, estimates of WTP for public risk reduction – which provides private and altruistic risk reduction – are as follows (from Equations 4.4 through 4.6).

Models 1 and 2 (sample's mean WTP):

$$WTP_{Pub} = (\alpha_1 + \alpha_2) \cdot 1 / -\alpha_3 . \quad (4.8)$$

Model 3 (consumer n 's WTP):

$$WTP_{Pub,n} = (\alpha_1 + \alpha_2 + \alpha_4 \cdot A \cdot income_n + \alpha_5 \cdot B \cdot income_n + \cdots + \alpha_{z-1} \cdot A \cdot Age_n + \cdots + \alpha_{z-1} \cdot A \cdot Age_n + \alpha_z \cdot B \cdot Age_n) \cdot 1 / -\alpha_3 . \quad (4.9)$$

Model 4 (consumer n 's WTP):

$$WTP_{Pub,n} = (\beta_{2n} + \beta_{3n}) \cdot 1 / -\beta_{1n}, \quad (4.10)$$

where $\beta_{1n} = b_1 + b_2 \cdot college_n + b_3 \cdot age_n + b_4 \cdot non - Cauc_n$ is the marginal utility of income, $\beta_{2n} = b_5 + b_6 \cdot rent_n + b_7 \cdot pollutionperc_n + b_8 \cdot environ_n + b_{13} \cdot A \cdot income_n$ is the marginal utility of altruistic risk reduction, and

$$\beta_{3n} = b_9 + b_{10} \cdot rent_n + b_{11} \cdot pollutionperc_n +$$

$b_{12} \cdot environ_n + b_{14} \cdot B \cdot income_n$ is the marginal utility of private risk reduction.

Private WTP values are as follows (from Equations 4.4 through 4.6).

Models 1 and 2 (mean sample WTP):

$$WTP_{priv} = (\alpha_2) \cdot 1 / -\alpha_3. \quad (4.11)$$

Model 3 (consumer n 's WTP):

$$WTP_{priv,n} = (\alpha_2 + \alpha_5 \cdot B \cdot income_n + \dots + \alpha_z \cdot B \cdot Age_n) \cdot 1 / -\alpha_3. \quad (4.12)$$

Model 4 (consumer n 's WTP):

$$WTP_{priv,n} = (\beta_{3n}) \cdot 1 / -\beta_{1n}. \quad (4.13)$$

Estimates of WTP for altruistic risk reduction are simply the difference between public and private WTP values. The follow subsection proves Equations 4.8 and 4.11.

Equations 4.9, 4.10, 4.12, and 4.13 can be similarly demonstrated.

Proof of Equations 4.8 and 4.11. – $WTP_{n,j}$ is the maximum amount of income consumer n will sacrifice to acquire good j . If consumer n purchases good j at a price equal to her WTP, she remains on the same indifference curve and the change in utility is zero. The following simple proof is analogous to Hanemann's (1984) utility difference method.

From Equation 4.4, the random, indirect portion of consumer n 's utility function in Models 1 is $V_j = \alpha_1 \cdot \text{altruistic}_j + \alpha_2 \cdot \text{private}_j + \alpha_3 \cdot \text{price}_j$. If good j is Program A, the public risk reduction, consumer n 's utility is $V_{n,\text{pub}} = \alpha_1 + \alpha_2 + \alpha_3 \cdot \text{price}_{n,\text{pub}}$. If good j is Program B, the private risk reduction, consumer n 's utility is $V_{n,\text{priv}} = \alpha_2 + \alpha_3 \cdot \text{price}_{n,\text{priv}}$. If consumer n declines to choose either program, her utility is $V_{n,\text{neither}} = 0$. To derive $WTP_{n,\text{pub}}$, $\text{price}_{n,\text{pub}}$ should be sufficiently high such that

$V_{n,\text{pub}} = V_{n,\text{neither}}$. If both utilities are equal, $WTP_{n,\text{pub}} = \text{price}_{n,\text{pub}}$; therefore,

$$\alpha_1 + \alpha_2 + \alpha_3 \cdot WTP_{n,\text{priv}} = 0, \text{ so}$$

$$WTP_{n,\text{priv}} = (\alpha_1 + \alpha_2) \cdot 1 / -\alpha_3. \quad (4.14)$$

To derive $WTP_{n,\text{priv}}$, $\text{price}_{n,\text{priv}}$ should be sufficiently high such that

$V_{n,\text{priv}} = V_{n,\text{neither}}$. If both utilities are equal, $WTP_{n,\text{priv}} = \text{price}_{n,\text{priv}}$; therefore,

$$\alpha_2 + \alpha_3 \cdot WTP_{n,\text{priv}} = 0, \text{ so}$$

$$WTP_{n,\text{priv}} = (\alpha_2) \cdot 1 / -\alpha_3. \quad (4.15)$$

Furthermore, $WTP_{n,\text{altruistic}} = (\alpha_1) \cdot 1 / -\alpha_3$ because $WTP_{n,\text{pub}} - WTP_{n,\text{priv}} = WTP_{n,\text{altruistic}}$ (from Equations 4.14 and 4.15).

Results

Regression Results

Regression results for Models 1, 2, and 3 are reported in Table 4.5. All of Model 1's coefficient estimates are significant. Parameter signs meet *a priori* expectations: higher costs decrease welfare, and more public and private safety increase welfare.

Table 4.5*Regression Results for Models 1, 2, and 3*

	Model 1 <i>n</i> =552		Model 2 <i>n</i> =436		Model 3 <i>n</i> =436	
	<i>Coefficient</i>	<i>S.E.</i>	<i>Coefficient</i>	<i>S.E.</i>	<i>Coefficient</i>	<i>S.E.</i>
<i>Cost</i>	-0.039	0.007 ***	-0.032	0.008 ***	-0.038	0.009 ***
<i>Altruistic</i>	0.954	0.165 ***	0.988	0.184 ***	1.846	0.697 ***
<i>Private</i>	0.518	0.276 *	0.470	0.314	0.855	0.845
<i>A*Rent</i>					-0.005	0.321
<i>A*Pollutionperc.</i>					0.021	0.041
<i>A*Environ.</i>					0.671	0.263 **
<i>A*College</i>					-0.269	0.265
<i>A*Age</i>					-0.034	0.008 ***
<i>A*Non-Cauc.</i>					-0.343	0.474
<i>A*Income</i>					-0.00002	0.000
<i>B*Rent</i>					0.770	0.405 *
<i>B*Pollutionperc.</i>					0.065	0.056
<i>B*Environ.</i>					0.627	0.372 *
<i>B*College</i>					-0.226	0.366
<i>B*Age</i>					-0.031	0.011 ***
<i>B*Non-Cauc.</i>					0.546	0.541
<i>B*Income</i>					0.00005	0.000
Successful prediction rate:	0.467		0.468		0.495	
Log of the likelihood function:	-497		-395		-374	

***, **, and * indicate statistical significance at 0.01, 0.05, and 0.1, respectively

Furthermore, the parameter estimates for Model 2 – the truncated sample – are not statistically different from the parameters for Model 1, although Model 2's private risk reduction coefficient is significant only at the 13 percent level.

In Model 3, the coefficient on private risk reduction is also insignificant. Nevertheless, because WTP is the ratio of two or more coefficients, it is possible to have statistically insignificant parameter estimates but significant WTP estimates. The marginal utility of income (the absolute value of the cost coefficient) is significant and relatively constant for all three models. The parameter estimates for public and private risk reduction in Model 3 significantly differ from the parameters in Models 1 and 2 because the marginal utility of private and public risk reduction vary across observations, as defined by product of interaction variables and demographic characteristics.

Model 3's successfully predicted choices for half of the sample, which is slightly better than Model 1 and 2's 47 percent prediction rate. Of the interaction variables, age and environmental concern seem to have the most statistically significant impact on choice. Age decreased the likelihood of selecting Program A or B, and environmental concern increases the likelihood of selecting one of the programs. Rental status increased the chances of selecting Program B, the private filter system. Pairwise regressions revealed that there is little collinearity between income and age ($r^2 = 0.0004$) and income and education ($r^2 = 0.062$).

Regression results for Model 4 are reported in Table 4.6. As noted above, this model allows the estimation of unique marginal utility values for each observation in the sample. The marginal utilities of income, altruistic risk reduction, and private risk

Table 4.6*Regression Results for Model 4*

Parameters	Variable	Estimates	
		<i>Coefficients</i>	<i>S.E.</i>
b_1	<i>Cost</i>	-0.013	0.015
b_2	<i>Cost*College</i>	-0.004	0.009
b_3	<i>Cost*Age</i>	-0.001	0.000 *
b_4	<i>Cost*Non-Caucasian</i>	0.011	0.016
b_5	<i>Altruistic</i>	1.552	0.497 ***
b_6	<i>Altruistic*Rent</i>	-0.668	0.314 **
b_7	<i>Altruistic*Pollutionperc.</i>	-0.035	0.048
b_8	<i>Altruistic*Environ.</i>	0.028	0.329
b_9	<i>Private</i>	-0.552	0.601
b_{10}	<i>Private*Rent</i>	0.910	0.394 **
b_{11}	<i>Private*Pollutionperc.</i>	0.070	0.056
b_{12}	<i>Private*Environ.</i>	0.564	0.368
b_{13}	<i>A*Income</i>	-0.00003	0.00006
b_{14}	<i>B*Income</i>	0.00003	0.00008
Successful prediction rate:			0.48
Log of the likelihood function:			-382

***, **, and * indicate statistical significance at 0.01, 0.05, and 0.1, respectively

Table 4.7*Marginal Utilities Evaluated at Mean Sample Statistics - Model 4*

Mean Marginal Utilities	
β_1 : marginal utility of income	0.036 ***
β_2 : marginal utility of altruistic risk reduction	1.107 ***
β_3 : marginal utility of private risk reduction	0.550 *

***, **, and * indicate statistical significance at 0.01, 0.05, and 0.1, respectively

reduction, all of which are evaluated at sample mean values, are reported in Table 4.7.

These values are very similar to the marginal values from Models 1, 2, and 3.

In Model 4, age significantly increases the marginal utility of income. Education also seems to increase the marginal utility of income, although the coefficient estimate is not significantly different from zero. As in Model 3, income coefficients are not significant, but higher income seems to indicate a greater demand for Program B. Homeowner status has a significant impact on WTP for private and altruistic risk reduction. Renters are more likely to demand private risk reduction, but less likely to be willing to pay to reduce others' probability of death.

Model 4's successful prediction rate is slightly higher than Models 1 and 2's prediction rate (48 percent vs. 47 percent), but lower than Model 3's. Models 3 and 4 produce the lowest log likelihood maximized value.

In summary, all three regression models seem to produce consistent results, and the signs largely meet expectations. Furthermore, estimates of the sample's mean marginal utility of income are fairly stable in all four models (Model 1: 0.039, Model 2: 0.032, Model 3: 0.038, and Model 4: 0.036).

WTP Estimates

Private, altruistic, and public WTP estimates for all four models are summarized in Table 4.8. (WTP for public risk reduction is WTP for Program A, WTP for private risk reduction is WTP for Program B, and WTP for altruistic risk reduction is the difference.) The values are reported in dollars per month. These WTP values were calculated using Equations 4.8 through 4.12 and the regression results reported above. Table 4.8 also displays 90 percent confidence intervals for the mean estimates,²⁸ as well as median, minimum, and maximum WTP estimates for Models 3 and 4 (Models 1 and 2 do not produce unique WTP estimates for each respondent) and the percent disparity between private and public WTP values.

All models yield positive WTP estimates for public, private, and altruistic risk reduction. Except for the altruistic WTP estimate from Model 3, all WTP estimates statistically differ from zero. Estimates of WTP for private risk reduction vary from \$13.19 to \$17.71, estimates of WTP for altruistic risk reduction vary from \$21.04 to \$30.89, and estimates of total WTP for the risk reduction (WTP for private plus WTP for altruistic risk reduction) vary from \$37.49 to \$45.65.

According to these results, the average person in the sample was willing to pay roughly \$40 per month for Program A, which removes carcinogens from public drinking

²⁸ These confidence intervals were computed using the delta method (Greene, 2008).

Table 4.8

*Estimates of WTP for Program A, Program B, and Altruistic Risk Reduction -
\$'s per Month*

	Model 1	Model 2	Model 3	Model 4
Program A - Public Risk WTP				
<i>Mean</i>	37.49	45.59	38.75	45.65
<i>90% C.I. *</i>	30.42 - 44.57	32.78 - 58.39	5.94 - 73.32	28.28 - 63.01
<i>Median</i>			42.69	46.72
<i>Minimum</i>			(55.05)	19.01
<i>Maximum</i>			118.40	172.10
Program B - Private Risk WTP				
<i>Mean</i>	13.19	14.69	17.71	15.15
<i>90% C.I. *</i>	4.72 - 21.66	3.40 - 25.99	8.31 - 27.62	4.85 - 24.45
<i>Median</i>			17.53	12.29
<i>Minimum</i>			(35.78)	(28.14)
<i>Maximum</i>			71.02	115.63
Altruistic Risk WTP				
<i>Mean</i>	24.30	30.89	21.04	30.50
<i>90% C.I. *</i>	11.54 - 37.06	10.54 - 51.24	(14.95) - 58.29	7.70 - 53.29
<i>Median</i>			23.80	30.35
<i>Minimum</i>			(22.47)	9.05
<i>Maximum</i>			55.23	110.06
Percent Disparity Between Private and Public WTP Values:				
	184%	210%	119%	201%

** C.I. denotes confidence interval.*

water at the source, and \$15 per month for Program B, which removes carcinogens from drinking water at each individual household. Both hypothetical programs have the same effect on the health of the person expressing WTP. By selecting Program B, however, survey participants were able to express a WTP to reduce the health risks of others.

According to these results, *average WTP for the risk reduction is 119 to 210 percent greater if it also applies to others.*

These results confirm the implications of Jones-Lee's (1992) hypothetical model and Araña and León's (2002) empirical model, which predict that WTP for public risk reduction is greater than WTP for private risk reduction. The Jones-Lee and the Araña and León studies, however, estimate that WTP for public risk reduction is only 10 to 40 percent greater than WTP for private risk reduction. This study finds a far greater disparity between private and public WTP values.

Implications. – Chapter 1 introduced the two anti-altruism assumptions. The first assumption is that WTP for altruistic risk reduction does not exist. The second is that cost-benefit analysts should ignore altruistic values. As reiterated throughout, if both assumptions are false, analysts should adjust the value of statistical life to account for altruism.

The results outlined in this chapter clearly suggest that the first anti-altruism assumption is false: people are willing to pay far more for health improvements if improvements affect others. (As demonstrated in Table 4.8, all estimates of WTP for public risk reduction are greater than estimates of WTP for private risk reduction; three of the four estimates are statistically significant.) Moreover, although accounting for altruism leads to double-counting in most instances, mortality risk reduction is unique, for, as Arrow (1963) argued and Jacobsson et al. (2007) demonstrated, altruism is paternalistic with respect to health improvements. Accounting for paternalistic altruism does not lead to double counting (see, for example, Chapter 2 above and McConnell [1997]). Thus, it seems, the second anti-altruism is also false.

Because both anti-altruism assumptions appear to be erroneous, the true value of preventing a single, anonymous death is the altruism-adjusted value of statistical life. The implications of a 120 to 210 percent increase – the disparity between the public and private WTP values found in this study – on agencies' value-of-statistical-life estimates are shown in Table 4.9.

Shortcomings and Recommended Future Research

Inclusion of Household. – In practice, most studies, such as wage differential analyses, yield WTP (or WTA) for personal decreases (or increases) in the risk of death. This value, dM_1/dp_1 , is used to estimate WTP to eliminate public health risks, which, if adjusted for altruism, is $\sum_{i=1}^n dM_1/dp_i$. The disparity between private and public WTP values is $D_1 = \sum_{i=1}^n dM_1/dp_i - dM_1/dp_1$.

In the Jakus survey, the private risk reduction system, Program B, is not entirely private because, in addition to reducing the respondents' probability of death, the system also lowers the risk faced by all members of the respondents' household. WTP for the household system is $\sum_{i=1}^j dM_1/dp_i$, where j is number of persons in the household.

Therefore, in this study, the disparity between WTP for Programs A and B is

$$\delta_1 = \sum_{i=1}^n dM_1/dp_i - \sum_{i=1}^j dM_1/dp_i. \text{ Because } dM_1/dp_1 \leq \sum_{i=1}^j dM_1/dp_i \leq \sum_{i=1}^n dM_1/dp_i, \delta_1$$

only serves as a lower-bound estimate of D_1 . Therefore, the actual disparity between private and public WTP values may be greater than 120 to 210 percent. Future studies

Table 4.9

Estimates of Disparity between Private and Public WTP Applied to Agency Value-of-Statistical-Life Estimates

Agency	Source	Value (millions \$)*	Adjusted Value - 120% (millions \$)	Adjusted Value - 210% (millions \$)
CPSC	Heinzerling (2000)	5	11.0	15.5
DOA	Sunstein (2004)	4.8	10.6	14.9
DOT	U.S. DOT (2002)	3	6.6	9.3
EPA	U.S. EPA (2000)	4.8 (1990\$), updated to relevant year	10.6	14.9
FDA	U.S. FDA (2004)	5 -- 6.5	11 -- 14.3	15.5 -- 20.15
FAA	Sunstein (2004)	1.5 -- 3	3.3 -- 6.6	4.65 -- 9.3
OMB	Sunstein (2004)	5	11.0	15.5

* *Note* : For many agencies, the value of statistical life is not fixed (Sunstein, 2004).

could refine this estimate by defining private risk reductions as reductions that apply solely to the respondent.

No Explicit Baseline Risk Level. – If the sample's average perception of the annual probability of acquiring lethal cancer from drinking water was 1 in 20,000, the

implied value of statistical life is roughly \$3.6 million and altruism adjusted value of statistical life is roughly \$9.6 million. Unfortunately, the survey did not explicitly state the baseline risk, and respondents did not express their risk perception level. It is therefore impossible to calculate the sample's value of statistical life because the denominator of the value-of-statistical-life function (Equations 2.4) is unknown. Still, the survey did inform respondents that "[e]ach program would eliminate the [carcinogenic] substances from drinking water and make it safe" (Jakus, 1992, p. 324). Both programs eliminated the same amount of risk, so the denominator of the value-of-statistical-life function is equal for both Program A and B. Therefore, although it is impossible to compare the absolute disparity between private and public value-of-statistical-life estimates in this study, it is possible to compare the two in a relative sense. Accordingly, this study provides a relative comparison of the value of statistical life and the altruism-adjusted value of statistical life, which is shown in Table 4.8 as the percent disparity between private and public WTP values. Future studies could go the next step and compute the value of statistical life by simply recording respondents' perceived level of reduction in risk.

CHAPTER 5

CONCLUSION

In neoclassical economics, WTP determines value. Paul's WTP to prevent his own death determines the amount government agencies spend to save his life. Why, then do economists largely ignore Peter's WTP to prevent Paul's life? After all, altruism is pervasive in modern society. People care about others, even persons that remain anonymous. Altruism surely plays a role in convincing people to collect donations for the Salvation Army.

Economists as far back as Adam Smith have argued that free markets allocate resources more effectively than alternative systems. (In the famous words of Mr. Smith, "As every individual...labours...[h]e intends only his own gain...and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention...By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it" [1776/1937, p. 572].) In the late nineteenth and early twentieth century, economists – many of whom eventually received the Nobel Prize – developed mathematical proofs and theorems that demonstrated the superiority of free markets.

These proofs, however, depend on a number of assumptions about consumer preferences. One assumption is that others' well-being does not affect personal welfare (Varian, 1992). Altruism does not exist, at least according to standard economic assumptions. If others' well-being does affect personal welfare, free market allocations are not necessarily optimal. The neglect of altruism takes roots in the fundamental theories of microeconomics.

The tendency to ignore altruism in CBA is justifiable in most regulatory decisions. As Bergstrom (1982) and Milgrom (1993) demonstrated, if altruistic concerns are absolutely neutral, it is not wise to increase the value of commodities to adjust for altruism. Perhaps a brief, final example will illuminate this point.

Assume Peter is a neutral altruist who wishes for Paul to have a better life. Presumably, then, Peter would want Paul to have better access to the Grand Canyon. After all, options – especially improved options – increase welfare. Paul, however, has little desire to visit the Grand Canyon. An improvement in road conditions to accommodate for Peter’s altruistic feelings would be undesirable for both Peter and Paul. Paul, because he does not wish to see the Grand Canyon, would prefer a cash payment in lieu of better roads, and Peter, who is a neutral altruist, would prefer the action that maximize Paul’s welfare as Paul perceives.

This example, though simple, applies to all situations where altruism is neutral. In most cases, government policies need not account for altruistic concerns.

Nevertheless, it seems that altruism is not neutral in the context of safety improvements. Nobel laureate Arrow articulated this idea in the 1960s: “The taste for improving the health of others appears to be stronger than for improving other aspects of their welfare” (1963, p. 941). Such altruism is paternalistically safety-focused. Jacobsson and associates’ 2007 study provides the clearest confirmation of safety-focused altruism. In the case of paternalistic altruism, Jones-Lee (1991) demonstrated that policymakers should increase expenditures on safety programs to account for altruistic concerns.

If altruism is indeed safety-focused, the true value of preventing Paul’s death should include Peter’s WTP to prevent it. This implies that analysts should increase

estimates of the value of statistical life to account for altruism. Jones-Lee (1992) estimates that WTP for public risk reduction (which includes private risk reduction and altruistic risk reduction) is 10 to 40 percent greater than WTP solely for private risk reduction. The study reported in Chapter 4 indicates a much larger disparity: public WTP is 120 to 210 percent greater than private WTP.

The loss of human life is irreversible. No person can serve as a perfect substitute for another. Thus, the tendency to ignore altruism may lead to inefficient levels of irreversible outcomes. What are the implications of irreversibility? One thing is clear: decision-makers should be cautious. It seems that the costs of overestimating the value of life are less severe than the costs of underestimating it. This implies that, although there may remain doubts about the nature of altruism, policymakers may wish to err on the side of caution by increasing value-of-statistical-life estimates.

REFERENCES

- Ackerman, F., and L. Heinzerling. (2004). *Priceless: On Knowing the Price of Everything and the Value of Nothing*. New York: The New Press.
- Acton, J.P. (1973). *Evaluating Public Programs to Save Lives: The Case of Heart Attacks*. Santa Monica: Rand Corporation.
- Alberini, A. (2005). "What Is a Life Worth? Robustness of VSL Values from Contingent Valuation Surveys." *Risk Analysis* 25(4), 783-800.
- Alberini, A., M. Cropper, A. Krupnick, and N.B. Simon. (2006). "Willingness to Pay for Mortality Risk Reductions: Does Latency Matter?" *Journal of Risk and Uncertainty* 32(3), 231-45.
- Altruism. (1992). *The MIT Dictionary of Modern Economics* (4th ed.). Cambridge, MA: MIT Press.
- Álvarez-Farizo, B., and N. Hanley. (2002). "Using Conjoint Analysis to Quantify Public Preferences over the Environmental Impacts of Wind Farms: An Example from Spain." *Energy Policy* 30(2), 107-116.
- Araña, J.E., and C.J. León. (2002). "Willingness to Pay for Health Risk Reduction in the Context of Altruism." *Health Economics* 11(7), 623-35.
- Arrow, K.J. (1963). "Uncertainty and the Welfare Economics of Medical Care." *American Economics Review* 53(5), 941-73.
- Arrow, K., R. Solow, P.R. Portney, E.E. Leamer, R. Radner, and H. Schuman. (1993). "Report of the NOAA Panel on Contingent Valuation." 58 *Fed. Reg.* 4601. Retrieved April 18, 2008, from <http://www.darrp.noaa.gov/library/pdf/cvblue.pdf>.
- Bergstrom, T.C. (1982). "When Is a Man's Life Worth More than His Human Capital." In M.W. Jones-Lee (ed), *The Value of Life and Safety: Proceedings of a Conference held by the Geneva Association*. Amsterdam: North Holland.
- Bishop, R.C., and T.A. Heberlein. (1990). "The Contingent Valuation Method." In R.L. Johnson and G.V. Johnson (eds), *Economic Valuation of Natural Resources: Issues, Theory, and Application*. Boulder, CO: Westview Press.
- Blaeijs, A., R.J.G.M. Florax, P. Rietveld, and E.T. Verhoef (2003). "The Value of Statistical Life in Road Safety: A Meta-analysis." *Accident Analysis and Prevention* 35(6), 973-86.
- Bowles, T.J., W.C. Lewis, and G. Wells. (2005). "Assessing Economic Damages in Personal Injury and Wrongful Death Litigation: The State of Idaho." *Journal of Forensic Economics* 17(3), 415-27.

- Boyle, K.J., T.P. Holmes, M.F. Teisl, and B. Roe. (2001). "A Comparison of Conjoint Analysis Response Formats." *American Journal of Agricultural Economics* 83(2), 441-54.
- Brady, K.L. (2008). "An Expressed Preference Determination of College Students' Valuation of Statistical Lives: Methods and Implications." *College Student Journal* 42(4), 968-81.
- Buchanan, J.M., and W.C. Stubblebine. (1962). "Externality." *Economica* 29(116), 371-84.
- Ciriacy-Wantrup, S.V. (1947). "Capital Returns from Soil-conservation Practices." *Journal of Farm Economics* 29(4), 1181-96.
- Ciriacy-Wantrup, S.V. (1952). *Resource Conservation: Economics and Policies*. Berkeley: University of California Press.
- Contingent Valuation. (1992). *The MIT Dictionary of Modern Economics* (4th ed.). Cambridge, MA: MIT Press.
- Corso, P.S., J.K. Hammitt, and J.D. Graham. (2001). "Valuing Mortality-Risk Reduction: Using Visual Aids to Improve the Validity of Contingent Valuation." *Journal of Risk and Uncertainty* 23(2), 165-84.
- Currie, J. (2008). "Cutting the Safety Net One Strand at a Time." In J.E. Stiglitz, A.S. Edlin, and J.B. DeLong (eds), *The Economists' Voice: Top Economists Take On Today's Problems*. New York: Columbia University Press.
- Davis, R.K. (1963). *The Value of Outdoor Recreation: An Economic Study of the Maine Woods*. Unpublished doctoral dissertation. Harvard University, Cambridge, MA.
- Diamond, P.A., and J.A. Hausman. (1994). "Contingent Valuation: Is Some Number better than No Number?" *Journal of Economic Perspectives* 8(4), 45-64.
- Dorman, P. (1996). *Markets and Mortality: Economics, Dangerous Work, and the Value of Human Life*. New York and Melbourne: Cambridge University Press.
- Exec. Order No. 12,044, 43 *Fed. Reg.* 12661 (1978).
- Exec. Order No. 12,291, 46 *Fed. Reg.* 13193 (1981).
- Exec. Order No. 12,866, 58 *Fed. Reg.* 51735 (1993).
- Fisher, A., L.G. Chestnut, and D.M. Violette. (1989). "The Value of Reducing Risks of Death: A Note on New Evidence." *Journal of Policy Analysis and Management* 8(1), 88-100.

- Fromm, G. (1965). "Civil Aviation Expenditures: The Value of Human Life." In R. Dorfman (ed), *Measuring Benefits of Government Investment*. Washington, DC: Brookings Institution.
- Fromm, G. (1968). Comment on T.C. Schelling's paper "The Life You Save May Be Your Own." In S. Chase (ed), *Problems in Public Expenditure Analysis*. Washington, DC: Brookings Institution.
- Frosh, D., and J. Lee. (2007, August 17). "Rescue Halted at Mine After 3 Deaths and 6 Injuries." *N.Y. Times* [online]. Retrieved April 18, 2008, from http://www.nytimes.com/2007/08/17/us/17cnd-mine.html?_r=2&hp&oref=slogin&oref=slogin.
- Gowdy, J.M. (2004). "The Revolution in Welfare Economics and Its Implications for Environmental Valuation and Policy." *Land Economics* 80(2), 238-57.
- Greene, W.H. (2002). *NLOGIT: Econometric Software* (version 3.0.2) [software]. Plainview, NY: Econometric Software, Inc.
- Greene, W.H. (2008). *Econometric Analysis* (6th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Hanemann, W.M. (1984). "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses." *American Journal of Agricultural Economics* 66(3), 332-41.
- Hanemann, W.M. (1991). "Willingness to Pay and Willingness to Accept: How Much Can They Differ?" *American Economic Review* 81(3), 635-47.
- Hanemann, W.M. (1994). "Valuing the Environment through Contingent Valuation." *Journal of Economic Perspectives* 8(4), 19-43.
- Hammitt, J.K., and J.D. Graham. (1999). "Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?" *Journal of Risk and Uncertainty* 18(1), 33-62.
- Heinzerling, L. (2000). "The Rights of Statistical People." *Harvard Environmental Law Review* 24(1), 189-207.
- Hultkrantz, L., G. Lindberg, and C. Andersson. (2006). "The Value of Improved Road Safety." *Journal of Risk and Uncertainty* 32(2), 151-70.
- Jakus, P.M. (1992). *Valuing the Private and Public Dimensions of a Mixed Good: An Application to Pest Control*. Unpublished doctoral dissertation. North Carolina State University, Raleigh, NC.
- Jacobsson, F., M. Johannesson, and L. Borgquist. (2007). "Is Altruism Paternalistic?" *Economics Journal* 117(520), 761-81.

- Johansson, P. (1992). "Altruism in Cost-benefit Analysis." *Environmental and Resource Economics* 2(6), 605-13.
- Johansson, P. (1994). "Altruism and the Value of Statistical Life: Empirical Implications." *Journal of Health Economics* 13(1), 111-8.
- Jones-Lee, M.W. (1991). "Altruism and the Value of Other People's Safety." *Journal of Risk and Uncertainty* 4(2), 213-9.
- Jones-Lee, M.W. (1992). "Paternalistic Altruism and the Value of Statistical Life." *Economics Journal* 102(410), 80-90.
- Kochi, I., B. Hubbell, and R. Kramer. (2006). "An Empirical Bayes Approach to Combining and Comparing Estimates of the Value of a Statistical Life for Environmental Policy Analysis." *Environmental and Resource Economics* 34(3), 385-406.
- Lewis, W.C., and T.J. Bowles. (2006). "Assessing Economic Damages in Personal Injury and Wrongful Death Litigation: The State of Utah." *Journal of Forensic Economics* 18(2 and 3), 227-42.
- McFadden, D. (1974). "Conditional Logit Analysis of Qualitative Choice Behavior." In P. Zarembka (ed), *Frontiers in Econometrics*. New York: Academic Press.
- McCloskey, D.N. (1983). "The Rhetoric of Economics." *Journal of Economic Literature* 21(2), 481-517.
- McConnell, K.E. (1997). "Does Altruism Undermine Existence Value?" *Journal of Environmental Economics and Management* 32(1), 22-37.
- Mears, B. (2007, October 29). "Supreme Court to Review Exxon Valdez Award." *CNN Money* [online]. Retrieved May 29, 2008, from http://money.cnn.com/2007/10/29/news/exxon_valdez/index.htm.
- Milgrom, P. (1993). "Is Sympathy an Economic Value? Philosophy, Economics, and the Contingent Valuation Method." In J.A. Hausman (ed), *Contingent Valuation: A Critical Assessment*. Amsterdam: North Holland.
- Miller, T.R. (1990). "The Plausible Range for the Value of Life – Red Herrings Among the Mackerel." *Journal of Forensic Economics* 3(3), 17-40.
- Mishan, E.J. (1971). "Evaluation of Life and Limb: A Theoretical Approach." *Journal of Political Economy* 79(4), 687-705.
- Mitchell, R.C., and R.T. Carson. (1986). *Valuing Drinking Water Risk Reductions Using the Contingent Valuation Method: A Methodological Study of Risks from THM and Giardia*. Report to U.S. EPA, Washington, DC.

- Mitchell, R.C., and R.T. Carson. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington, DC: Resources for the Future.
- Moore, M.J., and W. K. Viscusi. (1988). "The Quantity-adjusted Value of Life." *Economic Inquiry* 26(3), 369-88.
- Morall, J.F., III. (2003). "Saving Lives: A Review of the Record." *Journal of Risk and Uncertainty* 27(3), 221-37.
- Morey, E.R., K. Rossmann, L. Chestnut, and S. Ragland. (2002). "Valuing Reduced Acid Deposition Injuries to Cultural Resources: Marble Monuments in Washington." In S. Narvud and R. Ready (eds), *Valuing Cultural Heritage: Applying Environmental Valuation Techniques to Historic Buildings, Monuments and Artifacts*. Northampton, MA: Edward Elgar.
- Portney, P.R. (1994). "The Contingent Valuation Debate: Why Economists Should Care." *Journal of Economic Perspectives* 8(4), 3-17.
- Prest, A.R., and R. Turvey. (1965). "Cost-Benefit Analysis: A Survey." *Economic Journal* 75(300), 683-735.
- Randall, A. (1999). "Why Benefits and Costs Matter." *Choices: The Magazine of Food, Farm and Resource Issues* 14(2), 38-41.
- Rice, D.P., and B.S. Cooper. (1967). "The Economic Value of Human Life." *American Journal of Public Health* 57(11), 1954-66.
- Schwartz, S.H. (1973). "Normative Explanations of Helping Behavior: A Critique, Proposal, and Empirical Test." *Journal of Experimental Social Psychology* 9(4), 349-64.
- Small, K.A., and H.S. Rosen. (1981). "Applied Welfare Economics with Discrete Choice Models." *Econometrica* 49(1), 105-30."
- Smith, A. (1937). *An Inquiry into the Nature and Causes of Wealth of Nations*. New York: Modern Library. (Original work published 1776).
- Smith, R.S. (1974). "The Feasibility of an "Injury Tax" Approach to Occupational Safety." *Law and Contemporary Problems* 38(4), 730-744.
- Smith, R.S. (1979). "Compensating Differentials and Public Policy: A Review". *Industrial and Labor Relations Review* 32(3), 339-52.
- Sunstein, C.R. (2004). "Valuing Life: A Plea for Disaggregation." *Duke Law Journal* 54(2), 385-445.
- Thaler, R.H., and C.R. Sunstein. (2003). "Libertarian Paternalism." *American Economic Review* 93(2), 175-179.

- Train, K.E. (2003). *Discrete Choice Methods with Simulation*. Cambridge, UK: Cambridge University Press.
- U.S. Bureau of the Census. (1990). *Statistical Abstract of the United States* (110th ed.). Washington, DC: U.S. Government Printing Office.
- U.S. DOT. (1993). *Memorandum: Treatment of Value of Life and Injuries in Preparing Economic Evaluations*. Retrieved May 14, 2008, from <http://ostpxweb.dot.gov/policy/Data/VSL93guid.pdf>.
- U.S. DOT. (2002). *Memorandum: Revised Departmental Guidance: Treatment of Value of Life and Injuries in Preparing Economic Evaluations*. Retrieved May 14, 2008, from <http://ostpxweb.dot.gov/policy/Data/VSL02guid.pdf>.
- U.S. EPA. (1999a). *The Benefits and Costs of the Clean Air Act, 1990 to 2010*. Washington, DC: U.S. EPA.
- U.S. EPA. (1999b). *Section 126 Petitions: Final Rule Regulatory Impact Analysis – Supplementary Volume: Ozone-related Benefits of Regional NOx Emission Reductions, Chapter 1*. Retrieved April 18, 2008, from <http://www.epa.gov/ttn/oarpg/t1/reports/c1suppo3.pdf>.
- U.S. EPA. (1999c). *Section 126 Petitions: Final Rule Regulatory Impact Analysis – Supplementary Volume: Ozone-related Benefits of Regional NOx Emission Reductions, Chapter 4*. Retrieved April 18, 2008, from <http://www.epa.gov/ttn/oarpg/t1/reports/c4suppo3.pdf>.
- U.S. EPA. (2000). *Agency Guidelines for Preparing Economic Analyses*. Retrieved April 18, 2008, from [http://yosemite1.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html/\\$file/Guidelines.pdf](http://yosemite1.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html/$file/Guidelines.pdf).
- U.S. EPA. (2006a). *2006 National Ambient Air Quality Standards for Particle Pollution: Regulatory Impact Analysis, Executive Summary*. Retrieved April 18, 2008, from <http://www.epa.gov/ttnecas1/regdata/RIAs/Executive%20Summary.pdf>.
- U.S. EPA. (2006b). *2006 National Ambient Air Quality Standards for Particle Pollution: Regulatory Impact Analysis, Chapter 5*. Retrieved April 18, 2008, from <http://www.epa.gov/ttnecas1/regdata/RIAs/Chapter%205--Benefits.pdf>.
- U.S. EPA. (2006c). *2006 National Ambient Air Quality Standards for Particle Pollution: Regulatory Impact Analysis, Chapter 9*. Retrieved April 18, 2008, from <http://www.epa.gov/ttnecas1/regdata/RIAs/Chapter%209--Comparison%20of%20Costs%20and%20Benefits.pdf>.
- U.S. EPA. (2008a). *2008 National Ambient Air Quality Standards for Ground-Level Ozone, Executive Summary*. Retrieved April 18, 2008, from <http://www.epa.gov/ttnecas1/regdata/RIAs/0-ozoneriaexecsum.pdf>.

- U.S. EPA. (2008b). *2008 National Ambient Air Quality Standards for Ground-Level Ozone, Chapter 6*, Retrieved April 18, 2008, from <http://www.epa.gov/ttnecas1/regdata/RIAs/6-ozoneriachapter6.pdf>.
- U.S. FDA. (2004). *Bottled Water*. Retrieved April 18, 2008, from <http://www.fda.gov/ohrms/dockets/98fr/04n-0416-npr0001.pdf>.
- Varian, H.R. (1992). *Microeconomic Analysis* (3rd ed.). New York: W. W. Norton.
- Viscusi, W.K. (1992). *Fatal Tradeoffs: Public and Private Responsibilities for Risk*. New York: Oxford University Press.
- Viscusi, W.K. (1993). "The Value of Risks to Life and Health." *Journal of Economic Literature* 31(4), 1912-46.
- Viscusi, W.K., and J.E. Aldy. (2003). "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World." *Journal of Risk and Uncertainty* 27(1), 5-76.
- Whitaker, B., and M. Sullivan. (2005). *The 2005 Nationwide Blood Collection and Utilization Survey Report*. Washington, DC: Dep't of Health and Human Services. Retrieved April 18, 2008, from <http://www.hhs.gov/bloodsafety/2005NBCUS.pdf>.

APPENDICES

Appendix A. Permission Letter from *Natural Resources Journal*

July 31, 2008

Susan Tackman
Managing Editor
Natural Resources Journal
UNM School of Law

Dear Susan Tackman:

I am preparing my thesis in the Department of Economics at Utah State University. I hope to complete my degree in August of 2008. An essay, "The Value of Human Life: A Case for Altruism," which is scheduled to appear in your journal, reports an essential part of my thesis research. I would like permission to reprint it in my thesis. (Reprinting the essay may necessitate some revision. The reprinted essay will cite works using APA Citation Style.) Please note that USU sends theses to Bell & Howell Dissertation Services to be made available for reproduction.

I will include an acknowledgment to the article on the first page Chapter 1, as shown below. Copyright and permission information will be included in a special appendix. If you would like a different acknowledgment, please so indicate.

Please indicate your approval of this request by signing in the space provided and attach any other form necessary to confirm permission. If you charge a reprint fee for use of an article by the author, please indicate that as well.

If you have any questions, please call me at the number below or send me an e-mail message at. Thank you for your assistance.

Sincerely,

Kevin L. Brady

Kevin L. Brady
Department of Economics
Utah State University
3530 Old Main Hill
Logan, UT 84322-3530
435.770.1281
kev.bra@aggiemail.usu.edu

I hereby give permission to Kevin Brady to reprint the requested article in his thesis, with the following acknowledgment:

Much of the information that appears in Chapters 1, 2, and 5 of this thesis is scheduled to be published in an essay, "The Value of Human Life: A Case for Altruism," in a forthcoming issue of *Natural Resources Journal*. I wish to thank the staff at *Natural Resources Journal* for their help in preparing this section for publication.

Signed: 

Date: 7/31/08

Fee: N/A

Appendix B. Jakus Gypsy Moth Survey

Phase I Gypsy Moth Baseline Survey

Final Version 1/4/91

Hello, I'm calling as part of a research project at North Carolina State University. My name is _____. We are conducting a study on what people think about environmental issues. It won't take much of your time and your answers will be kept strictly confidential.

[Additional information only if necessary.]

Your cooperation is important because we want to find out what the general public knows about environmental issues. This is not a sales call.

1. First, let me verify your phone number, Is this _____?
[phone number]

2. Does this number serve a residence? *[Read choices, mark one.]*

Yes 01

No 02

[Say thank you, hang up.]

[Write in if they report a specific type of activity, e.g., business, school, etc.]

I need to speak with someone who makes decisions for your household.

[If a child, need to get an adult.]

- 2a. Do you own your residence?

Yes 01 *[continue]*

No 02 *[continue]*

3. Would you describe your home as:

- a. Detached residence _____
- b. Duplex _____
- c. Townhouse _____
- d. Apartment _____
- e. Other _____

4. First, I am going to read a list of several sources of pollution. On a scale from 1 to 10 with 1 meaning "not at all serious" and 10 meaning "very serious," please tell me how serious you think each source of pollution is for _____
[Maryland/ Pennsylvania]. The first source is: [Randomize the order.]

- a. Garbage from city or county landfills _____
- b. Air pollution from cars and factories _____
- c. Radon in homes _____
- d. Pollutants in drinking water _____
- e. Hazardous wastes in landfills _____
- f. Pests that damage or kill trees and shrubs _____

5. When it comes to the environment, people describe themselves in various ways. For each statement I read, please tell me if the statement describes you very well, somewhat well, or not at all. First *[read from list]*. Does that describe you *[read choice]*?

	<u>Very</u> <u>Well</u>	<u>Somewhat</u> <u>Well</u>	<u>Not</u> <u>At All</u>	<u>Don't</u> <u>Know</u>
a. I am concerned about the environment.	01	02	03	94
b. I exercise and/or watch what I eat to protect my health.	01	02	03	94
c. I feel that taking care of my yard is a necessary evil.	01	02	03	94
d. I don't pay very much much attention to the trees in my neighborhood.	01	02	03	94
e. I feel that trees are important to the landscape of a park and town.	01	02	03	94

6. During the past year, have you read, heard, or had any experience with gypsy moths?

- a. Yes *[Go to question 6a.]*
 b. No *[Go to question 7.]*
 c. Not sure *[Go to question 6b.]*

- 6a. Have you had experience with gypsy moths in the trees in your *[read list]*

- | | | | | |
|------------------|-------|------------------------|------|------------------|
| a. home? | Yes } | <i>[If any one</i> | No } | <i>[If all</i> |
| b. neighborhood? | Yes } | <i>of list is yes,</i> | No } | <i>are no,</i> |
| c. town? | Yes } | <i>go to 6b.]</i> | No } | <i>go to 7.]</i> |

- 6b. About how many years have gypsy moths been present in your area?

_____ years
 _____ not sure

- 6c. People have different opinions about whether gypsy moths are a problem and if they should be controlled. Do you agree or disagree with the following statements? First, *[read appropriate statement]*. Do you strongly agree, agree, disagree, or strongly disagree with this statement?

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>	<u>Don't</u> <u>Know</u>
a. Gypsy moths cause serious problems for trees in my area of the state.	01	02	03	04	94
*b. The control of gypsy moths is a private homeowner's responsibility.	01	02	03	04	94
*c. County and state authorities should organize control programs for gypsy moths.	01	02	03	04	94

**[Randomize the order of these two.]*

7. Now I would like to discuss another topic--the indoor air pollutant, radon. During the past few months, have you seen or heard anything about radon?

- a. Yes 01 *[Go to 7a.]*
- b. No 02 *[Skip to question 9.]*
- c. Don't know 94 *[Skip to question 9.]*

7a. Have you had your home tested for radon?

- a. Yes 01 *[Go to 7b.]*
- b. No 02 *[Skip to question 8.]*
- c. Don't know 94 *[Skip to question 8.]*

7b. Were your radon results over 4 picocuries per liter?

- a. Yes 01 *[Skip to question 7d.]*
- b. No 02
- c. Don't know or not sure 94

7c. Did the radon reading exceed the EPA Action Guideline?

- a. Yes 01
- b. No 02
- c. Don't know 94

7d. Did you do anything to fix the problem?

- a. Yes 01 *[Go to 7e.]*
- b. No 02 *[Skip to question 9.]*
- c. Don't know 94 *[Skip to question 9.]*

7e. About how much did you spend to fix the problem?

_____ *[Skip to question 9.]*

8. Suppose your local health department was offering a radon test for a one-time cost of (\$5 \$10 \$25 \$50 \$100 \$250). *[Interviewer instruction: Select one value, a different one for each person interviewed, advance in sequence with each call; record value used as a separate variable.]* The money would pay for two small radon detectors, which you would set up in your home for a short period of time and then send to a lab that would inform you of the results, and an informational booklet about radon. Would you take part in such a radon testing program?

- a. Yes 01
- b. No 02 *[Go to 8a.]*
- c. Don't know 94 *[Don't read.]*

- 8a. People answer "no" to these types of questions for a lot of different reasons. Can you tell me why you would not purchase a test? *[Don't read.]*

- Cannot afford it.
- I don't have a problem.
- I don't feel radon is a problem.
- Can get the test done more inexpensively.
- Need more information on radon levels in the area.
- Other _____ [Fill in briefly.]

9. Is your drinking water provided by your own private well or a city, town, or private company water system that is piped to your home?

- a. Private well 01 [Go to 10b.]
b. Piped water system 02 [Go to 10a.]

- 10a. According to the Environmental Protection Agency, some places have small amounts of substances in their drinking water that may cause cancer. Although the risk is low, the agency recommends that these towns or cities undertake one of two types of programs.

Program A has the local water utility install equipment to remove substances at the central pumping and treatment plant. Because the cost of this program may be high for some towns, an alternative plan is Program B. Under this program, the local water utility would install a filtration device in each home that agrees to participate. Each household would decide if they wanted the system and would receive filters monthly. Each program would eliminate the substances from drinking water and make it safe.

If Program A (the central system) had added (\$2 \$8 \$5 \$15 \$25 \$40) to your monthly water bill and Program B (the private system) had an added cost of (\$15 \$20 \$25 \$30 \$35 \$60), which would you prefer? *[Interviewer instruction: Select one value for each system, different ones for each person interviewed, advance in sequence with each call; record values used as separate variables.]*

- Program A 01 *[Skip to 10c.]*
 Program B 02 *[Skip to 10c.]*
 Neither 94 What would you do? _____
[Skip to 111]

- 10b. According to the Environmental Protection Agency, some places have small amounts of substances in their drinking water that may cause cancer. Although the risk is low, the agency recommends that towns encourage residents to check their water supplies. Two types of programs are available.

Program A has a private licensed technician test your well water once a year for these substances and provide an explanation of the results at an annual cost of (\$10 \$25 \$50 \$75 \$100 \$250). *[Interviewer instruction: Select one value, a different one for each person, advance in sequence with each call; record value used as a separate variable.]* Because this program would not fix any problems, you could participate in Program B.

Program B allows you to purchase a filtration system for your well water that would remove these substances if they are present. Local government would help you to finance the system but would require full repayment in ten years. The annual payments would be (\$50 \$75 \$100 \$175 \$200 \$325) after it was installed. *[Interviewer instruction: Select one value, a different one for each person interviewed, advance in sequence with each call; record value used as a separate variable.]*

Would you prefer one of these programs or neither?

- A. Program A (the technician checking) 01 *[Skip to 10c.]*
 - B. Program B (the water filter) 02 *[Skip to 10c.]*
 - [Interviewer: if they report both A and B, record but ask for preferred choice.]*
 - C. Neither 94
- What would you do? _____ *[Skip to 11.]*

- 10.c. People describe programs like this one to eliminate hazardous substances in different ways. Please tell me if the following statement describes your feelings very well, somewhat well, or not at all. *[Select the relevant statement based on answer to 10a. and 10b.]*

Program A will be effective in reducing the risks to me from these substances in my drinking water.

- a. Very well 01
- b. Somewhat well 02
- c. Not at all 03

Program B will be effective in reducing the risks to me from these substances in my drinking water.

- a. Very well 01
- b. Somewhat well 02
- c. Not at all 03

11. Thanks for giving me your views on these questions. The next stage of our study will focus on problems caused by gypsy moths. I would like to send you a short booklet that describes how gypsy moths affect trees and then call you again after you have read it for a short interview. Would you be willing to help us in understanding how people feel about options for controlling gypsy moths?

- a. Yes 01 *[Go to 12.]*
- b. No 02 *[Repeat request* and if still "no," go to 14.]*

**[Repeat that it is important to try to get as many people as we can to read this information and tell us how they feel about gypsy moths.]*

12. To send you the booklet, we will need your name and address. It will not be placed on mailing lists for any other purpose.

_____ [Fill in name.]

_____ [Fill in street address.]

_____ [Fill in city, state, and
zip code.]

[Interviewer instruction: it is essential to get an accurate address.]

13. When are good times to call for the second interviews after you have received the material?

_____ [Fill in times.]

To conclude the interview, I have a few background questions:

14. What was the highest grade of school that you completed?

- a. No school
- b. Grade school (1-8)
- c. Some high school (9-11)
- d. High school (12)
- e. Some college (13-15)
- f. College graduate (16)
- g. Post graduate (17+)

15. How old are you? _____ [Fill in years.]

16. What is your racial or ethnic background?

- a. White or Caucasian
- b. Black or African American
- c. Hispanic
- d. Asian
- e. Native American Indian
- f. Interracial
- g. Other _____ [Fill in.]

17. _____ [Fill in sex of respondent.]

18. I am going to read a list of income categories for family income from all sources before taxes during 1989. Please stop me when I get to yours.
- a. \$5,000 or under
 - b. \$5,000 to 15,000
 - c. \$15,001 to \$25,000
 - d. \$25,001 to \$35,000
 - e. \$35,001 to \$50,000
 - f. \$50,001 to \$65,000
 - g. \$65,001 to \$80,000
 - h. \$80,000 and over

Thank you very much for your cooperation. Your answers will be most helpful in this study.