CASE STUDY:

Corso, P.S., J.K. Hammitt, and J.D. Graham. 2001. "Valuing Mortality-Risk Reduction: Using Visual Aids to Improve the Validity of Contingent Valuation." *Journal of Risk and Uncertainty.* 23(2):165-184.

EE465/EE463 Project Evaluation

Semester 2/2014

Introduction

- Value of statistical life (VSL) is estimated from the rate at which an individual would trade her money for a small change in her chance of dying.

  ➔ VSL = MRS

- Two approaches:

  1. Revealed preference – estimate tradeoff using information about individuals' choices between jobs or goods that differ in monetary consequences and risk.
  2. Contingent valuation (CV) – ask survey respondents to state their WTP for a specified hypothetical risk reduction

Introduction (cont'd)

- In theory, the WTP for a small risk reduction should be proportionate to the magnitude of the risk reduction.
- However, in most CV studies, the WTP values vary less than proportionately to the risk reduction.
  - Derived VSL depends on arbitrary choice of risk reduction.
- Objective: to test whether alternative methods of communicating risk enhance the sensitivity of estimated WTP to the magnitude of risk reduction.
- Method: estimate WTP for an automobile-safety device (a side-impact airbag) in 4 subsamples with different visual aids: a logarithmic scale, a linear scale, an array of dots, or no visual aid.

Theoretical Background

- Assume individual maximizes the expected utility:

$$EU(p, y) = (1 - P)u_a(y) + pu_d(y)$$

where p = prob of dying, $u_a(y)$ = utility conditional on surviving, and $u_d(y)$ = utility conditional on dying.

➔ $VSL = \frac{dy}{dp} = \frac{u_a(y) - u_d(y)}{(1-p)u'_a(y) + pu'_d}$

Assume $u_a(y) > u_d(y)$; $u'_a(y) > u'_d(y) \geq 0$; $u'_a(y) \leq 0$; and $u'_d(y) \leq 0$.

➢ VSL (MRS between mortality risk and income) increases with *p* and *y*.

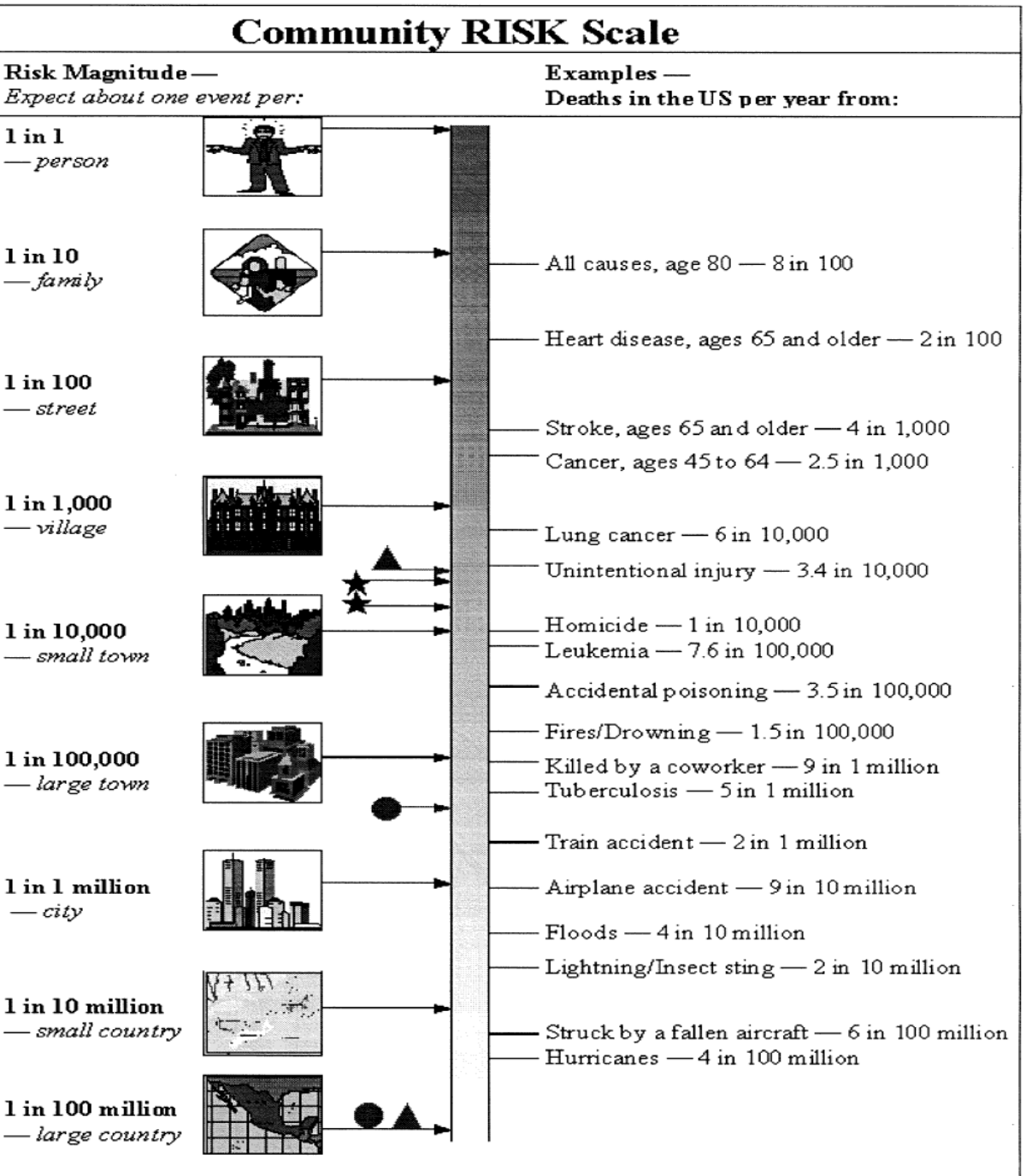
➔ For a small risk change (Δp), MRS should be nearly constant, and WTP should be approximated by (initial VSL)x Δp.

Survey Design and Method

- Data were collected from a random of US residents age 18+ by mixed mode (phone-mail-phone).
  - First interview collected socio-demographic data.
  - Second interview collected elicited WTP information.
- Respondents were mailed surveys with appropriate visual aids, and asked about their WTP to reduce annual mortality risk associated with automobile crashes.
- Respondents were told the initial and final annual risk levels if they chose to purchase an optional side-impact airbag on the next vehicle. There are 2 versions:
  1. Initial risk is 2.5/10,000 and final risk is 1.5/10,000.
  2. Initial risk is 2.0/10,000 and final risk is 1.5/10,000.

Survey Design (Cont'd)

- WTP was elicited using a double-bounded dichotomous-choice question format.
- Respondents were randomly assigned a first bid amount with predetermine lower and higher follow-up bids.
- Bid vectors are: {$50,$25, $100}, {$100, $50, $200}, {$200,$100,$400}, and {$400, $200, $800}.
- The bid vectors produce a wide range of VSL from VSL less than $250,000 to VSL greater than $16 million.
- 8 versions of visual-aid packets: 2 baseline levels of mortality risk (2.5 and 2.0 in 10,000) and 4 visual-aid groups (a linear scale, a logarithmic scale, an array of dots, and no visual aids).



Logarithmic Risk Scale

Linear Risk Scale

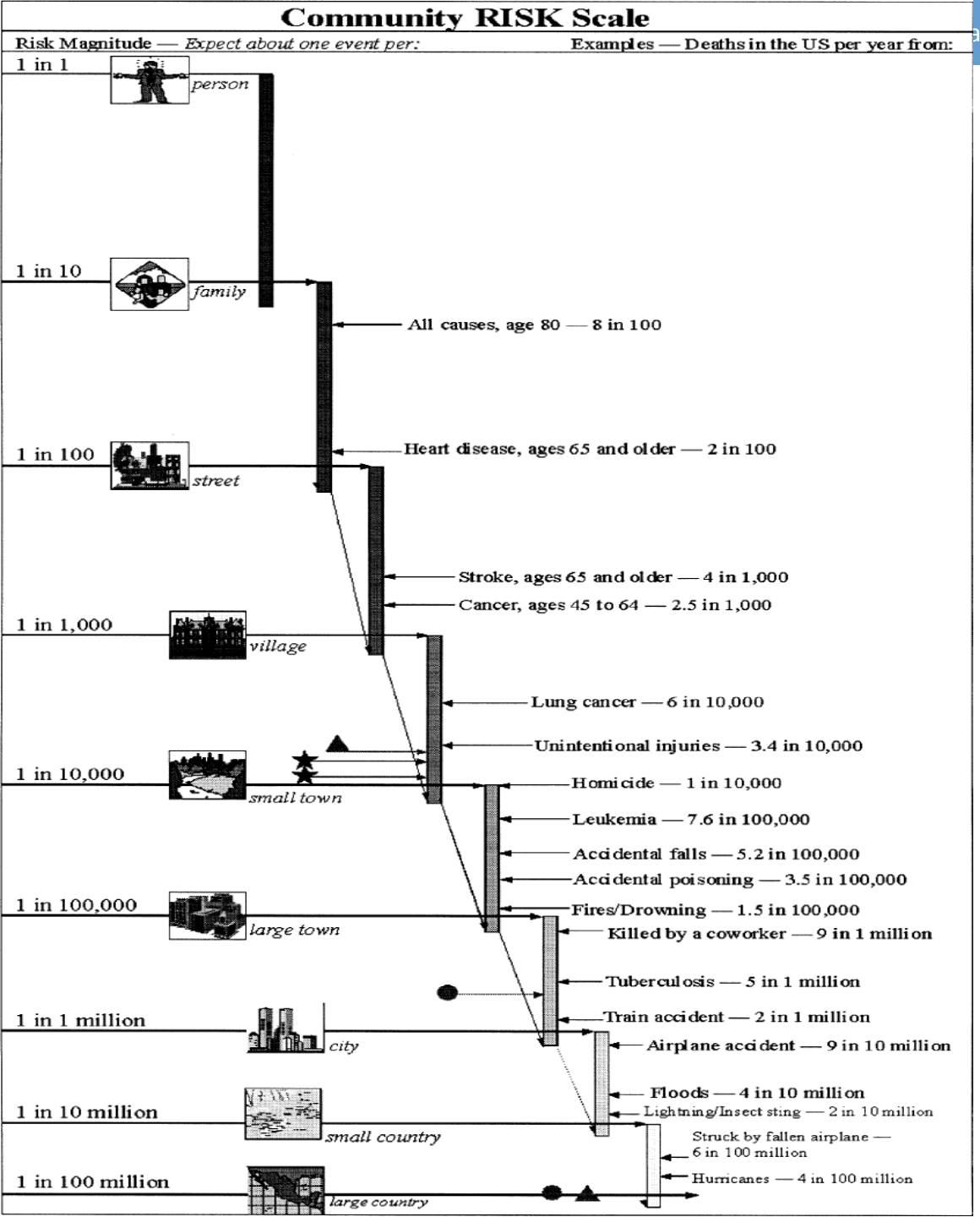


Table 1 Sample Statistics

Variable	No aid	Linear	Logarithmic	Dots
Sample size (1,104 total)	277	288	264	275
Response rate (%)[a]	77	74	76	76
Male (%)	41	51	48	43
Age[b]	43.0	42.3	42.9	44.4
Income ($1,000)[c]	47.6	46.5	45.4	46.4
Education (years)[d]	14.5	14.6	14.2	14.4
Perceived airbags as "very effective" (%)	42	49	46	42
Perceived risk ≥ stated risk (%)	62	59	58	56
Quality of life (1 to 10 scale)	7.5	7.6	7.5	7.5
Employed full-time (%)	59	56	58	51
Married (%)	58	56	52	56
Children <18 living at home (%)	44	37	38	38
White (%)	81	76	83	81

[a]Based on 1,456 participants recruited.

[b]Age provided within the following categories: (18–24), (25–29), (30–34), (35–39), (40–44), (45–49), (50–54), (55–59), (60–64), (65–69), and (70+). Age 70 was used for the upper bound.

[c]Household income (in $1000) within the following categories: (<$15), ($15–$25), ($25–$40), ($40–$50), ($50–$75), ($75–$100), (>$100). $15 and $100 were used for the lower and upper bounds, respectively.

[d]Years of educational attainment, where less than high school = 10; graduated high school = 12; some college = 14; graduated college = 16; and graduate or professional school = 18.

Estimation of WTP

- Estimation equations are estimated using a lognormal distribution.
- "Risk change" is a dummy variable:
  - equal to one for subsample presented with the larger risk reduction (1.0/10,000), and
  - Equal to zero for subsample presented with the smaller risk reduction (0.5/10,000).
- The coefficient of "risk change" can be used to estimate the ratio of WTP for the larger risk reduction to WTP for the smaller risk reduction.
  - If the WTP is exactly proportional to the two-fold absolute difference in risk-reduction, the expected value of the coefficient is ln(2) = 0.693.

Table 2. Estimated WTP by visual aid, no covariates

Variable	No aid	Linear	Logarithmic	Dots
Constant	5.448***	5.630***	5.333***	5.067***
	(0.141)	(0.145)	(0.145)	(0.141)
Risk change[a]	0.097	0.318	0.503**	0.658***
	(0.198)	(0.202)	(0.198)	(0.209)
N	277	288	264	275
Log-likelihood	−362.96	−357.01	−354.62	−350.55
WTP ratio (from regression)[b]	1.10	1.37	1.65	1.93
Median WTP[c]	$253/$235	$362/$293	$337/$209	$290/$159
95% CI	$193–$331	$278–$472	$257–$441	$221–$382
	$174–$317	$209–$412	$154–$284	$115–$219
WTP ratio (from subsamples)[d]	1.08	1.24	1.61	1.82

Notes: (standard error)

***, **, *statistically significant from 0 at 1%, 5% and 10%, respectively.

[a]Indicator variable = 1 for larger risk reduction and 0 for smaller risk reduction.

[b]Ratio of WTP for larger risk reduction to WTP for smaller risk reduction estimated by the coefficient on "Risk change."

[c]Median WTP for larger and smaller risk reductions estimated from regression using only corresponding subsample.

[d]Ratio of median WTP by subsample.

Table 3. Estimated WTP by visual aid, with covariates

Variable	No aid	Linear	Logarithmic	Dots
Constant	6.009***	4.993***	5.253***	4.837***
	(0.741)	(0.734)	(0.727)	(0.788)
Risk change[a]	0.062	0.349*	0.429**	0.678***
	(0.195)	(0.196)	(0.191)	(0.206)
Age	−0.015**	−0.005	−0.013*	0.0001
	(0.007)	(0.007)	(0.007)	(0.007)
Male	−0.434**	−0.318	−0.191	−0.249
	(0.206)	(0.198)	(0.193)	(0.210)
Income ($1,000)	0.0096**	−0.00007	0.00005	0.0088**
	(0.004)	(0.004)	(0.004)	(0.004)
Education	−0.034	0.038	0.015	−0.006
	(0.048)	(0.047)	(0.047)	(0.050)
Effective[b]	0.263	0.633**	1.102***	0.078
	(0.317)	(0.309)	(0.298)	(0.309)
Perceived Risk[c]	0.194	0.122	0.292	−0.279
	(0.261)	(0.277)	(0.254)	(0.271)
Effective ∗ Perceived Risk	0.454	0.258	−0.486	0.601
	(0.407)	(0.402)	(0.384)	(0.417)
N	277	288	263	275
Log-likelihood	−351.18	−346.33	−341.14	−344.02

Table 3 (Cont'd)

Variable	No aid	Linear	Logarithmic	Dots
WTP ratio (from regression)[d]	1.06	1.42	1.54	1.97
Median WTP[e]	\$244/\$233	\$365/\$287	\$321/\$210	\$303/\$164
VSL[f] (millions)	\$2.4/\$4.7	\$3.7/\$5.7	\$3.2/\$4.2	\$3.0/\$3.3

Notes: (standard error)

***, **, *statistically significant from 0 at 1%, 5% and 10%, respectively. One record was excluded because all socio-demographic variables were missing. 77 missing income values were predicted using a regression of income on gender, age, and years of education.

[a]Indicator variable = 1 for larger risk reduction and 0 for smaller risk reduction.

[b]Indicator variable = 1 for rating of airbags as "Very Effective" and 0 otherwise.

[c]Indicator variable = 1 if perceived risk is greater than or equal to stated risk, 0 otherwise.

[d]Ratio of WTP for larger risk reduction to WTP for smaller risk reduction estimated by the coefficient on "Risk change."

[e]Median WTP for larger and smaller risk reduction predicted for average respondent using regression for corresponding visual aid.

[f]Value per Statistical Life = WTP/mortality-risk reduction.

Results

- The hypothesis that WTP is insensitive to the magnitude of risk reduction can be rejected for subsamples receiving the dots ($p<0.01$), the logarithmic scale ($p<0.05$), and the linear scale ($p<0.08$), but cannot be rejected for the group receiving no visual aid.
- The hypothesis that WTP is proportional to the risk reduction can be rejected for the group receiving no visual aid ($p<0.01$), the linear scale ($p<0.05$), or the logarithmic scale ($p<0.1$), but not for the group receiving the array of dots.
- The derived VSL is higher for smaller risk reductions because the estimated WTP is less than proportionate to the risk reduction.

Conclusion

- This study finds important differences in the effect of alternative visual aids on sensitivity of estimated WTP to magnitude of mortality-risk reduction.
- The estimates of WTP using the logarithmic scale and the array of dots are consistent with proportionality between WTP and risk reduction.
- The average VSL for automobile-fatality risk is in the range of $3 to $4 million.
- This suggests that visual aids have the potential for improving the communication of small probabilities in CV studies design to estimate WTP for reduction in mortality risks.