The (Very) Heterogeneous Value of a Statistical Life: Evidence from U.S. Army Retention Decisions

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What is the Value of Statistical Life (VSL)?

- The VSL is the willingness to trade changes in wealth (W) for marginal changes in the probability of death (p)

$$VSL = \frac{\Delta W}{\Delta p}$$

- VSL is not a measure of the value of a life
  - Most would give up all to avoid certain death
  - The VSL is the MWTP for a change in the probability of a fatality

VSL Has Tremendous Practical Value

1. Should the government impose a pollution-reducing regulation that saves 10 lives but increases manufacturer's costs by $30 million?

2. Should California install guard rails along Highway 1 if they cost $100 million per life saved?

3. Should the Army procure MRAPs, purchase drones, or pay soldiers more money as for accepting higher risk of mortality?

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  - Consensus estimate of $6.5 million, but estimates vary wildly (DoD uses $10 million)
  - Little focus on how VSLs vary with different levels of risk

Using U.S. Army Reenlistment Decisions To Estimate the VSL

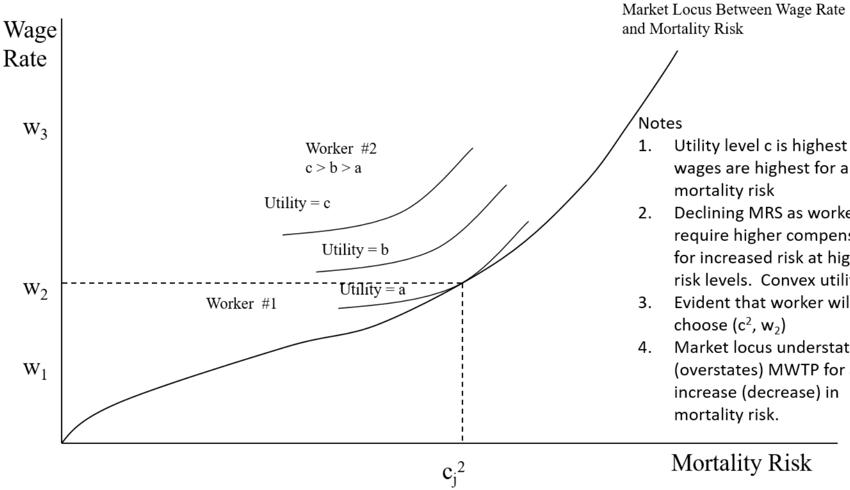
- We examine the reenlistment decisions of 430,000 U.S. Army soldiers from 2002-2010 who were nearing the end of their initial enlistment
- We impute the VSL by estimating how reenlistment responds to mortality risk and lump-sum Selective Reenlistment Bonuses (SRBs)
- Substantial variation in bonus offers and mortality risk within and between occupations during this time-period

Preview of Results

- We estimate average VSL in the range of $600,000
- Substantial heterogeneity across sub-groups and within sub-groups
  - Women appear to have higher VSLs than men
  - Modest evidence that men in combat occupations have lower VSLs than men and women in non-combat occupations
- Variation in mortality risk and bonus offers enables us to uncover average MWTP functions (i.e. indifference curves) - the combinations of mortality and bonuses that give the same level of utility
  - Reveals even more VSL heterogeneity when we compare combat vs. non-combat soldiers who face similar morality risk

Talk Outline

The Hedonic Approach to Measuring the VSL



Notes

1. Utility level c is highest b/c wages are highest for a given mortality risk
2. Declining MRS as workers require higher compensation for increased risk at higher risk levels. Convex utility fn.
3. Evident that worker will choose (c^2, w_2)
4. Market locus understates (overstates) MWTP for an increase (decrease) in mortality risk.

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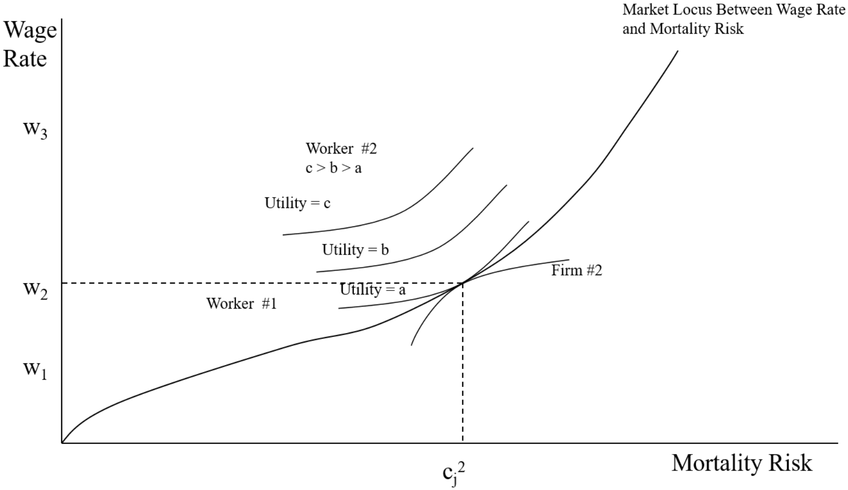

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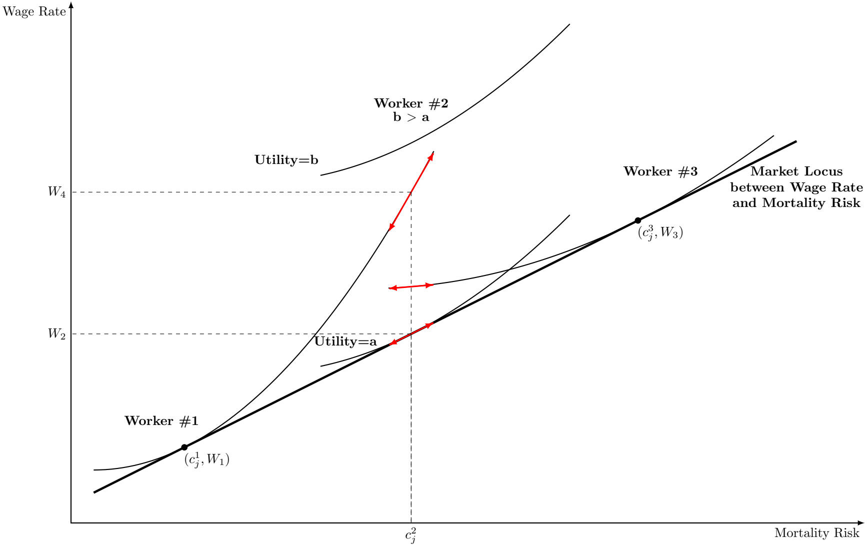

The Hedonic Approach to Measuring the VSL: Key Takeaways

- **Hedonic Approach (Ideal).** Rosen (1974) proposed a 2-step approach to recover worker MWTP functions, but this approach has not met great success (Epple 1987; Chay and Greenstone 2005)

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  1. Unobserved job features are correlated with fatality risk
  2. Fatality risks are unknown in many settings
  3. Market locus does not uncover **MWTP functions**

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- **Three Empirical Challenges with Hedonic VSL Estimates**
  1. Unobserved job features are correlated with fatality risk
  2. Fatality risks are unknown in many settings
  3. Market locus does not uncover **MWTP functions**
     - Market locus reveals average MWTP for safety across unknown number of types
     - Slope of market locus understates worker VSL when risk levels increase

Key Empirical Challenges of Estimating VSL (how this project compares)

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  - Occupation fixed effects, and (Occupation)x(Year) fixed effects
  - Robust to individual controls; controls for time-varying job characteristics and local economic conditions; multiple conditional logit specifications
  - Moment forest machine learning technique of Nekipelov et al. (2019) produces similar VSL estimates when we make no stipulations on which controls to include

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- Fatality risks are unknown in many settings
  - Soldier deaths published in newspapers, confidential briefings, and widely discussed within the Army

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- Unobserved job features are correlated with fatality risk
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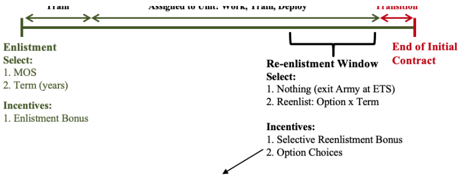
- Market locus does not uncover MWTP functions
  - Substantial variation in bonus offers and mortality rates allow us to estimate how reenlistment decisions vary with bonus and risk levels

Talk Outline

Army Reenlistment Setting



Reenlistment Alternatives

Option	Occupation	Home Post Location*	Term Length
1	No Change	Army Chooses	2, 3, 4, 5, or 6 years
2	No Change	Stay at Current Post	2, 3, 4, 5, or 6 years
3	New Occupation	Army Chooses	3, 4, 5, or 6 years
4	No Change	Pick Overseas Post	3, 4, 5, or 6 years

- Soldier chooses initial term of service and occupation at enlistment
- Army chooses unit of assignment and deployment based on needs

Reenlistment Options

- Soldiers at reenlistment choose between five options
    1. Regular Army, same military occupational specialty (MOS)
    2. Current station stabilization, same MOS
    3. Retrain to another MOS
    4. Station of choice Outside Continental US (OCONUS), same MOS
    5. Station of choice Continental US (CONUS), same MOS

- Soldiers also choose a reenlistment term length
    - 2, 3, 4, 5, or 6 years for options 1 and 2
    - 3, 4, 5, or 6 years for options 3, 4, and 5

Selective Reenlistment Bonus (SRB) is Primary Policy Tool

- SRB is the Army's primary policy tool to influence reenlistment rates

- Bonus policies set by a small staff at Human Resources Command and change frequently at irregular intervals through Military Personnel (MILPER) messages
  - Bonuses fill short-term MOS shortages, meet endstrength requirements
  - Size of bonus varies with occupation (MOS), years of service, and rank
  - Commanders cannot influence bonus offers
  - Bonuses NOT a function of individual soldier characteristics

SRB and Sample Selection Details

- We (COL Yankovich) reconstructed bonus offers by compiling all bonus-related MILPER messages from 2002 - 2010
- Between 2002 and 2010, most soldiers entered their reenlistment window 12 months prior to the end of their initial contract (initial ETS), but there were many exceptions and policy changes
- Modal reenlistment time in our sample is 12 months prior to initial ETS
  - We map soldiers to bonuses offered exactly 12 months prior to initial ETS
  - Results robust to alternative "Reenlistment Decision Dates"
- Sample restricted to first-term soldiers who served longer than 1 year
  - "Reenlistment Eligibility" changes frequently, difficult to measure
  - Soldiers with less than 1 year of service rarely eligible for reenlistment
  - Consistent with sample restriction in Borgschulte and Martorell (2018)

Measure of Expected Mortality Hazard

- Army administrative data includes both combat and non-combat deaths
- Preferred measure of a soldier's expected risk is the mortality rate of soldiers in the same MOS in the 12 months before she enters her reenlistment window
- Expected mortality risk measure summed over reenlistment option years (typically 4 years), discounting future years at 7.2% (Simon, Warner, and Pleeter, 2015)
- Results robust to several alternative measures of expected mortality hazard

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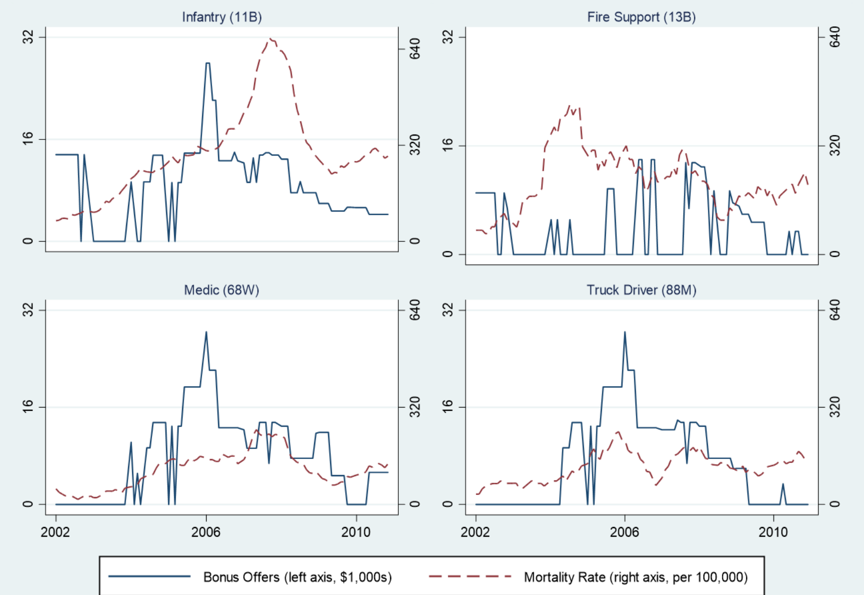
Substantial Bonus and Mortality Hazard Variation Within and Across Occupations



Observed Reenlistment Choices

Table 2: Reenlistment Proportions by Option and Term, 2002-2010

	Reenlistment Term (Years)						
Reenlistment Option	0	2	3	4	5	6	Total
0 (Exit Army)	0.547						0.547
1 (Regular Army)		0.034	0.018	0.030	0.013	0.023	0.117
2 (Current Station Stabilization)		0.005	0.033	0.038	0.022	0.043	**0.141**
3 (MOS Retraining)			0.006	0.021	0.006	0.007	0.040
4 (OCONUS Station of Choice)			0.003	0.033	0.008	0.008	0.051
5 (CONUS Station of Choice)			0.036	0.035	0.014	0.017	0.102
Total	0.547	0.039	0.096	**0.156**	0.064	0.097	1.000

Summary Stats

	A. Full Sample	B. Men, Non-Combat	C. Men, Combat	D. Women
	(1)	(2)	(3)	(4)
Proportion Reenlisted	**0.453**	**0.488**	**0.431**	**0.409**
Bonus Offer	**7,198**	**6,890**	**8,164**	**5,727**
($2010)	**[6,828]**	**[6,957]**	**[6,627]**	**[6,614]**
MOS Mortality Hazard	**150**	**90**	**247**	**82**
(annual, per 100K soldiers)	**[128]**	**[48]**	**[150]**	**[45]**
Female	0.166	0.000	0.000	1.000
Black	0.172	0.201	0.080	0.317
Hispanic	0.126	0.126	0.118	0.143
High School GED / Dropout	0.138	0.128	0.178	0.071
High School Graduate	0.733	0.733	0.721	0.762
AFQT Score	59.50	60.37	60.04	55.87
	[19.16]	[19.49]	[19.05]	[18.12]
Observations	429,375	189,270	168,943	71,162

Summary Stats (Summarized)

- 45.3% of soldiers in sample reenlisted
    - 91% of reenlistees reenlisted into the same MOS
- Average bonus offer is $7,200
    - Slightly higher bonus offers for soldiers in combat occupations
- Average mortality rates (per 100,000 person-years)
    - Men in Combat Occupations: 247
    - Men in Non-Combat Occupations: 90
    - Women (Roughly 95% Non-Combat Occupations): 82

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Estimation Notes

- Discrete choice (multinomial logit) framework
- Primarily focus on standard binary logit model (reenlist=1, exit=0)

$$y_i = \alpha + \gamma Hazard_i + \delta Bonus_i + X_i' \beta + \epsilon_i$$

  - Assumes soldier is considering a 4 year reenlistment in the same MOS
  - Maps soldier to largest bonus offer available to her initial MOS
- $VSL = \frac{-\gamma}{\delta}$
- X_i' includes MOS FE, Cohort FE, Term-Length FE, gender, race, education, AFQT, home-state FE, MOS deployment probability, home-county unemployment
- Standard errors clustered on MOS

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Results: Binary Logit, Full Sample

		(1)
Bonus Offer	Logit Coefficient	0.193***
(10,000s of $2010)		(0.026)
	Effect of $10,000	0.046***
	Bonus Increase	(0.006)
Mortality Hazard	Logit Coefficient	-0.100***
(per 100 soldiers)		(0.023)
	Effect of Mortality	-0.024***
	Increase (1 per 100)	(0.005)
Estimated VSL ($M)		0.520
VSL CI		(0.302 , 0.738)
Cohort FE, MOS FE, Term FE		X

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Results: Binary Logit, Full Sample

		(1)	(2)	(3)	(4)	(5)
Bonus Offer	Logit Coef	**0.193*** **	**0.192*** **	**0.205*** **	**0.208*** **	**0.210*** **
(10,000s of $2010)		(0.026)	(0.025)	(0.025)	(0.031)	(0.031)
Mortality Hazard	Logit Coef	**-0.100*** **	**-0.111*** **	**-0.121*** **	**-0.125*** **	**-0.113*** **
(per 100 soldiers)		(0.023)	(0.024)	(0.024)	(0.028)	(0.028)
Estimated VSL ($M)		**0.520**	**0.575**	**0.592**	**0.602**	**0.540**
VSL CI		**(0.302 , 0.738)**	**(0.332 , 0.819)**	**(0.349 , 0.836)**	**(0.416 , 0.787)**	**(0.349 , 0.730)**
MOS FE, Cohort FE, Term FE		X	X	X		
Deployment Probability Control			X	X	X	X
Individual Controls				X	X	X
(MOS) x (Cohort) x (Term) FE					X	X
Local Unemployment Rate						X

Results: Binary Logit, Key Subsamples

	(1)
Panel A. Men in Non-Combat Occupations (N=189,270)	
Bonus Offer	**0.224*** **
(10,000s of $2010)	(0.034)
Mortality Hazard	**-0.191*** **
(per 100 soldiers)	(0.069)
Estimated VSL	**0.853**
VSL CI	**(0.162 , 1.545)**
Panel B. Men in Combat Occupations (N=168,943)	
Bonus Offer	**0.122*** **
(10,000s of $2010)	(0.025)
Mortality Hazard	**-0.065** **
(per 100 soldiers)	(0.030)
Estimated VSL	**0.530**
VSL CI	**(0.210 , 0.849)**
Panel C. Women in All Occupations (N=71,162)	
Bonus Offer	**0.284*** **
(10,000s of $2010)	(0.026)
Mortality Hazard	**-0.358*** **
(per 100 soldiers)	(0.128)
Estimated VSL	**1.261**
VSL CI	**(0.461 , 2.060)**

Results: Binary Logit, Key Subsamples

	(1)	(2)	(3)	(4)	(5)
Panel A. Men in Non-Combat Occupations (N=189,270)					
Bonus Offer	**0.224*** **	**0.221*** **	**0.239*** **	**0.233*** **	**0.235*** **
(10,000s of $2010)	(0.034)	(0.034)	(0.033)	(0.042)	(0.042)
Mortality Hazard	**-0.191*** **	**-0.224*** **	**-0.176** **	**-0.172** **	**-0.157** **
(per 100 soldiers)	(0.069)	(0.079)	(0.076)	(0.079)	(0.079)
Estimated VSL	**0.853**	**1.012**	**0.738**	**0.738**	**0.670**
VSL CI	(0.162 , 1.545)	(0.179 , 1.845)	(0.008 , 1.468)	(0.059 , 1.416)	(-0.002 , 1.342)
Panel B. Men in Combat Occupations (N=168,943)					
Bonus Offer	**0.122*** **	**0.120*** **	**0.140*** **	**0.127*** **	**0.129*** **
(10,000s of $2010)	(0.025)	(0.025)	(0.024)	(0.029)	(0.029)
Mortality Hazard	**-0.065** **	**-0.053** **	**-0.063** **	**-0.069*** **	**-0.058*** **
(per 100 soldiers)	(0.030)	(0.026)	(0.028)	(0.020)	(0.021)
Estimated VSL	**0.530**	**0.438**	**0.451**	**0.544**	**0.449**
VSL CI	(0.210 , 0.849)	(0.146 , 0.731)	(0.168 , 0.734)	(0.305 , 0.784)	(0.211 , 0.686)
Panel C. Women in All Occupations (N=71,162)					
Bonus Offer	**0.284*** **	**0.284*** **	**0.297*** **	**0.367*** **	**0.368*** **
(10,000s of $2010)	(0.026)	(0.026)	(0.025)	(0.027)	(0.027)
Mortality Hazard	**-0.358*** **	**-0.361*** **	**-0.327** **	**-0.526*** **	**-0.520*** **
(per 100 soldiers)	(0.128)	(0.133)	(0.135)	(0.151)	(0.149)
Estimated VSL	**1.261**	**1.274**	**1.104**	**1.435**	**1.415**
VSL CI	(0.461 , 2.060)	(0.440 , 2.109)	(0.260 , 1.948)	(0.689 , 2.182)	(0.677 , 2.154)

Results: Binary Logit Random Coefficient Estimates

- Random coefficients model allows for possibility of unobservable heterogeneity in soldiers' responses to the bonus and the expected mortality rate
- Random coefficients estimated with MOS FE, cohort FE, initial term-length FE, and the deployment probability control (column 2 specification)

	Full Sample	**Men, Non-Comb.**	**Men, Combat**	**Women**
Bonus Offer	0.189***	0.246***	0.106***	0.272***
(10,000s of $2010)	(0.005)	(0.015)	(0.016)	(0.016)
Mortality Hazard	-0.145***	-0.187***	-0.064***	-0.417***
(per 100 soldiers)	(0.018)	(0.052)	(0.011)	(0.049)
Sigma Bonus	0.717***	0.869***	0.402***	0.729***
	(0.157)	(0.260)	(0.140)	(0.216)
Sigma Hazard	0.733***	0.131***	0.346***	0.263***
	(0.209)	(0.044)	(0.107)	(0.076)
VSL ($M)	**0.769**	**0.758**	**0.599**	**1.530**
VSL CI	**(0.571 , 0.967)**	**(0.394 , 1.122)**	**(0.379 , 0.818)**	**(1.102 , 1.958)**

Discrete Choice (Multinomial Logit) Methodology

- Utility of choice $j \in J$ for soldier i is:

$$u_{ij} = x'_{ij}\beta + \epsilon_{ij}$$

  - x_{ij} are observable covariates (bonus offer, mortality rate, other controls)
  - β is a vector of marginal utilities
  - ϵ_{ij} is an idiosyncratic error we assume is distributed Type 1 Extreme Value
  - Normalize outside option (leaving Army) to zero
  - Soldier i chooses option with highest utility

- Model generates the usual logit probabilities of choice:

$$Pr(i \ chooses \ j) = \frac{exp(x'_{ij}\beta)}{1 + \sum_k exp(x'_{ik}\beta)}$$

- VSL is negative of ratio of coefficient on mortality over coefficient on bonus
- Cluster standard errors on MOS

Multinomial Logit and Nested Logit Models

- **$J = 5$ Multinomial Logit Estimates.** Soldier chooses between all five reenlistment options, but maps soldiers to bonus and mortality hazard associated with a 4-year reenlistment

- **$J = 5$ Nested Logit Estimates.**
  - *Independence of Irrelevant Alternatives (IIA)* in multinomial logit model assumes no correlation between reenlistment options
  - Nested logit nests same-MOS reenlistment options (Options 1, 2, 4, and 5)
  - Limited to high-density MOSs (>5,000 soldiers) due to computational limits

- **$J = 22$ Multinomial Logit Estimates.** Soldier chooses between all possible reenlistment options. Also restricted to high-density MOSs

- Estimated with MOS FE, cohort FE, initial term-length FE, and the deployment probability control (column 2 specification)

Results: Multinomial and Nested Logit Estimates

	All MOSs	High Density MOSs (>5000 soldiers)		
	MNL, J=5	**MNL, J=5**	**Nest. Logit, J=5**	**MNL, J=22**
	(1)	(2)	(3)	(4)
Panel A. Full Sample				
Bonus Offer (1,000s of $2010)	0.197***	0.203***	0.204***	0.300***
	(0.021)	(0.034)	(0.036)	(0.026)
Mortality Hazard (per 1,000)	-0.139***	-0.145***	-0.133***	-0.177***
	(0.028)	(0.034)	(0.034)	(0.033)
VSL ($M)	**0.702**	**0.717**	**0.653**	**0.592**
VSL CI	**(0.404 , 0.999)**	**(0.365 , 1.069)**	**(0.314 , 0.992)**	**(0.398 , 0.786)**
Observations	429,375	277,877		

- Subsample multinomial logit estimates similar to binary logit estimates

Additional Logit Specifications

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- Multinomial logit estimates are similar ($\approx 600 - 700$ \$K)
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  - Machine learning method of Nekipelov et al. (2019)
  - Estimates binary logit moment forest with three parameters: constant, bonus, hazard
  - Permits forest to split on all controls in the column (5) specification
  - Why bother with this?

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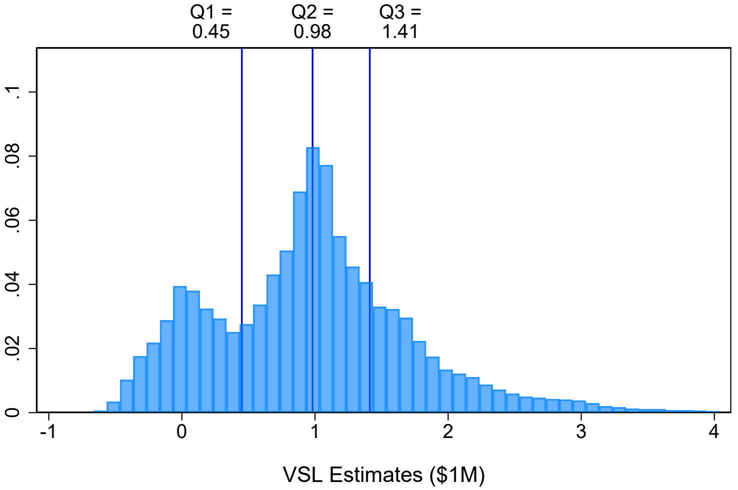
  - Why bother with this?
    1. Uncovers substantial heterogeneity we can't otherwise detect
    2. Robustness check: the data drives moment forest results, not our decisions

Moment Forest Results: Estimated VSL Distribution Among Full Sample

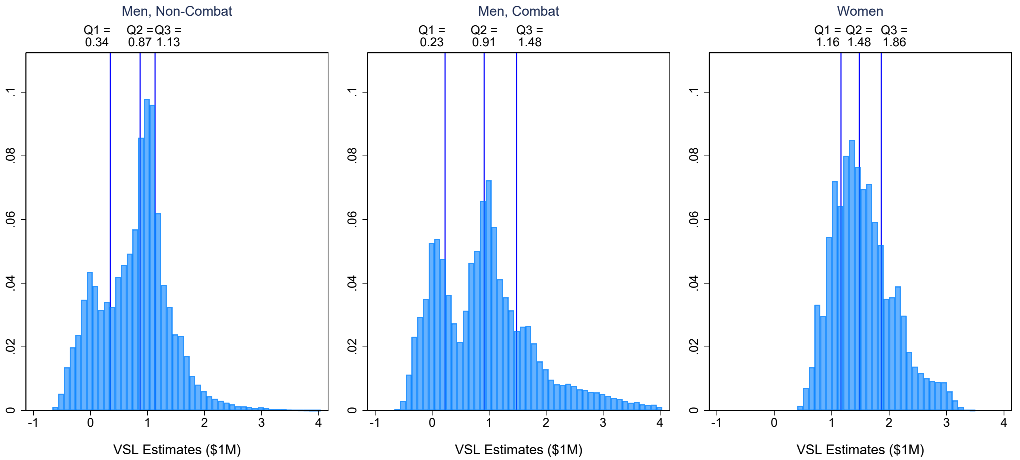


Moment Forest Results: Average Estimates

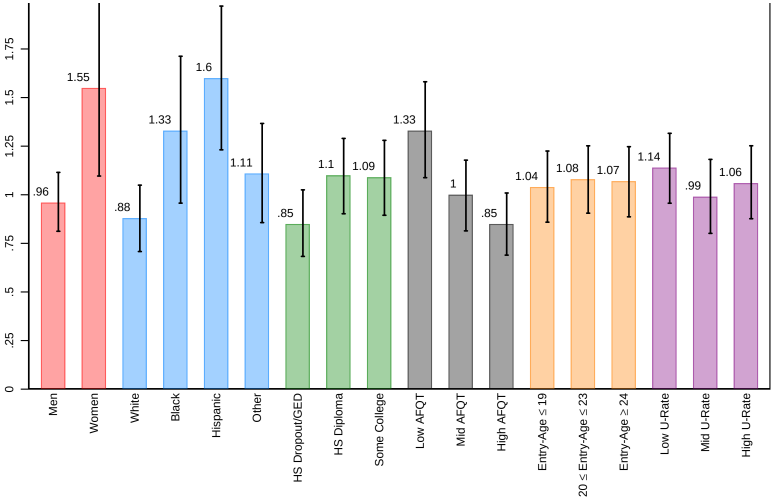
	(1) Full Sample	(2) Men, Non-Combat	(3) Men, Combat	(4) Women
Bonus Offer	0.185***	0.199***	0.158***	0.210***
(10,000s of $2010)	(0.007)	(0.007)	(0.008)	(0.010)
Mortality Hazard	-0.161***	-0.136***	-0.125***	-0.315***
(per 100 soldiers)	(0.014)	(0.014)	(0.012)	(0.044)
VSL ($M)	**0.874**	**0.685**	**0.789**	**1.503**
VSL CI	**(0.697 , 1.051)**	**(0.525 , 0.844)**	**(0.634 , 0.944)**	**(1.047 , 1.959)**
Observations	429,375	189,270	168,943	71,162

- Also find heterogeneity along other characteristics
  - Black and Hispanic soldiers have higher VSLs than White soldiers
  - High school graduates have higher VSLs than high-school dropouts
  - No evidence of heterogeneity by AFQT or local unemployment rates

Moment Forest Results: Estimated VSL Distribution Among Key Samples



Moment Forest Results: VSL Heterogeneity Among Other Characteristics



Recovering Indifference Curves: Evidence from Binary Logits with B-Splines

- Analysis up to this point imposes constant marginal response to bonuses and mortality rates

- We estimate a flexible functional form using B-splines to allow marginal responses to vary with the level of the bonus and mortality hazard
  - All b-spline estimates include MOS FE, Cohort FE, Term-Length FE, and the deployment probability control (column 2 specification)
  - We impose monotonicity and convexity so we can solve for indifference curves

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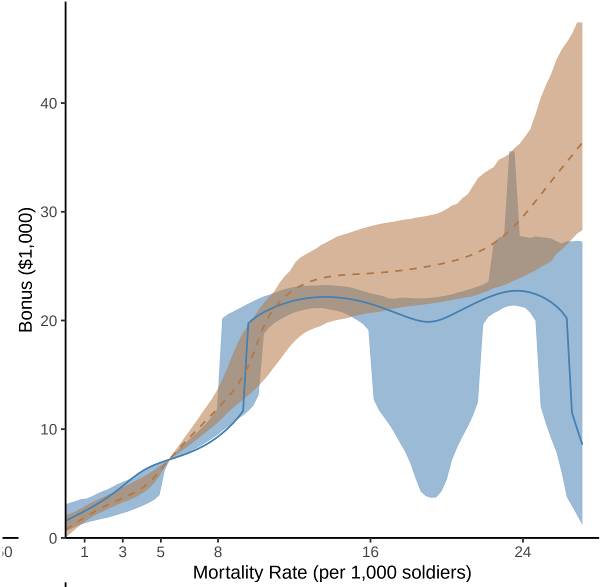
- Estimating marginal reenlistment responses at different bonus and hazard levels allows us uncover the set of bonuses and risk levels that yield the same average "utility" (i.e. average indifference curve)
  - $dU = \frac{\partial U}{\partial H} dH + \frac{\partial U}{\partial B} dB = 0$
  - Slope of the indifference curve is the implied VSL at a particular hazard level

Indifference Curve From Binary Logit B-Spline Estimates (Full Sample)



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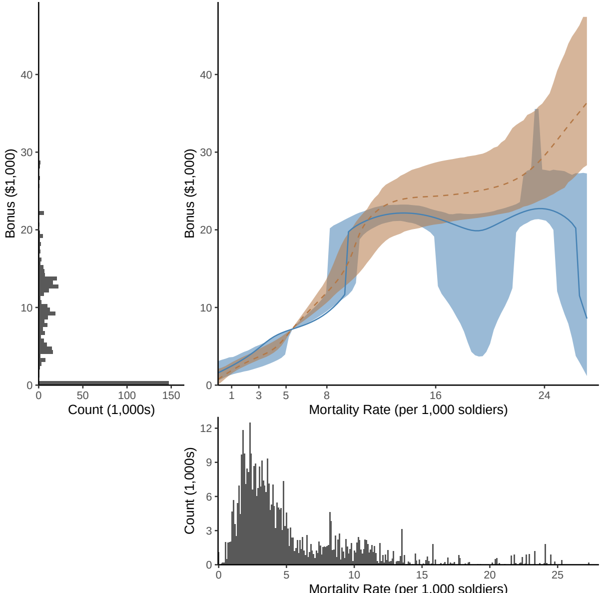
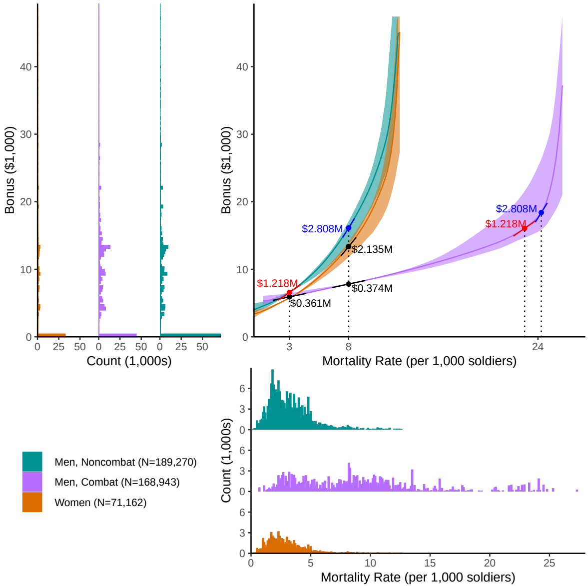


Indifference Curve From Binary Logit B-Spline Estimates (Main Subsamples)



VSL Estimates At Different Mortality Hazards

	Mortality Hazard Rate (per 1,000 soldiers)					
	1	3	5	8	16	24
Full Sample	0.482	0.594	0.672	0.792	1.440	4.685
	[0.253, 0.723]	[0.540, 0.722]	[0.590, 0.938]	[0.644, 1.021]	[1.100, 1.433]	[3.103, 14.200]
Men, Non-Combat	0.717	1.218	1.667	2.808		
	[0.425, 0.921]	[0.781, 1.397]	[1.214, 1.865]	[2.144, 3.281]		
Men, Combat	0.177	0.361	0.387	0.374	0.506	2.022
	[0.042, 0.512]	[0.246, 0.438]	[0.274, 0.395]	[0.290, 0.374]	[0.414, 0.918]	[0.983, 3.901]
Women	0.789	0.940	1.423	2.135		
	[0.429, 0.980]	[0.833, 1.094]	[1.138, 1.592]	[1.551, 2.462]		

Robustness to Soldier Beliefs

- A major concern of our empirical approaches thus far is assumption that all soldiers have identical expectations about hazard
- Dickstein and Morales (QJE, 2017) propose an estimator that relaxes this assumption
- Basic idea: agents take actions given their expectations, X^e, about future variable, X
- Expectations can be function of observables (Z), unobservables (W)
- Econometrician observes realization of variable, not expectation
  - $X = X^e + \nu$
- Assume: agents have rational expectations, so that they get it right on average
- We explore several specifications of Z

Overview of DM Discrete Choice

- How does this work?
- If the agent made a decision and our observed X is a noisy signal of X^e, we need to integrate out the error
- Consider the FOC from the LLH:

$$FOC : E[d(1 - F(X'\beta))/F(X'\beta) + (1 - d)|W, Z] = 0. \quad (1)$$

- If F is log-concave, then $(1 - F)/F$ is convex; apply Jensen's inequality:

$$FOC : E[dE_X[(1 - F(X'\beta))/F(X'\beta)] + (1 - d)|W, Z] \geq 0. \quad (2)$$

- DM propose additional moment inequalities based on revealed preference

Practical Estimation and Inference: Conditional to Unconditional Moments

- Follow Andrews and Shi (ECMA, 2013) and use indicator functions based on hypercubes:

$$\mathcal{G}_{c-cube} = \{g(x) : g(x) = 1(x \in C) \cdot 1_k \text{ for } C \in \mathcal{C}_{c-cube}\} \tag{3}$$

where

$$\mathcal{C}_{c-cube} = \Bigg\{ C_{a,r} = \prod_{u=1}^{d_x} ((a_u - 1)/(2r), a_u/(2r)] \in [0,1]^{d_x} :$$
$$a = (a_1, \ldots, a_{d_x})', a_u = \{1, 2, \ldots, 2r\} \text{ for } u = 1, \ldots, d_x \text{ and } r = r_0, r_0 + 1, \ldots \Bigg\}$$

- Moment inequality becomes:

$$E[m(X, \beta) \cdot g(W, Z)] \geq 0. \tag{4}$$

What Can We Do With This?

- This approach robustifies estimation approach to beliefs / measurement error
- In contrast to, say, GPV (ECMA, 2000), we never estimate distribution of beliefs
- Allows for partial sets of information
- Orthogonality of information to errors allows for testing of information sets
- Use the specification tests laid out in Bugni, Canay, and Shi (JE, 2017) and Andrews and Soares (ECMA, 2010)
  - Perfect foresight: test LLH estimates in DM estimator
  - Various instruments for Z
- Using AS to invert tests for CI

Preliminary Results

- Baseline specification: lagged 12-month hazard rate as Z
  - Men in combat occupations: VSL $=$ \$615k
  - Women: VSL $=$ \$1887k
- While still very much WIP, these are consistent with other specifications
- Don't have formal statement, but confident going to reject the perfect foresight model
- Few thoughts/questions here:
  - The estimator is sensitive to choice of $g(x)$ functions
  - Which variables go into Z
  - How to perform inference on VSL if we get a set-identified result?
  - We are working out STATA bridge code

Real-World Application 1: Enhanced Body Armor

U.S. Army began issuing enhanced body armor to soldiers in 2005. The enhanced armor cost $760 per unit, had a total system cost of $200M, and was estimated to reduce mortality by 15 percent.

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- Policy Implications Considering Heterogeneity
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  - Infantry mortality rate in 2005 was 11.3 per 1000 ⇒ VSL of $428,000
  - At 2005 mortality, program is welfare improving for truck drivers, but not for infantry
  - Policy implication: in 2005, give truck drivers body armor, give infantry larger bonus

Real-World Application 2: MRAPs

"Ultimately, we would buy some 27,000 MRAPS, including thousands of new all-terrain version for Afghanistan, at a total cost of nearly $40 billion ($52B in $2019)" (Secretary Robert Gates)

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- In a conflict like WWI or WWII, mortality risk will be much greater, implying higher VSLs. MRAPs could be welfare-improving in such scenarios

Appendix

Average Bonuses, Mortality Rates, and Base Pay Over Time

Milper Message Number 07-141
SELECTIVE REENLISTMENT BONUS (SRB) PROGRAM

Issued 04 JUNE 2007. This MILPER message will expire NLT 31 DECEMBER 2007.

This message announces changes to the Regular Army Active Component SRB Program. The effective date for additions to SRB multipliers or maximum payments is 05 JUNE 2007. The effective date of decreases and terminations to the SRB Program is 05 JULY 2007.

Zone A includes soldiers who have between 17 months and 6 years of service at time of reenlistment.

MOS/TITLE	SPC	SGT	SSG	CAP
11B Infantryman	1A	1.5A	1.5A	$15,000
13B Cannon Crew Member w/"P"	0	1A	0	$10,000
13F Fire Support Specialist	1.5A	2A	2A	$10,000
25U Signal Support Systems Spec.	1.5A	1.5A	0	$10,000
31B Military Police	1A	1.5A	1A	$10,000
68W Health Care Specialist	1A	1A	1A	$15,000
88M Motor Transport Operator	2A	1.5A	1A	$10,000
92Y Unit Supply Specialist	0.5A	0	0	$10,000
97E Interrogator	4A	4A	4A	$30,000

Leon and Miguel (AEJ-Applied, 2017): Table 4

TABLE 4—TRANSPORTATION CHOICES AND THE VALUE OF A STATISTICAL LIFE—MIXED LOGIT ESTIMATES

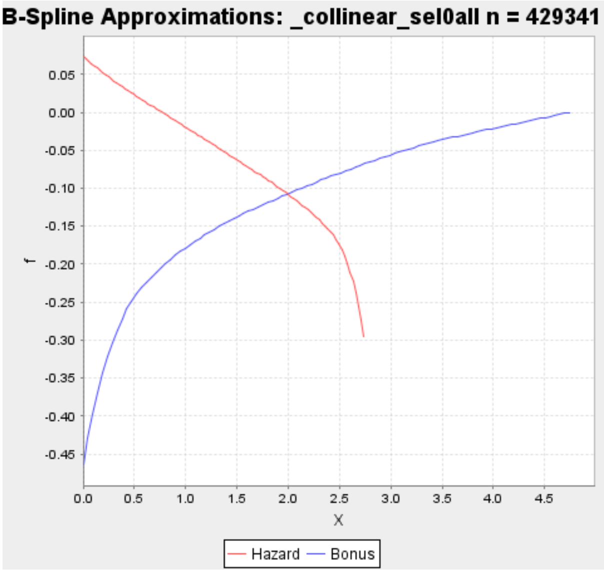
	Africans		Non-Africans		Full sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Random coefficients						
Probability of completing the trip $(1-p_j)$	7.809	10.209	10.936	10.572	8.559	10.155
	(1.769)	(2.182)	(2.205)	(2.311)	(1.371)	(1.595)
Total transportation cost $(Cost_{ij})$	−0.032	−0.020	−0.012	−0.012	−0.026	−0.019
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
Fixed coefficients						
Ranking: Comfort of the seats		−0.483		1.205		0.109
		(0.347)		(0.416)		(0.263)
Ranking: Noise level		0.478		−0.232		0.137
		(0.394)		(0.415)		(0.284)
Ranking: Crowdedness		−1.162		−0.258		−0.694
		(0.353)		(0.401)		(0.262)
Ranking: Convenient location		−0.735		0.379		−0.142
		(0.308)		(0.338)		(0.227)
Ranking: Quality of the clientele		0.179		−0.593		−0.339
		(0.398)		(0.458)		(0.296)
Observations	3,292	3,292	2,124	2,124	5,416	5,416
Number of travelers	336	336	225	225	561	561
Number of trips	1,083	1,083	710	710	1,793	1,793
log-likelihood	−881.550	−855.262	−685.531	−679.567	−1,572.818	−1,556.953
Mean VSL (in '000 US$ PPP)	295.275	577.260	1,010.737	923.928	394.464	597.749
2.5 percentile	194.546	397.616	750.145	685.191	260.995	418.572
97.5 percentile	696.085	1,142.138	1,351.103	1,263.699	783.952	1,046.118

Leon and Miguel (AEJ-Applied, 2017): Table 5

Table 5—Value of a Statistical Life Estimates in Different Subsamples and with Alternative Specifications

Row	Estimation	Sample	VSL (in '000 US$ PPP) Mean	95 percent confidence interval Lower	Upper
(1)	Mixed logit	Full sample	597.749	418.572	1,046.118
(2)		Africans	577.260	397.616	1,142.138
(3)		Non-Africans	923.928	685.191	1,263.699
(4)		Sierra Leoneans	411.924	286.093	990.665
(5)		Africans, non-Sierra Leonean	856.559	526.720	1,281.698
(6)		Full sample, excluding first trip	490.930	368.584	794.655
(7)		Full sample, paid for the trip	521.349	366.147	1,003.541
(8)	Mixed logit, including weather controls interacted with risk and cost variables	Full sample	793.055	541.402	1,406.617
(9)		Africans	617.890	414.874	1,230.820
(10)		Non-Africans	1,579.203	942.776	2,379.649
(11)	Conditional logit	Full sample	984.261	198.428	1,770.095
(12)		Africans	778.492	235.181	1,321.803
(13)		Non-Africans	2,960.968	−4,674.640	10,596.57

B-Spline Approximations (Full Sample)



Bid-Curve Approximation (Full Sample)