Filling some of the gaps…

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The final economist

Flashback: June 2000

- So many HAPs, so little (time/data/funding)

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- So many HAPs, so little (time/data/funding)
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- Chafing against the one-size-fits-all VSL
- ….What I did with my last eight summer vacations

HAP-space vs. Health-outcome-space

- In marketing, it is common to reduce a huge "product space" into a more manageable "attribute space" wherein the huge number of products can be located.
- Identify demand for marginal amounts of each attribute? Can cobble together a guess about demand for new product as a bundle of those attributes.
- Can't identify benefits for each of 180+ HAPs? Identify and value smaller set of significant health effects. Locate each HAP in health-outcome-space to the best of our ability—infer benefits.

Individualization

Each person, i , may live in an area with different emissions, have a different exposure, different vulnerability, different perceptions, and a different utility function. **Damage function has an *i* subscript everywhere**:

$$\frac{\partial \text{exposure}_i}{\partial \text{emissions}_i} \cdot \frac{\partial \Pr(\text{death})_i}{\partial \text{exposure}_i} \cdot \frac{\partial \text{utility}_i}{\partial \Pr(\text{death})_i} \cdot \frac{\partial \text{net income}_i}{\partial \text{utility}_i} = \frac{\partial \text{net income}_i}{\partial \text{emissions}_i}$$

$$\underbrace{\frac{\partial \text{net income}_i}{\partial \Pr(\text{death})_i} \approx VSL}_{\text{(economists' purview)}} \qquad \underbrace{\left[\begin{array}{c} WTP \text{ for} \\ \text{regulation} \end{array}\right]}$$

Aggregate across people at what point?

- **Standard:** Aggregate across *physical effects* (i.e. reductions in risks of death or morbidity)

$$\Downarrow$$

$$\left.\begin{array}{l} \dfrac{\Delta \text{exposure}_1}{\Delta \text{emissions}_1} \cdot \dfrac{\Delta \Pr(\text{death})_1}{\Delta \text{exposure}_1} \\ \dfrac{\Delta \text{exposure}_2}{\Delta \text{emissions}_2} \cdot \dfrac{\Delta \Pr(\text{death})_2}{\Delta \text{exposure}_2} \\ \vdots \\ \dfrac{\Delta \text{exposure}_n}{\Delta \text{emissions}_n} \cdot \dfrac{\Delta \Pr(\text{death})_n}{\Delta \text{exposure}_n} \end{array}\right\} \left[\begin{array}{c} \sum_{i=1}^{n} \Delta \Pr(death)_i \\ = \#\ \text{statistical lives} \end{array}\right] \times \left[\begin{array}{c} "The" \\ VSL \end{array}\right] = \$Benefits$$

Preserve heterogeneity

- **Advocate:** allow people to have different terms all the way along, including different willingness to trade off income for risk reductions

$$\Downarrow$$

$$\left.\begin{array}{l} \dfrac{\Delta \text{exposure}_1}{\Delta \text{emissions}_1} \cdot \dfrac{\Delta \Pr(\text{death})_1}{\Delta \text{exposure}_1} \cdot \dfrac{\Delta \text{net income}_1}{\Delta \Pr(\text{death})_1} \\ \dfrac{\Delta \text{exposure}_2}{\Delta \text{emissions}_2} \cdot \dfrac{\Delta \Pr(\text{death})_2}{\Delta \text{exposure}_2} \cdot \dfrac{\Delta \text{net income}_2}{\Delta \Pr(\text{death})_2} \\ \vdots \\ \dfrac{\Delta \text{exposure}_n}{\Delta \text{emissions}_n} \cdot \dfrac{\Delta \Pr(\text{death})_n}{\Delta \text{exposure}_n} \cdot \dfrac{\Delta \text{net income}_n}{\Delta \Pr(\text{death})_n} \end{array}\right\} \left[\begin{array}{l} \sum_{i=1}^{n} \Delta \text{net income}_i \\ = \text{aggregate WTP} \end{array}\right] = \$\mathit{Benefits}$$

It’s not just death…

- Reduction in emissions will spawn many “chains of derivatives” *at the second term*
  - Different illnesses
  - Different latencies
  - Different durations
  - Different prognoses
- Story is much richer than just “number of deaths”

Group-specific WTP for risk reductions

Stated preference study funded by US EPA (Program Director: Will Wheeler), Health Canada (Paul DeCivita), National Science Foundation

1. Private WTP for health risk reductions in the US
2. Private WTP for health risk reductions in Canada
3. WTP for public health programs in the US
   - To *prevent* community illnesses and deaths
   - To *treat* community illnesses, reduce deaths

Team has included

- Co-PI: J.R. DeShazo (UCLA School of Public Policy)
- University of Oregon Ph.D. students
  - Ryan Bosworth (public choices component)
    - Now at NCSU Policy School
  - Erica Johnson (diseases, family structure, correcting for scenario adjustment; final defense May 21)
    - Now at Gonzaga University
  - Eric Duquette (methodology: choice difficulty)
  - Peter Stiffler (Canada/US differences)

Private health care choices

- Consider an illness profile that you might suffer with a given baseline risk over your remaining life: latency, sick-time, recovered/remission time, lost life-years
- A disease label attached to this profile
- A risk reduction (and revised risk) if you pay for an annual diagnostic test not covered by insurance
- Five choice sets, each with two risk reduction programs and “neither program”

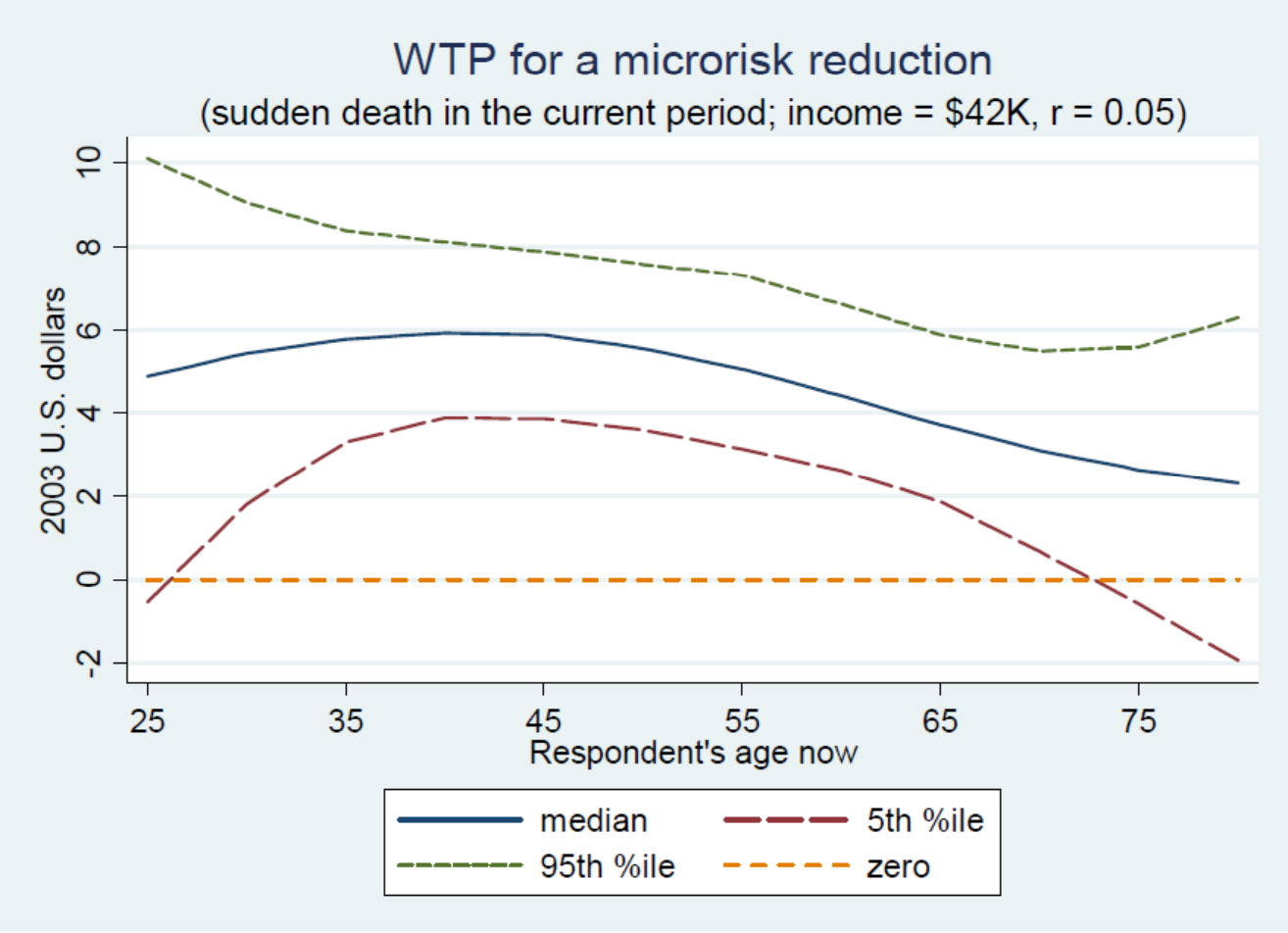
Under “homogeneous” preferences

(Basic model from the flagship paper)

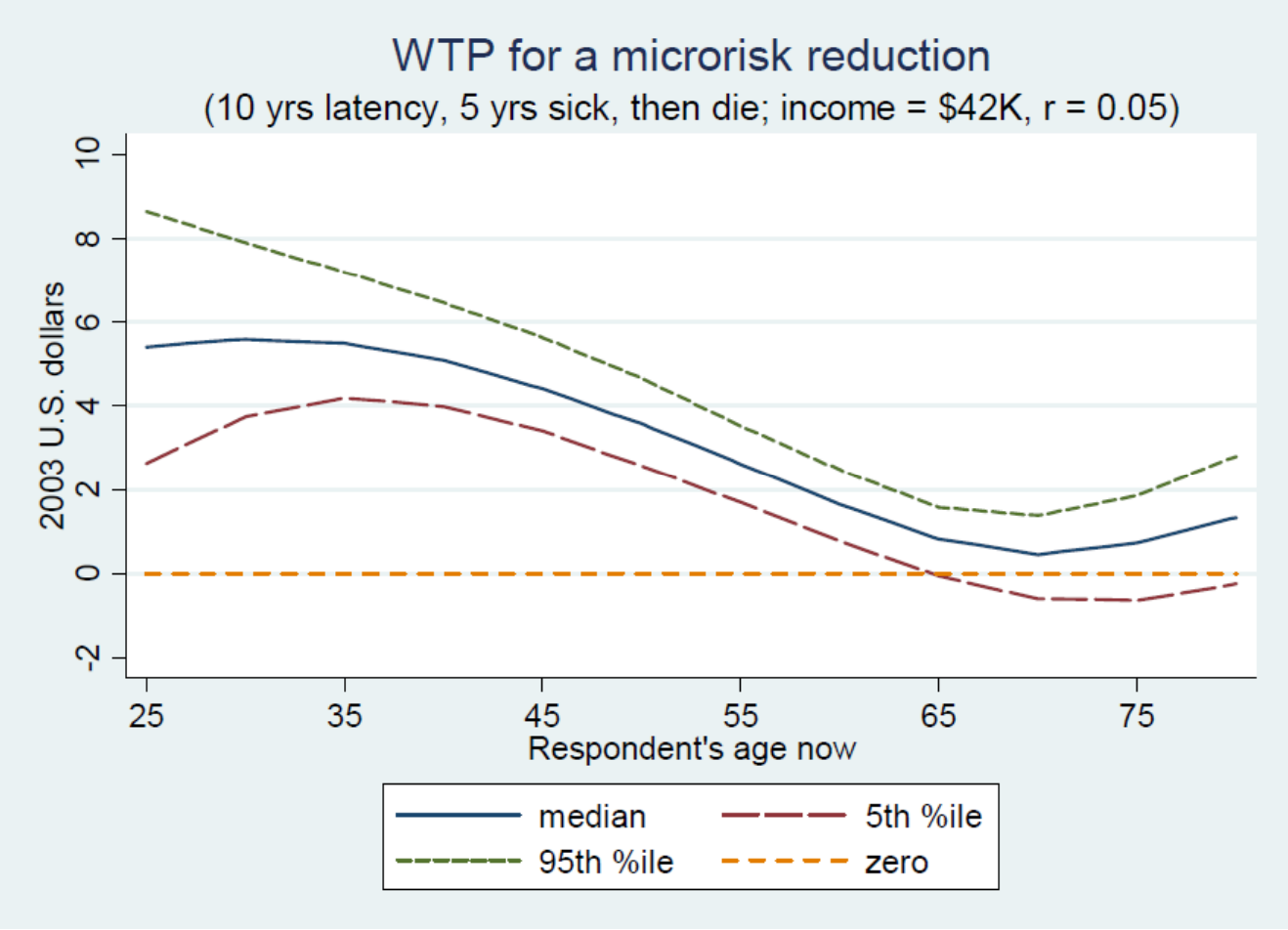
WTP for risk reduction still depends unavoidably on several factors:

- Respondent’s income and current age
- The pattern of latency, sick-time, recovered/remission time and lost live-years
- The discount rate (by sensitivity analysis)

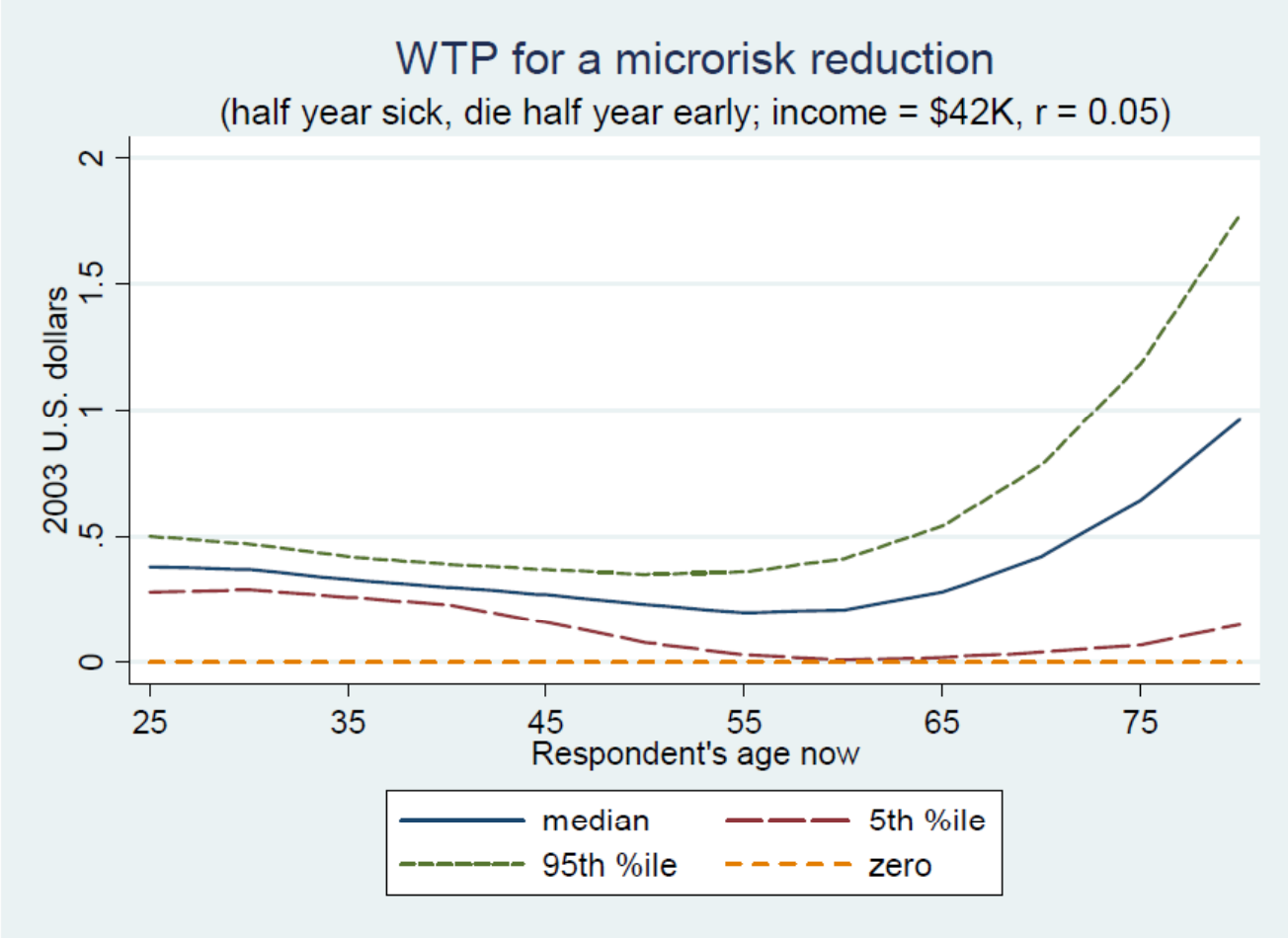
Wage-risk type VSL scenario: Sudden death now, $42k hhld income



10 yrs latency, 5 yrs sick, then die



End-of-life effects: half-year sick, die half-year early; WTP=f(age now)



Preferences are heterogeneous

WTP varies with lots of things….

- With age now, but also with age-when-you-would-get-sick (the “age paper”)
- With gender and household composition: presence of kids of different ages, now and at the time you would get sick (Johnson dissertation chapter)
- Between Canada and the US (Stiffler dissertaton chapter)

WTP varies with disease labels

Cancer

- Breast cancer (women)
- Prostate cancer (men)
- Colon cancer
- Lung cancer
- Skin cancer

Non-cancer

- Heart attack
- Heart disease
- Respiratory disease
- Stroke
- Diabetes
- Alzheimer's disease
- Traffic accident

Benchmark on "sudden death now" scenario for comparison to wage-risk VSL (focus on heterogeneity in values of lost life-years)

Estimates are normed on neutral/modal categories for

- Subjective **vulnerability** of suffering from at least one of these illnesses (or a recurrence) in the next 20 years
- Confidence that they would receive timely and high-quality **medical treatment** if they suffered one of these illnesses/injuries
- **Subjective risk** of suffering from each specific type of illness/injury (although cancers in general)
- **Subjective controllability** of each specific type of illness/injury (although cancers in general)

Profile	Sudden Death Now		
Health Threat			
Age now	30	45	60
Breast Cancer	7.87	8.39	6.98
Prostate Cancer	7.38	7.78	6.4
Colon Cancer	4.46	4.88	3.47
Lung Cancer	.95	0.97	0.22
…* smoker	10.59	11.05	9.62
Skin Cancer	0.43	0.36	0.04
Heart Attack	8.22	8.68	7.29
Heart Disease	8.26	8.73	7.36
Stroke	6.37	6.79	5.4
Respiratory Disease	0.38	0.29	0.03
…* smoker	5.95	6.34	5.01
Traffic Accident	1.11	0.82	0.07
Diabetes	5.3	3.36	0.3
Alzheimer's Disease	0.2	0.85	2.24

Household income = $42K

Heart attacks and heart disease also have high WTP.

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Non-smokers are not willing to pay very much to reduce their risks of lung cancer or respiratory disease

…but **smokers** are.

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For some types of illness and some age groups, WTP for a micromort will be greater than $6

(i.e. VSL > $6 million)

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Household income = $42K

For others, WTP for a micromort will be less than $6

(i.e. VSL < $6 million)

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Health Threat			
Age now	**30**	**45**	**60**
Breast Cancer	7.87	8.39	6.98
Prostate Cancer	7.38	7.78	6.4
Colon Cancer	4.46	4.88	3.47
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10 yrs latency,
sick 5 years,
then die

Can produce fitted distribution for any combination of latency, sick-time, recovered/remission time, and lost live-years

Profile	10 year latency; sick 5 years, then death		
Health Threat			
Age now	**30**	**45**	**60**
Breast Cancer	8.66 (6.6, 11.04)	6.64 (4.08, 8.35)	4.44 (2.93, 6.03)
Prostate Cancer	7.25 (5.26, 9.42)	5.65 (4.1, 7.44)	4.05 (2.62, 5.69)
Colon Cancer	6.32 (4.67, 8.15)	4.76 (3.6, 6.03)	3.09 (2.03, 4.26)
Lung Cancer	2.36 (0.8, 3.99)	0.78 (-0.53, 1.92)	0.04 (-2.34, .3)
…* smoker	12.43 (9.75, 15.7)	10.93 (8.58, 13.59)	9.24 (7.22, 11.86)
Skin Cancer	1.37 (-0.01, 2.79)	0.16 (-1.55, 0.85)	0 (-3.49, -.67)
Heart Attack	7.58 (5.76, 9.69)	6.09 (4.58, 7.84)	4.4 (3.01, 5.97)
Heart Disease	9.05 (7.08, 11.32)	7.01 (5.59, 8.62)	4.82 (3.6, 6.26)
Stroke	5.96 (4.17, 7.93)	4.33 (2.99, 5.87)	2.7 (1.29, 4.13)
Respiratory Disease	1.18 (-0.3, 2.81)	0.13 (-1.97, 0.85)	0 (-3.78, -0.69)
…* smoker	7.81 (5.57, 10.51)	6.22 (4.29, 8.34)	4.62 (2.73, 6.72)
Traffic Accident	2.69 (1.42, 4.08)	0.63 (-0.6, 1.64)	0.01 (-3.2, -0.12)
Diabetes	7.15 (5.1, 9.53)	3.24 (2.1, 4.45)	0.07 (-2.15, 0.47)
Alzheimer's Disease	0.73 (-4.06, 3.35)	0.91 (-1.31, 2.7)	1.03 (-0.55, 2.43)

Same-illness morbidity, number of other comorbid conditions

Table 7 – Simulations:[a] based on Model 3 (both actual morbidity/comorbidity and subjective risks (VSI in $million; with y=$42,000, discount rate=0.05)

Sensitivity to actual morbidity levels (samorbid and comorbid)

45 years old now; At 45:	***samorbid*=0** ***comorbid*=0** ***sasubrsk*=-0.25** ***cosubrsk*=-0.25**	***samorbid*=1** *comorbid*=0 *sasubrsk*=-0.25 *cosubrsk*=-0.25	*samorbid*=0 ***comorbid*=1** *sasubrsk*=-0.25 *cosubrsk*=-0.25
1 yr sick; non-fatal	**2.21** **[0.84, 3.76]**	4.25 [-lots, 55.90]	2.01 [0.85, 3.32]
5 yrs sick; non-fatal	**3.44** **[2.05, 5.06]**	7.01 [-lots, 90.29]	3.09 [2.00, 4.54]
1 yr sick; then die	**4.21** **[2.40, 6.03]**	11.95 [-lots, 140.68]	3.81 [2.31, 5.61]
5 yrs sick; then die	**3.73** **[1.88, 5.98]**	10.35 [-lots, 125.76]	3.34 [1.67, 5.41]
Sudden death	**4.40** **[2.60, 6.42]**	12.54 [-lots, 146.50]	4.05 [2.47, 6.05]

Same-illness subjective risk rating, other-illness average subjective risk

Table 7 – Simulations[a] based on Model 3 (both actual morbidity/comorbidity and subjective risks (VSI in $million; with y=$42,000, discount rate=0.05)

Sensitivity to subjective risk levels (mean-1 and mean+1 for sasubrsk and cosubrsk)

45 years old now; At 45:	***samorbid*=0 *comorbid*=0 *sasubrsk*=-0.25 *cosubrsk*=-0.25**	*samorbid*=0 *comorbid*=0 ***sasubrsk*=-1.25** *cosubrsk*=-0.25	*samorbid*=0 *comorbid*=0 ***sasubrsk*=0.75** *cosubrsk*=-0.25	*samorbid*=0 *comorbid*=0 *sasubrsk*=-0.25 ***cosubrsk*=-1.25**	*samorbid*=0 *comorbid*=0 *sasubrsk*=-0.25 ***cosubrsk*=0.75**
1 yr sick; non-fatal	**2.21 [0.84, 3.76]**	1.40 [0.05, 2.79]	2.95 [1.63, 4.37]	2.71 [1.35, 4.27]	1.60 [0.28, 3.00]
5 yrs sick; non-fatal	**3.44 [2.05, 5.06]**	1.81 [0.39, 3.20]	4.99 [3.63, 6.83]	4.66 [3.18, 6.54]	2.07 [0.62, 3.69]
1 yr sick; then die	**4.21 [2.40, 6.03]**	-0.21 [-2.03, 1.45]	8.37 [6.17, 11.40]	6.55 [4.48, 9.60]	1.63 [-0.28, 3.57]
5 yrs sick; then die	**3.73 [1.88, 5.98]**	-1.22 [-3.36, 0.69]	8.50 [6.08, 11.74]	6.63 [4.48, 9.70]	0.63 [-1.35, 2.62]
Sudden death	**4.40 [2.60, 6.42]**	0.52 [-1.36, 2.45]	8.06 [5.92, 11.10]	6.42 [4.20, 9.31]	2.28 [0.23, 4.49]

Public choice study

Bosworth, Cameron and DeShazo, in upcoming May 2009 issue of *Journal of Environmental Economics and Management*

- Marginal WTP for avoided illness
- Marginal WTP for avoided death
- (negative) WTP for "either policy" as opposed to the status quo (i.e. systematically more likely to prefer the status quo, on average)

Illness-related results

1. No differences by source of risk (pesticides, drinking water, air pollution, road hazards)
2. No difference, by illness label, in marginal WTP for a reduced illness or a reduced death
3. Differences in total WTP for policies, regardless of their reduced illnesses or deaths, with
   - Illness label
   - Own morbidity with same illness
   - Subjective risk of same illness

Jonathan Levy's talk (Equity)

- "incorporation of cost side (if desired)"
- Very few environmental regulations or policies are a "gift" to the beneficiaries. Most people will have to pay something for those benefits…in terms of higher prices, lower wages, or reduced investment returns.

Distributional consequences of a policy cannot be understood without considering the distribution of costs as well as the distribution of benefits…equity depends on NET BENEFITS

E.g. Cai and Cameron (2008)

WTP for climate change mitigation depends on

- Perceived regressiveness of climate change (AND whether the individual cares)
- Survey's stated incidence of domestic and international costs (AND whether this matches the individual's ideas about of who *should* pay)
- Don't know? Don't care? → No component of WTP that reflects distributional preferences

Implications

- Private goods? May be able to control the cost-equity percepton, elicit personal benefits
- For public goods? Other-regarding preferences, and realistic policy involves who bears the costs; distributional consequences are inextricably tied up in WTP estimates...can't separate the efficiency story from the equity story.
- E.g. "Payment vehicle bias" is often a result of disapproval of the distribution (incidence) of costs

EPA's Longer-Term Approach?

- Ted Gayer thinks research resources should be targeted at the earlier terms in the "chain of derivatives" in the Damage Function
- But there are many "chains"…a different one leading to each possible health endpoint
- Without devoting some thought to the relative sizes of the "economists' term" across endpoints, it isn't clear along which chain you should concentrate your efforts on the fate-and-transport or tox'-and-epi' terms…

The $640,000 question?

- Or perhaps several of them?

The $640,000 question?

- Or perhaps several of them?
- There remain MANY open questions…
- Is there going to be any substantive EPA support for work on the research needs identified at this Workshop?