DISCUSSION PAPER SERIES

Behavioral Economics and the Value of a Statistical Life

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Claremont Graduate University, Syracuse University and IZA

ABSTRACT

Behavioral Economics and the Value of a Statistical Life*

There are many possible connections between VSL and behavioral economics. A list of topics includes endowment effects, risk salience, ambiguity aversion, present bias, reference groups, reference points, and experienced versus decision utilities. There are also nudges that connect to estimating or using VSL in government decisions and cousins of behavioral economic research including interpersonal heterogeneity, experiments, neuroeconomics, and beauty or personal attractiveness. Current evidence suggests that VSL and behavioral economics best connect via (1) possible multi-attribute reference group effects and (2) a possible distinction between decision utility and experienced utility.

Corresponding author:
Thomas J. Kniesner
Claremont Graduate University
Harper East 216
Claremont, CA 91711
USA
E-mail: thomas.kniesner@cgu.edu

1 Introduction

I have a long-standing personal interest in the value of a statistical life (VSL), not only as

a researcher but also as a son and a grandson. In addition to being hooked by the early

work of Schelling (1968), Thaler and Rosen (1976) and Viscusi (1979) there is a family

history to share. Since about 1940 many of my closest family members have worked in a

chemical plant in Cleveland, Ohio. The list includes my maternal grandfather, my

mother, my uncle (her brother), my father, and most recently me. While my father was

away in the Army during World War II, my mother and my grandfather had the

misfortune of working in the chemical plant when it was (unknown to them but known to

the government) contaminated by radiation from producing part of the atomic bomb

(Eisler 2000a, 2000b). My grandfather ultimately died of colon cancer and my mother

ultimately died of lung cancer, both of which were covered by a special federal

government program that compensated their closest survivors, my uncle and me, because

of our respective parents' radiation exposure.[1] The amount was maybe 10-15 percent of

the values of their statistical lives (VSL). Because VSL is a main component of the

benefit side of a benefit-cost calculation of a program intended to save lives, my family's

situation furthered my interest in understanding, calculating, and using VSL in private

and public decisions. Moreover, my family was exposed to carcinogens due to

government subterfuge, misperceptions, inattention or possibly non-salience of their

workplace hazards (myself included when I worked there). All are core issues in

behavioral economics. Moreover, VSL got its first policy application with respect to

OSHA hazard communication regulation, and without the VSL workers would still not be

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[1] It is the Energy Employees Occupational Illness Compensation Program Act, Part B (U.S.
Department of Labor 2001).

getting the information that I and my family lacked (Viscusi, 2018a, Chapter 1). In what follows I focus on connecting the results of the emerging area of behavioral economics to the estimation and applications of VSL with a focus on identifying connections already made and ones that are the most promising areas of future research based on their respective relative importance to economists and policymakers.

I begin by noting in Section 2 the connection between VSL and the development of the field of behavioral economics. I emphasize how early work on VSL suggesting a possible difference in willingness to pay for slightly more safety and willingness to accept slightly less safety is supposedly what got Richard Thaler to focus more of his attention on behavioral economic issues.[2] In Section 3 I flesh out the reasons why we care about how behavioral economics may be important to VSL research and its uses. I note the large amount of VSL research done by the conference honoree, Kip Viscusi, that can be considered behavioral economics (Viscusi 2018a). Section 4 develops a list of topics in behavioral economics that might be the most fruitful connections between it and VSL research. Section 4 then argues that the core behavioral economic issues of risk salience,

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[2] In documenting Thaler's Nobel Prize winning career Barbaris (2018, p. 663) notes, "In the early 1970s, when Thaler was a graduate student at the University of Rochester, the rational expectations revolution had begun in earnest. Not surprisingly, then, his dissertation, in which he estimated the economic value of a human life, took a traditional rational approach, one based on comparing wages across professions with different rates of accidental death. One day it occurred to him that he might learn something by conducting some surveys. Specifically, he asked survey participants how much they would be willing to pay to reduce their probability of dying over the next year by 0.001, but also how much they would need to be paid in order to accept an 0.001 increase in this probability. When reviewing people's answers, Thaler noticed something curious: the amount people were willing to pay to reduce their probability of dying was much lower than the amount they required in order to accept an increase in this probability, even though traditional economic theory predicted that the two quantities would be roughly equal. This was Thaler's first encounter with the "endowment effect", the most famous of the anomalies he studied: the finding that the amount people are willing to pay for an object of economic value is much lower than the amount they are willing to accept in order to give the object up. Thaler first described the endowment effect in a 1980 paper (Thaler, 1980). He used not only the above example, but also other examples that he had come across … "

ambiguity aversion, present bias, reference group effects, reference point effects and experienced versus decision utility are where future VSL research may benefit most, including possible past and future nudge policies that connect to estimating or using VSL in government decisions. Section 5 considers briefly that there are two first cousins and one second cousin of behavioral economic research that are also of interest. They include research involving experiments, neuroeconomics, or beauty/personal attractiveness. Section 6 concludes by summarizing the effects of the behavioral economics movement on VSL as of now, via reference effects, and possible high value future impacts of behavioral economic ideas such as the distinction between decision and experienced utilities, for how economists estimate and use VSL.

2 Early connections between behavioral economics and VSL

There are clear links between behavioral economics and VSL in the early published works of Thaler and Viscusi (Thaler and Rosen 1976; Viscusi 1979). Although Schelling (1968) is often credited with the concept of VSL, it is Thaler and Rosen and Viscusi who gave empirical content to the concept via econometric research with micro survey data estimating VSL from revealed preferences in the labor market.[3] VSL measures both the willingness to pay for additional workplace safety (WTP) which in basic models of worker utility maximization is also equal to the payment necessary for a person to be willing to accept less safety (WTA). As mentioned earlier, in his dissertation research underlying Thaler and Rosen (1976), Thaler noted a possible endowment effect where individuals' WTP << WTA or that people said they were willing to pay noticeably less for more safety than the compensation necessary for them to take less safety (Barberis

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[3] For additional econometric background on estimating VSL from an hedonic wage equation see Kniesner and Ziliak (2015).

2018). In his published dissertation, Viscusi (1979) described some of what later would become core issues of behavioral economics as misperceptions of prices, rewards, and risks. He noted that people may not get the health risks correct when choosing employment, but that they could learn and adjust by ways that include quitting and working elsewhere.

3 Why care about a behavioral economics-VSL connection?

VSL is a mainstay component in the benefits of government safety programs and (ideally) private sector decisions about product safety (Rohlfs, Sullivan, and Kniesner 2015; Sunstein 2018; Viscusi 2018a). There is influential recent research on how a benefit cost analysis might need to be revised transcendentally due to behavioral economic considerations (Robinson and Hammitt 2011, Sunstein 2018, Weimer 2017). My focus is more modest here. If behavioral economic concepts enrich our research on VSL to the extent that they change how we estimate VSL and in turn change the resulting estimates, then the benefit-cost analysis (BCA) of safety is changed because the B component is changed (Sunstein 2014, Viscusi 2018a).

The recent 1797-page book by Dhami (2016) is a tour de force of behavioral economic concepts and associated findings. For the more faint-hearted but equally interested readers there are the excellent two companion pieces by DellaVigna (2018) and Bernheim and Taubinsky (2018) that summarize the field's current state of knowledge. Another way to define the field of behavioral economics is to examine the Nobel Prize lecture in Thaler (2018). Boiled down, it is sometimes argued that behavioral economics encompasses two basic topics: behavior that is anomalous with economic models driven by economic rationality and models that flesh out more fully the psychological aspects of

decisions (Barberis 2018). Ancillary to this are policy based on so-called nudges (Thaler and Sunstein 2008, Viscusi 2018b).

4 How core issues in behavioral economics connect to VSL research

Thaler emphasizes three issues in behavioral economics in his Nobel Lecture: endowment effects/loss aversion/status quo effects, present bias, and policy built on choice architecture interventions (nudges). I now discuss the general aspects of behavioral economics that best connect to VSL research.

4.1 Risk salience and nudges

As in the story of my family and the chemical plant, worker misperceptions of workplace fatality risk have been a fundamental concern in the VSL literature (Viscusi 1979). If workers perceived risk is less than their actual risk, then they believe their VSL is lower than what economists would estimate because $VSL = V[W]/\pi V_W$, where V is expected indirectly utility of income (wealth) W, V_w is the marginal indirect utility of income/wealth, and π is the probability of survival (Viscusi 1979). Here is a situation where a nudge that leads workers to the correct data on risk could be effective at clarifying the true VSL as better information would lead workers to take safer jobs and in turn increase our VSL estimates. Of course, there can be a nudge that, like any policy, is counter-productive by frightening workers excessively about health hazards and lead them to over-estimate health risks ultimately. Keeping in mind the case of my family's experience with chemical plant employment, where information on health hazards was held back from workers (Eisler 2000a, 2000b), evidence that workers do not generally under-estimate risk is summarized in Kniesner, Viscusi, Woock, and Ziliak (2014).

4.2 Ambiguity aversion and VSL

It is possible that workers experience risk ambiguity wherein they do not know the moments of the risk distribution, which has been labeled risk ambiguity. In the enlightening paper by Treich (2010) he shows that the effects of risk ambiguity on VSL are themselves ambiguous. Evidence presented by Hartog and Vijverberg (2007) is that more wage risk ambiguity will have a first-round effect of raising the wage and in turn may raise VSL, but that more ambiguity (as measured by exogenous increases in wage variance and skewness) could also twist the hedonic locus. The effect of wage ambiguity on VSL is then ambiguous a priori.[4]

4.3 Present bias effects on VSL

In an intertemporal setting the VSL for a person who is age τ is $\text{VSL}^\tau = \frac{1}{V_w} \sum_\tau^T \frac{V[c_t]\pi_t}{(1+r)^{t-\tau}}$, where t indexes age, T is maximum possible lifetime, π_t is the probability of becoming at least t years old conditional on having survived until age τ. The expression is the VSL because it is the remaining expected present value of utility converted to monetary units by dividing by V_w (Johansson 2002).

A recent emphasis of behavioral economic research is whether it is reasonable to continue to characterize individuals' intertemporal decisions as being discounted exponentially as opposed to quasi-hyperbolically. Under conventional exponential discounting the present value of a wage or utility at time t is discounted in the above expression by $\delta = 1/(1 + r)^{t-\tau}$ where r is the interest rate. Under quasi-hyperbolic discounting a wage or utility at time $t - \tau$ would be discounted by $(\beta\delta) = \beta/(1 + r)^{t-\tau}$

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[4] For a general discussion of risk ambiguity effects, which are how risk aversion depends on income (the third derivative of the effect of income on utility) see Baillon (2017).

where $0 < \beta < 1$. The basic effect is that $\beta\delta$ discounting reduces the present value of a future something relative to discounting by δ. For example, if $r = 0.1$, and $\beta = 0.5$, then at time $t - \tau = 1$, expected utility (or a wage) is discounted by 2.2 versus 1.1, which is double under quasi-hyperbolic discounting. Although there will also be so-called time-inconsistency where future decisions change when the present arrives, the issue for us is that hyperbolic discounting pulls the economic value of a wage/utility stream into the present. Pulling economic value into the present raises current VSL relative to future VSL such that workers have higher current VSL in their labor market choices. The behavioral economics point here is that quasi-hyperbolic or more general forms of discounting can increase B in a static BCA of safety enhancing regulations.[5]

4.4 Reference group/life-cycle effects

Behavioral economists have also considered that a person perhaps judges his or her economic success by outcomes relative to that of a reference group. This is also a focus of the social interactions literature, which includes so-called spillover effects in the labor market (Grodner, Kniesner, and Bishop 2010). One hypothesis is that a worker's wage compared to his or her relative position in the wage distribution matters for the worker's wage demands (Frank and Sunstein 2001). If relative economic position is important empirically for labor and product market decisions, then VSL depends on relative wage position, and the researcher must re-specify the hedonic wage equation used to construct VSL. The VSL as used in conventional cost-benefit analysis may be too low due to omitted variable bias. In turn, the B in any associated CBA using VSL is too low too.

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[5] For a complete background on theoretical models and implications of discounting in general and behavioral economic underpinnings in particular see Dhami (2016, Part 3, Chapters 9-11).

To elaborate, the argument is that not only does a worker's utility depend on job risk and absolute wage, but that well-being also depends on relative income considerations such that a worker might accept a lower compensating wage differential for a given fatal injury risk than if there were no relative economic position effects. However, it seems unlikely that earning, say, an extra $1000 from a not particularly glamorous risky job that likely also causes you injury really confers much additional social status. The relative position effect in VSL estimation has been critiqued theoretically in Kniesner and Viscusi (2003) and examined empirically in Kniesner and Viscusi (2005) who find that VSL estimates are not increased but instead reduced by 25-33 percent when relative economic position is included in a hedonic wage equation used to estimate VSL. Although an intriguing theoretical idea because of how a relative economic position variable puts distributional issues into a standard hedonic wage equation simply, omitting relative economic position effects does not bias downward VSL as conventionally estimated using the marginal effect of the fatality risk variable.

As part of their research into reference effects in wages and VSL, Kniesner and Viscusi (2005) and Kniesner, Viscusi, and Ziliak (2006) augment the hedonic wage equation by including a measure of the individual's planned consumption. Because persons with higher planned consumption should also have higher wages and safer jobs the estimated VSL should be enlarged. Moreover, because consumption covaries with age via wealth then the effects of aging on VSL are more complex. Adding consumption to the hedonic wage model typically used increases the average estimated VSL by as much as 20 percent (Kniesner, Viscusi, and Ziliak 2006). Age effects are important for the so-called senior discount controversy wherein VSL is discounted for the elderly

because they have fewer years of life remaining. Kniesner, Viscusi, and Ziliak (2006) find that even though the VSLs for the elderly are lower that the peak VSLs appearing in middle age, they are still higher than the VSLs for workers who are 36 years old or younger. Policymakers must be careful therefore considering age adjustments in VSL when it is used for CBAs of programs involving health of the elderly because a consumption-adjusted VSL can lead to a conclusion of no senior discount.

4.5 Reference point effects

Earlier I noted that a fundamental idea of behavioral economics is the possibility that the WTP $\neq$ WTA where workplace safety (π) is concerned. So-called loss aversion effects associated with the research of Kahneman and Tversky (1979) would lead to the outcome that WTA($\pi-$) > WTP($\pi+$). In a neoclassical economic world, we noted that hedonic wage outcomes should yield WTA = WTP. The issue can be examined with modern econometric techniques applied to micro revealed preference data. The model of possible asymmetry in VSL due to reference point/loss aversion is developed in Kniesner, Viscusi, and Ziliak (2014).

If there is a reference point/loss aversion effect, then in the hedonic wage equation the right-hand derivative of fatality risk should exceed the left-hand derivative. In the context of a panel data regression Kniesner, Viscusi, and Ziliak (2014) examine workers who change jobs and allow the wage effect of moving to a more dangerous job to differ from the wage effect of less or equally dangerous job. They find no statistical difference in the magnitudes of the estimated additional compensation for fatal injury risk increases versus the reduced compensation for fatal injury decreases. A straightforward interpretation of the result is that where revealed preference for a major gain or loss is

concerned people are much more careful and perspicacious than for their willingness to pay for consumer items or to sell a previously gifted coffee mug. Recent careful examination of the product market leads to a similar conclusion that goods and services consumption reference point effects are also much less important than previously thought (Gal and Rucker 2018).

4.6 Decision utility and experienced utility

An interesting area for future behavioral economic based VSL (BE-VSL) research would be to explore a core issue of behavioral economics that yields so-called internalities. The idea is that when people are deciding to purchase a good or service, they calculate its utility value at the margin (shadow price) and compare it to the market price. The utility they use to compute the willingness to pay is based on the concept of decision utility or what they expect the utility benefit to be from the purchase. However, once the purchase is made it may be the case that $U(\text{decision}) \neq U(\text{experienced})$, which is called an internality (Mullainathan, Schwartzstein, and Congdon 2012; Chetty 2015). In neoclassical economics the two are the same so that one may use the market demand curve to compute the welfare benefit of a good or service to the consumer. When there is an internality then the market demand and market price does not reveal the marginal shadow value when the good or service is actually used. If, for example, $U'(\text{decision}) > U'(\text{experienced})$ then there is so-called over-consumption internality and if the inequality is reversed then there is an under-consumption internality. For example, when buying pre-diabetes medical treatment people may undervalue the benefits that will occur when the treatment is consumed and might over-value when buying, and in turn over-consume, a service such as hair transplantation.

In the case of hedonic wage/VSL estimation the issue is whether after taking a job a worker later revises upward or downward the utility from a workplace situation. The econometric model needed to estimate wages in the presence of a labor market internality is so-called frontier estimation. The extant frontier estimation literature has examined production/cost and wage equation frontiers.[6]

To summarize the approach, the frontier estimation model has a three-component error term that is $\varepsilon = \varepsilon_{(+,-)} + \varepsilon_{(+)} + \varepsilon_{(-)}$. The first is the usual random error (most typically assumed to be normal), the second is a one-sided (say, half-normal) error that is only positive or zero, and the third error component (usually also assumed as half-normal) is only negative or zero the researcher can segment the observations into those where decision utility equals experienced utility versus where it does not, either positively or negatively. The frontier regression model specification, by its greater econometric generality allowing for internalities, could reveal the magnitudes of internality effects in VSL.

5. Cousins of behavioral economics

I now make brief mention of three research areas that are research cousins of the BE-VSL connection. One is the use of an experimental approach either in a controlled lab or naturalistic setting. Another is the connection between neuroeconomic research and VSL estimation. The third is more of an intellectual stretch to connect to VSL, which is the research on the role of beauty in labor market outcomes.

In a controlled laboratory setting economists have begun to study compensating wage differentials for the task disamenity. It is difficult to see how one could ever

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[6] The frontier estimation literature has focused on examining production/cost inefficiency by firms and ignorance of job/wage opportunities by workers. For econometric background see Kumbhakar, Wang, and Horncastle (2015) and Polachek and Yoon (1996).

construct a laboratory experiment where some of the subjects died so as to infer a compensating differential and associated VSL. It is possible that there is some historical situation involving prisoners in wartime where there is an implied willingness to pay to avoid death, but I know of none nor would I want to discuss it in general or its external validity in particular.[7] Finally, Deaton and Cartwright (2018) recently noted that the random controlled trial (RCT) framework produces very restrictive evidence and is not the be-all and end-all in empirical research because of emerging interests in more than just mean differences in outcomes.

The neuroeconomic research literature is a way of producing additional evidence on risk related feelings, which can provide additional data relevant to VSL. As one might expect, the topic has not escaped the eye of Viscusi, whose paper (Coaster, et al. 2011) examines brain activity and perceived risk of physical harm. When studying brain activity regions sensitive to possible physical harm, the researchers found that subjects, when presented with identical risk information in different formats, rated identical risks to be greater when information was presented as frequencies as opposed to probabilities. Although interesting in and of itself it is not yet clear how future research in neuroeconomics could be directed at refining the estimation of VSL and its policy implications.

Finally, Hamermesh (2011) examines the issue of how personal physical attractiveness affects labor market outcomes, cet. par. The idea is that in most (not all) cases physical attractiveness (beauty/handsomeness) has little to do with marginal

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[7] For the interested reader there is recent research on the value of life from the view of a murderous dictator. Dower, Markevich, and Weber (2018) find that the amount of money Stalin would have been willing to accept for a reduction in citizens' fatality risk during his interwar Great Terror was about 6 percent of the VSL in the U.S. at the time and about 29 percent of the VSL in modern India.

physical productivity and as such would not be rewarded in a competitive economic environment. This is not completely the case because even in occupations where beauty is not part of the product such as movies and television, persons who are physically attractive receive higher wages, ceteris paribus. Hamermesh notes that, on average, handsome men earn no more than average looking men but that ugly men earn about 13 percent less, cet. par., than average looking men. In the case of women, beautiful women earn about eight percent more than average looking women and ugly women earn about four percent less, cet. par., than average looking women.

Why mention a beauty-wage connection research here? The reason is that VSL and VSI (value of a statistical injury) estimates should change when beauty is added to the hedonic wage estimating equation such as ones used in Viscusi and Gentry (2015). There may be an interaction effect on wages between injury risks and beauty/handsomeness such that avoiding a fatal injury or a non-fatal disfiguring injury is more highly valued by physically attractive people who believe they have more to lose, cet. par., which would yield a higher estimated VSL or VSI. Studying the physical attractiveness-wage connection in a regression context could yield results of some interest to VSL/VSI research and the policy applications of the estimates to benefit-cost analysis of safety regulation.

6. Future research possibilities

As of now there has been little cross-fertilization between the behavioral economics and VSL literatures, which is why the BE-VSL connection seems worth examining as a component of this special issue of the *Journal of Risk and Uncertainty* on risk guidelines for a safer society.

One area of possible future marriage of behavioral economics to VSL estimation concerns well-known results on heterogeneity of VSL by income and demographics (Kniesner, Viscusi, and Ziliak 2010; Viscusi 2010). It may be possible for behavioral economists to identify the underlying psychology of interpersonal differences in VSL, say in the area of sex differences or age differences. Another is possible connections between emerging behavioral economic topics and the estimation or use of VSL in policy decisions involving safety regulation.

A specific place where behavioral economics may matter is in multi-dimensional reference group effects.[8] There seem to be definite impacts on wages and VSL of how old a worker is relative to other workers (not just his or her own age in isolation). In addition, a person may be his or her own consumption reference group which can influence VSL. A planned consumption VSL connection means that VSL does not decline with age as much as was initially hypothesized, so that government policymakers must think harder about any so-called senior discount whereby regulatory benefits are treated as declining severely with age due to lower longevity of the elderly. It is the increased value of each year of life that can decline less severely with age, which can noticeably offset somewhat the fewer years of life remaining.

Finally, a topic much interest to behavioral economists is the possible internality in consumption and labor supplied, which allows for over- or under- consumption or supply because decision utility exceeds (is less than) experienced utility. In addition to understanding why persons under or overestimate the utility value of their purchases or job choices and wage, the frontier estimation approach may have two future research

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[8] For example, Grodner, Kniesner, and Bishop (2010) examine how there are spillover effects on individual labor supply and earned income from a reference group that is like the individual both economically and nearby geographically.

aspects of great consequence to the BE-VSL connection. The first is to accept decision utility as revealed by the data and see if the three error components regression model of discussed in Section 4.6 yields a VSL that differs significantly from what we now estimate via a conventional econometric framework. A more widespread use of frontier estimation of internalities is an example of how Thaler (2016) believes that behavioral economics will eventually whither-away as its ideas become part of economists' toolkit rather than a special topic area. A possible benefit from the three error components hedonic wage equation regression model involves identifying nudge effects more confidently. If one had panel data for workers before and after a nudge, such as providing more accurate and widespread fatality risk information, then the researcher could observe how the nudge affected any internalities and if they change differently by demographic characteristics of workers. This could provide greater empirical knowledge of the decisions underlying nudge effects and their cost-effectiveness, the importance of which is emphasized recently in Viscusi (2018b).

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