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Fear-based Policymaking: How Government Agencies Exploit Mortality Risk Perceptions

Alecia M. Hunter
Utah State University

FEAR-BASED POLICYMAKING: HOW GOVERNMENT AGENCIES

EXPLOIT MORTALITY RISK PERCEPTIONS

by

Alecia M. Hunter

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Approved:

_____   _____
Randy T Simmons, PhD   Ryan M. Yonk, PhD
Major Professor   Committee Member

_____   _____
Chris Fawson, PhD   Ryan Bosworth, PhD
Committee Member   Committee Member

_____
Mark McLellan, PhD
Vice President for Research and
Dean of the School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

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ABSTRACT

Fear-based Policymaking: How Government Agencies

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by

Alecia M. Hunter, Master of Science

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Major Professor: Randy Simmons
Department: Economics and Finance

The Value of a Statistical Life represents how much a population values reducing the probability of death. American citizens and government agencies use the Value of a Statistical Life estimates in benefit-cost analysis to pass life-saving policies. The public uses this measurement as a scientific and objective tool to identify potentially favorable policy from ineffective and inefficient policy. Institutional incentives, however, are aligned for agencies to exaggerate Value of a Statistical Life calculations and overregulate markets. This thesis summarizes how the Value of a Statistical Life data sources, methods of estimation, and inconsistent behavioral reference points distort the statistical calculations. Despite the distorted estimation, agencies still rely heavily on the Value of a Statistical Life as a tool to pass policy. Public choice theory explains that agencies employ distorted information as a tactic to pass regulation. The theory

demonstrates that regulators are self-interested not unlike the general public. This thesis

provides a public choice analysis and concludes that agencies are incentivized to employ

distorted data sources, methods of calculation, and public risk perceptions to inflate the

Value of a Statistical Life and overregulate. As such, the Value of a Statistical Life will

continue to be biased and inaccurate with the current methods of calculation and

addressing political incentives.

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PUBLIC ABSTRACT

Fear-based Policymaking: How Government Agencies

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The objective of this thesis is to explore how government policymakers use distorted Value of a Statistical Life (VSL) calculations for their personal benefit. The VSL estimates how much a large group of citizens would jointly pay to save the life a one random person from a fatal disease. The VSL is used by government agencies like the Environmental Protection Agency. Agencies use the VSL in benefit-cost analyses to help determine potentially favorable life-saving policy from wasteful policy. Despite the well-intentioned objectiveness and decisiveness of the VSL, the political framework incentivizes miscalculated and exaggerated VSL estimates. Public choice theory addresses plausible reason as to why the decades of suggested VSL inaccuracies have not been resolved by those with political power. Public choice theory explains that policymakers are self-interested people. The general public expects political leaders, however, to become self-sacrificing public servants once elected. This thesis is an example and an explanation why those in political office employ distorted VSL calculations. Specifically, those in government agencies aim to maximize budgets and regulatory control for job security. The VSL data sources, methods of estimation, and inconsistent behavioral reference points exaggerate VSL calculations. These miscalculated or purposefully inflated VSL estimates lead to large policy implications that add to government inefficiencies and impose costs on taxpayers and businesses.

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INTRODUCTION

Regulatory agencies are in the business of making rules. After Congress passes a law, agencies create specific rules and regulations to implement each law. Each agency is expected to justify their proposed rules by comparing expected benefits to expected costs. Formal benefit-cost analyses allow agencies to portray the value of their proposed rules. As long as the agencies can plausibly show that the benefits outweigh the costs, then the proposed policies are promulgated. Agencies use what is called the Value of a Statistical Life (VSL) to monetize the benefits of proposed regulations. The VSL is a tradeoff between wealth and small risk reductions (e.g., 1 in 10,000) in a defined period. For example, the VSL is how much a group of similar individuals are jointly willing to pay to avoid one random, premature death within the group. Despite being a key component for agencies to justify regulations under acts of Congress, VSL calculations are often inflated or biased, which skews agencies' abilities to accurately assess the impact of regulations.

Evidence suggests that government agencies purposefully calculate VSLs to ensure regulations that seem beneficial rather than costly. Both regulators and the public use the VSL as a tool for their own benefit. The general public wants agencies to calculate the costs and benefits of proposed regulations. The average person, however, has a difficult time accurately perceiving the true probabilities of risks (Slovic, 1987). People systematically overestimate small risks, meaning that the VSL is often skewed. Regulators allow these misperceptions to inflate the VSL and overstate the benefits of proposed regulation. Regulators are incentivized to inflate the VSL estimate as high as possible to make their proposed regulation seem especially beneficial. Regulators inflate

the VSL by employing ambiguous estimation methods, biased data sources, and exaggerated risk misperceptions. As long as VSLs are calculated in this way, the benefit estimates of proposed regulations will continue to be biased and inaccurate. This thesis examines the VSL calculations, the behavioral economics of risk misperceptions in the general public, and the public choice incentives of regulators who capitalize on these misperceptions for their own benefit.

UNIQUE CONTRIBUTION

This thesis is a public choice analysis on government agencies use of the Value of a Statistical Life (VSL) in benefit-cost analyses. Public choice analyses observe and explain political behavior through institutional incentives. The general VSL literature has overwhelming research that suggest VSL calculations are highly uncertain or strictly inflated. More recent research explores how risk perception and behavioral biases also distort VSL estimates.

Only one paper, though, combines both behavioral economics and public choice theory. In March 2015, W. Kip Viscusi and Ted Gayer published "Behavioral Public Choice: The Behavioral Paradox of Government Policy." Viscusi and Gayer's contribution specifically targets Sunstein's call for behavioral public choice theory in the context of the VSL. Their paper describes first, that politicians are vulnerable to psychological biases rather than highly functioning benevolent dictators, and second, that policymakers have public choice incentives.

This thesis is also a public choice analysis. This paper, however, encompasses a broader analysis of public choice incentives to distort VSL calculations. First, the paper explains the VSL and how it is used by agencies and Congress. Next, the paper analyzes three areas of VSL distortions: the data utilized by agencies, the methods of estimating the VSL, and behavioral biases used as inconsistent reference points for policymaking. The three VSL distortions are tied together with a public choice analysis, which is the thesis's main contribution to VSL and public choice literature. The public choice analysis explains areas of the VSL where regulators employ uncertainty and inflation, as well as

explore the conflicting use of VSL estimates by policymakers and the general public. All groups of people are rationally self-interested and use the VSL differently to attempt to maximize their well-being. Lastly, this paper recommends "nudges" and free-market solutions that respect consumer sovereignty rather than override consumer choice.

THE VALUE OF A STATISTICAL LIFE

The VSL is an estimation of how much a hypothetical group of people would jointly pay to prevent the death of one random person in the group within the next year. For example, if the VSL is calculated at $3 million and a proposed government regulation is predicted to save 20 lives, the monetized benefits of the regulation would be $60 million. When agencies can monetize the benefits of a proposed regulation, they can contrast the expected benefits with the expected costs. Benefit-cost analyses (BCA) have become one of the most decisive methods for implementing rules and regulations.

The title "Value of a Statistical Life" is often confused with the value of a human life, which are two very different measurements. The value of a human life evaluates the worth of an identified person. A statistical life does not identify the worth of an individual but the willingness of society to pay to decrease the risk of death. A simple way to visualize the VSL is to imagine a group of 100,000 people. Suppose that one person in that group is likely to die from lead poisoning without government intervention. The group of 100,000 is willing to spend a certain amount to save that one random person who is statistically predicted to die without the government policy. The VSL is this willingness to pay for the "life" conserved.[1]

VSL estimates differ across agencies. The Office of Management and Budget (OMB) suggests that agencies use VSL estimates ranging from $1 million to $10 million per statistical life (no specified dollar year). The Food and Drug Administration (FDA) currently uses a VSL ranging from $7 million to $9 million, the Environmental Protection

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[1] This is an annual measurement.

Agency's (EPA) VSL is at $8.7 million, and the Department of Transportation's VSL is estimated at $9.4 million.,

Each agency has a different VSL calculation because of the varying pool of available and appropriate studies for each of the agencies' fatality scenarios. For example, a large body of data exists for occupational injury-related accidental deaths rather than death from disease. The Department of Transportation uses of injury-related data to calculate their VSL is relatively more similar to the scenarios that the DOT addresses than, for say, the energy or health agencies. The EPA, on the other hand, also mostly uses occupational data and some consumer product data, such as studies on cigarette purchases and smoke detector usage. Much of this data is between 25 and 40 years old, making EPA estimates less relevant to the scenarios they are trying to model.

VSLs also vary between agencies because each agency adjusts their base VSL studies differently. Agencies adjust VSL estimates when data does not reflect the specific regulatory scenarios being assessed. Data may differ from the actual affected population by data characteristics such as age, income, and health status. The OMB asserts, however, that there is only sufficient evidence to adjust for real income and for delays in death after exposure to a harmful scenario. VSLs are adjusted to reflect a population's income. Greater income is associated with a larger WTP for fatal risk reductions. Latency of a fatal scenario can be reflected in the VSL by discounting the benefits of a policy over the years from when the policy is enacted until the population has gained the full policy benefits. For example, if a policy reduces an environmental pollution in one year, but the entire benefits of the policy take effect five years later, the VSL would be adjusted to account for the 5-year lag of full benefits.

This thesis focuses heavily on the EPA's VSL because the EPA is one of the widest reaching and fastest growing agencies. The EPA claims that their rules have provided trillions of dollars of benefits, but these benefits are rooted in their flawed VSL calculations. For instance, the EPA claims that the Clean Air Act provided more than $22 trillion in benefits from 1970 until 1990, but this massive number relied on the risk reduction estimated by the EPA's own VSL (EPA, 1999). Of the total benefits calculated using VSLs, the EPA's rules accounted for as much as 80% of the total benefits of all rules proposed in 2012 (GPO, 2012). Analyzing the EPA's use of VSLs is particularly beneficial because the EPA's rules affect nearly every aspect of daily American life and industry.

The EPA faces the major problem that their reliance on occupational data is not reflective of environmental risk-reducing scenarios. The EPA's occupational studies only include those in the labor force and middle-aged employees. Therefore, there is a large gap between the studies and actuality because EPA policies affect a much broader range of the population than middle-aged people in the workforce. Because few studies are available, it is not always possible to update the research literature to reflect the differences for each policy scenario. In attempt to close the gap between data and reality, agencies adjust the base estimates for income growth and any time lags that in policy benefits.

Methods of Calculating the VSL

A basic method of estimating the VSL starts with researchers observing compensation and risk trends in revealed and stated preference studies. For instance,

using occupational data, a researcher observes the risk of death of a coal miner and how much that coal miner is compensated. The coal miner's risk-compensation data is used to estimate how much wealth people are willing to forgo to obtain less risky employment.

Next, researchers translate the change of risk into terms of compensation. Occupational fatalities and injury risk data comes from actuarial tables, workers' compensation data, and death certificate statistics. These risk probabilities vary for each source, which may alter VSL estimates.[2] Using the previous example, the coal miner's chance of dying is 1 in 13,000 and she is compensated $60,000 per year, versus a construction worker's chance of dying which is 1 in 15,000 and then compensated $58,500 per year. A researcher then generalizes that people are willing to give up $1,500 for the reduced chance of death of 1 in 2,000, all other variables held constant.

The final step of calculating an agency's VSL is generalizing the risk to wealth exchange for all risk-reducing policies. Field experts estimate how much a proposed policy will reduce the risk of death for the specified hazard. Referring back to the examples of the coal miner and the construction worker, if a policy were to decrease the risk of death by 1 in 2,000 for 2,000 homogenous people with the same willingness to pay of $1,500, then 2,000 people would jointly pay $3 million to randomly save one group member's life. The $3 million is the group's VSL estimate for that policy.

More complex estimation methods, however, are used to estimate the VSL. For example, a Bayesian approach is often used by VSL researchers to model the probability of uncertain events (Kochi et al., 2006). A meta-regression is used to examine how individual VSL estimates vary with study and respondent characteristics. Study and

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[2] Viscusi and Aldy (2003) explore the differences in risk estimation with the listed sources of risk data further.

respondent characteristics include occupational or traffic studies as well as age and education features.

VSL estimates are based off of utility functions. Utility theory assumes that the consumer will only give up income in exchange for a risk reduction as long as her utility stays the same. Utility functions are also subject to a personal budget constraint. An individual has limited resources and is unlikely to expend all her income on ensuring her safety.

Figure 1 shows an indifference curve within a utility function. This indifference curve represents different bundles of risk and wealth along the entire curve. The left-hand side of the curve has lower probabilities of survival with higher pay, and the right-hand side of the curve has higher probabilities of survival with lower pay. Utility, or the consumer satisfaction between levels of risk and income packages, is the same along the entirety of the indifference curve. The expected utility function assumes that an individual prefers to consume in areas above the indifference curves, and she disfavors any area of consumption below her indifference curve (Binger & Hoffman, 1998).

A person's preferred level of risk to wealth tradeoff is illustrated in Figure 1. The point X depicts a person's starting income and mortality risk. The vertical axis represents income or wealth, and the horizontal axis represents the probability of survival. The slope of the indifference curve describes a person's rate of exchange between wealth and risk with the intention of the consumer maximizing her utility. The most she would trade to change her probability of surviving (Δp) is a proportional change in wealth (Δw). From the coal miner and construction worker example, the researcher estimated that people gave up \$1,500 (Δw) to reduce their risk of death by 1 in 2,000 (Δp) while maintaining

their utility. This hypothetical model of a population estimates the VSL for the group as

$3 million.[3]
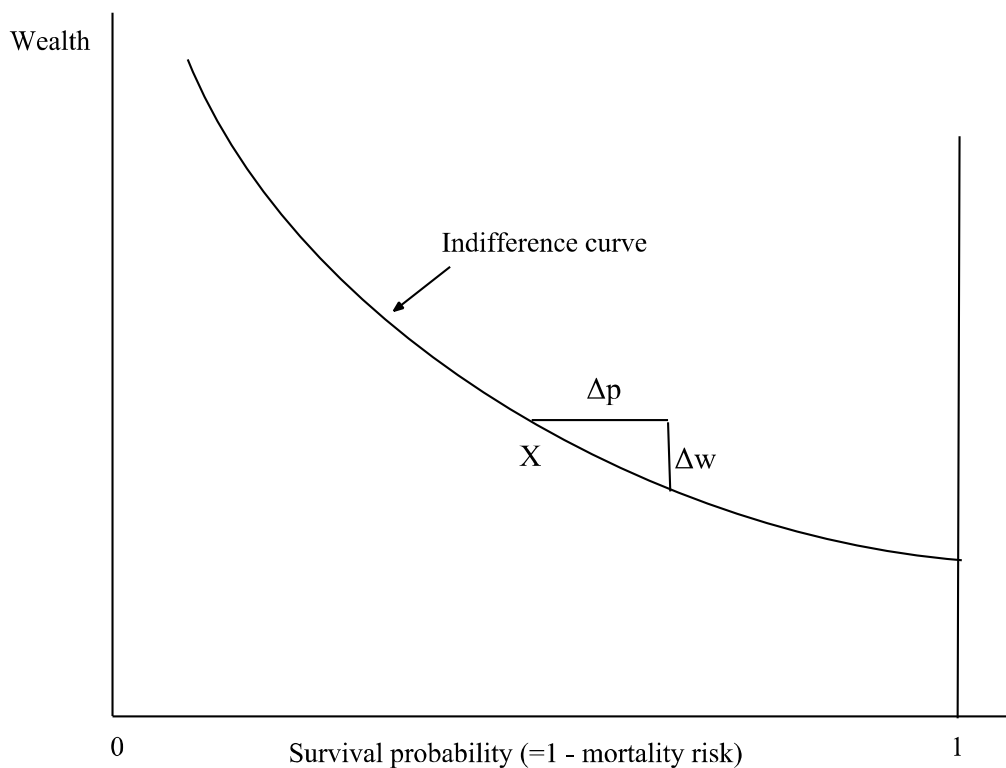
Figure 1. Preference for income and survival probability

Nonmarket Value Estimations

The VSL calculations requires two pieces of information: the total risk reductions

from a proposed policy and how much the population is willing to pay for the risk

reductions. Field specialists estimate the number of public lives "saved" from a proposed

policy. Economists use revealed and stated preference studies as nonmarket values to

derive willingness to pay for risk reductions.

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[3] $30*100,000 = $3 million

Economists use proxy market values to estimate the VSL because public goods, like environmental quality, are not exchanged between people or groups. People cannot trade goods without private property rights. Property rights must be defined, secure, and transferable (Coase, 1960). Environmental quality and other public goods, thus, cannot be traded without ownership. Because public goods are not traded in the market, prices cannot be directly determined. The equilibrium between what people are willing to pay and the cost of the product cannot be observed directly by economists. Instead, economists use nonmarket scenarios. Researchers use revealed preference and stated preference studies as proxy scenarios to estimate willingness to pay for fatal risk reductions. These estimates, in turn, are used in the VSL derivation.

Revealed preference studies analyze individuals' actual purchasing decisions of a specific good. Revealed preference studies are often used in nonmarket valuation studies. For example, economists observe people's preferences for reduced air and noise pollution through property markets. They use econometric techniques to find the correlation between property prices and pollution levels.

Wage-risk studies are the most common revealed preference approaches in VSL analysis. Wage-risk studies observe the difference in pay for riskier jobs, holding other worker characteristics constant. This means that economists expect that employees demand higher pay for greater risk of death. It is assumed that worker preferences are reflected through the level of occupational risk and level of compensation.

Revealed preference studies used to estimate VSLs, however, are somewhat controversial. The markets for the scenario of interest often do not exist. For instance, the EPA's air pollution policies are not represented well with wage-risk data. The benefits of

air pollution affect younger and older demographics that are not included in the labor market, which are not included in wage-risk data. Revealed preference data often requires researchers to adjustment the data to reflect the scenarios modeled by agencies. These data adjustments are explored further later in this paper.

Stated preference studies are the other nonmarket valuation method. Stated preference studies have previously been conducted with mail-in surveys or interviews. In more recent years, researchers have adapted to online willingness to pay surveys. Online surveys can arguably collect a more representative population sample at a lower cost than alternative options. Additionally, online surveys have contributed to the comprehensibility of the survey questions. Online surveys typically include interactive visuals to aid respondents in understanding the meaning of the surveys and the value of their answers.

Stated preference studies are often useful in VSL literature because the questions can seek specific information. Researchers can ask questions regarding a respondent's decisions given a theoretical situation. VSL survey questions often target situations that cannot be assessed using revealed preference data.

Stated preferences studies, however, are used less often than revealed preference data. It is often found that survey answers do not match how respondents act in the marketplace. Intuitively, respondents may have thoughtless answers because survey-takers face no real consequences.

Revealed and stated preference studies are then used together in a meta-analysis. Agencies use meta-analysis to calculate the official agency VSL. A meta-analysis is a collection of independent preference studies to form one large analysis. This method of

analysis increases the statistical validity of the study by including more and diverse observations. Meta-analyses help address variation in demographic characteristics as well as methods used to estimate the VSL.

Meta-analyses, however, are still prone to statistical biases and problems. This is because the collection of studies depends on the judgment of the researcher and his or her "best estimate." The researcher decides which studies to include in the meta-analysis and which populations to represent. The subjectivity of the researcher may bias the results. Additionally, not all studies will include the same variables across studies. This is a common problem in VSL occupational data. Many labor studies often do not include variables for both industry and occupation. Excluding these variables increases the difficulty of the meta-analysis and decrease the accuracy of the results.

Finally, economists calculate the benefits of a proposed policy by using meta-analysis methods. The benefits are used in agencies' benefit cost analyses (BCA). The benefits are calculated by multiplying the predicted number of statistical lives saved from a proposed policy by the willingness to pay for the proposed policy. If the benefits are greater than the costs of the policy, then the policy is passed as a regulation to implement the laws created by Congress. The BCA is a soft determinant of passing regulation. Sometimes agencies will ignore cost and pass policy anyways.

DISTORTIONS IN VSL ESTIMATES

There are three contexts of the VSL estimate that suggest that the VSL is distorted. The first distortion comes from the data and studies used to estimate the VSL. It is arguable that they are not representative of the scenarios that agencies attempt to address with policy. Data and study problems included publication biasedness, uncertain estimates with stated preference studies, and limitations with revealed preference studies. Second, analysts use oversimplified VSL estimation methods by prematurely averaging and aggregating collected data. Doing this suppresses the values of a demographic characteristics, which are imperative to increase the accuracy of econometric results. The last distortion occurs because of behavioral biases. Behavioral economics shows that individuals systematically overestimate small risks and underestimate relatively larger risks (Tversky & Kahneman, 1973, 1974). Peoples' risk misperceptions are fundamental evidence that the VSL is exaggerated. Rather than align incentives for consumers to overcome psychological biases, agencies use these biases as justifications to create policy. Despite the VSL's intention to be used as an objective tool, government agencies use distorted and inflated VSL calculations to overregulate markets.

Uncertain VSL Estimates from Preference

Studies and Econometric Methods

Publication Biasedness

Previous VSL researchers have assumed that the menu of VSL estimates were model samples of the current population and therefore valid to use in meta-analysis.

Analysts, however, have not accounted for publication bias (Doucouliagos, 2012).

Publication bias happens when researchers less frequently report insignificant or negative

VSL estimates or such results are less likely to be published. Doucouliagos et al. (2012)

explain that authors of nonmarket valuation studies may be hesitant to publish VSL

estimates that are small, statistically insignificant, or negative. In a previous study,

Doucouliagos and Stanley (2008) conclude that the VSL literature is no special case of

selectivity biasedness. They report that two-thirds of experimental economics are prone

to publication bias. Additionally, Doucouliagos et al. (2012) found "if the available VSL

estimates are truncated and/or a selected sample, then any average, weighted or simple,

will lead to a biased estimate of VSL." Truncation and selectivity result in inflated VSL

averages leading to faulty benefit-cost analysis interpretations.

Doucouliagos et al. (2012) estimated their own VSL using conservative

adjustments for publication bias. Their VSL was estimated at $3.77 million (2015), below

most major estimates. In 2015 dollars, Miller (2000) reported a VSL of $5.27 million[4]

and $9.63 million[5] from Viscusi and Aldy (2003). Not all VSL estimates, however, are

lower than that assessed by Doucouliagos. Mrozek and Taylor (2002) found a lower

estimate of around $3 million.[6] Overall, Doucouliagos et al. find significant evidence

suggesting that the VSL literature does not adjust VSL estimates for publication

biasedness. Failing to do so exaggerates the reported VSL estimates.

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[4] Inflated using the CPI inflation calculator from $3.9 million 2000 dollars.
[5] Inflated using the CPI inflation calculator from $7 million 2003 dollars.
[6] Inflated using the CPI inflation calculator from $2.34 million 2000 dollars.

Inaccurate Stated Preference Studies

Stated preference studies also provide uncertain and inconsistent information. This is because survey-takers have little incentive to have thoughtful survey responses. Respondents face no real consequences for the information they provide (Blumenschein et al., 2009).

Researchers use scope tests to increase the reliability of stated preference studies. Scope tests measure the respondents' sensitivity to the degree of risk reduction. Scope tests, however, are often not used by agencies. When used, the preference studies do not pass a scope test (Ludwig & Neumann, 2012). To pass a strong scope test, respondents must report a proportionate willingness to pay for risk reductions changes. A weak scopes test requires willingness to pay to increase with risk reduction regardless of the magnitude.

For example, in 2010 the EPA attempted to update the studies used to estimate the VSL with three meta-analyses (EPA, 2011b). Of the new studies collected, only about half of the studies underwent a scope test. Of these studies, 90% of the VSL estimates passed the weak scope test but only 15% passed the strong scope test (Ludwig & Neumann, 2012). The studies collected by the EPA were never incorporated into official guidance, nor subject to a Science Advisory Board (SAB) peer-review process.

Given that agencies like the EPA inconsistently use scope tests and few studies pass strong scope tests, it can be concluded that stated preference studies are another form of VSL distortion.

Limitations of Revealed Preference Studies

Revealed preference studies, unlike stated preference studies, directly observe

consumer behavior. VSL researchers are particularly interested in observing levels of risk

of death and income, controlling for other variables such as education. The VSL literature

identifies three main problems with the EPA's revealed preferences studies. These

problems can be extended to other agencies' VSL estimation methods because of all

agencies' reliance on occupational studies. Problems with revealed preference studies

stem back to reliance on older risk data and endogeneity of job risk.

VSL estimates are largely made up of occupational because of the prevalence of

census data. Consumer products are also used for revealed preference studies, which

include observations with cigarette purchases, automobile safety, and smoke detectors

(Fisher et al., 1989). The current data that the EPA uses for their VSL estimates were

published between 1974 and 1991 (EPA, 2010). Older data has more questionable

sources and methods of measurement than the current methods of data collection. In

addition, the preferences of individuals represented in the data collected 25 plus years ago

may not be reflective of the population's preferences today.

Econometric Challenges

Econometric calculations are not a new challenge for VSL economists. The

statistical methods to estimating the VSL have alarming problems and are worth

questioning the validity of the VSL. For instance, the EPA employed Black et al. (2003)

and Black and Kniesner (2003) to recreate wage-risk estimations using 10 arrangements

of commonly used laborer and risk datasets. Black et al. found that the value on lethal

risk varied broadly. Additionally, the fatal risk variable was only statistically significant in less than half of the studies (Cropper et al., 2011). The authors deduced, "Collectively, these findings lead us to have severe doubts about the usefulness of existing estimates to guide public policy" (p. 3).

Econometric methods are often complicated because of collinearity between important variables like fatal and nonfatal risk as well as industry and occupational variables. Collinearity makes it difficult to disentangle the relative impacts of each variable on the dependent variable. For example, fatal and nonfatal risk both explain higher incomes. Including both variables in an econometric model, however, results in less precise estimates. Studies show that omitting nonfatal injury risk can bias VSL estimates by 20% to 150% using actuary risk data on U.S workers (Viscusi, 1977). Additionally, Liu and Hammitt (1999) used stated preference studies form Taiwanese workers and found that VSL estimates were biased by 100%.

Panel data and instrumental variables can be used to combat collinearity. Kniesner et al. (2012) and Hintermann et al. (2010) used cross-sectional time-series data to estimate workers' compensation and risk for the United States and the United Kingdom. Kniesner found that VSL estimates were reduced by about 50% when they controlled for worker characteristics compared to cross-sectional studies. Hintermann, on the other hand, did not find statistically significant VSL measures when using cross-sectional time-series data.

Omitted variables may explain endogeneity of job risk (Garren, 1988; Cropper et al., 2011). Sometimes variables are difficult to measurable such as how much individuals can control his or her level of risk. For example, one person may have more awareness of

the risks associated with a job when compared to someone else with the same job. That awareness of the risk is difficult to measure but important in explaining the difference between occupational death rates (Shogren & Stamland, 2002). Shogren and Stamland found inflated VSL estimates without variables to account for worker's' unobservable skills.

Oversimplified VSL Estimation Methods

Many economists question if a fixed VSL is a serious oversimplification (Aldy & Viscusi, 2008, Braathen et al., 2009; Cameron, 2010, Cameron & DeShazo, 2013; Hammitt, 2000). There is a plethora of VSL literature studying specific adjustments that show the problem of oversimplifying the VSL. Two of the most commonly discussed adjustments include age and wealth. In 2011, the Science Advisory Board (SAB) stated that the risk reduction estimates are not "one size fits all" values (EPA, 2011b). In 2003 the EPA found evidence showing that elderly people tend to not be willing to pay (WTP) as much to decrease their risk of death (Aldy & Viscusi, 2007, 2008). With this information, the EPA attempted to decrease the VSL for those 65 years and older. After a political upheaval, however, all attempts to change the EPA's estimate were dropped (Cameron, 2010). These political behaviors raise questions about agency agendas.

The two main arguments in support of a one-size-fits-all VSL are political simplicity and fairness (Cameron, 2010). Many people view that placing different values on the lives of individuals with varying characteristic is discriminatory. Some people insist that—wealthy or poor, old or young, risk-takers or those involuntarily exposed to risk—everyone ought to have the same risk reduction value for fatal risk changes.

Generalizing risk reduction values to all people, however, decreases the accuracy of VSL estimates.

Before jumping into the mathematical methods that generalize VSL estimates, it is conducive to review how VSLs are calculated. The mathematical VSL equation requires risk reductions and how much people are willing to pay for those risk reductions that are provided by a regulation. First, field specialists estimate risk reductions of an affected population that come from a proposed government program. Next, the fractional risk reductions are aggregated to form statistical "lives."[7] Lastly, willingness to pay methods for risk reductions are used to monetize the valued risk-reductions for a benefit-cost analysis.

All characteristic information for the data observations, however, is lost because risk is aggregated in the first step. Thus, the dollar measure cannot reflect individual preferences or budget limitations. The calculation is simply the change in risk multiplied by the average population's marginal willingness to pay per statistical life. This has previously been acceptable to keep calculations simple and to maintain the "fairness" argument for a one-size-fits-all VSL. Intuitively, it is clear that people's marginal WTP for risk reduction and the risk reductions themselves will vary widely from a proposed policy. Therefore, the current VSL calculation is only appropriate if the population faces the same risk reductions and has the same willingness to pay for the risk reduction.

A more accurate way to estimate the VSL is to postpone aggregation. For instance, if the EPA proposed tighter environmental standards, it will impact people differently based on whether some people are already satisfying the higher standard than

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[7] One statistical life has been reached once enough fractional risk reductions have been aggregated.

others. Higher incomes may be correlated to those neighborhoods that are in compliance compared to those that are not. Those not in compliance with the policy will have greater benefits, whereas the community already in compliance will not gain anything from the proposed policy. Individual marginal WTP for forecasted risk reduction is negatively correlated with higher income as people are not willing to pay for risk reductions when there are no benefits. If the negatively correlated WTP differences are ignored by analysts, the social benefits of the policy are exaggerated.

Rather than allow VSL estimates to vary by significant demographic preferences, agencies generalize one VSL for the entire population. The current method of estimating the VSL is an appropriate method of measurement only if everyone faces the same risk and have the same willingness to pay for the proposed program. Because individuals are unique, the VSL is not representative of the citizens and is therefore not an appropriate measurement. A more appropriate method of calculating VSL is to postpone aggregation. Postponing aggregation would allow analysts to more accurately estimate the benefits of a proposed policy.

Exaggerating Mortality Risks

This section explores a few direct psychological biases as well as their effects on VSL estimates. Sources of psychological biases include two aspects of the prospect theory and the availability heuristic. The first source of biasedness is explained by how individuals overestimate uncertainty in low-probability events, which is often modeled by VSL estimates. For example, Lichtenstein and associates (1978) compared the actual death rates of diseases to the study respondents' perceived rates of death. The study

included rare illnesses including botulism, smallpox, and poisoning by vitamins. They found that low frequency events were ten times overestimated than actual risks. In contrast, high frequency events were underestimated like stomach cancer and heart disease. Viscusi and Gayer (2015) stated, "one of the best-documented biases people exhibit in thinking about risky choices is related to their perceptions of the absolute level of a risk." Strictly speaking, people tend to deflate relatively large risks such as stroke and heart disease, while inflating small risks. Viscusi and Gayer continued, "[t]his property creates a substantial potential for overreactions to small risks such as those posed by weak carcinogens and nanoparticles."

The next source of biasedness to VSL estimates—ambiguity aversion— demonstrates that people have stronger preferences for a certain outcome rather than chance outcome (Ellsberg, 1961). This was explained in the earlier example: if option A is a 90% chance of winning $800 but a 10% chance of winning nothing, and option B guarantees $500, people tend to prefer option B. People systematically avoid ambiguous situations. Similarly, health scenarios addressed by agencies like the EPA face the difficult task of estimating health and life risks faced by the population. Additionally, citizens demand zero risk for food safety and environmental risk to avoid health uncertainties (Camerer & Kunreuther, 1989). Viscusi et al. (1991) tested ambiguity aversion on environmental pollution resulting in the possibility of nerve disease. When survey respondents were given the choice to live in two polluted areas with equal mean probabilities of risk, respondents preferred the location with less ambiguous risk. The study supports that people tend to avoid ambiguity.

Government institutions also often suffer from ambiguity aversion. Policies lean toward the conservative side to avoid ambiguous risk. When outcomes are uncertain, agencies tend to pass more stringent regulations. For example, Viscusi and Zeckhauser (2014) found that the (FDA) allow risk uncertainty to influence which pharmaceuticals meet public standards. The FDA places greater value on the possibility of error than of that of improving the quality of lives or saving lives. The FDA is incentivized to avoid the responsibility of a faulty drug, resulting that fewer pharmaceuticals enter into the market.

Lastly, Tversky and Kahneman (1973) explained the availability heuristics as a mental shortcut used to deal with complex situations where a person must judge the probability of an event occurring. For example, if someone were asked what their probability of being poisoned by their water source is, the average response may be greater than the actual risk. This is because those in the study mentally work through their experiences and may remember reading about water contamination in the news. Others may think about how they, or their friends or family, have never had a problem with their water safety. The extreme and frightening events tend to receive more media coverage than normal events, which may add to the available memories in an individual's mind. This cognitive process explains why people tend to systematically overestimate risk and VSL estimates.

The VSL requires people, who are psychological agents, to place a value on risks that they perceive. To help mitigate behavioral anomalies, it is suggested that studies pass scope tests. Scope tests are used as a tool to increase the reliability of stated preference studies because it measures respondents' sensitivity to the magnitude of risk reduction.

Though scope tests are one method to increase the reliability of studies, the tests are often not used or the studies do not pass the test (Ludwig & Neumann, 2012). The biases and failed scope tests both suggest that the general public does not consistently act rationally. Therefore, the VSL lacks a normative reference point.

The following examples demonstrate that different agencies use inconsistent policy reference points based on public risk perceptions. Additionally, the risk perceptions of these two scenarios are largely susceptible to behavioral biases and public choice incentives, which helps explain two case studies later in this paper.

First, environmentally risky scenarios are sometimes viewed as uncontrollable and frightening such as the result of cancer. Slovic (1987) found that the WTP for stomach cancer was nearly double that for other sources. Referring to prospect theory and the availability heuristic, individuals often exaggerate the probability of death from environmental-related scenarios. This is because environmental risks tend to be uncertain due to the low-frequency of fatal events occurring. Additionally, when these tragic events do happen, they tend to have large media coverage which increases the perceived relevance to an individual's life.

Second, people tend to underestimate fatal traffic risks. The preference to drive rather than fly is an example of underestimated risk perception. Even though the risk is well-known, some people still spend additional resources on the riskier option of driving rather than flying. The false assumption is that a person is in control of her vehicle and can control the riskiness of her driving (Camerer & Kunreuther, 1989).

These sources of uncertainty, inconsistency, and risk misperception support that the VSL relies on arbitrary methods of calculation and is fundamentally the public's

exaggerated risk perceptions. This leads to the VSL being grossly exaggerated which in turn allows agencies to create misrepresented policy.

PUBLIC CHOICE

Public choice theory explains why government agencies use arbitrary and inflated VSL estimates. According to public choice theory, people are rationally self-interested, whether they are in the public or the private sector. Key to public choice theory is methodological individualism. This is the idea that people have preferences and make decisions and groups do not (Buchanan, 1984). For example, and to reiterate, Congress and agencies do not make decisions. The members of these groups makes decisions based off their interests. This aligns with basic economic theory that the units of observation are choosing, acting, and behaving people rather than units of groups, states, or branches of government that make decisions. The VSL was originally created with the intention to account for society's preferences to determine the value of mortality risk reductions. Congress and government agencies, nonetheless, use the VSL to ensure job security by creating policies that play to the public's fears and misunderstandings found in the VSL.

Public and Private Use of the VSL

The private individuals that make up society employ the VSL to help determine what level of risk the public is willing to accept or willing to pay to avoid risks. Government policies are not intended to protect every citizen from all fatal risks, because minimizing public risk would be too costly. People accept some level of risk in exchange for other personal preferences. For example, speed limits are not 40 miles per hour on freeways because the lower speed limits increase the transportation time, which is considered an economic cost. The drivers miss an opportunity to be productive at work or

enjoy their leisure time. Current speed limits show that the benefits of lower and safer speed limits do not exceed marginal benefits of traffic injury and fatality.

The BCA appears to be conducive method to pass efficient policy, meaning that at least one individual's life can improve without making anyone else worse off. The two strengths of the VSL in a benefit-cost analysis (BCA) is first, that the BCA is a decisive tool, and second, that society's preferences are represented in the model through the VSL. A BCA can identify a socially optimal policy from an inefficient and ineffective policy. Citizens can then utilize this analysis to pass agreeable regulations that increase society's well-being.

Distorted VSLs, however, can directly determine the level of public welfare. The individuals composing of the general public are self-interested utility-maximizers who want accurate benefit-cost analysis for proposed regulations. If the BCA is correctly calculated, it can be a decisive method for passing policy. A policy that does not pass a BCA and, yet, a rule is still approved because of incorrect calculations would mean that citizens are being overregulated and their utility restricted. Mandates are funded either through taxes or increased costs of products, due to regulations and additional expenses imposed on businesses. The more income that an individual can spend on goods and services rather than spending to decrease the risk of death, the more the individual can increase his or her utility. The public views the BCA as a method to safeguard that their money is not being spent on needless regulations. Similarly, society would not have the correct amount of benefits from a regulation if the BCA is not correctly calculated and no policy is passed. Inaccurate measurements for life-saving policy can overregulate, decreasing the public's welfare, or under regulated, allowing potential premature deaths.

Though BCA and the VSL are intended to be a scientific method to pass regulation, the standards of an accurate measurement are not being met by government agencies. The public relies on the dangerous assumption that only socially beneficial policies, as determined with BCAs, are passed (Buchanan, 1978). Most people, however, do not expend their time or resources to research the details of agencies' methods of passing regulations. Little does the public know of the large uncertainty and inflation in the VSL calculations for BCAs. Agencies' reliance on uncertain data and statistical estimations as well as risk perceptions are often exaggerated to inflate the VSL. Furthermore, rather than use a fully informed individual's risk-preferences as a reference point to determine BCA's, government agencies exploit public risk misperceptions when it is in the agencies' favor.

Public choice theory asserts that both Congress and bureaus utilize the VSL to progress their agendas. The individuals that make up Congress and bureaus are rationally self-interested individuals (Buchanan, 1978). Congress will often propose policies if it increases their likelihood of reelection. For example, a constituent supports stricter environmental regulation because she views the state of the environment may be harmful to her health. If a Congresswoman uses the information that people prefer more environmental policy, that Congresswoman will attempt to pass acts, which will increase the public's positive view of her. Agencies then utilize this information to pass regulations that will advance the Congresswoman's goals in addition to the agency's foals. Congress, of course, allows the regulations to stand, as the regulations advance their interests in reelection. Regulators are incentivized to inflate the VSL to create policy with the intention of increasing the agency's regulatory power and budgets (Niskanen, 1971).

Inflating the VSL advances agencies' goals to maximize budgets and to pass an ambitious level of policies. Agencies inflate the VSL through ambiguous estimation methods, utilizing common risk misperceptions, and adopting flawed guidelines for behavioral failures. The (OMB) determines the regulatory agenda, allowing for poor policy guidelines to progress the president's agenda.

Politicians are incentivized to pervert the VSL to deceptively boost benefit-cost analysis. Despite the VSL and BCAs being viewed by the public as a rational and honest method of passing favorable policies, the calculations will likely not change without correctly aligned political incentives for more accurate assessments.

Case Studies: Incentives of Regulatory Agencies

These two case studies demonstrate how the Environmental Protection Agencies (EPA) and the Department of Transportation (DOT) institutionalize behavioral biases and political incentives. The case studies provide evidence that both agencies' VSLs are highly uncertain if not inflated.

"Senior Discount Rate"

In 2003, a political outrage over a proposed age adjustment to the EPA's VSL demonstrates political incentives to maximize budgets and regulatory power. The "senior death discount," as many media centers named it, was a suggestion made by the EPA that supported lowering the VSL by 37% for those 65 years and older (EPA, 1999). A political firestorm broke out over the EPA's policy. Any chance of reducing the EPA's VSL to account for the preferences of the elderly were dropped. In 2011, the Science

Advisory Board (SAB) stated that the EPA's VSL is not a "one size fits all" value, and that a constant VSL may not reflect public preferences and is likely inaccurate (EPA, 2011b). The problems with a constant VSL is that it does not communicate what kind of risk is actually being reduced; different risks are found to have significantly different WTP preferences (e.g. cancer mortality WTP compared to traumatic injury).

In 2003, the EPA found evidence to support adjusting their VSL to accommodate for different willingness to pay estimates for different ages, particularly decreasing the VSL for those 65 years old and older (Jones-Lee, 1989; Jones-Lee et al., 1993). Senator Boxer of California responded to this decrease in the VSL by immediately claiming that it was "outrageous" and that she would introduce legislation to "reduce this unconscionable decision" (Robinson, 2008). No legislation was passed to allow the VSL to decrease, regardless of the new studies, research, and evidence found that suggested a lower VSL for the subpopulation. Senator Boxer even threatened to pass legislation that set a floor to a VSL value (Robinson, 2008). Additionally, Congress prohibited the EPA from underwriting an analysis on age adjustments to the VSL in the fiscal year 2004 Appropriation Bill (H.R. 2673). Later, the OMB advised government agencies to avoid adapting VSLs for age (Graham, 2003), based off of more current research published by Alberini (2004). Even with the evidence that elderly people are willing to pay less for small mortality risk reductions, politics intervened in the process of updating the accuracy of the EPA's VSL and halted further research on age adjustments.

Reestimating the VSL using Speed
Limits and Traffic Fatalities

The DOT is the second case study that demonstrates another bias in VSL

estimates. The study takes place in 1987 when the federal government permitted states to

increase their speed limits on rural Interstates. Higher speed limits are associated with

greater traffic fatalities (Ashenfelter & Greenstone, 2002). Only a handful of states

increased their speed limits, which increased the federal speed limit by 2 mph and

national motor vehicle fatalities by 35% (Ashenfelter & Greenstone, 2002). Ashenfelter

and Greenstone (2002) used the number of hours saved with the increased speed limits,

multiplied it by the average wage, and estimated that the VSL was equal to $2.4 million,

in terms of the increased state speed limits. The DOT (2015) officially reports, however,

that their VSL to be more than $9.2 million. The VSL Ashenfelter and Greenstone

calculated suggests that the DOT's policies may be lower than the DOT estimates. A

lower VSL would decrease the benefits of the DOT's proposed policies, decreasing the

DOT's regulatory power and economic impact.

To reiterate from the behavioral economics section, people tend to deflate

relatively larger risks like transportation and heart disease. Though the risks of driving

are well-known, state representatives still increased speed limits in 1987. Raising speed

limits while fully informed of the additional risk implies that representatives listen to

their constituents and are implementing constituent's psychological biases. Increasing

transportation risks is inconsistent use of peoples' risk perceptions and willingness to pay

to avoid risk. In terms of public policy, the regulators may be employing the biased

information that individuals perceive driving as less risky than reality and prefer higher speed limits.

Both the case study of the "Senior Discount Rate" and a DOT case study support public choice theory that bureaus aim to maximize their budgets and powers (Niskanen, 1971). These case studies demonstrate that government agencies inconsistently institutionalize psychological biases to increase an agency's regulatory power. The EPA tends to regulate ambiguous and less controllable situations. People tend to avoid uncertainty and ambiguity or inflate the actual risk probability. On the other hand, instead of inflating the probability of harm, people tend to deflate the probability of death or injury when it comes to transportation risks. People believe that they are more in control of their vehicle and can avoid the risk of death. People undervalue the actual probability of death via vehicle accident and therefore underestimate transportation risk values. In short, an inflated VSL may mean that there is overregulation in agencies that use VSLs in their BCAs, and agencies like the DOT inconsistently employ VSLs, which contradicts the agency's objectives to increase social welfare.

Civil Society Solutions Versus Government Solutions

Government solutions are often sought after to rectify individuals harmed or killed by difficult-to-pinpoint sources like environmental pollutions or traffic hazards. It is not often considered, however, whether or not citizens may be better-off with "nudges" or nongovernment solutions.

When harmful externalities affect populations, the government intervenes to prevent additional health problems or premature deaths. Agencies often do this by

passing regulations which can lead to overregulated markets. Public choice explains that agencies are incentivized to create regulations to maximize agency budgets and regulatory power (Niskanen, 1971). When the public acts rationally based off of bad information that cause self-harm (e.g., people over or underestimate risks), there are two options considered: one, analysts choose the best policy option, and two, analysts respect consumer sovereignty. Informational "nudges" or consumer sovereignty options are often not considered as a solution to externalities, but nudges or free-markets could provide the more socially optimal solutions than government solutions.

With option one, analysts choose the "best" policy option to address public self-harm (e.g., overestimated risks), which infringes on consumer sovereignty. This option, using public choice theory, is shown as not providing the best solution for the public. According to public choice theory, the political incentives are aligned for overregulated and inefficient markets. This is because regulators are not incentivized to do what's necessarily best for the public but rather to do what's best for their own self-interest. The VSL is an example where politicians overregulate at the cost to social welfare.

In option two, analysts respect consumer sovereignty and ignore shouts of unfairness. Private consumers have incentives to maximize their utility. If individuals face the consequences of their decisions, people are incentivized to overcome their biases in order to increase their utility and lifespan. Furthermore, individuals have greater local information compared to an analyst or government, and thus are able to overcome biases or use market solutions (Hayek, 1945).

An example of an informational "nudge" comes from the EPA and the National Highway Traffic Safety Administration (NHTSA) fuel economy rule in 2011 (EPA,

2011a). The agencies now require fuel economy labels for all new vehicles. This provides

consumers with information and an easy method for comparison and prioritization. This

information may help increase rational consumer decision-making.

Informational nudges are also not necessarily required for consumers to make

decisions. If the information is valued by society, entrepreneurs and opportunists often

find ways to provide information to consumers, making both the consumers and the

supplier better-off. The supplier gains profits, and the consumer's demands are satisfied.

Market solutions also tend to be economically efficient because of supplier competition.

More competition decreases equilibrium prices if demand is constant. Lower prices allow

consumers to spend their limited income on other goods and services, in turn increasing

individual satisfaction. A case of private markets providing consumer information are the

case of diet fads. Many companies have begun labeling food to match consumer demand.

Recent example of this include labels for organic, gluten-free, or free-range products.

Just as the EPA and NHTSA and industries provide information to consumers to

increase decision-making power for consumers, informational nudges and/or markets are

also capable and perhaps more efficient for providing life-saving solutions. Two aspects

must be addressed: psychological biases and proposed solutions to mitigate risk. For

example, a business can report how much arsenic is in a public water system and also

provide the statistical risk and what side effects are of being affected by the arsenic. With

that information, people can decide for themselves if they are willing to pay for the water

provided by the business in order to mitigate the risk of the public water with the higher

levels of arsenic. This method also avoids the oversimplification problem addressed

previously.

CONCLUSION

Government agencies use the Value of a Statistical Life in benefit-cost analyses to pass regulations. There are significant areas of distortion, however, with the methods and content used to calculate the VSL. These distortions exaggerate the VSL and lead to overregulated markets and an inefficient economy. Public choice theory explains why ambiguous and inflated estimates have been employed by agencies with the objective of maximizing budgets and increasing regulatory power.

People, including those in government offices, are rationally self-interested. Individuals in government positions do not lose self-interest once elected to become selfless public servants. Agencies aim to maximize budgets and job security. The VSL is an example of an opportunity where agencies employ distorted information and public risk biases to pass regulation.

Congress enacts rules that lay down a road for overregulation. Agencies are expected to create mandates that satisfy the rules passed by Congress. Agencies, however, use outdated and often irrelevant data, inaccurate and imprecise econometric methods, and institutionalize public behavioral biases to inflate VSL values in order to enforce Congressional laws.

Though many situations, like those discussed in this paper, suggest that people are behaviorally biased, it is often not considered how individuals can overcome those biases. Policies and regulations are an inefficient and indirect method of changing unwanted public behaviors. Without direct and accountable incentives to avoid harm, markets will be overregulated and inefficient, which in turn makes society worse-off. If people face

the consequences of their decisions, they are incentivized to search out true information

to avoid those harms. Rather than remove choice from individuals through regulation,

providing "nudges" are often an optimal compromise of decreasing the cost of

information without removing consumer consequences. To avoid government

inefficiencies and unnecessary costs, society must require representative VSL estimations

or adopt free-market solutions.

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