Age-Adjusted Value of Statistical Life: Evidence from Automobile Purchase Decisions

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Camp Resources XX
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Motivation:

Age variation in the VSL from vehicle choice

- People of all ages purchase cars
- Extend revealed preference evidence

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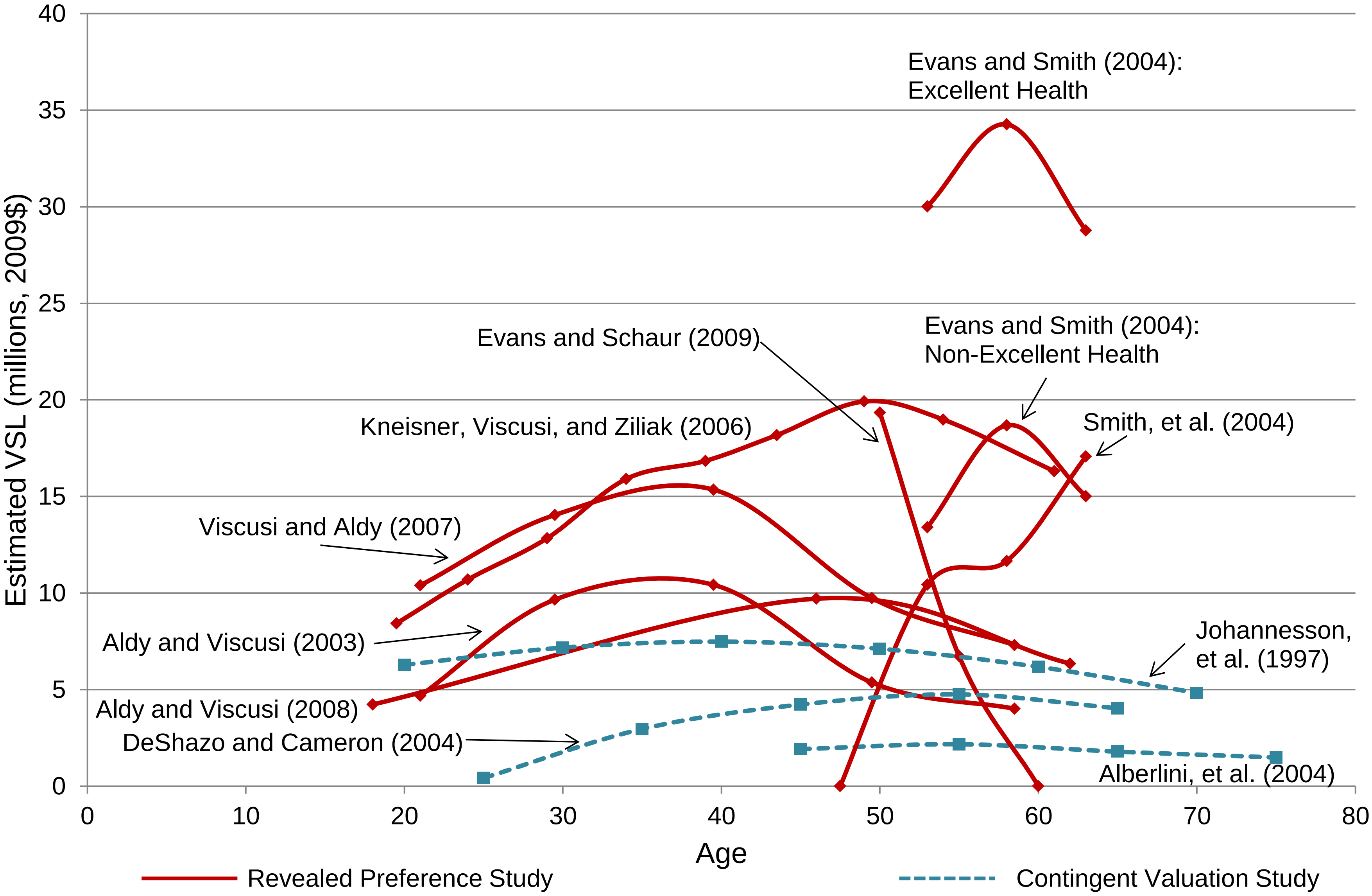
Estimate VSL in a different context:

Possibly more applicable to road and vehicle safety regulations

Selected Age-VSL Results in Recent Literature



Multinomial Vehicle Choice Model

Standard McFadden (1974) MNL framework:

Consumers obtain utility from vehicle attributes:

$$U_i^n = \sum_c \beta_{1c} risk_i^c * I_c(age_n) + \sum_c \beta_{2c} \frac{cost_i}{income_n} * I_c(age_n) + X_i^n \gamma + \varepsilon_i^n$$

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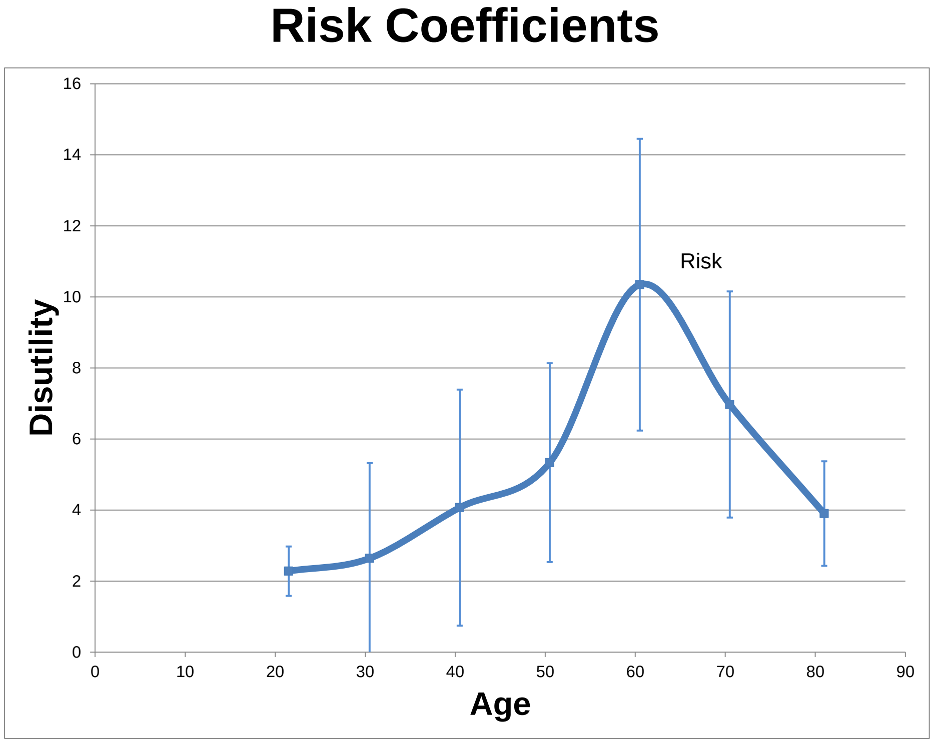
Value of Statistical Life

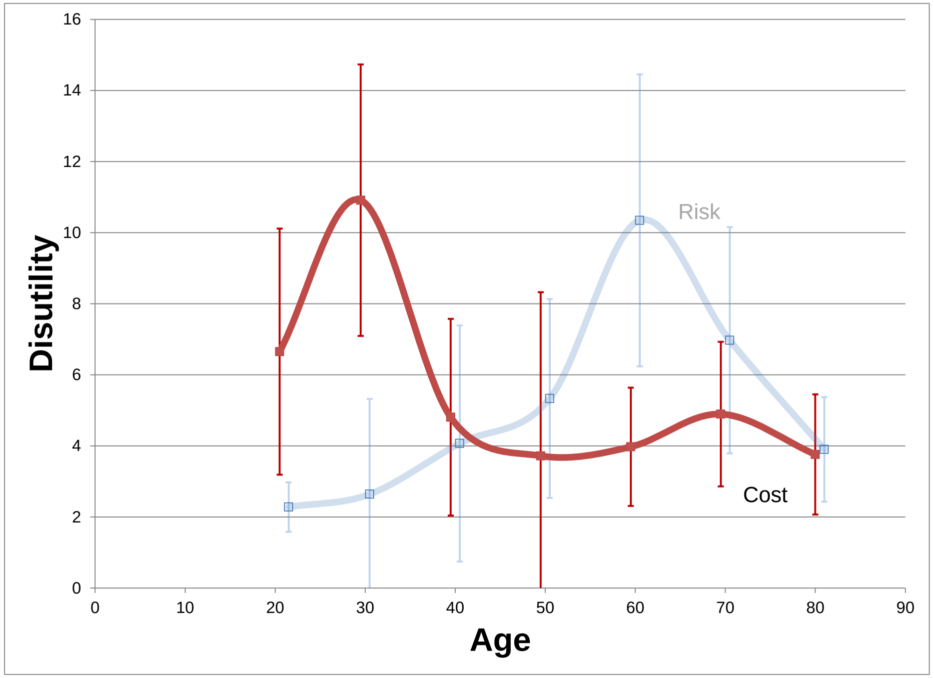
$$-\frac{\partial cost}{\partial risk^c} = \boxed{VSL^c = \frac{\beta_{1c}}{\beta_{2c}} * \overline{income}^c}$$

Multinomial Results



Multinomial Results

Cost Coefficients



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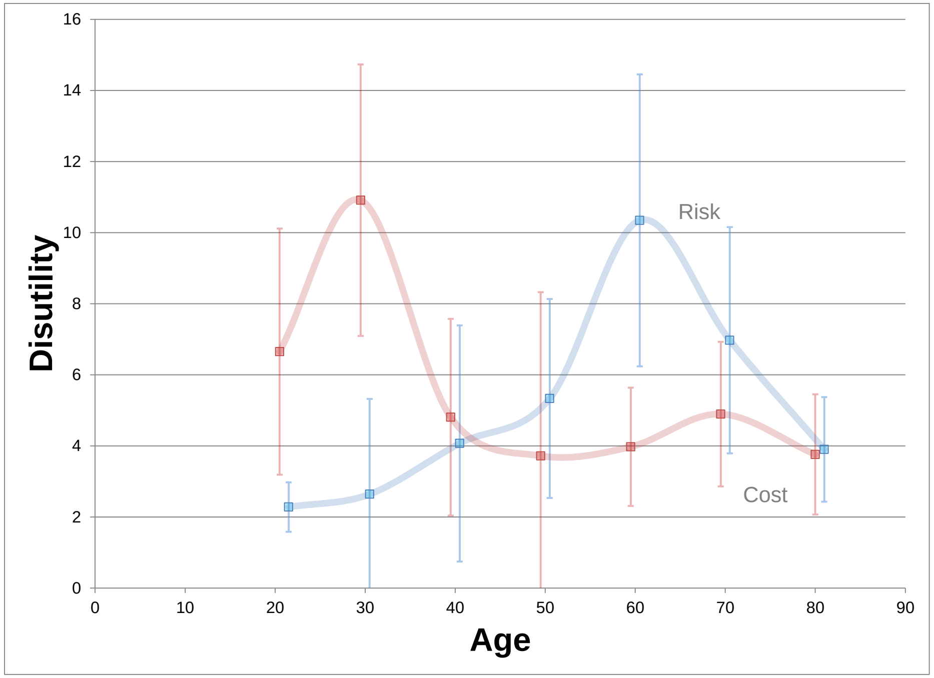
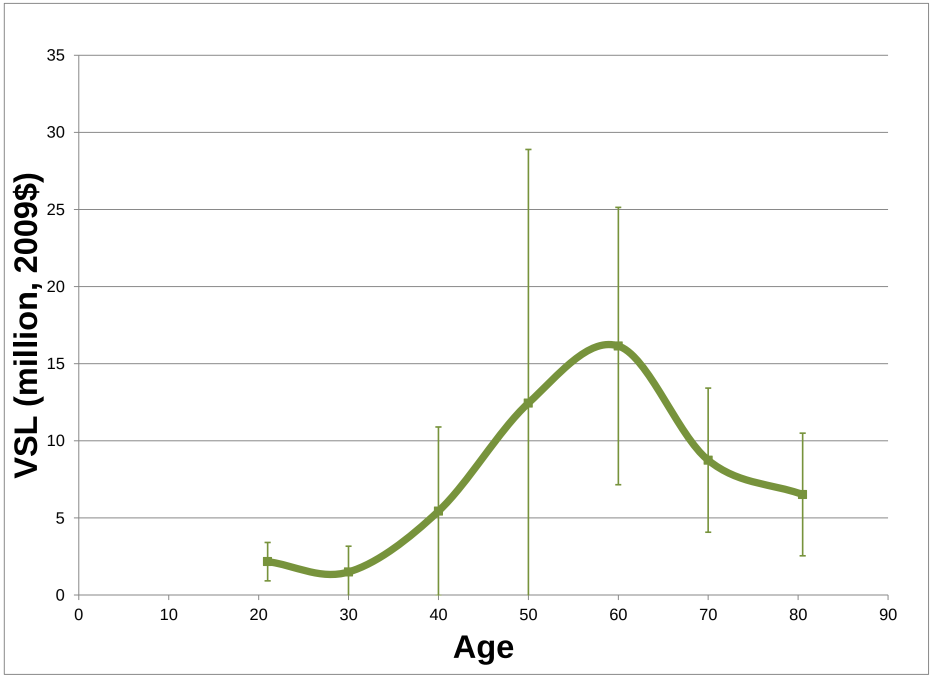
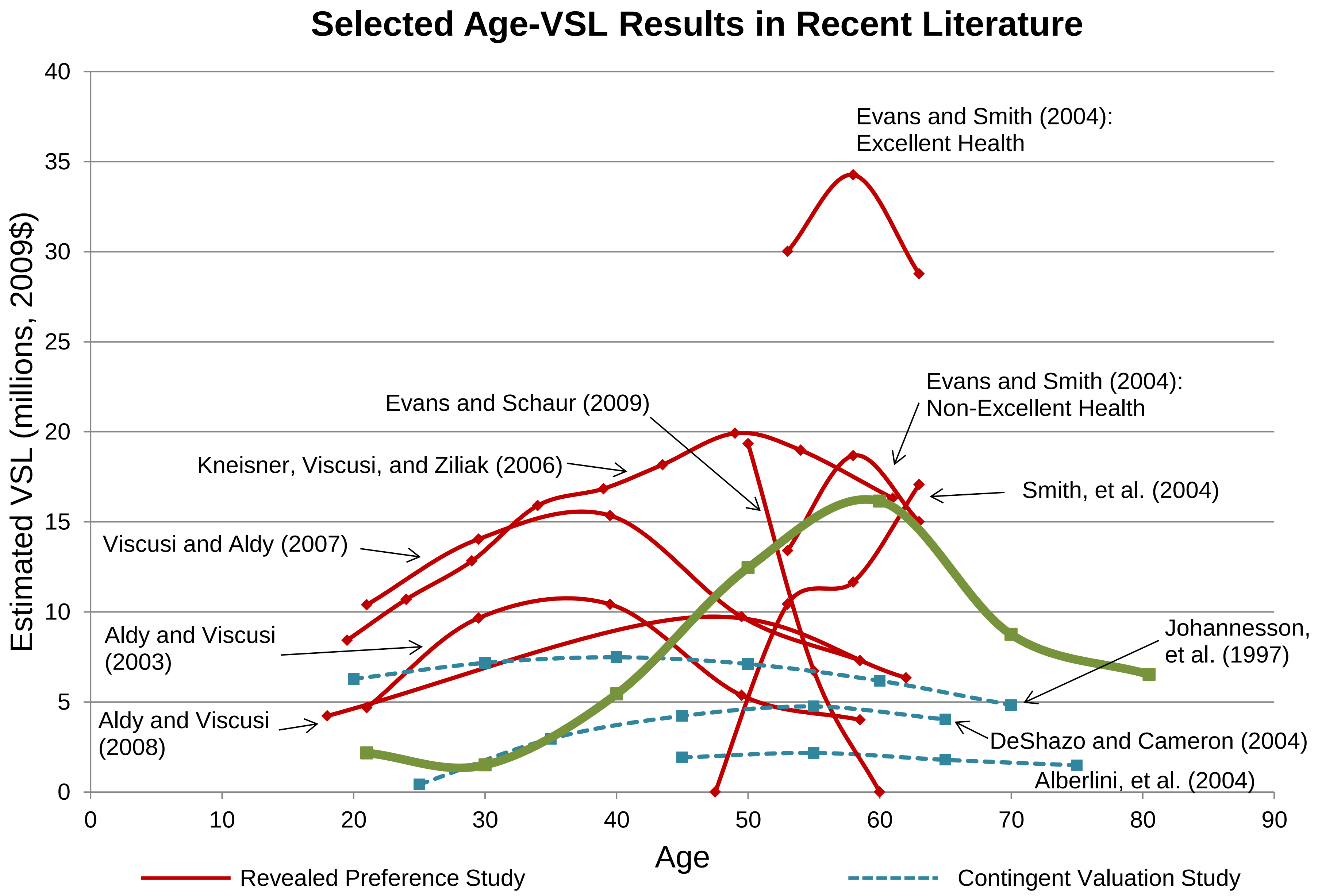
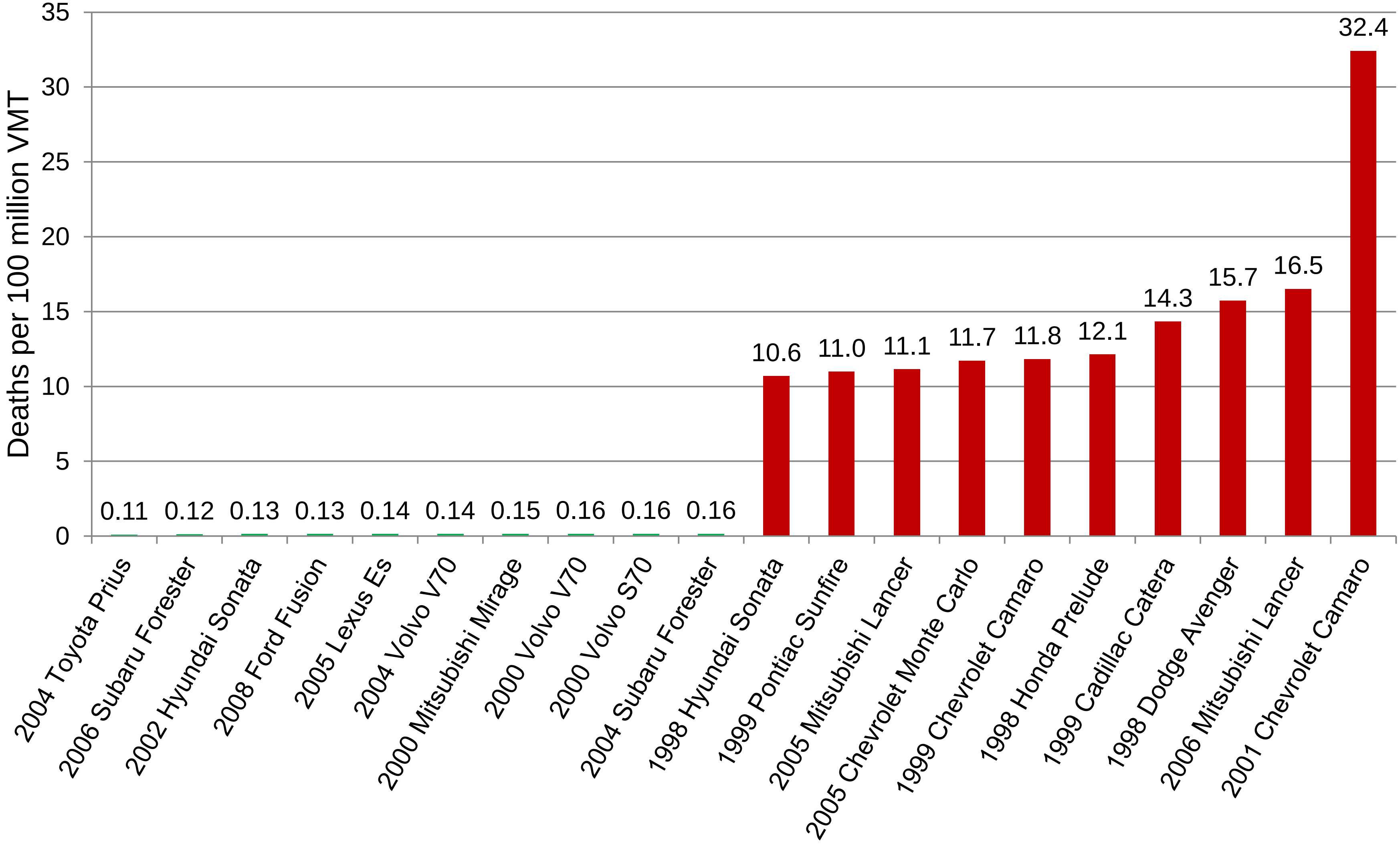


VSL Estimates




Selected Age-VSL Results in Recent Literature
Estimated VSL (millions, 2009$)
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
Age
Evans and Smith (2004):
Excellent Health
Evans and Smith (2004):
Non-Excellent Health
Evans and Schaur (2009)
Kneisner, Viscusi, and Ziliak (2006)
Smith, et al. (2004)
Viscusi and Aldy (2007)
Aldy and Viscusi
(2003)
Johannesson,
et al. (1997)
Aldy and Viscusi
(2008)
DeShazo and Cameron (2004)
Alberlini, et al. (2004)
Revealed Preference Study
Contingent Valuation Study

Endogenous Car Choices



Accounting for Driver Behavior

i. Estimate relative driver effects based on crash test results and single-vehicle fatalities ($Y_{i,c}$)

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$$E\left[Y_{i,c}\right] = \underbrace{\alpha_v}_{\text{Driver effects}} \underbrace{\lambda_c}_{\text{Age cohort effects}} \underbrace{X_i}_{\text{Crash test results}}$$

Accounting for Driver Behavior

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$$E[Y_{i,c}] = \alpha_v \lambda_c X_i$$

Driver effects

Age cohort effects

Crash test results

ii. Adjust overall deaths per mile ($Z_{j,c}$) for each alternative based on the $\hat{\alpha}$'s

(example: find the fatality risk in a Camaro if driven by a Prius driver)

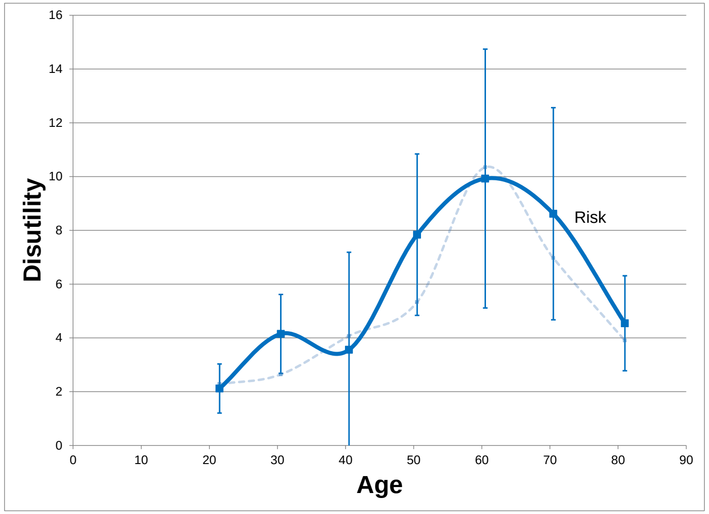
Deaths per mile in data

Counterfactual deaths per mile

$$\widetilde{risk}_{j,c}\Big|_i = \frac{\hat{\alpha}_i risk_{j,c}}{\hat{\alpha}_j}$$

Adjusted MNL Results

Risk Coefficients



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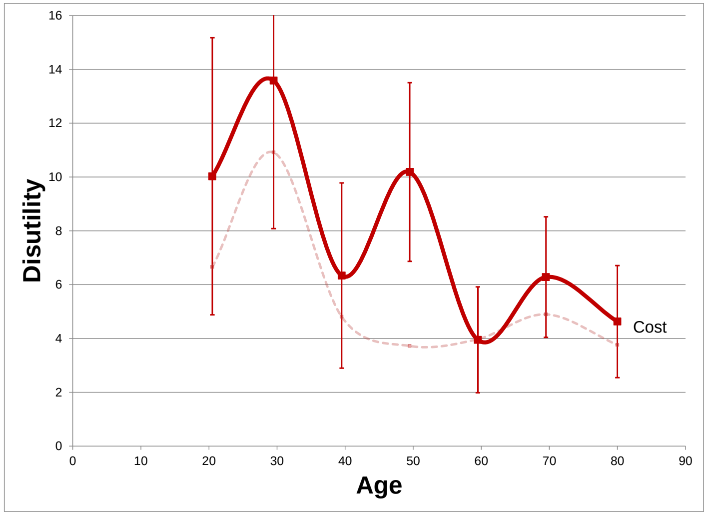

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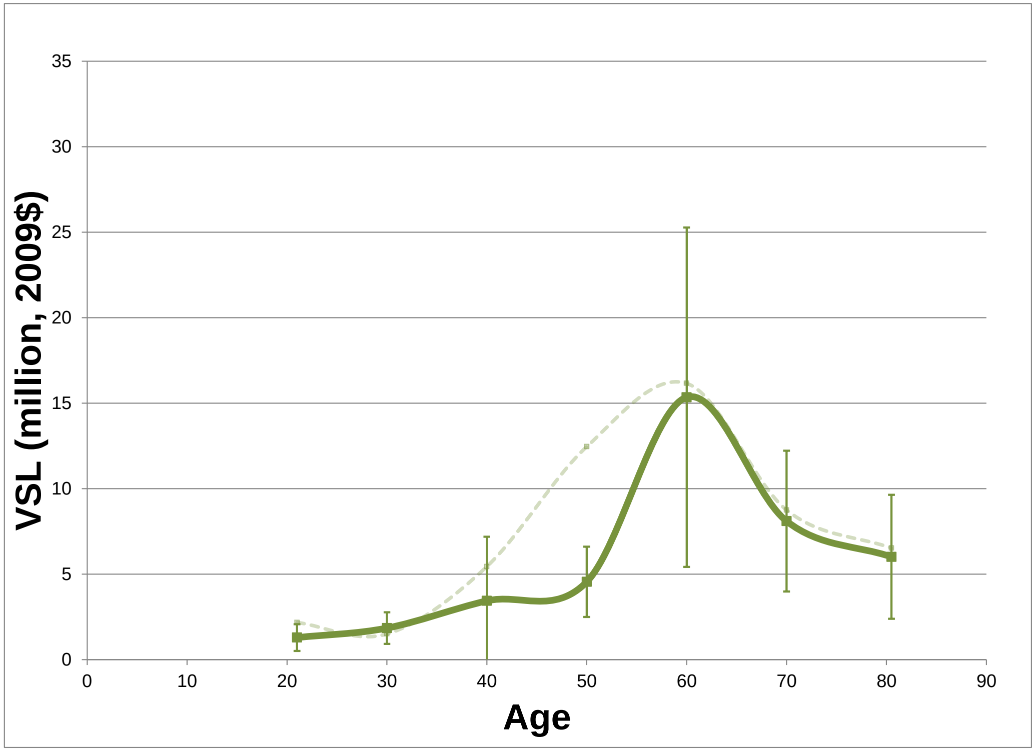

Alternative Approach: Control Function

- Problem is due to the correlation between between $risk_i^c$ and ε_i^n

$$U_i^n = \sum_c \beta_{1c} risk_i^c * I_c(age_n) + \sum_c \beta_{2c} \frac{cost_i}{income_n} * I_c(age_n) + X_i^n \gamma + \varepsilon_i^n$$

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- Separate the portion of the error that is problematic

$$\varepsilon_i^n \equiv \underbrace{\sum_c \varepsilon_{ic}^{1n} * I_c\,(age_n)}_{\text{Problematic}} + \varepsilon_i^{2n}$$

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- Include consistent estimates of ε_{ic}^{1n} as **additional regressors**

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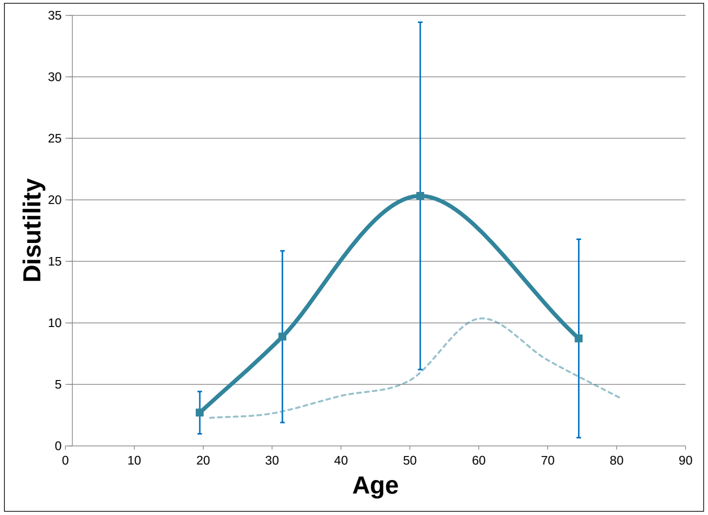
$$+ \boxed{\sum_c \widehat{\varepsilon_{ic}^{1n}} * I_c\ (age_n)} + \varepsilon_i^{2n}$$

Control Function Results

Risk Coefficients



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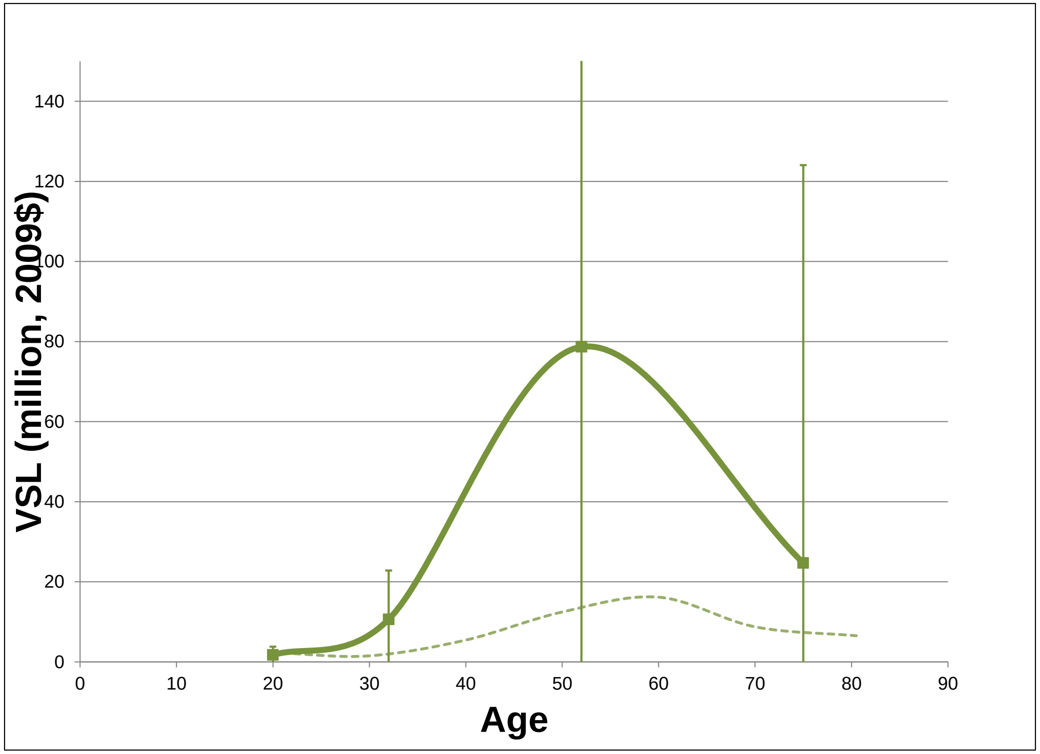

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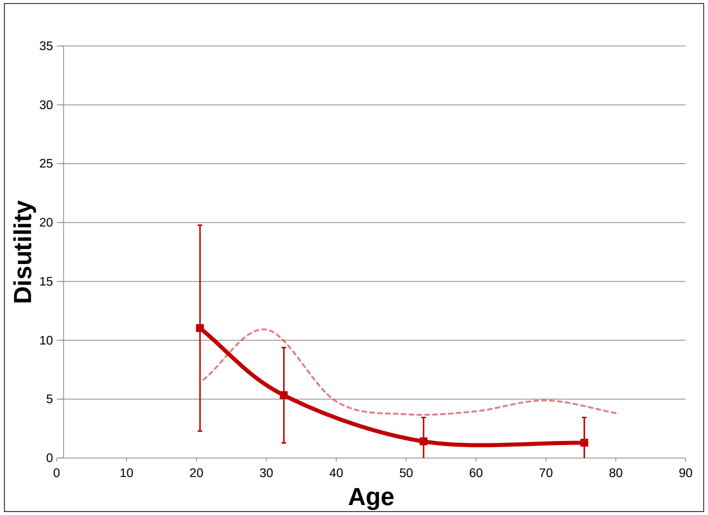
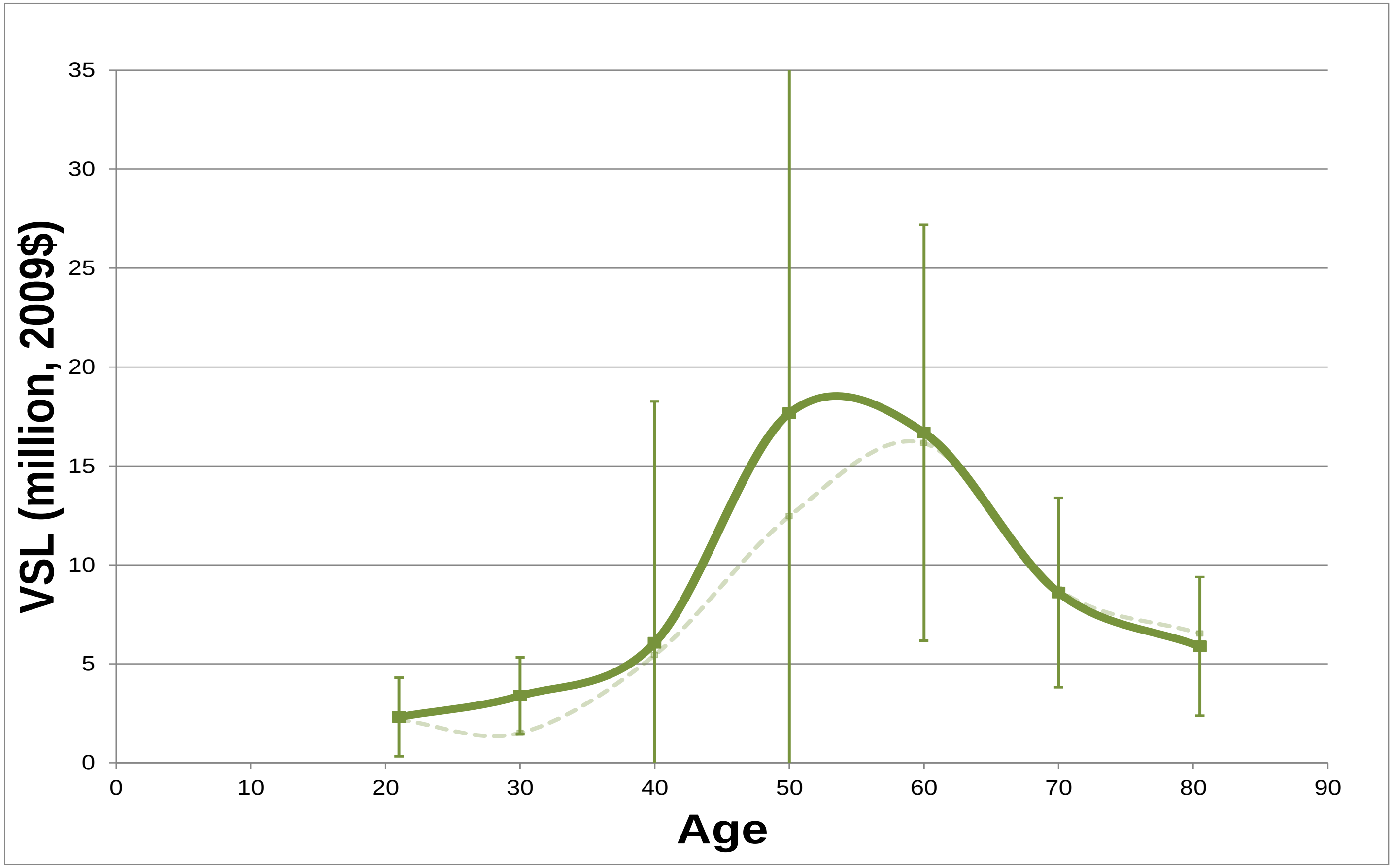


Conclusion

- Extend range of revealed preference evidence
- No evidence of a “senior discount” *per se*
- Corroborate inverted-U shape
- Risk adjustments and Control Functions are *very* preliminary

Appendix 1

VSL of Households with No Children



Appendix 2: Control Function Details

- Bias arises because of a correlation between $risk_i^c$ and ε_i^n

$$\varepsilon_i^n = \sum_c \varepsilon_{ic}^{1n} * I_c\,(age_n) + \varepsilon_i^{2n}$$

$$risk_i^c = crashtest_i \delta^c + Z_i \theta^c + \mu_i^c$$

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- Assume ε_{ic}^{1n} and μ_i^c are correlated and jointly normal
- Observe that:

parameters

$$\varepsilon_{ic}^{1n} \equiv E\left[\varepsilon_{ic}^{1n} \middle| \mu_i^c\right] + \widetilde{\varepsilon_{ic}^{1n}} = \varphi_c \mu_i^c + \rho_c \eta_c \longleftarrow \text{standard normal}$$

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- Sub into utility function, and model is purged of endogeneity

$$U_i^n = \sum_c \beta_{1c} risk_i^c * I_c(age_n) + \sum_c \beta_{2c} \frac{cost_i}{income_n} * I_c(age_n)$$
$$+ X_i^n \gamma + \sum_c \varphi_c \widehat{\mu_i^c} * I_c\,(age_n) + \sum_c \rho_c \eta_c + \varepsilon_i^{2n}$$

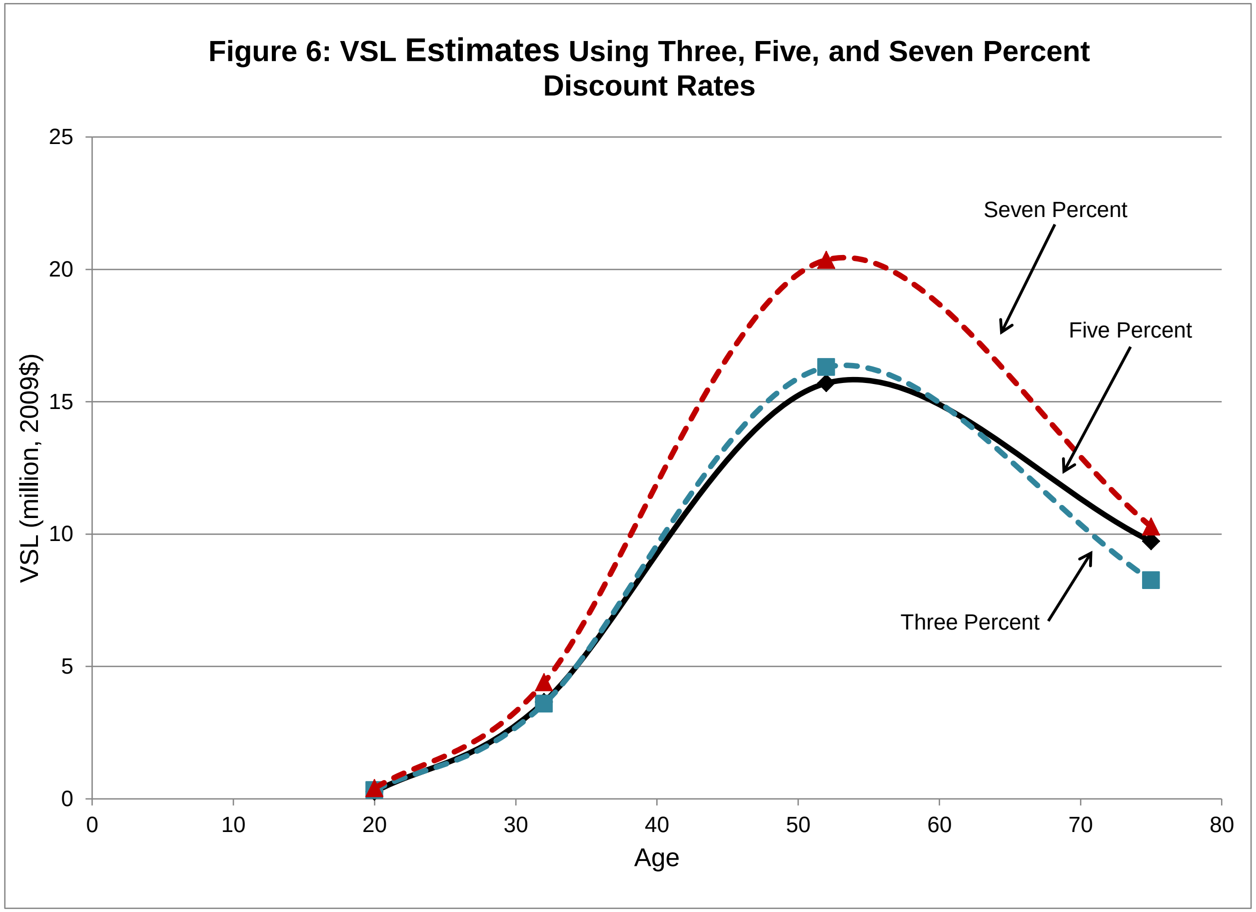
Appendix 3: Other MNL Covariates

Other covariates

Engine Displacement	0.13†
	(0.08)
Cylinders	-0.07
	(0.05)
Cylinder*Pickup	0.31†
	(0.17)
Passenger Volume	0.24*
	(0.05)
Luxury Brand	-0.38*
	(0.10)
Gross Vehicle Weight	-0.01
	(0.05)
Imported	-0.05
	(0.06)
Model Year 2003-2005	0.56*
	(0.06)
Model Year 2006-2008	1.39*
	(0.08)
Class specific constants	Yes

Appendix 3

Effects of Various Discount Rates



Mortality and Age

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Clean Air Act Amendments

237,100 Annual Deaths

Seniors: 173,864
(73 percent)

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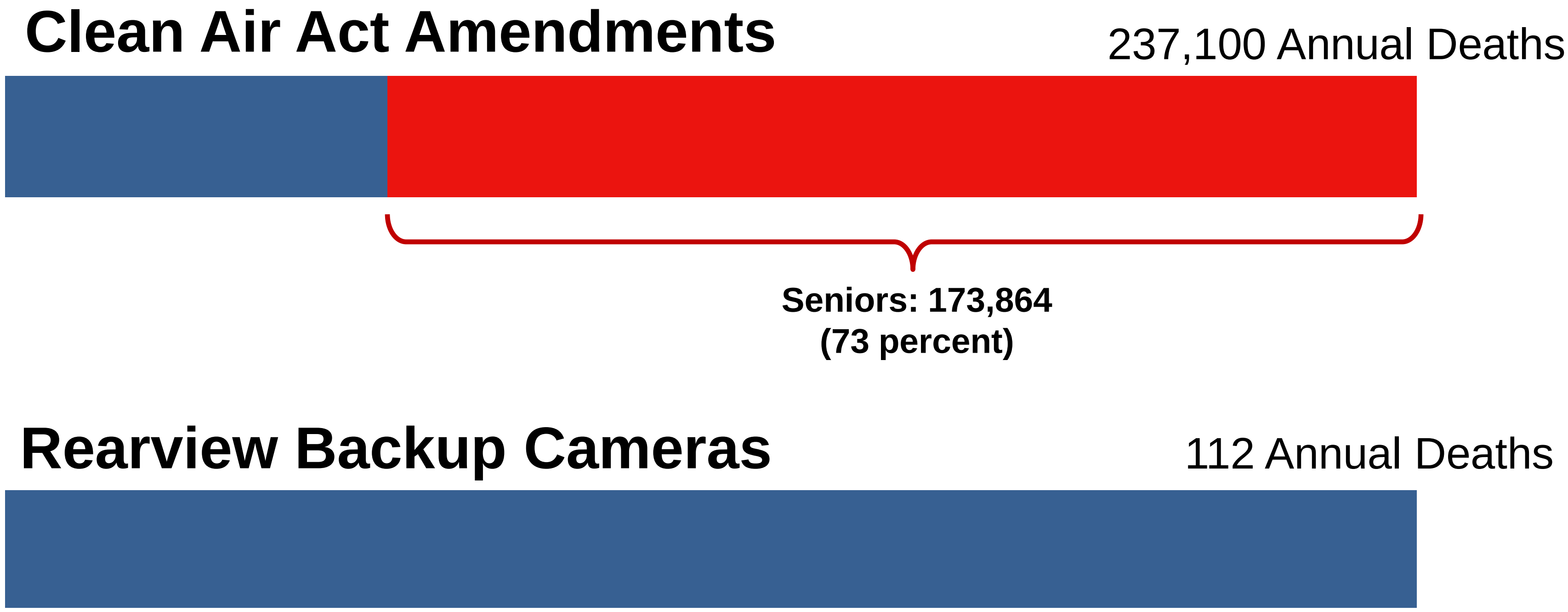

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Rearview Backup Cameras

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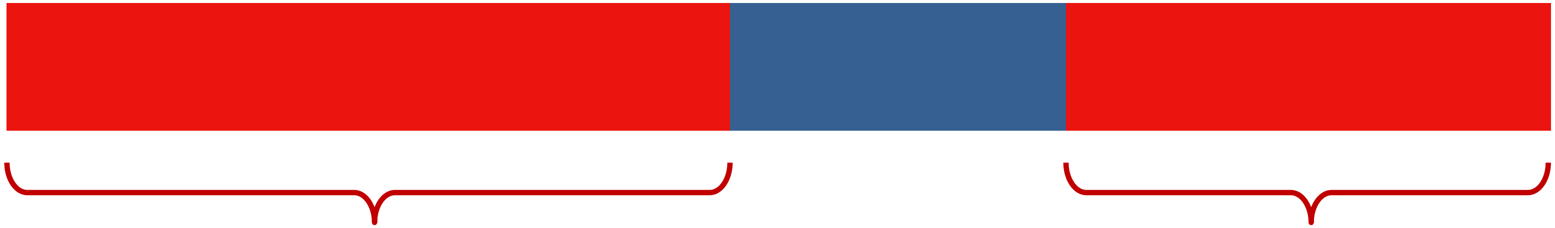

50 Children Under 5: 50
(44 percent)

Adults over 70: 37
(33 percent)

Crash Test Results

Risk of getting into a severe accident (Behavior) → Risk of dying, conditional on being in a severe accident (Vehicle Integrity) → Overall Fatality Risk

Relative Driver Effects

Vehicle Class	Alpha
Full size	1.23*
	(0.08)
Compact	0.82*
	(0.07)
Standard	1.11*
	(0.05)
Mini	1.55
	(0.42)
Pickup	2.48*
	(0.1)
SUV	1.22*
	(0.05)
Van	1.24*
	(0.06)
n	10,360

Significant at the five (*) and ten (†) percent level. Values shown are incident rate ratios relative to economy class vehicles. Age cohort fixed-effects and crash-test coefficients are not shown.

First Stage Results:

Dependent Variable: Deaths per Mile (for Relevant Cohort)

		Age Cohort			
	Overall	**Age 18 to 34**	**Age 35 to 49**	**Age 50 to 64**	**Age 65 to 85**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Front Head Injury	0.51†	2.57	0.19	0.72*	3.02*
	(0.29)	(2.38)	(0.46)	(0.29)	(0.93)
Front Chest Injury	24.86*	67.18	26.49*	8.61	84.77*
	(8.30)	(60.41)	(11.70)	(6.88)	(24.50)
Side Head Injury	-0.06	-2.95*	-0.31	-0.16	-1.06*
	(0.11)	(0.83)	(0.20)	(0.12)	(0.39)
F-stat for crash-test variables	12.73	6.746	4.044	4.864	16.35
n	1,381	1,142	873	822	822
Adj. R Squared	0.217	0.112	0.160	0.175	0.138

Note: Other controls: curb weight, tire size, passenger volume, number of cylinders, engine displacement, and indicators for imported, luxury, vintage, and class. Significant at the 5 percent (*) or 10 percent (†) level.