

# Valuing Large Reductions in Individual Mortality Risks

by

W. Kip Viscusi

University Distinguished Professor  
Vanderbilt University

Presentation at EPA Workshop on Estimating  
Benefits of Reducing Hazardous Air Pollutants  
April 30, 2009

-DRAFT, Not for Citation-

## Benefit Assessment

- Benefit assessments for mortality risk reductions generally use values based on tradeoffs involving small risks
- Issue to be explored here is whether magnitude of EPA risks requires new valuations of risk or adjustments in current values to reflect extent of risk change .

-DRAFT, Not for Citation-

## Labor Market Wage-Risk Studies

- Estimate a regression average rate of tradeoff between wages and job fatality risk
- Use results to calculate value of statistical life (VSL)
- Labor market studies are the most frequent source of government VSL estimates

-DRAFT, Not for Citation-

## Valuation Amounts

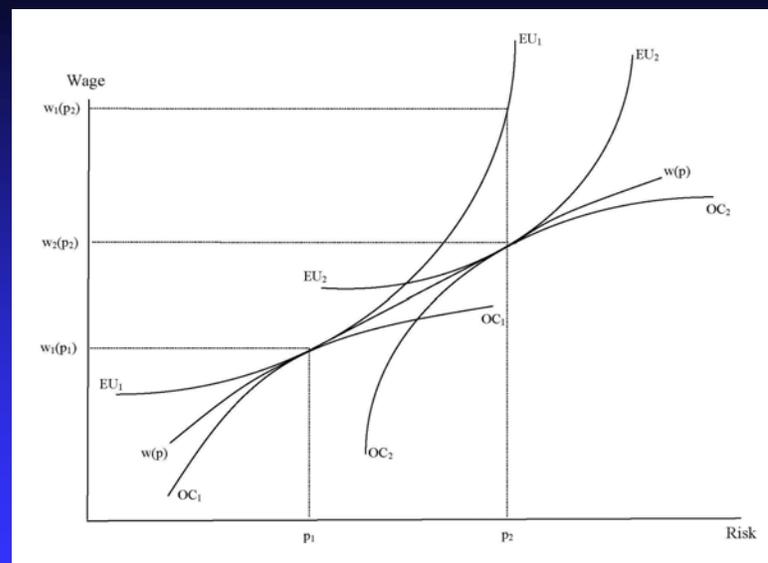
- Hedonic wage studies focus on willingness to accept (WTA) values
- Benefit assessment is based on willingness to pay (WTP)
- For very small risk changes  $WTP=WTA$

-DRAFT, Not for Citation-

## Hedonic Market Approach

- Firms have wage offer curves as function of risk
- Outer envelope of offer curves represents highest available wage at each risk level
- Workers have a series of constant expected utility loci defined on risk and wages
- Workers select highest valued wage-risk combination
- Estimated hedonic wage function  $w(p)$  is the locus of these points

-DRAFT, Not for Citation-



-DRAFT, Not for Citation-

## Local versus Global Tradeoffs

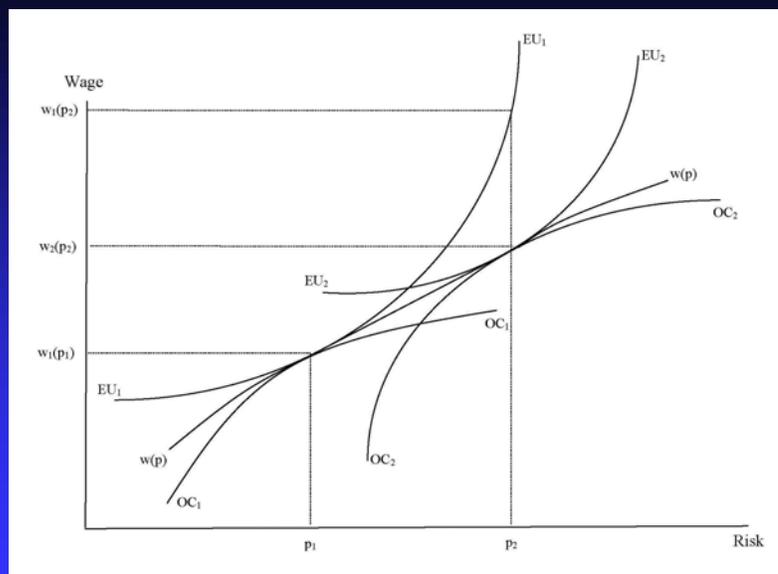
- VSL estimates pertain to average value of narrow changes on constant expected utility locus
- Let VSL equal representative person's local tradeoff rate
- VSL will overstate implied VSL based on WTP for non-incremental risk changes
- VSL will understate implied VSL based on WTA for non-incremental risk changes .

-DRAFT, Not for Citation-

## Non-Local Risk Changes

- Movement along  $w(p)$  indicates how other workers value risk
- To assess major risk valuations, want WTA or WTP on constant expected utility locus
- Application of VSL will understate WTA and overstate WTP for large risk changes .

-DRAFT, Not for Citation-

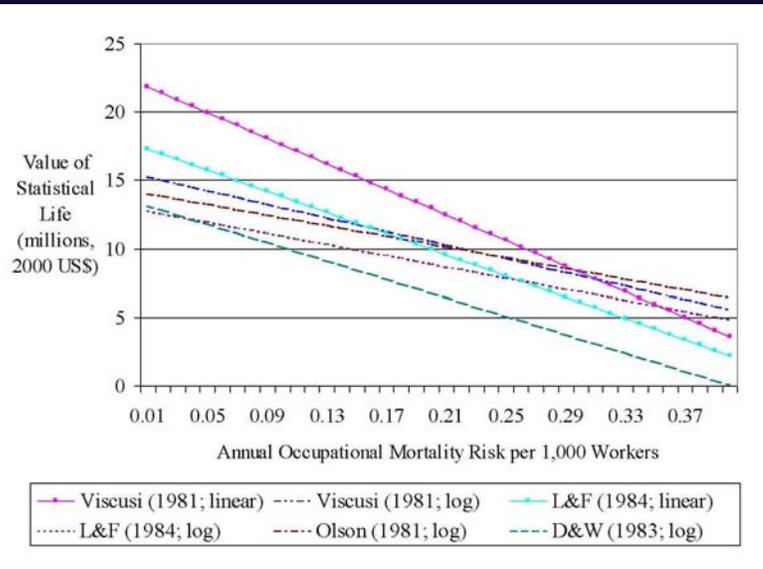


-DRAFT, Not for Citation-

## Labor Market Complications

- Expect people to sort based on risk preferences
- High VSL people choose lower risk jobs, lower VSL people choose higher risk jobs
- Examining large risk jobs compounds sorting issue (depressing VSL) with rising WTA for large risks (raising VSL)

-DRAFT, Not for Citation-



-DRAFT, Not for Citation-

## Labor Market Study Annual Fatality Risk Ranges

- Risk in early BLS studies 1/10,000 but some high risk studies at 1/1,000
- NIOSH data used in middle period have risks from 1/10,000 to 4/10,000
- Recent studies using BLS CFOI data have risks of 1/25,000

-DRAFT, Not for Citation-

## VSL Formulas

- Let  $u(y)$  be utility function when healthy
- Let  $p$  = probability of death
- Suppose bequest has zero value
- $VSL = u(y) / [(1-p) u'(y)]$
- Let  $u(y) = a + \ln y$  for illustrative example

-DRAFT, Not for Citation-

## Willingness to Accept (WTA) Calibration Example

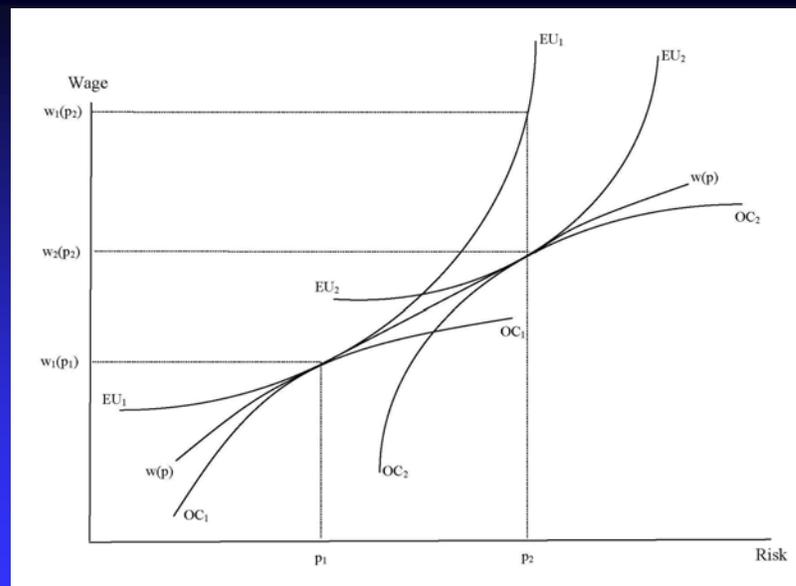
- Suppose  $VSL = \$7$  million based on fatality risk of  $1/10,000$  and annual income  $\$27,200$  (CPS blue-collar workers)
- What is WTA to keep workers on constant expected utility locus if risk is increased to  $1/1,000$ ?
- Magnitude of risk change not relative risk is influential
- Risk change is  $9/10,000$ , WTA is  $\$6,966$  versus  $\$6,300$  based on VSL, or 10% more
- Additional annual required wage compensation implies  $VSL = \$7.7 \times 10^6$  based on WTA

-DRAFT, Not for Citation-

## Willingness to Pay (WTP) Calibration Example

- Comparable reductions for WTP if starting risk is 1/1,000
- Same starting income of \$27,200
- Start risk at 1/1,000, reduce to 1/10,000
- WTP is \$5,825 or implicit VSL =  $\$6.5 \times 10^6$
- Large risk reduction WTP is 8% less than estimated VSL
- Note that WTP gap is less than WTA gap due to curvation of constant expected utility locus .

-DRAFT, Not for Citation-

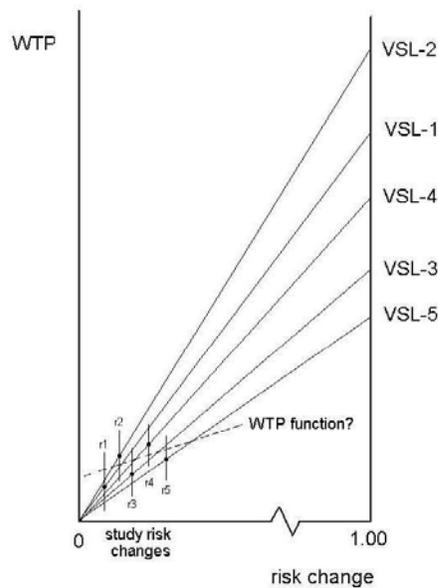


-DRAFT, Not for Citation-

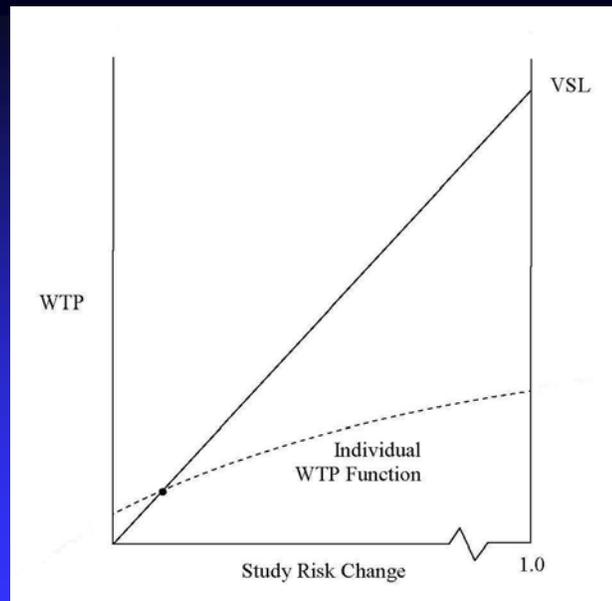
## Application to Series of VSL Studies

- Figure from SAB report indicates how meta analyses pool valuations across studies and worker groups
- Use similar diagram to explore how for given risk-wage combination the WTP differs from that predicted by constant VSL

-DRAFT, Not for Citation-



-DRAFT, Not for Citation-



-DRAFT, Not for Citation-

## Lifetime Risks of Labor Market

- Annual risk of 1/25,000 in recent low risk studies
- If 40 year worklife, lifetime risks 1.6/1,000
- If VSL = \$7 million, annual wage premium is \$280
- Undiscounted lifetime premium is \$11,200, even smaller if longer time period

-DRAFT, Not for Citation-

## Example of Large EPA Risks

- Draft Benzene Case Study (March 2008) of CAA reduction in lifetime risks of leukemia
- Risk decrease for high risk county, Brazoria County is from 2/10,000 to  $3 \times 10^{-6}$
- Two orders of magnitude lifetime risk change
- Absolute magnitude of change is more important
- But magnitude of lifetime risk change not dissimilar from annual job risk in many studies
- If leukemia risk is for annual exposure over 10 years, annual risk is 2/100,000, even smaller if longer time period

-DRAFT, Not for Citation-

## Framing the Benefits Question

- Nature of risk exposure is one time only or sequence of risks giving rise to a distribution of outcomes over time?
- Nature of payment mechanism is one time only policy expense for risk reductions or annual expense if a stream of risk reductions?
- How much does the answer to either of these questions matter?

-DRAFT, Not for Citation-

## Role of Latency

- Stated preference survey could elicit valuations based on latency
- Hyperbolic discounting, a form of irrational behavior
- Overly complex stated preference task to require discounting and valuation
- Discount WTP benefits measure by discount rate, e.g., 3%

-DRAFT, Not for Citation-

## Cancer Risk Valuation

- Even without magnitude of risk issue, more refinement of estimates is needed
- Most studies don't describe morbidity effects, and the few that do yield different results
- Magat, Viscusi, and Huber (1996) found cancer value equivalent to auto accident risk, with no latency
- Van Houtven, Sullivan, and Dockins (2008) found cancer risk with a 5 year latency 3 times as valued as auto risk
- Research needs to pinpoint cancer risk-money tradeoff for small and large risks

-DRAFT, Not for Citation-

## Summary and Conclusion

- VSL focuses on local risk tradeoffs
- For non-incremental risk changes, tradeoffs implied by VSL understate WTA, overstate WTP
- Need knowledge of utility function or direct stated preference values for major risk changes
- For risk changes between 1/1,000 and 1/10,000, WTA is understated by 10%, WTP is overstated by 8%

-DRAFT, Not for Citation-

## Summary and Conclusion, cont'd.

- Annual risk levels in hedonic wage studies often are in range 1/10,000 to 1/1,000, but some are larger
- Environmental risks viewed as large on a lifetime basis may be comparable to labor market risks on an annual basis
- Benefit issues to be resolved include valuation of different cancer risks as well as the influence of size of risk change

-DRAFT, Not for Citation-