RESEARCH BRIEF

The Heterogeneous Value of a Statistical Life: Evidence from U.S. Army Reenlistment Decisions

Based on BFI Working Paper No. 2021-75, "The Heterogeneous Value of a Statistical Life: Evidence from U.S. Army Reenlistment Decisions," by Kyle Greenberg, US Military Academy at West Point; Michael Greenstone, Milton Friedman Distinguished Service Professor at the University of Chicago and Director of the Becker Friedman Institute (BFI); Stephen P. Ryan, Washington University; and Michael Yankovich, US Military Academy at West Point

KEY TAKEAWAYS

- ✓ Some goods or services, like clean air and job safety, do not have an explicit market that can determine prices or values; in other words, it is difficult to account for the value of life.
- ✓ Economists and policymakers have long employed a measure, the value of statistical life (VSL), that broadly applies to all nonmarket goods and services, regardless of whether people have different preferences.
- ✓ This research offers a first-of-its-kind VSL based on the re-enlistment choices of 430,000 US Army soldiers to reveal that their VSLs range on average from $500,000 to $900,000, considerably lower than existing VSL estimates for the general population.
- ✓ Importantly, this work rejects the notion of a static VSL that applies to all persons in varied occupations; accounting for different VSLs is crucial to formulating effective policy.

If readers recall anything from their Econ 101 class, it is likely that the intersection of supply and demand curves reveals a product's price and the quantity produced. Of course, there are many situations where those curves shift and complications arise within markets, but the general insight holds: the interaction of buyers and sellers informs prices and quantities.

However, what if an explicit market does not exist for a particular good or service? How can we reliably draw supply and demand curves for such items as clean air, for example, or school quality and job safety? How, in other words, do we account for the value of life? These questions have vexed economists and policymakers for decades, and solving them is no mere academic exercise, as the answers have important implications for many policies that affect people's lives.

In "The Heterogeneous Value of a Statistical Life: Evidence from U.S. Army Reenlistment Decisions," the authors examine reenlistment choices to show how US soldiers, in effect, price the risk of certain career options. By analyzing the preferences of individuals whose lives are literally on the line, this novel study pushes existing research beyond its static assessment of the value of life and reveals a range of such values that, perhaps surprisingly,

Becker Friedman Institute
FOR ECONOMICS AT UCHICAGO

5757 S. University Ave.
Chicago, IL 60637
Main: 773.702.5599
bfi.uchicago.edu

are much lower than current estimates from the general population. The authors' methodology offers new insights into how people assign different values to choices in their lives, which can help inform policy decisions about non-market goods and services that profoundly affect social welfare.

The challenge of valuing life

Research in the mid-1970s by UChicago's Sherwin Rosen and Booth's Richard Thaler laid the groundwork for the analysis of non-market goods and services that led to development of what economists call the value of a statistical life (VSL), or the willingness to trade-off changes in wealth for changes in the probability of death. It may seem distasteful to put a dollar value on life. However, the VSL is not the value of preventing a certain death—which nearly everyone would give up everything to avoid—but rather the value of a change in the probability of death. This has wide-ranging practical applications. For example, worker safety regulations are enforced, in part, by fines that reflect regulators' application of a VSL, which also informs insurance plans for those workers. If we do not have a sense for the value of a life, how can we enact regulations and policies to adequately protect it?

Beyond the workplace, a VSL provides a measure of the benefits accruing from such public health mandates as environmental regulation, occupational safety standards, speed limits, and product safety requirements. In each case policymakers make decisions that trade off safety for other benefits, like increased industrial capacity or faster transit.

Economists' VSL research has had tremendous impact on policymakers over time, but is not without criticism, especially on the following three counts:

> The average VSL estimated across the population of soldiers and observed range of mortality rates averages between $500,000 and $900,000. These estimates are precise and a great deal less than the median VSL estimate of $10 million from overall US labor market studies.

- Current estimates set the VSL at a constant and do not reflect heterogeneity in preferences across individuals and how individuals' valuations vary with different levels of risk. You may be willing to travel much faster than others, for example, regardless of the risk to your life and the lives of others. Similarly, your willingness to spend for additional safety may be lower when you are in a very low risk setting, than a higher risk one. Current VSL estimates do not account for these differences.

- It is not easy to determine the effect of mortality risk on non-market goods and services. There are a lot of factors at play; to extend the previous example, you may be willing to drive faster because you can afford the safest car on the road, or the road doesn't have dangerous curves.

- Finally, people may simply not know the mortality risk involved in each circumstance, for example, when they choose a particular job, or when they choose to live downwind of a polluting plant, or choose to drive over the speed limit, among the many other choices people make about their livelihood. This factor makes it especially difficult to assess the value of empirical results.

Regarding speed limits and road safety, one of the paper's co-authors, Michael Greenstone, in an episode of BFI's podcast, The Pie[1], describes the choices that society makes every day when it comes to trading off the probability of death with other benefits. It is possible, Greenstone suggests, to ensure that road fatalities in the US would plummet to near zero by giving everyone their own road and lining it with bumpers. However, it is equally plausible that nobody would agree to such a plan as the cost and space requirements would cross the line into absurdity. On the other extreme, a system of unlimited speeds on all roads and no guardrails would be equally untenable. Likewise, society makes choices based on trade-offs somewhere along a continuum.

So, what is the VSL? What value do policymakers and analysts place on a human life when setting rules and regulations that affect our daily lives? A series of studies involving US data estimates a VSL of $10 million in 2019 dollars, while the federal government uses a VSL of $11.6 million in 2020 dollars. Are those numbers low or high or right on target? Your answer to that question is certainly different from others' and how your answer varies across contexts, and these differences, or heterogeneity, is what a static VSL does not capture. That is the challenge addressed in this research—to provide insight into how different people make different choices based on their assessment of risk and reward.

[1] thepie.uchicago.edu

Stay or go? The answer is telling

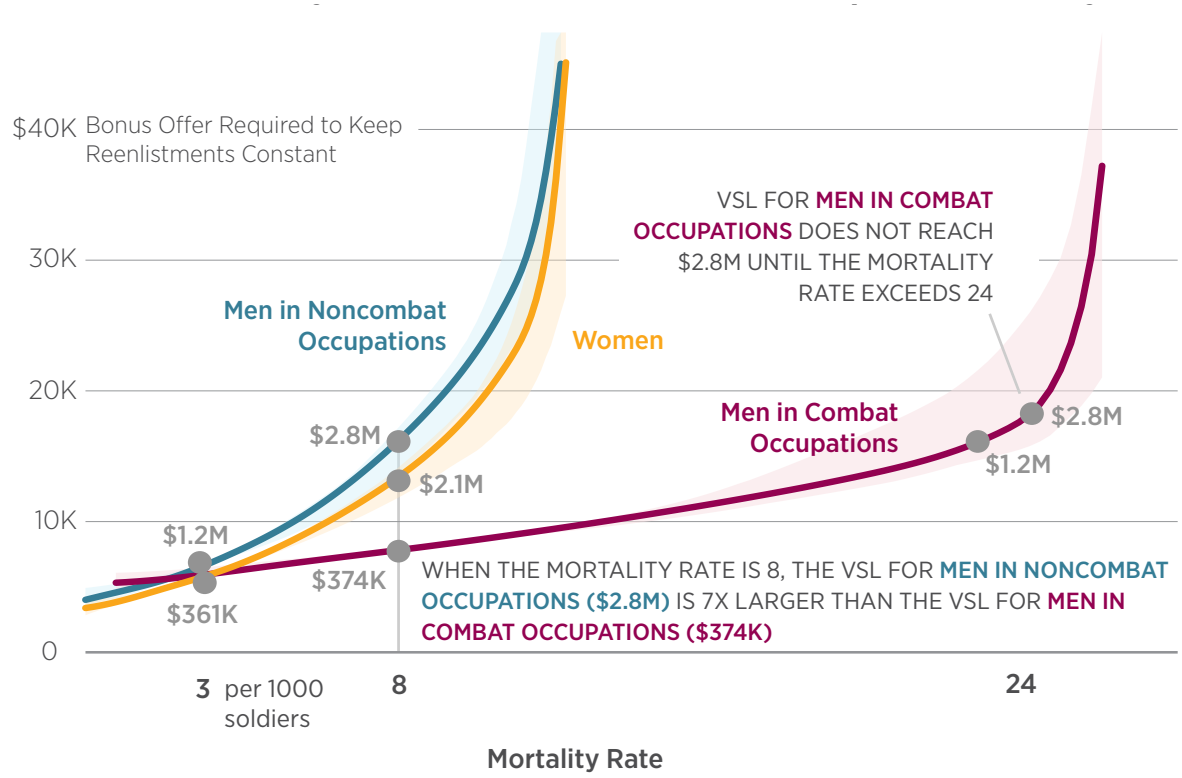
The authors' unique approach involves an analysis of the reenlistment decisions of 430,000 US Army soldiers who completed their first term of service between 2002 and 2010. The military is a good setting to study VSL as decisions about everything from weapons to compensation entail a choice between higher costs and lower fatality risks. In an all-volunteer army that relies on reenlistments to fill senior ranks, these choices are particularly urgent. Further, the US military accounts for about $1 trillion in annual spending (inclusive of the Department of Defense and Veterans Affairs budgets), and 7.5 percent of men and 1.7 percent of women between the ages of 25 and 44 are veterans or are currently serving in the military. All told, US military operations account for a large portion of public policy decision-making.

Like any other resource-constrained agency, the US military must optimize its limited budget to maintain an efficient fighting force. The US Army, the branch of service examined in this study, uses lump-sum reenlistment bonuses that vary widely by occupation and over time, and are nonnegotiable. For example, during the 2002-2010 period, the reenlistment bonus ranged between $0 and $18,600 (mean of $4,100) for a four-year reenlistment as a combat engineer, while it varied between $0 and $37,900 (mean of $11,000) for human intelligence collectors.

How do these bonuses correlate to mortality risk? The period under study begins in peacetime and extends into the height of the Afghanistan and Iraq wars when mortality rates more than quadrupled; likewise, mortality rates varied tremendously both across and within specialties. For example, the four-year mortality rate for infantrymen increased by 600 percent between 2002 and 2007 (from 3.5 deaths per 1,000 soldiers to 24.6 deaths per 1,000 soldiers), while it increased by 145 percent (from 2.0 deaths per 1,000 to 4.9 deaths per 1,000) for wheeled vehicle mechanics over the same time.

The authors developed an empirical model of the decision to reenlist that incorporates bonuses and fatality risk and includes information related to various career paths, like noncombatant vs combatant jobs. In this case, the VSL represents the amount of money required to hold reenlistment rates constant for a marginal increase in mortality.

Figure 1 · Comparing Average Value of a Statistical Life (VSLs) by Soldier Type at Different Expected Mortality Rates



Note: Using the author's data, this figure depicts the bid-curves for three key subsamples. Bid-curves reveal the average bonus offer required to keep reenlistments constant at different mortality rates. The slope of a bid-curve is the implied VSL, which is denoted in dollar amount text labels at different mortality rates. The shaded area around each curve indicates the 95 percent confidence interval. For more on how the authors' constructed this figure, please refer to the working paper.

Their analysis reveals the following key findings:

1. Higher bonuses increase the reenlistment rate and higher mortality rates reduce it. A $1,000 increase in the bonus for a four-year term raises the probability of reenlistment by 0.46 percentage points. To put this in context, the overall reenlistment rate in this period was 45.3 percent, these soldiers earned about $30,000 annually, and average bonuses increased by $11,000 between 2003 and 2006. In the other direction, mortality, unsurprisingly, has the opposite effect: an increase in the expected 4-year mortality rate of 1 per 1,000 decreases the reenlistment rate by roughly 0.26 percentage points. As a basis of comparison, the authors estimate that the overall 4-year mortality rate increased by 7.2 soldiers per 1000 from the low in 2002 to the peak in 2007.

2. The average VSL estimated across the population of soldiers and observed range of mortality rates is between $500,000 and $900,000. These estimates are precise and, as noted above, a great deal less than the median VSL estimate of $10 million from overall US labor market studies.

3. This work answers the decades-long research challenge of incorporating heterogeneity into decisions regarding trade-offs between wealth and mortality. The VSL increases rapidly as mortality risk increases. Furthermore, even within the population of Army soldiers, there are great differences across occupations: the "bravest" (that is, those with the lowest VSL) go into the riskiest occupations, as we might expect.

CLOSING TAKEAWAY

This work reveals striking differences in preferences for safety and wealth when comparing different types of soldiers at the same mortality rate. For example, when the four-year mortality rate is 8 per 1,000 soldiers, the implied VSL for men in noncombat occupations is 7 times larger than the implied VSL for men in combat occupations ($2.808 million for noncombat men compared to $374,000 for combat men).

To put a price on it, men in noncombat occupations facing an expected mortality rate of 1 death per 1,000 soldiers have an estimated VSL of $717,000, which more than doubles to $1.667 million when they face a mortality rate of 5 deaths per 1,000. Among men in combat occupations, the estimated VSL does not reach $1.667 million until the mortality rate exceeds 23 deaths per 1,000 soldiers, which is the 97th percentile of their mortality distribution.

The accompanying figure reveals striking differences in preferences for safety and wealth when comparing different types of soldiers at the same mortality rate. For example, when the four-year mortality rate is 8 per 1,000 soldiers, the implied VSL for men in noncombat occupations is 7 times larger than the implied VSL for men in combat occupations ($2.808 million for noncombat men compared to $374,000 for combat men). Combat men, it seems, know what they are getting into when they choose to re-enlist and, likewise, need less compensation to balance perceived risks (or, in economic terms, infantry soldiers self-select).

These are not idle computations. Rather, the authors show how an understanding of VSL variation by occupation and risk can help shape effective policy. In 2005, for example, the US Army began issuing enhanced body armor to soldiers in all occupations. At $760 per unit, the total projected system cost was $200M, with mortality reductions estimated at 15 percent.

The authors' VSL estimate of $575,000 would imply that the $200M enhanced body armor program was welfare-improving if it saved 350 lives, not unreasonable given that nearly 4,000 service-members died in Iraq between 2003 and 2007.

However, this standard cost-benefit analysis is derived from a single VSL. As such, it could miss crucial differences among and within occupations that could impact social welfare, in the same way that the current $10 million VSL misses likely variation in the general labor force. In this example, the authors examined the varying VSLs among noncombatant and combatant soldiers (again, as illustrated in the accompanying figure) to find a VSL for male truck drivers of roughly $2.73M and for infantry soldiers of $428,000.

According to the authors' calculations, if enhanced body armor reduced mortality by 15 percent across all occupations, then the program would clearly be welfare improving for male truck drivers, who would be willing to pay much more than the system's unit cost. On the other hand, infantry soldiers' willingness to pay would fall short of unit costs. Thus, the welfare maximizing policy in

2005—with a goal of keeping reenlistment rates constant as mortality rates increase—would have been to issue enhanced body armor to truck drivers and to maintain infantry staffing levels through higher bonuses.

Conclusion

By coupling a rich data set of re-enlistment decisions of US Army soldiers with a model that accounts for differences among soldiers confronting career options, this research offers the first empirical assessment of a long-standing theoretical—and practical—problem: how to determine VSLs that incorporate people's preferences at different mortality rates when making trade-offs between wealth and mortality. The authors reveal that the VSL among early-career US Army soldiers facing reenlistment is far lower than those in the full US labor market. For example, the median VSL based on US data is about $10 million in 2019 dollars, significantly higher than the $500,000 to $900,000 average revealed in this study. This reveals that soldiers are different—they are willing to accept more risk than others.

Importantly, this work firmly rejects the notion of a single and universal VSL. As this work shows, estimated VSLs vary substantially within an observed range of mortality risk among men in combat occupations. In other words, people make different choices when confronted with similar options. Indeed, the authors reveal a seven-fold difference in the VSL across occupation categories when they compare those categories at the same level of risk.

The broader message from this resarch is that accounting for heterogeneity in valuations for safety is critical. Just as there is not a single VSL among soldiers, there is almost certainly not a single VSL for everyone else. A better understanding of how consumers value a wide range of non-market goods and services, including clean air, public transportation, school quality, and a host of other issues, will result in better policies going forward and have a positive impact on social welfare.

READ THE WORKING PAPER

NO. 2021-75 · JUNE 2021

The Heterogeneous Value of a Statistical Life: Evidence from U.S. Army Reenlistment Decisions

bfi.uchicago.edu/working-paper/202175

ABOUT OUR SCHOLAR

Michael Greenstone
Milton Friedman Distinguished Service Professor, University of Chicago; Director, Becker Friedman Institute
economics.uchicago.edu/directory/michael-greenstone

THE KENNETH C. GRIFFIN DEPARTMENT OF ECONOMICS

Written by David Fettig, BFI Senior Writer and Editor