Journal of Risk and Uncertainty (2019) 58:101–119
https://doi.org/10.1007/s11166-019-09307-3

Risk guideposts for a safer society: Introduction and overview

W. Kip Viscusi[1]

Published online: 28 June 2019

Abstract
This symposium issue of the *Journal of Risk and Uncertainty* addresses wide-ranging policy issues pertaining to risk regulation and the economic underpinnings of these efforts. One such intervention consists of policies to address informational market failures. Whether new information has a positive value is less obvious than economists often assume. When more stringent regulations are required, the structure and evaluation of these efforts often hinges on the value of a statistical life, or the VSL. This symposium reports estimates of the utility functions that generate these local risk-money tradeoffs as well as new estimates of the VSL using both stated-preference and revealed-preference approaches. Articles also explore the behavioral factors that affect VSL estimates, the effect of health risks on product prices, and how income taxation affects stated-preference survey elicitations of the VSL. The symposium reports estimates of the VSL for almost 200 countries as well as the VSL levels used by U.S. government agencies in analyses of over 100 government regulations from 1985 to 2018.

JEL Classifications I10 · K13 · K32 · D8 · D61 · J17

1 Introduction

Health, safety, and environmental regulations comprise the most costly regulatory interventions in the United States as well as in much of the world. Efforts to evaluate these policies in monetary terms have led to the value of a statistical life (VSL) being the most important policy parameter used in evaluating government regulations.[1]

[1]U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, 2015 *Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act*, p. 13.

✉ W. Kip Viscusi
kip.viscusi@vanderbilt.edu

[1] Vanderbilt Law School, 131 21st Ave. South, Nashville, TN 37203, USA

Economic analyses also come into play with respect to examinations of the rationales for these interventions as well as the choice of the regulatory mechanism.

This symposium includes contributions from prominent contributors to analyses of risk regulations: Joseph E. Aldy, Susan Chilton, Elissa Philip Gentry, James K. Hammitt, Thomas J. Kniesner, Cass R. Sunstein, and W. Kip Viscusi. The symposium was organized around a conference on the book *Pricing Lives: Guideposts for a Safer Society*, which provides a comprehensive perspective on the development of the VSL approach, the potential range of its applications, and the degree to which current risk policies often fail to strike an efficient balance between costs and risk. The articles in this issue further our knowledge of well-established research issues and explore a wide range of recent and emerging topics. Two contributions have a behavioral economics focus, including an article on the desirability of providing risk information and an article on the implications of behavioral economics for the VSL literature. Other articles explore estimates of the VSL using approaches that are based on novel stated-preference methods and revealed-preference methods, as well as using estimates derived from individual utility functions. The symposium articles also address the price-risk tradeoffs for pharmaceutical products as well as how survey approaches should elicit VSL estimates in policy contexts in which income taxation plays a role.

After providing a brief overview of the contribution in each of the articles, this introductory overview article also provides a detailed summary of my recommended VSL figure for almost 200 countries. This overview also includes a tally of the VSL measures used in over 100 U.S. government regulatory analyses, as that has been the most prominent policy context where the VSL has come into play.

2 Sunstein: The welfare effects of information

A principal source of market failure with respect to risk and uncertainty is a lack of information about the risk. If provision of information is costless or inexpensive, a standard policy remedy is to provide information that individuals can use in making better decisions about which risky activities and products to choose and which precautions they should take. Accurate information in these models always plays a constructive role. As the article by Sunstein demonstrates, this stylized characterization falls short both in terms of how people value information and the complexity of assessing the economic desirability of informational policies.

Sunstein (2019) reports original survey results on whether people would want to receive different kinds of information, ranging from knowing the annual cost of operating appliances to whether they are genetically predisposed to cancer or heart disease. Even if the information is costless to acquire, many respondents would prefer to not receive this information. His survey results are consistent with the finding by Thunström et al. (2016) that many people would prefer to not know the calorie content of their foods. Sunstein designates the welfare loss from information in the case of popcorn eaters who do not want to know the calorie content of their favorite snack as a "hedonic tax." A particularly striking result was the widespread nature of the public's negative attitudes toward information. There was not the expected high degree of support for any of the myriad types of information that Sunstein examined—a finding which also indicates that one should be cautious in assessing the degree to which

people will process information that is provided and the degree to which they will utilize the information in their decisions.

Additional complications arise with respect to attempts to assess the desirability of information provision in policy contexts. Eliciting the public's willingness to pay for information is often problematic, though it is usually possible to undertake regulatory analyses based on likely behavioral responses or to use breakeven analysis. But how should we address changes in preferences that arise once people develop new habits and new tastes as a result of the information? Which preferences should count is an issue that arises in other contexts as well. If people express a willingness to pay for worthless information, such as labels for bioengineered food, should the government initiate such labeling requirements despite the lack of any health benefits? Sunstein's article explores a wide range of such issues pertaining to how we might conceptualize the benefits and costs of information policies, which is a task that is not always straightforward when behavioral economics issues are present.

3 Viscusi: Utility functions for health risks

The preferences people express for risk are based on their underlying utility functions. For many policy purposes, it is not necessary to know the shape of the utility function in different health states. Information on money-risk tradeoffs at the person's initial (money, risk) situation is sufficient to estimate local values such as the VSL. Knowing the shape of the underlying utility functions is, however, essential to address broader economic issues. If a policy will generate a non-incremental change in risk, using local values will overstate the willingness to pay (WTP) amount for a risk decrease and understate the willingness to accept (WTA) value for a risk increase. Similarly, to assess people's valuations of changes in risk at a different baseline risk level, once again the baseline tradeoff rates would not be the correct measure of the VSL. The structure of utility functions also has implications for optimal insurance and compensation policies. If injuries are tantamount to a loss in income, making the person "whole" after the injury is the efficient outcome if actuarially fair insurance is available. But if the injury reduces the marginal utility of income, then it will not be optimal to restore the person to the pre-injury level.

Viscusi (2019) begins with a comprehensive review of the economics literature assessing the empirical characteristics of utility functions contingent on health status. Most of these studies are based on stated-preference surveys that elicit two points on a constant expected utility locus. The two principal utility function structures involve either treating injuries and illnesses as a monetary equivalent or treating the adverse health event as altering the structure of the utility function. Combinations of these two effects are also possible. The empirical estimates are broadly consistent across different health outcomes. Mild injuries and illnesses are tantamount to a monetary equivalent and can be treated as such for benefit assessment purposes. Monetary transfers after the adverse event provide optimal insurance in this situation. Severe health impacts, such as multiple sclerosis or disabling injuries, alter the structure of utility functions, typically reducing the marginal utility of income so that less than full insurance is optimal. These different results do not reflect any underlying empirical inconsistency but rather are driven by how the differing severity of different types of health impacts will not have the same effect on utility levels and the marginal utility of income.

The impact of serious health effects on utility functions is evident in the new results presented by Viscusi for cancer. The empirical estimates imply that the marginal utility of income is significantly reduced by cancer to just over half of its pre-cancer value. The extent of this decline varies across the population. People who expect to suffer a large drop in their marginal utility of income due to cancer or who have higher perceived personal risks of cancer also have a higher WTP for risk reduction. Respondents who were particularly averse to cancer risks are those who believed that their own cancer risk was high and those who are older, female, or who view themselves as environmentalists. These relationships are also mirrored in estimates of the heterogeneity of direct stated-preference estimates of WTP to reduce cancer risks.

4 Hammitt et al.: Stated-preference estimates of the VSL in China

The article by Hammitt et al. (2019) utilizes a stated-preference approach to ascertain the VSL in Chengdu, a large city in China. What is particularly distinctive about this study is that the authors undertook a stated-preference study in 2016 that closely followed their previous study in 2005. This innovative survey approach made it possible to compare how estimates of the VSL have changed in the rapidly developing Chinese economy, which provides insight into how health risk preference will evolve in other developing economies.

The health outcome of interest in the study was the person's risk of mortality. Respondents were able to reduce their mortality risk by taking "a preventive and painless treatment that would reduce the risk that one would die during the next year." Using parallel survey techniques, Hammitt and coauthors find that the estimated VSL in China has increased markedly over the 2005 to 2016 time period, from $22,000 U.S. dollars to $550,000 U.S. dollars. Although median income levels tripled over that period, the estimated VSL rose by a factor of about 25. By comparing the VSL at different points in time, the results make it possible to estimate the implied income elasticity of the VSL if the increase is due solely to changes in income. The substantial jump in the VSL would be consistent with an income elasticity of 3.0.

The article also presents a detailed application of the procedure based in part on the criteria presented in Hammitt and Graham (1999) for assessing the consistency of survey participants' WTP responses. For small changes in risk, the expressed WTP should be positive and should increase roughly proportionally with the magnitude of the change in the risk. Somewhat surprisingly, only 72% of respondents in the earlier survey and an even lower 52% of respondents in the more recent survey reported a positive WTP for reduced risk. The high level of non-positive WTP amounts highlights the potential importance of the rationality restrictions. An additional requirement emerges from Hammitt et al.'s consistency tests. They hypothesize that more than proportional increases in WTP in response to decreases in the risk are inconsistent with economic theory. Applying their proportionality test screened out an additional group of respondents who did not pass this consistency test. These sample screens also affected the implied VSL from the surveys. Hammitt et al. report overall results for subsamples of respondents whose answers are consistent with the validity criteria and conclude that many stated-preference studies that fail to make such consistency test adjustments lead to underestimates of the VSL.

5 Aldy: Labor market VSL estimates for dual-earner families

Government agencies in the United States place substantial reliance on VSL estimates based on workers' revealed preferences with respect to job risks. Because of the availability of detailed employment data and a high quality Census of Fatal Occupational Injuries data, it is more feasible to obtain reliable labor market estimates of the VSL in the U.S. than in other countries. Nevertheless, a long-standing issue in the literature has been the role of omitted variables, such as unobserved individual characteristics, which may bias the results. Among the most prominent concerns have been the role of individual differences in risk attitudes and the ability to ameliorate job-related risks. Evidence on the VSL using panel data is instructive, but has been limited (Kniesner et al. 2012).

The creative econometric approach adopted by Aldy (2019) utilizes an analysis of two-earner families, making it possible to control for couple-specific unobservable characteristics. His analysis inquires how the differences between a husband and wife, such as their different job-related fatality risk levels, affect the difference in their wages. Economists have long hypothesized that unobserved risk attitudes and differences in the ability to mitigate risk may influence job risk decisions and the estimated VSL. If there is assortative matching based on consistent risk attitudes or if couples develop common risk attitudes after they are married, then analysis of these within-couple differences serves to control for these pertinent unobserved preferences and abilities with respect to risk.

Based on Aldy's preferred specifications, he finds that the VSL range is from $9 million to $13 million (2016 dollars), which is a range that includes the $10 million estimate (2017 dollars) in Viscusi (2018) and the $9 million to $10 million estimates used by most U.S. government agencies. Aldy demonstrates that these findings are robust with respect to several different fatality risk measures based on worker industry, industry by age, and the industry-occupation cell. The VSL for the couples' analysis also displays the established inverted-U shape with respect to age. The most distinctive aspect of the study is the novel econometric approach and the important finding that labor market VSL estimates are not seriously biased by omission in the empirical analysis of risk tolerance and abilities to reduce risk.

6 Kniesner: Behavioral economics and the VSL

Neoclassical economic models provide the theoretical grounding of the VSL approach. Since the time of Adam Smith, economists have observed that workers will demand extra pay to face extra risk, giving rise to compensating differentials for risk, which are used to estimate the VSL. Studies in the literature have been cognizant of some ways in which markets may depart from the stylized neoclassical assumptions, such as whether workers are fully informed of the risks that they face. However, there has not been a comprehensive assessment of how the implications of the emerging behavioral economics literature might affect the estimation and interpretation of the VSL results. The article by Kniesner (2019) provides a detailed overview of these pertinent considerations, the extent to which they have been addressed in the literature, and the open questions for future research.

Kniesner's extensive roster of behavioral economics factors that relate to the VSL includes, among others: endowment effects, risk misperception, ambiguity aversion, reference groups, reference risk levels, and hyperbolic discounting. To date, economists have made substantial headway in some of these domains. Early work in the area examined the characteristics of risk beliefs and how people learn about risks on the job and adapt by quitting. There also have been assessments of the role of reference groups in the population whereby if workers compare their income with that of others, concern with their relative income status may affect the risks that they are willing to incur to boost their relative income position. The role of risk reference points has played a prominent role in the survey literature on the large discrepancy between the WTP and WTA values. Do wage-risk tradeoff rates differ depending on the direction of the change? While survey estimates of WTA values often greatly exceed WTP values, labor market estimates of WTP and WTA values for job changers indicate no such disparity in the VSL estimates attributable to the direction of the risk change.

Many of the behavioral issues have not been fully resolved. In situations in which economists have not developed empirical assessments of the impact of behavioral concerns, Kniesner indicates the likely implications of the behavioral factors and their relative importance. For example, he indicates how present bias and time-inconsistency may affect the VSL and the appropriate VSL estimates to be used for evaluating government regulations. Kniesner's list of not fully explored research areas in which behavioral economics insights could be influential is extensive. A prominent target for future research is determining the respective roles of decision utility and experienced utility. How does the potential gap between the anticipated utility from decisions and the actual utility that is experienced affect the role of internalities? Some of these matters may be more consequential for assessing the role of market failures and for valuing nonfatal health risk rather than for the VSL.

7 Gentry: Price penalties for pharmaceutical risks

Revealed-preference analyses of money-risk tradeoffs pertain to the product market even if third-party payments play a substantial role. Gentry (2019) analyzes the price-risk tradeoffs for narrow therapeutic index (NTI) drugs, which are relatively risky pharmaceutical products. The market equilibrium price should be reduced by the presence of attendant product risks such as those posed by NTI drugs. The potentially higher risks of toxicity and ineffectiveness for generic versions of the NTI drug also should have price effects. The role of the potentially differing risk levels of NTI drugs and their generic counterparts also may affect drug switching behavior, not unlike the role of changes in perceived job risks affecting worker quitting in the labor market context.

Gentry explores these diverse market responses for a set of 10 NTI drugs using a large sample of over 60,000 observations from the Medical Expenditures Panel Survey. The hedonic price model is the product market counterpart of the hedonic wage model used in VSL studies. Consistent with economic theory, the riskier NTI drugs command a lower price. Generic drugs and drugs for which there are competitive products are also priced less. Because the lax standards of bioequivalence cause generic versions of NTI drugs to be imperfect substitutes for brand-name versions, switching between brand-name and generic versions of NTI drugs, or between different generic versions of NTI drugs, poses additional risks. Even small differences in these generic drugs can

lead to serious adverse drug reactions and therapeutic failures. As a result of the greater costs of switching among NTI drug versions, the price gap between brand-name drugs and generics is smaller for NTI drugs than for other prescription drugs.

Taking drugs can be viewed as a process of medical experimentation to find out which drug is most effective for the patient. Because brand-name drugs and generic drugs are not perfect substitutes, there is a risk to the patient from any switch from a currently effective drug regimen. The greater reluctance of patients to switch drugs to incur additional risks from an alternative drug has market effects not unlike those observed for job switching. In particular, the risk-related pay premium workers receive when switching to jobs will be reflective of the risk levels of those jobs. These underlying economic principles of the labor market VSL models are borne out in product market situations as well.

8 Beeson et al.: Stated preference benefit assessments in the presence of distortionary taxation

Stated-preference studies to value risk often use income taxation as the payment mechanism. However, depending on the nature of the income tax structure, the estimates of WTP may be distorted. The theoretical model developed by Susan Chilton and her coauthors in this paper (Beeson et al. 2019) places respondents behind a veil of ignorance. Respondents do not know their position in society, their wealth levels, how they will benefit personally from the public good, or how they will be personally affected by the system of taxation. They are, however, aware of the taxation system and the overall societal distribution of wealth and private benefits. Their model predicts for this situation that there should not be a distortionary effect of taxation.

The authors then use an experimental setting to test this framework. If people are not behind a veil of ignorance but instead are subject to distortionary taxation, the presence of taxation alters their WTP amounts, as predicted by theory. Further, the magnitude of the distortionary tax effect increases with the size of the subject's endowment position. The effect of distortionary taxation is not evident if subjects are behind a veil of ignorance, meaning that WTP in this situation is consistent with purely altruistic, risk-neutral WTP in front of a veil.

This study has general implications for the construction of stated-preference analyses of VSL and other publicly provided goods. It implies that if individuals are subject to distortionary taxation, that will affect their WTP responses. However, if the survey is designed so that they are placed behind a veil of ignorance, the WTP values will not be distorted. If the policies are to be implemented in a real-world situation in which the tax structure is not a first-best tax, the results imply a mismatch between an optimal level of provision of the public good and the amount implied by the particular tax structure in the survey.

9 VSL estimates for policy

9.1 VSL estimates used in government regulation

As discussed in Viscusi (2018), the first application of the VSL in a U.S. government analysis was in 1982 when the author was asked to settle a dispute over the proposed

hazard communication regulation between the Office of Management and Budget (OMB) and the U.S. Department of Labor. OMB had rejected the U.S. Department of Labor's regulatory proposal because the estimated costs were in excess of the calculated benefits. U.S. government agencies at that time monetized mortality risks based on the "cost of death," which consisted of the present value of lost earnings and medical costs associated with fatalities. This approach was consequently not based on the WTP principles that govern benefit assessment for government policies more generally.

Viscusi's estimates of the VSL at that time were over $3 million, or over $8 million in current dollars. Monetizing the benefits using the VSL boosted the mortality-related benefits of the regulation by about an order of magnitude, leading to calculated benefits that were now in excess of the costs. The day after Viscusi's report in support of the regulation reached the Reagan White House the regulation was approved. Subsequently, government agencies switched from the cost-of-death approach to the VSL.

Table 1 reports a partial list of the VSL estimates used by most government agencies from 1985 to 2017, and Table 2 reports a separate compilation for the U.S. Environmental Protection Agency (EPA), where all figures have been converted to 2017 dollars. Although government agencies recognized the desirability of adopting the VSL, what number they selected based on the available VSL literature remained influenced by the values that the agency used previously. Because these baseline numbers used the cost-of-death approach, there was a tendency to select lower estimates of the VSL from those reported in the literature. As discussed in Viscusi (2018), this anchoring bias in the choice of the VSL also influences the VSL estimates currently used in the U.K. and in Australia.

There is an upward trend in the VSL estimates in both Tables 1 and 2, where all figures are in 2017 dollars. In the early years in which agencies adopted the VSL, agencies remained anchored on their previous estimates and used relatively low VSL estimates. The pace at which agencies changed their VSL estimates differed greatly. EPA was the first agency to undertake a comprehensive assessment of the implications of the VSL literature. EPA responded to the findings in the economics literature most quickly, as the agency was using VSL estimates of $9 million or above by the mid-1990s. Subsequently the VSL estimates used by EPA have included values of $10 million or above. The pace of increase in the VSL estimates that other agencies applied was more sluggish. As Table 1 indicates, the VSL estimates at these other agencies increased fairly slowly in the initial years but have increased greatly recently. The U.S. Department of Transportation, which formerly used low VSL values, has become a leader in drawing on the most recent economics literature on the VSL. Since 2009, all of the VSL estimates reported in both Tables 1 and 2 have been in the range of $9 million or above. Consequently there has been convergence of the VSL figures to a general range that is in line with the economics literature.

Use of different VSL estimates across agencies is not necessarily problematic. Selection of different VSL estimates across the government may be consistent with economic theory. There may be heterogeneity in the risk preferences of the populations exposed to the risk, and the nature of the fatality and associated morbidity costs may differ. But the differences across agencies that have been evident have not been tied to such considerations. The estimated VSL for traumatic job-related fatality risks serves as the most prominent source of VSL estimates, though the EPA often supplements these estimates with stated-preference values.

Table 1 Selected Values of Statistical Life Used by U.S. Regulatory Agencies*

Year	Agency	Regulation	VSL ($ 2017)
1985	Federal Aviation Administration	Protective Breathing Equipment	$1.4
1988	Federal Aviation Administration	Improved Survival Equipment for Inadvertent Water Landings	$2.0
1990	Federal Aviation Administration	Proposed Establishment of the Harlingen Airport Radar Service Area, TX	$2.9
1994	Food and Nutrition Service (USDA)	National School Lunch Program and School Breakfast Program	$2.4, $4.9
1995	Consumer Product Safety Commission	Multiple Tube Mine and Shell Fireworks Devices	$8.0
1996	Food Safety Inspection Service (USDA)	Pathogen Reduction; Hazard Analysis and Critical Control Point Systems	$2.7
1996	Food and Drug Administration	Regulations Restricting the Sale and Distribution of Cigarettes and Smokeless Tobacco to Protect Children and Adolescents	$3.8
1996	Federal Aviation Administration	Aircraft Flight Simulator Use in Pilot Training, Testing, and Checking and at Training Centers	$4.3
1996	Food and Drug Administration	Medical Devices; Current Good Manufacturing Practice Final Rule; Quality System Regulation	$7.8
2000	Consumer Product Safety Commission	Portable Bed Rails; Advance Notice of Proposed Rulemaking	$7.1
2000	Department of Transportation	NPRM on Tire Pressure Monitoring System	$4.5–$7.1
2006	Food and Drug Administration	Recordkeeping Requirements for Human Food and Cosmetics Manufactured From, Processed With, Or Otherwise Containing, Material From Cattle	$6.1–$7.9
2007	Department of Homeland Security	Advance Information on Private Aircraft Arriving and Departing the United States	$3.6–$7.2
2008	Coast Guard	Vessel Requirements for Notices of Arrival and Departure, and Automatic Identification System	$7.3
2008	Consumer Product Safety Commission	Standard for the Flammability of Residential Upholstered Furniture	$5.9
2008	Department of Homeland Security	Documents Required for Travelers Departing From or Arriving in the United States at Sea and Land Ports-of-Entry From Within the Western Hemisphere	$3.5–$7.0
2008	Federal Motor Carrier Safety Administration	New Entrant Safety Assurance Process	$6.7
2008	Pipeline and Hazardous Materials Safety Administration	Hazardous Materials: Improving the Safety of Railroad Tank Car Transportation of Hazardous Materials	$6.7 ($3.7, $9.8)
2008	U.S. Customs and Border Protection	Advance Information on Private Aircraft Arriving and Departing the United States	$3.5 & $7.0
2009	Food and Drug Administration	Prevention of Salmonella Enteritidis in Shell Eggs During Production, Storage, and Transportation	$5.9 & $7.6
2009	Food Safety & Inspection Service	Nutrition Labeling of Single-Ingredient Products and Ground or Chopped Meat and Poultry Products	$6.4

Table 1 (continued)

Year	Agency	Regulation	VSL ($ 2017)
2009	NHTSA	Federal Motor Vehicle Safety Standards; Roof Crush Resistance; Phase-In Reporting Requirements	$6.7/$7.1
2009	Transport Security Administration	Air Cargo Screening	$6.7
2009	Transport Security Administration	Aircraft Repair Station Security	$6.7
2010	Coast Guard	Passenger Weight and Inspected Vessel Stability Requirements	$7.2
2010	Federal Aviation Administration	Flightcrew Member Duty and Rest Requirements	$6.9 & $9.8
2010	Federal Motor Carrier Safety Administration	Electronic On-Board Recorders for Hours-of-Service Compliance	$6.6
2010	Federal Motor Carrier Safety Administration	Limiting the Use of Wireless Communication Devices	$6.9
2010	Federal Railroad Administration	Positive Train Control Systems	$6.9
2010	Mining Safety and Health Administration	Maintenance of Incombustible Content of Rock Dust in Underground Coal Mines	$9.9
2010	Mining Safety and Health Administration	Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors	$9.9
2010	Mining Safety and Health Administration	Examinations of Work Areas in Underground Coal Mines for Violations of Mandatory Health or Safety Standards	$9.9
2010	NHTSA	Federal Motor Vehicle Safety Standards; Roof Crush Resistance	$6.6
2010	Occupational Safety and Health Administration	Walking-Working Surfaces and Personal Protective Equipment (Fall Protection Systems)	$8.3
2010	Occupational Safety and Health Administration	Cranes and Derricks in Construction	$9.9
2011	Department of Homeland Security	Ammonium Nitrate Security Program	$6.6
2011	Federal Motor Carrier Safety Administration	Hours of Service of Drivers	$6.6
2011	Federal Railroad Administration	Hours of Service of Railroad Employees; Substantive Regulations for Train Employees Providing Commuter and Intercity Rail Passenger Transportation; Conforming Amendments to Recordkeeping Requirements	$6.6
2011	Federal Railroad Administration	Railroad Workplace Safety; Adjacent-Track On-Track Safety for Roadway Workers	$6.9
2011	Food and Drug Administration	Labeling and Effectiveness Testing; Sunscreen Drug Products for Over-the-Counter Human Use	$237,000 VSLY
2011	Food and Drug Administration	Labeling for Bronchodilators To Treat Asthma; Cold, Cough, Allergy, Bronchodilator, and Antiasthmatic Drug Products for Over-the-Counter Human Use	$8.8
2011	Food Safety & Inspection Service	Not Applying the Mark of Inspection Pending Certain Test Results	$7.4

Table 1 (continued)

Year	Agency	Regulation	VSL ($ 2017)
2011	Mining Safety and Health Administration	Proximity Detection Systems for Continuous Mining Machines in Underground Coal Mines	$9.7
2011	Occupational Safety and Health Administration	General Working Conditions in Shipyard Employment	$9.7
2011	Transportation Security Administration	Air Cargo Screening	$6.6
2012	Federal Aviation Administration	Pilot Certification and Qualification Requirements for Air Carrier Operations	$6.5
2012	Federal Aviation Administration	Flightcrew Member Duty and Rest Requirements	$6.7
2012	Mining Safety and Health Administration	Examinations of Work Areas in Underground Coal Mines for Violations of Mandatory Health or Safety Standards	$9.5
2014	Occupational Safety and Health Administration	Electric Power Generation, Transmission and Distribution; Electrical Protective Equipment	$10.2
2015	Department of Transportation	Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains	$9.8
2016	Department of Transportation	All Policy Analysis	$10.0
2016	Food and Drug Administration	Amendments to Registration of Food Facilities	$9.5
2016	Health and Human Services	Guidelines for Regulatory Impact Analysis	$10.4
2016	Occupational Safety and Health Administration	Walking-Working Surfaces and Personal Protective Equipment (Fall Protection Systems)	$9.9
2017	Food and Drug Administration	Tobacco Product Standard for N-Nitrosonornicotine Level in Finished Smokeless Tobacco Products	$10.0

VSLY is the value of a statistical life year

*When the published summaries of the regulatory impact analyses for these rules do not specify the year in which the reported dollars are denominated, the calculations assume that the dollar year corresponds to the date of rule publication for purposes of converting all values into December 2017 dollars using the CPI-U. Note that the CPSC reported a VSL of $5 million in both its 1995 and 2000 regulations; the difference in values reflects the conversion to December 2017 dollars

Table 2 Values of Statistical Life Used by the U.S. Environmental Protection Agency*

Year	Regulation or Regulatory Impact Analysis (RIA)	VSL ($ 2017)
1985	Regulation of Fuels and Fuel Additives; Gasoline Lead Content	$2.4
1988	Protection of Stratospheric Ozone	$6.9
1996	Requirements for Lead-Based Paint Activities in Target Housing and Child-Occupied Facilities	$8.9
1996	RIA: Proposed Particulate Matter National Ambient Air Quality Standard	$9.0
1996	RIA: Proposed Ozone National Ambient Air Quality Standard	$9.0
1997	Economic Analysis for the National Emission Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production; Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Categories-Phase 1	$4.0–14.6
1997	National Ambient Air Quality Standards for Ozone	$8.9
1998	RIA: NOx SIP call, FIP, and Section 126 Petitions	$9.0
1999	RIA: Final Regional Haze Rule	$9.0
1999	Radon in Drinking Water Health Risk Reduction and Cost Analysis	$8.9
1999	RIA: Final Section 126 Petition Rule	$9.0
1999	RIA: Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements	$9.0
2000	Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements	$9.0
2000	Revised National Primary Drinking Water Standards for Radionuclides	$8.9
2000	Guidelines for Preparing Economic Analysis	$9.0
2000	Arsenic in Drinking Water Rule	$9.0
2004	RIA: Stationary Internal Combustion Engine (RICE)NESHAP	$8.9
2004	RIA: Industrial Boilers and Process Heaters NESHAP	$8.2
2004	Final Regulatory Analysis: Control of Emissions from Nonroad Diesel Engines	$8.9
2005	RIA: Final Clean Air Mercury Rule	$8.2
2005	RIA: Final Clean Air Interstate Rule	$8.2
2005	RIA: Final Clean Air Visibility Rule or the Guidelines for Best Available Retrofit Technology (BART) Determinations Under the Regional Haze Regulations	$8.2
2005	Economic Analysis for the Final State 2 Disinfectants and Disinfection Byproducts Rule	$10.4
2006	RIA: Review of the Particulate Matter National Ambient Air Quality Standards	$8.2
2006	National Primary Drinking Water Regulations: Ground Water Rule; Final Rule	$9.9
2008	RIA: Final Ozone National Ambient Air Quality Standards	$8.1
2008	RIA: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder	$7.9
2009	Reconsideration of the 2008 Ozone National Ambient Air Quality Standards (NAAQS)	$11.0
2009	Proposed SO2 National Ambient Air Quality Standards (NAAQS)	$11.0
2009	Proposed NO2 National Ambient Air Quality Standards (NAAQS)	$11.0
2010	Existing Stationary Spark Ignition (SI) RICE NESHAP	$10.6
2010	Proposed Federal Transport Rule	$9.7
2010	Guidelines for Economic Analysis	$9.1
2010	Proposed National Emission Standards for Hazardous Air Pollutants (NESHAP) for Mercury Emissions from Mercury Cell Chlor Alkali Plants	$11.0
2010	Existing Stationary Compression Ignition Engines NESHAP	$10.6
2010	NO2 National Ambient Air Quality Standards	$11.0
2010	Amendments to the National Emission Standards for Hazardous Air Pollutants and New Source Performance Standards (NSPS) for the Portland Cement Manufacturing Industry	$10.7

Table 2 (continued)

Year	Regulation or Regulatory Impact Analysis (RIA)	VSL ($ 2017)
2011	Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units	$10.6
2011	Final Mercury and Air Toxics Standard	$10.8
2011	Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone in 27 States; Correction of SIP Approvals for 22 States	$9.7
2011	Proposed Manganese Ferroalloys RTR	$10.6
2011	Reconsideration Proposal for National Emissions Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers and Process Heaters at Major Sources	$10.6
2011	Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Commercial and Industrial Solid Waste Incineration Units	$10.6
2011	Proposed Toxics Rule	$9.7
2012	Proposed Reconsideration for Existing Stationary Spark Ignition RICE RESHAP	$10.6
2012	Proposed Reconsideration of Existing Stationary Compression Ignition Engines NESHAP	$10.6
2012	Proposed Revisions to the National Ambient Air Quality Standards for Particulate Matter	$11.0
2012	Final Revisions to the National Ambient Air Quality Standards for Particulate Matter	$10.1
2012	Petroleum Refineries New Source Performance Standards	$10.6
2013	Reconsideration of Existing Stationary Compression Ignition (CI) Engines NESHAP	$10.6
2013	Reconsideration of Existing Stationary Spark Ignition (SI) RICE NESHAP	$10.6
2014	Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants	$11.1
2015	O3 NAAQS	$11.2
2015	Residential Wood Heaters NSPS Revision	$9.1
2015	Clean Power Plan Rule	$11.1
2015	Brick and Structural Clay Products NESHAP	$10.9
2016	Cross-State Air Pollution Rule (CSAPR) Update for the 2008 O3 NAAQS	$11.1
2018	Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program	$10.9

*When the published summaries of the regulatory impact analyses for these rules do not specify the year in which the reported dollars are denominated, the calculations assume that the dollar year corresponds to the date of rule publication for purposes of converting all values into December 2017 dollars using the CPI-U. Some minor differences in VSL levels are due to rounding effects rather than changes in the agency's valuation

9.2 VSL estimates throughout the world

While fatality rate data and employment data for the United States are sufficiently refined to permit reliable revealed-preference estimates of the VSL, data in most other countries are not as well-developed. Survey evidence often can be instructive, but there has been a tendency of published international survey estimates to be anchored on estimates in the literature, creating substantial upward bias in the reported results (Viscusi and Masterman 2017).

The approach advocated in Viscusi (2018) is to use the U.S. estimate of $10 million as the baseline and then to adjust it to other countries based on differences in the gross national income (GNI) per capita and the income

Table 3. International Transferred Estimates of the VSL

	GNI per capita ($ thousands)	VSL ($ millions)		GNI per capita ($ thousands)	VSL ($ millions)
Afghanistan	1.940	0.337	Lebanon	13.750	2.390
Albania	11.310	1.966	Lesotho	3.290	0.572
Algeria	14.310	2.487	Liberia	0.720	0.125
Angola	6.470	1.124	Lithuania	27.570	4.791
Antigua and Barbuda	22.280	3.872	Luxembourg	72.080	12.527
Argentina	20.010	3.478	Macao	102.480	17.810
Armenia	8.770	1.524	Macedonia	13.730	2.386
Australia	45.320	7.876	Madagascar	1.410	0.245
Austria	49.160	8.544	Malawi	1.140	0.198
Azerbaijan	17.170	2.984	Malaysia	26.190	4.552
Bahamas, The	21.970	3.818	Maldives	11.480	1.995
Bahrain	38.660	6.719	Mali	1.970	0.342
Bangladesh	3.560	0.619	Malta	33.170	5.765
Barbados	15.610	2.713	Marshall Islands	5.430	0.944
Belarus	16.920	2.941	Mauritania	3.800	0.660
Belgium	45.660	7.935	Mauritius	19.940	3.465
Belize	8.020	1.394	Mexico	16.860	2.930
Benin	2.050	0.356	Micronesia, Fed. Sts.	4.120	0.716
Bermuda	65.733	11.424	Moldova	5.400	0.938
Bhutan	7.630	1.326	Mongolia	11.220	1.950
Bolivia	6.710	1.166	Montenegro	16.460	2.861
Bosnia and Herzegovina	10.900	1.894	Morocco	7.690	1.336
Botswana	15.510	2.696	Mozambique	1.170	0.203
Brazil	15.050	2.616	Myanmar	4.930	0.857

Table 3. (continued)

	GNI per capita ($ thousands)	VSL ($ millions)		GNI per capita ($ thousands)	VSL ($ millions)
Brunei Darussalam	82.140	14.275	Namibia	10.380	1.804
Bulgaria	17.880	3.107	Nepal	2.500	0.434
Burkina Faso	1.660	0.288	Netherlands	49.410	8.587
Burundi	0.730	0.127	New Zealand	36.150	6.283
Cabo Verde	6.320	1.098	Nicaragua	5.060	0.879
Cambodia	3.300	0.574	Niger	0.950	0.165
Cameroon	3.070	0.534	Nigeria	5.810	1.010
Canada	43.900	7.629	Norway	65.430	11.371
Central African Republic	0.620	0.108	Oman	38.650	6.717
Chad	2.110	0.367	Pakistan	5.320	0.925
Chile	22.760	3.956	Palau	14.730	2.560
China	14.390	2.501	Panama	20.460	3.556
Colombia	13.550	2.355	Papua New Guinea	3.060	0.532
Comoros	1.490	0.259	Paraguay	8.680	1.509
Congo, Dem. Rep.	0.720	0.125	Peru	12.060	2.096
Congo, Rep.	6.320	1.098	Philippines	8.940	1.554
Costa Rica	14.910	2.591	Poland	25.930	4.506
Cote d'Ivoire	3.260	0.567	Portugal	29.060	5.050
Croatia	22.380	3.889	Qatar	138.480	24.067
Cuba	22.824	3.967	Romania	21.610	3.756
Cyprus	31.660	5.502	Russian Federation	23.770	4.131
Czech Republic	31.550	5.483	Rwanda	1.720	0.299
Denmark	49.240	8.558	Samoa	5.740	0.998
Dominica	10.500	1.825	Sao Tome and Principe	3.250	0.565

Table 3. (continued)

	GNI per capita ($ thousands)	VSL ($ millions)		GNI per capita ($ thousands)	VSL ($ millions)
Dominican Republic	13.600	2.364	Saudi Arabia	54.840	9.531
Ecuador	11.270	1.959	Senegal	2.380	0.414
Egypt	10.710	1.861	Serbia	13.420	2.332
El Salvador	8.240	1.432	Seychelles	25.670	4.461
Equatorial Guinea	27.200	4.727	Sierra Leone	1.560	0.271
Eritrea	1.895	0.329	Singapore	81.360	14.140
Estonia	28.390	4.934	Slovak Republic	29.440	5.116
Ethiopia	1.620	0.282	Slovenia	31.180	5.419
Fiji	8.850	1.538	Solomon Islands	2.190	0.381
Finland	42.600	7.404	South Africa	12.870	2.237
France	41.680	7.244	South Sudan	1.630	0.283
Gabon	18.880	3.281	Spain	34.880	6.062
Gambia, The	1.550	0.269	Sri Lanka	11.500	1.999
Georgia	9.340	1.623	St. Kitts and Nevis	24.370	4.235
Germany	49.090	8.531	St. Lucia	10.780	1.873
Ghana	4.080	0.709	St. Vincent and the Grenadines	11.090	1.927
Greece	26.530	4.611	Sudan	3.990	0.693
Grenada	13.090	2.275	Suriname	16.610	2.887
Guatemala	7.530	1.309	Swaziland	8.260	1.436
Guinea	1.120	0.195	Sweden	48.700	8.464
Guinea-Bissau	1.450	0.252	Switzerland	64.100	11.140
Guyana	7.540	1.310	Tajikistan	3.460	0.601
Haiti	1.760	0.306	Tanzania	2.630	0.457
Honduras	4.750	0.826	Thailand	15.520	2.697

Table 3. (continued)

	GNI per capita ($ thousands)	VSL ($ millions)		GNI per capita ($ thousands)	VSL ($ millions)
Hong Kong	57.860	10.056	Timor-Leste	4.550	0.791
Hungary	25.240	4.387	Togo	1.330	0.231
Iceland	47.160	8.196	Tonga	5.590	0.971
India	6.030	1.048	Trinidad and Tobago	32.180	5.593
Indonesia	10.700	1.860	Tunisia	11.100	1.929
Iran	18.240	3.170	Turkey	19.740	3.431
Iraq	15.340	2.666	Turkmenistan	15.760	2.739
Ireland	54.610	9.491	Tuvalu	6.690	1.163
Israel	36.040	6.263	Uganda	1.820	0.316
Italy	37.030	6.436	Ukraine	7.840	1.363
Jamaica	8.680	1.509	United Arab Emirates	70.020	12.169
Japan	42.310	7.353	United Kingdom	40.900	7.108
Jordan	10.760	1.870	United States	57.540	10.000
Kazakhstan	23.480	4.081	Uruguay	20.400	3.545
Kenya	3.070	0.534	Uzbekistan	6.200	1.078
Kiribati	4.230	0.735	Vanuatu	3.130	0.544
Korea, Rep.	34.810	6.050	Venezuela, RB	16.890	2.935
Kosovo	9.870	1.715	Vietnam	5.720	0.994
Kuwait	84.360	14.661	West Bank and Gaza	5.070	0.881
Kyrgyz Republic	3.310	0.575	Yemen, Rep.	2.720	0.473
Lao PDR	5.400	0.938	Zambia	3.640	0.633
Latvia	24.840	4.317	Zimbabwe	1.710	0.297

Note: All VSLs are calculated using an income elasticity of 1.0. Base U.S. VSL is $10.0.

elasticity of the VSL, which is about 1.0 internationally.[2] This procedure leads to a downward adjustment in the VSL except for some outliers such as Qatar. Using this income-adjusted VSL procedure that generates lower values than in the United States does not lead to less protective safety policies in those countries. Rather, the projected VSL based on the estimates in Table 3 is higher than the VSL values currently used throughout the world. As has been the case in the United States, government agencies in other countries have been slow to move beyond values consistent with the cost-of-death approach. Adopting the VSL estimates in Table 3 would be consistent with more stringent safety and environmental regulations.

As the estimated VSL statistics in Table 3 indicate, the income-based extrapolation procedure produces a broad range of VSL estimates. Very low VSL estimates are observed for extremely low-income countries such as Burundi, Ethiopia, Liberia, Rwanda, and Zimbabwe, all of which have VSL estimates below $500,000. As expected, the more advanced OECD countries have VSL estimates closer to those in the United States. For example, the VSL is $8.5 million in Germany, $7.9 million in Australia, $7.6 million in Canada, and $7.1 million in the United Kingdom. The values shown in Table 3 greatly exceed the VSL estimates used in these other countries (Viscusi 2018).

10 Conclusion

The VSL has become established as the pivotal parameter for the evaluation of risk and environmental policies in the United States and, increasingly, throughout the world. The prominent role of the VSL has increased the policy relevance of this line of research and also has highlighted new policy-relevant directions for research. Economists continue to refine their estimates of the average VSL for the population and the VSL for different population groups to explore the heterogeneity of the VSL.

The articles in this symposium issue have contributed to this advancement in a variety of ways. These analyses have examined the role of risk information in enabling people to make their own risk tradeoffs, the role of individual utility functions in driving the valuation and optimal insurance of health risks, the stark changes in the VSL in rapidly advancing economies, econometric procedures to control for unobserved worker characteristics, the impact of behavioral economics concerns on the VSL literature, analogous risk-money tradeoffs in product markets, and the effect of income taxation on surveys to elicit the VSL. The diversity of these contributions are a reflection of the vibrancy of research related to establishing the economic foundations for risk policies.

[2] The exchange rates were calculated using the purchasing power parity method.

References

Aldy, J. E. (2019). Birds of a feather: Estimating the value of statistical life from dual-earner families. *Journal of Risk and Uncertainty, 58*(2/3).

Beeson, M., Chilton, S., Jones-Lee, M., Metcalf, H., & Nielsen, J. S. (2019). Can a "veil of ignorance" reduce the impact of distortionary taxation on public good valuations? *Journal of Risk and Uncertainty, 58*(2/3).

Gentry, E. P. (2019). Empirical evidence of risk penalties for NTI drugs. *Journal of Risk and Uncertainty, 58*(2/3).

Hammitt, J. K., Geng, F., Guo, X., & Nielsen, C. P. (2019). Valuing mortality risk in China: Comparing stated-preference estimates from 2005 and 2016. *Journal of Risk and Uncertainty, 58*(2/3).

Hammitt, J. K., & Graham, J. D. (1999). Willingness to pay for health protection: Inadequate sensitivity to probability? *Journal of Risk and Uncertainty, 18*(1), 33–62.

Kniesner, T. J. (2019). Behavioral economics and the value of a statistical life. *Journal of Risk and Uncertainty, 58*(2/3).

Kniesner, T. J., Viscusi, W. K., Woock, C., & Ziliak, J. P. (2012). The value of a statistical life: Evidence from panel data. *Review of Economics and Statistics, 94*(1), 74–87.

Sunstein, C. R. (2019). Ruining popcorn? The welfare effects of information. *Journal of Risk and Uncertainty, 58*(2/3).

Thunström, L., Nordstrom, J., Shogren, J., Ehmke, M., & Veld, K. (2016). Strategic self-ignorance. *Journal of Risk and Uncertainty, 52*(2), 117–136.

Viscusi, W. K. (2018). *Pricing lives: Guideposts for a safer society*. Princeton: Princeton University Press.

Viscusi, W. K. (2019). Utility functions for mild and severe health risks. *Journal of Risk and Uncertainty, 58*(2/3).

Viscusi, W. K., & Masterman, C. J. (2017). Anchoring biases in international estimates of the value of a statistical life. *Journal of Risk and Uncertainty, 54*(2), 603–628.