# BCA: Triumphs and Troubles

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# BCA is …

Lester Lave, an economist at the Brookings Institution, said that cost-benefit analysis "is a delightful tool for economists because it is complete, flexible and allows you to look at everything."

...[In] many cases, benefit–cost analysis cannot be used to prove that the economic benefits of a decision will exceed or fall short of the costs.... [But it] can provide illuminating evidence for a decision, even if precision cannot be achieved because of limitations on time, resources, or the availability of information. (Arrow et al. 1996, 5)

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# Definition

- Use of a monetary measure of aggregate change in individual well-being from a prospective policy decision/regulation
- Advantages are transparency, possibly accountability, framework for consistent data collection and gap identification, ability to aggregate over dissimilar effects.
- Disadvantages: one dimensional

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# Who does CBA? (Smith and Braathen, OECD EWP, No. 92

ENV/WKP(2015)13

Table 1. Summary of questionnaire responses

| | | Transport investments | | Energy investments | | Other investments | | New policy assessments | | Ex post assessments | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % | # | % | # | % |
| Are there clear criteria for how to do CBAs? | Yes | 18 | 90% | 15 | 75% | 10 | 77% | 15 | 83% | 11 | 65% |
| | No | 2 | 10% | 5 | 25% | 3 | 23% | 3 | 17% | 6 | 35% |
| | Total | 20 | 100% | 20 | 100% | 13 | 100% | 18 | 100% | 17 | 100% |
| What is the share of cases in the last 3-5 years that have been CB-analysed? | All | 3 | 16% | 3 | 19% | 3 | 25% | 4 | 25% | 0 | 0% |
| | Most | 14 | 74% | 6 | 38% | 5 | 42% | 8 | 50% | 4 | 27% |
| | Some | 1 | 5% | 3 | 19% | 4 | 33% | 3 | 19% | 6 | 40% |
| | A few | 1 | 5% | 3 | 19% | 0 | 0% | 1 | 6% | 2 | 13% |
| | None | 0 | 0% | 1 | 6% | 0 | 0% | 0 | 0% | 3 | 20% |
| | Total | 19 | 100% | 16 | 100% | 12 | 100% | 16 | 100% | 15 | 100% |

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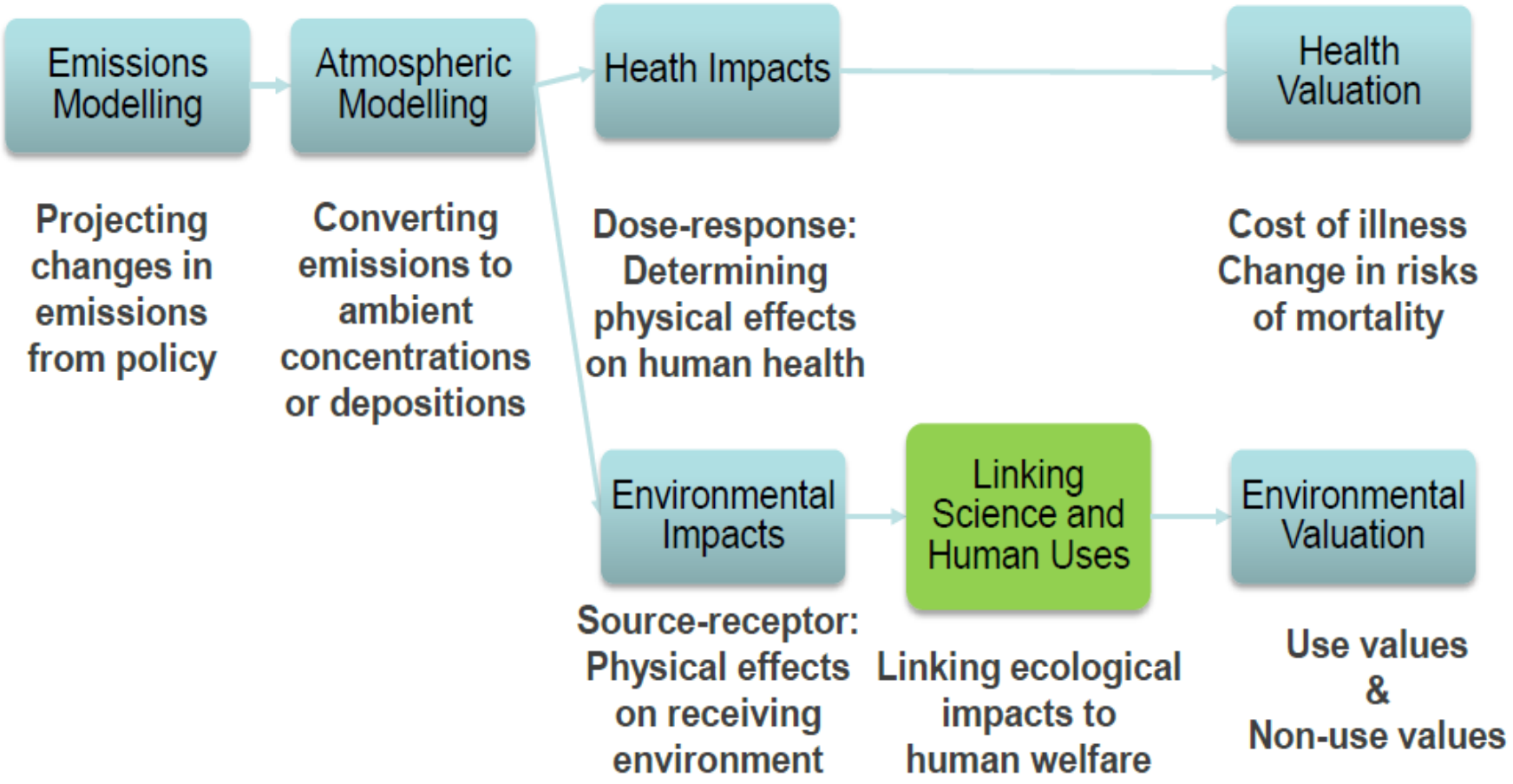
# From Science to Policy: The Role of Economics



# What makes toxic chemicals special relative to air pollution

Economics implications

- From regulatory perspective: thousands of substances, used in products, banning an option; focus on substitutes
- Endpoints: emphasis on cancer/mutagens/birth defects/serious morbidity
- Latency

Physical/biological science implications

- Multiple exposure points
- Long-lived (particularly in ecosystems)/accumulative
- Synergies across chemicals
- Creation of new chemicals with uncertain effects

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# EPA RIA for disinfection by-products

- No VSL adjustment for bladder cancer
- Morbidity increment of fatal bladder cancer: medical costs
- Nothing on adverse reproductive and developmental health effects.
- For non-fatal bladder cancers: 1996 (!) study on risk-risk tradeoff with curable lymphoma and death (58.3% of death). $587K.
- Adjustments for real income growth
- Handling lags in impacts
- Use Monte Carlo simulation to handle uncertainties
- Discount rates: norm at EPA/OMB is 3% and 7%

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# New TOSCA rule

In proposing and promulgating a rule on a specific chemical, Administrator shall consider and publish a statement on the costs and benefits of the rule. This can be for testing a chemical, banning it, etc.

- Reauthorized TOSCA law says “without consideration of costs” about 50 times.
- Mentions “benefits” twice; focuses on risks
- Mentions costs and benefits together once. But EO would require it anyway.

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# Outline of Talk

1. What we do well
2. What we need to do better
3. What we mostly ignore
4. What we do that we shouldn't

Some caveats:

- Most of my experience with BCA analyses is U.S.
- Skipped environmental valuation

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# What we do well or at least agree on

- Market valuation in general
- Focus on linkage: Health endpoints-valuation startpoints
- Options analyses (although sometimes seems contrived); sensitivity analyses
- Adjustments for income growth
- Co-benefits
- Discounting? (sensitivity analyses, hyperbolic discounting)

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# What we need to do better: mortality valuation

- EU: Braathen et al: ~ $4 million SP studies
- US: ~$9 million mostly RP studies

- Cancer (including latency/cessation lags)
- Public vs private context
- Children
- PPP vs. Exchange rate (for transfer)
- Income elasticity of WTP (for transfer)
- A new name: EPA trying out value of a micro risk (e.g., $8 per 1/1,000,000)
- VSL vs. VSLY

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Alberini and Scasny (1/16) (draft)

Value of Statistical Life ($millions CAN$)

| Type | Adult | Parent for Child |
|---|---|---|
| Cancer | 7.0 | 8.7 |
| Road Accident | 4.7 | 6.8 |
| Respiratory | 5.0 | 7.8 |
| Add'l if Public | 1.8 | 2.4 |

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# VSLY

- Years Life Lost is “probably” a better metric than “lives lost”

  ➔Need VSLY
- Just as there’s no one VSL, there’s no one VSLY
- Three approaches in literature
  - Amortize VSL – exponential function; need discount rate (~$300,000)
  - SP (Desaigues et al 2011; Chilton et al, 2004; Cameron and DeShazo, 2013)

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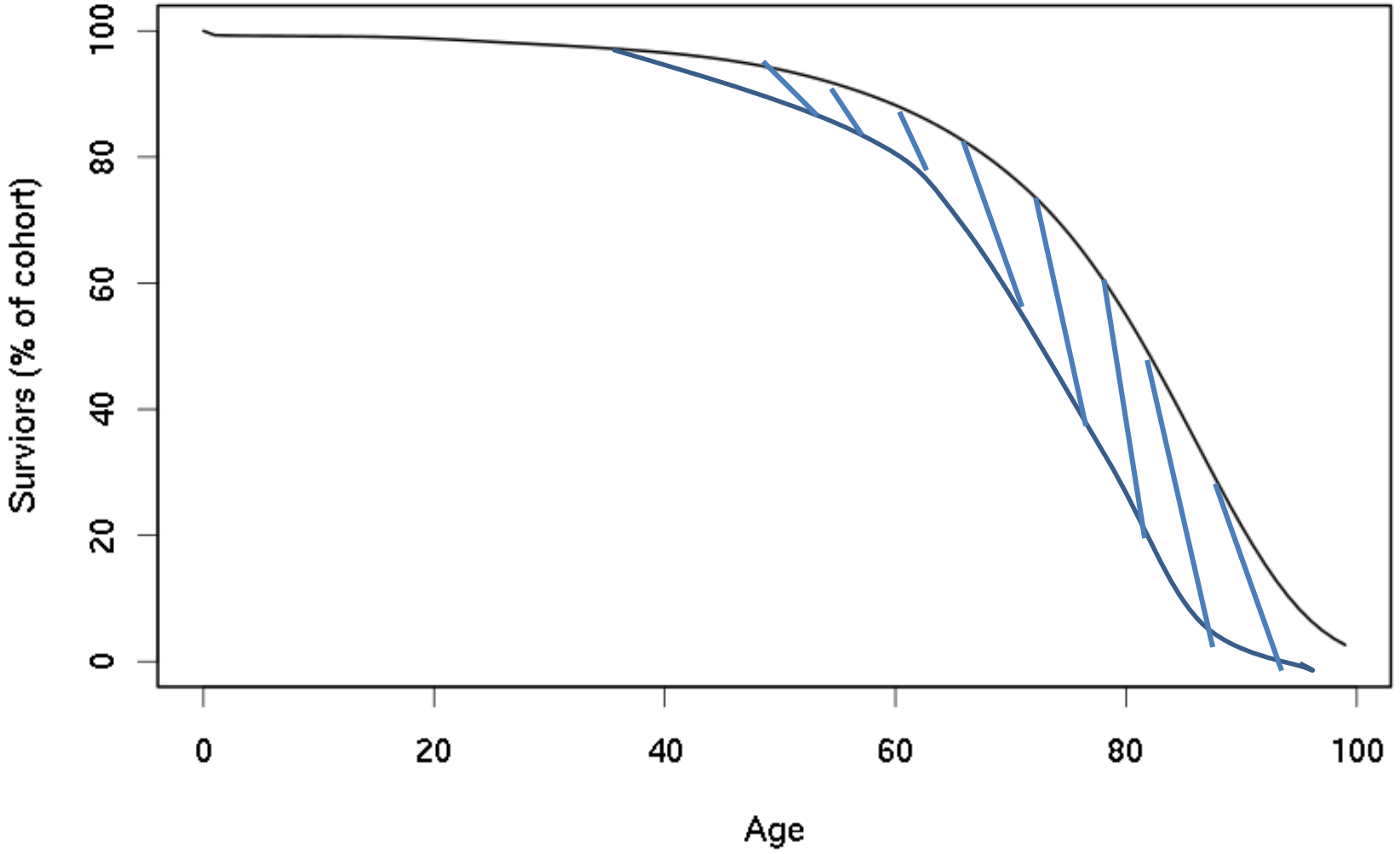
# Shift in Survival Function



# What we need to do better: serious morbidity valuation

- Holy Grail: Choice experiment with sufficient attributes to describe/differentiate between toxic chemicals – do for products with substances and with substitutes
- Do studies for particular endpoints or chemicals
  - ECHA review (2016) of studies in Italy, Czech R, UK and Neth. (skin irritation, kidney failure and disease, fertility and developmental toxicity, cancer). Fertility/Birth defects study in Canada (Scazny and Zverinova, 2016)

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# Integrating across Morbidity/Mortality and Beyond

- Add morbidity cost to mortality
- Choice experiments with qualitatives
- Choice experiments with quantitatives
- Choice experiments with illness profiles
- Choice experiments with chemical properties

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# Georgiou et al (2015) ppt. WTP to reduce Deca-BDE

| | Current Situation | Alternative 1 | Alternative 2 |
|---|---|---|---|
| Risks of death due to household fires | 5 in a million | 15 in a million | 10 in a million |
| Relative level of risks of impact on wildlife | High | High | Low |
| Relative level of risks of impact on human health | High | Low | High |
| Increase in annual household expenditure | £ 0 | £ 50 | £ 5 |

# Integrated morbidity/mortality valuation studies

Adamowicz et al (2011)

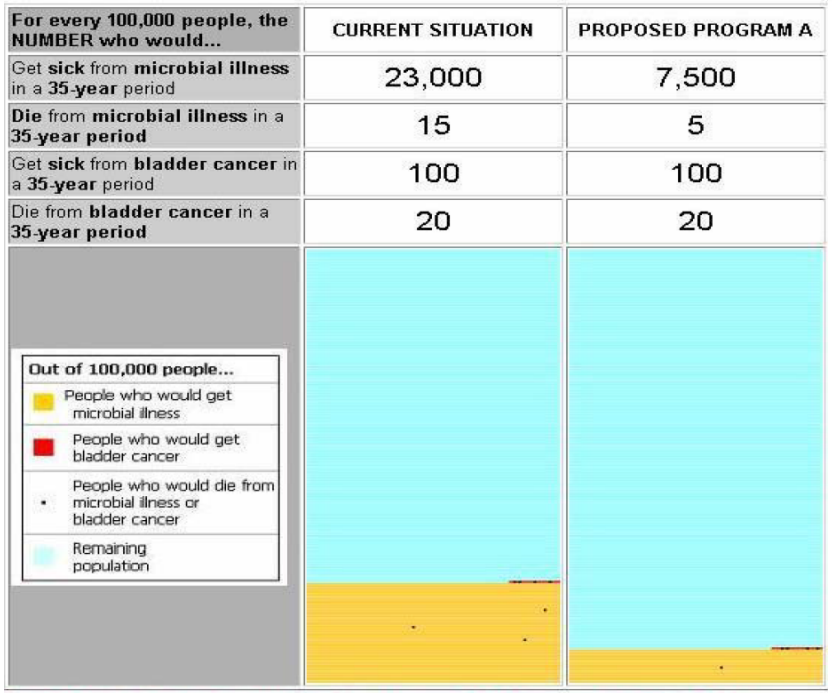


**Table 8. Value of Statistical Life and Value of Statistical Illness Calculations**

| | Conditional Logit Models[a] | | | WTP Space Models[a] | | |
|---|---|---|---|---|---|---|
| | V5 | V6 | V5 + V6 | V5 | V6 | V5 + V6 |
| Microbial death | **17,498,000** (4,510,100)[b] | **17,135,000** (4,333,800) | **17,634,000** (3,585,000) | **20,016,990** (4,988,558) | **21,953,310** (3,988,718) | **19,677,680** (5,206,360) |
| Microbial illness | **25,188** (4,291) | **18,591** (3,322) | **24,013** (3,124) | **34,269** (4,164,685) | **19,330** (3,867,622) | **31,248** (26,983) |
| Cancer death | **16,021,000** (4,057,400) | **8,538,000** (3,261,100) | **13,559,000** (2,785,800) | **16,691,720** (5,404,344) | **10,927,880** (4,331,812) | **15,408,610** (4,628,368) |
| Cancer illness | **2,539,900** (903,860) | **4,330,900** (943,830) | **2,952,400** (624,130) | **3,275,405** (5,978,036) | **4,908,321** (4,123,471) | **4,113,380** (4,685,878) |

Example: One of the 11,385 randomized choice sets. (Cameron and DeShazo, 2013)

Choose the program that reduces the illness that you most want to avoid. But think carefully about whether the costs are too high for you. If both programs are too expensive, then choose Neither Program.

If you choose "neither program", remember that you could die early from a number of causes, including the ones described below.

| | **Program A for Heart Disease** | **Program B for Colon Cancer** |
|---|---|---|
| **Symptoms/ Treatment** | Get sick when 71 years old<br>2 weeks of hospitalization<br>No surgery<br>Moderate pain for remaining life | Get sick when 68 years old<br>1 month of hospitalization<br>Major surgery<br>Severe pain for 18 months<br>Moderate Pain for 2 years |
| **Recovery/ Life expectancy** | Chronic heart condition<br>Die at 79 | Recover at 71<br>Die of something else at 73 |
| **Risk Reduction** | 5%<br>From 40 in 1,000 to 38 in 1,000 | 50%<br>From 4 in 1,000 to 2 in 1,000 |
| **Costs to you** | $15 per month<br>[ = $180 per year] | $4 per month<br>[ = $48 per year] |
| **Your choice** | **Reduce my chance of heart disease** | **Reduce my chance of colon cancer** |

**Neither Program**

# Valuation study for Canada's Chemicals Management Plan (Patterson et al, 2016)

EXHIBIT 1. ATTRIBUTES AND ATTRIBUTE LEVELS

| ATTRIBUTE | LEVELS |
|---|---|
| Persistence | Not Persistent<br>Persistent |
| Bioaccumulation | Does Not Bioaccumulate<br>Bioaccumulates |
| Environmental Impacts | No Impacts<br>Impacts Water Quality<br>Impacts Air Quality<br>Impacts Soil Quality |
| Toxic to Non-Human Organisms | No Effects<br>Toxic to Non-Human Organisms |
| Carcinogenic to Humans | Not Carcinogenic<br>Carcinogenic |
| Other Potential Health Effects on Humans | No Effects<br>Respiratory/Cardiovascular Effects<br>Reproductive Effects<br>Developmental Effects |
| Additional Cost Per Month | $0, $5, $30, $60, $90, $120, $150 |

# Results ($ per Household per Month)

EXHIBIT 25. CONDITIONAL LOGIT MODEL - IMPLIED WILLINGESS-TO-PAY TO AVOID ADVERSE EFFECTS OF CHEICALS

| Remove chemicals that .... | Implied WTP |
|---|---|
| ... are carcinogenic to humans | $49.23 |
| ... are toxic to non-human organisms | $41.06 |
| ... affect soil quality | $37.42 |
| ... affect water quality | $37.22 |
| ... affect air quality | $35.76 |
| ... are persistent in air water or soil | $28.83 |
| ... have adverse effects on the lungs, heart, or other aspects of the respiratory or circulatory systems in humans | $26.64 |
| ... bioaccumulate | $25.66 |
| ... adversely affect a person's ability to conceive a child by damaging reproductive organs or disrupting physiological processes related to reproduction | $23.73 |
| ... increase the likelihood of birth defects or adversely affect the normal growth and development of a human foetus or child | $17.54 |

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# What we need to do better: market valuation of chemicals policies

Opportunity costs of a ban: market net consumer and producer surplus and non-market value difference (accounting for substitutes)

- Don’t know the feasible set of substitutes
- Sometimes don’t know the health effects (let alone their value)
- Sometimes there are no approved options

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# What we mostly ignore

- Equity.
  - Describe
  - Inequality aversion
- Uncertainty In net benefits
- Benefits/costs to other countries:

  ➔ EPA RIA for CPP: 10/15:

# Inequality Aversion (Cropper et al, 2016)

- Assume an individual has a utility function defined over the distribution of health risks in a society.
- The Equally Distributed Equivalent risk (EDE) is the amount of risk which, if equally distributed, yields the same utility as the existing distribution of risk.
- For the Atkinson SWF over bads (Sheriff & Maguire):
  - *EDE = mean risk * (1+A')*, where *A'* is the Atkinson inequality index for health risks
  - *A'* can be interpreted as the proportionate increase in average risk a person would accept if the remainder were distributed equally

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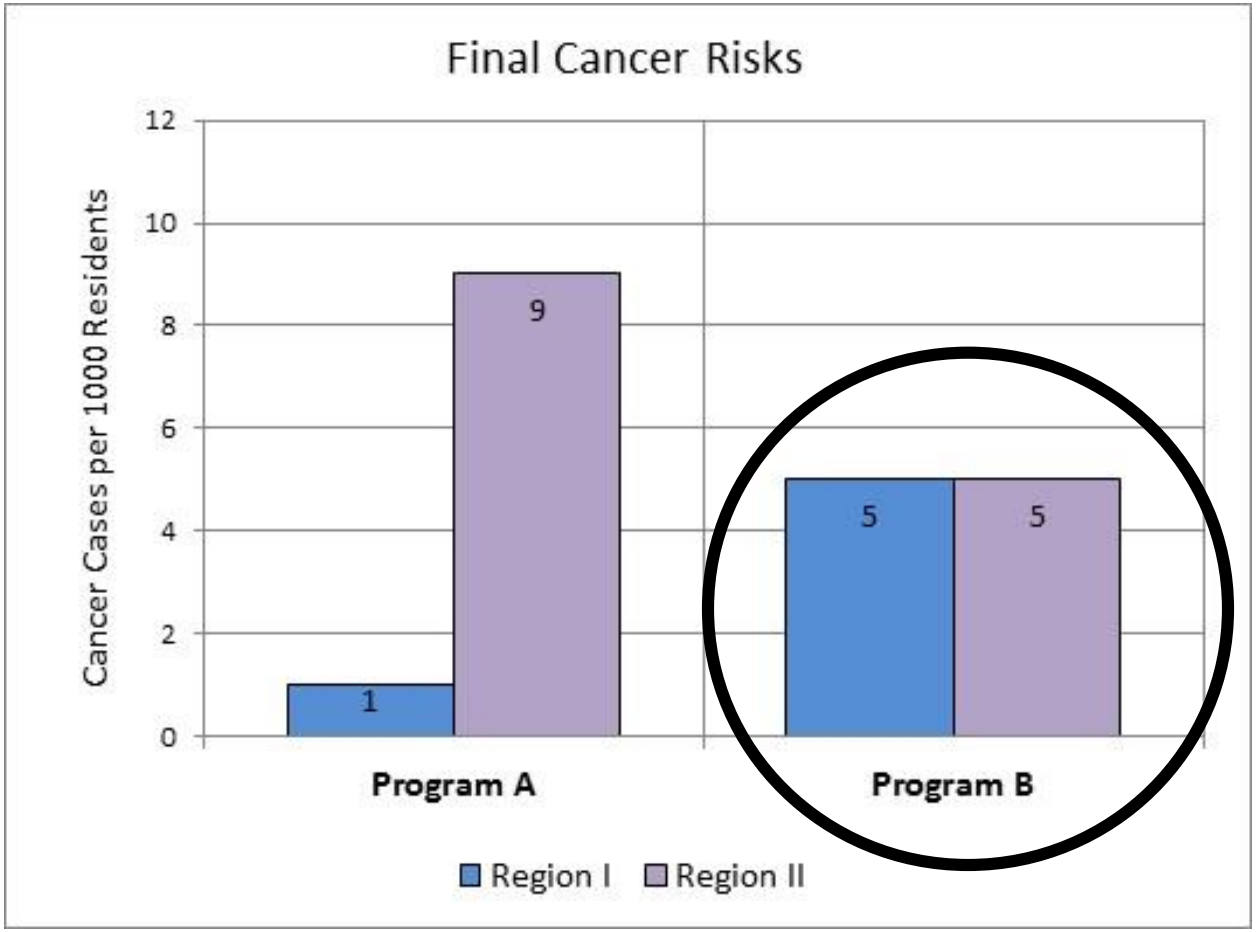


| | Program A | Program B |
|---|---|---|
| Final risk for Region I | 1 in 1000 | 5 in 1000 |
| Final risk for Region II | 9 in 1000 | 5 in 1000 |
| Total cancer cases per 1000 residents | 10 | 10 |

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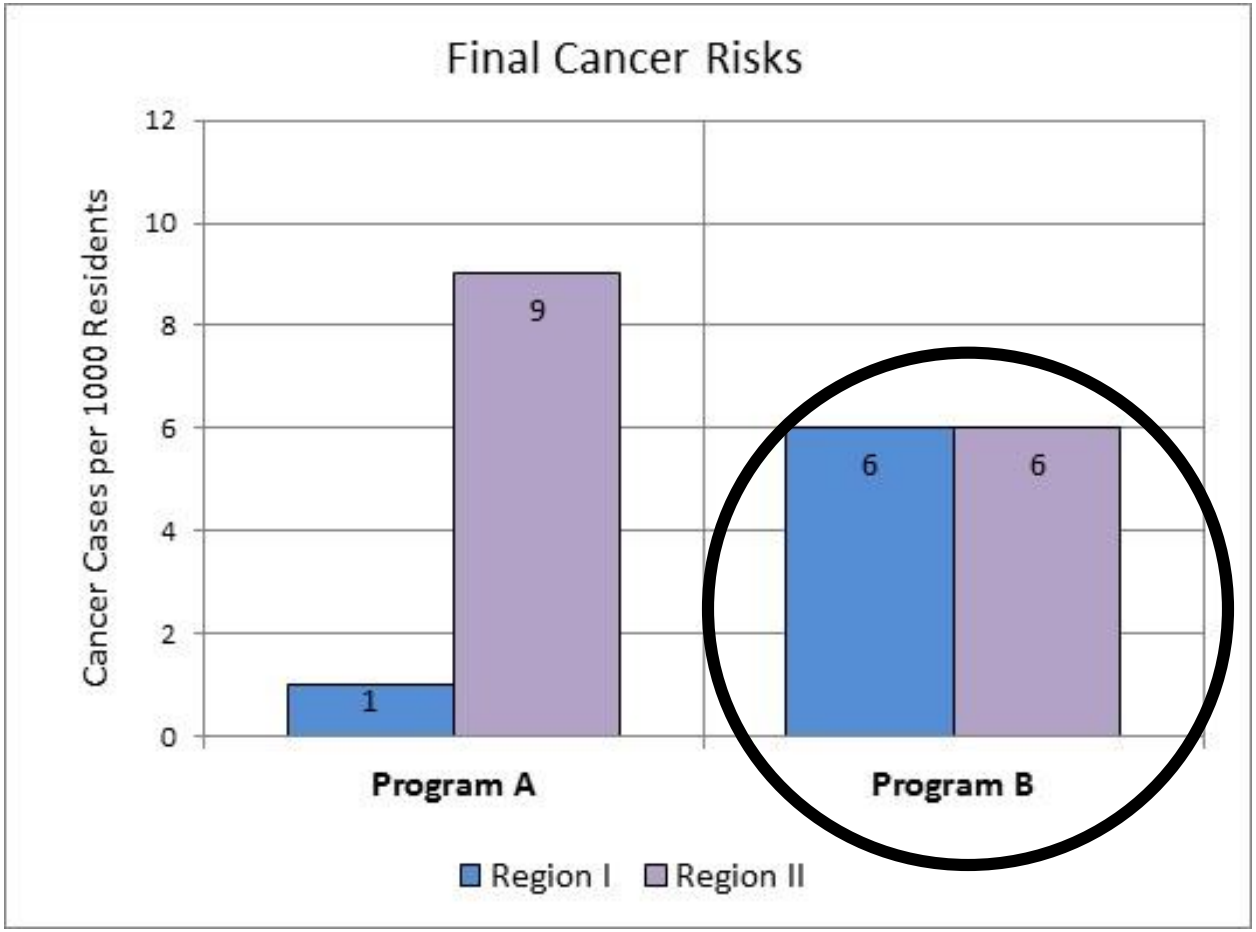


| | Program A | Program B |
|---|---|---|
| Final risk for Region I | 1 in 1000 | 6 in 1000 |
| Final risk for Region II | 9 in 1000 | 6 in 1000 |
| Total cancer cases per 1000 residents | 10 | 12 |

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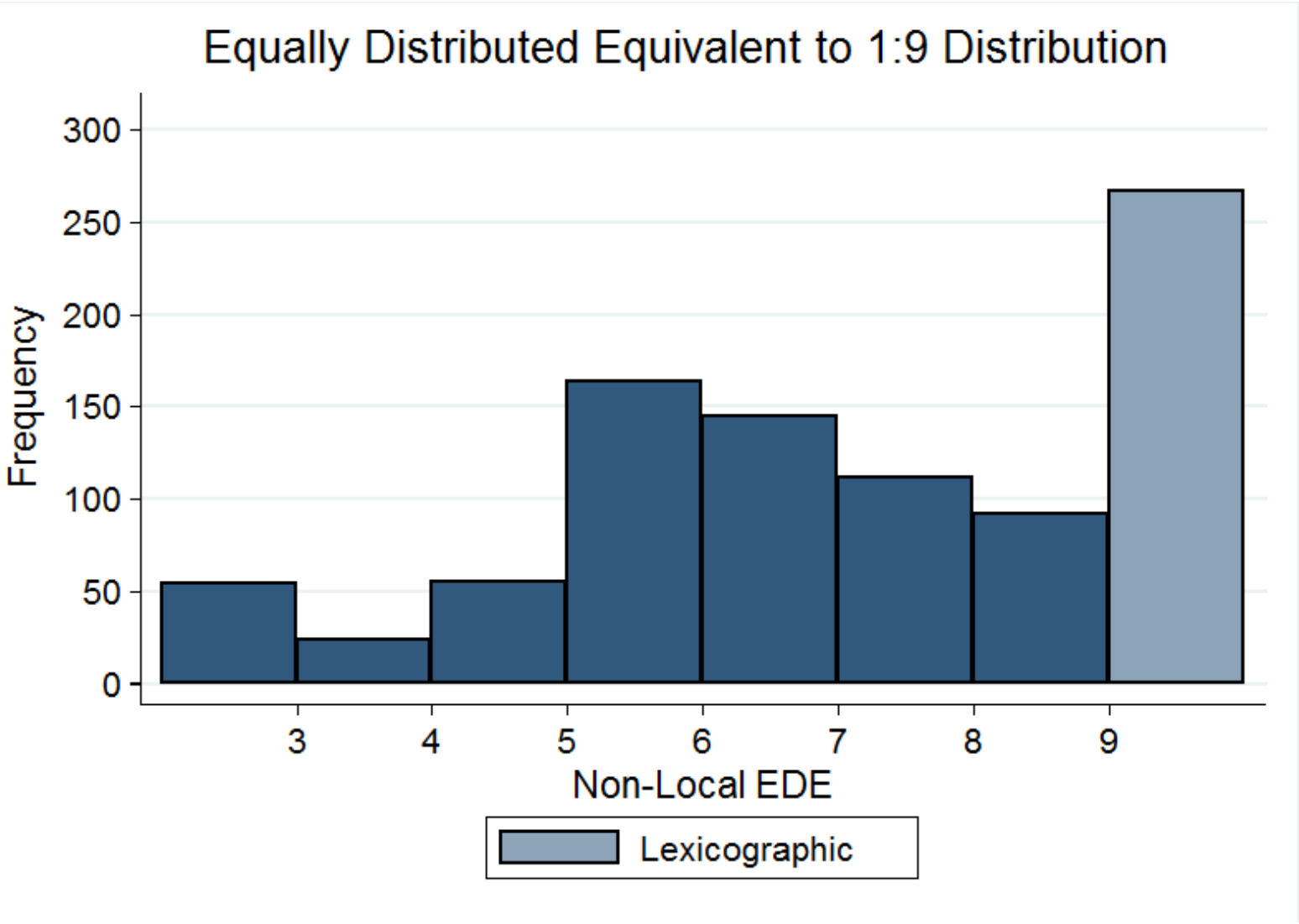
# Results


Equally Distributed Equivalent to 1:9 Distribution
Frequency
300
250
200
150
100
50
0
3
4
5
6
7
8
9
Non-Local EDE
Lexicographic

# Home on the range (Krupnick, Morgenstern, Nelson, 2005)

"A big  part of my frustration was that scientists would give me a range. And I would ask, 'please just tell me at which point you are safe, and we can do that.'  But they would give a range, say from 5 to 25 parts per billion (ppb).  And that was often frustrating."

*Christine Todd Whitman,*
*quoted in Environmental Science and Technology Online, April 20, 2005*

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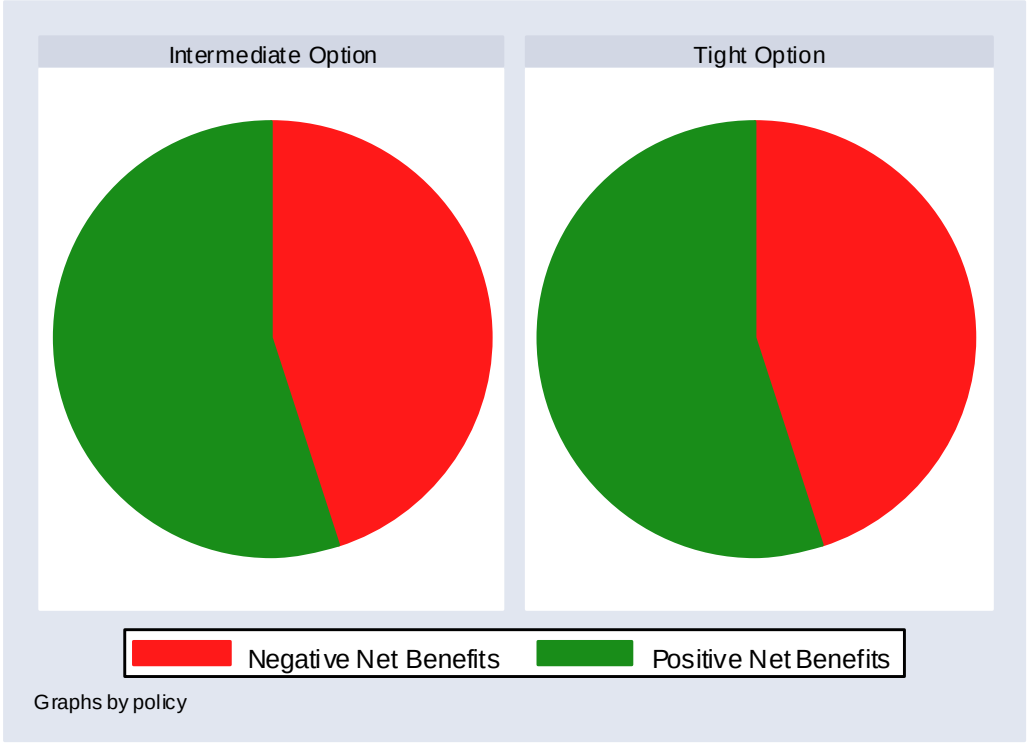
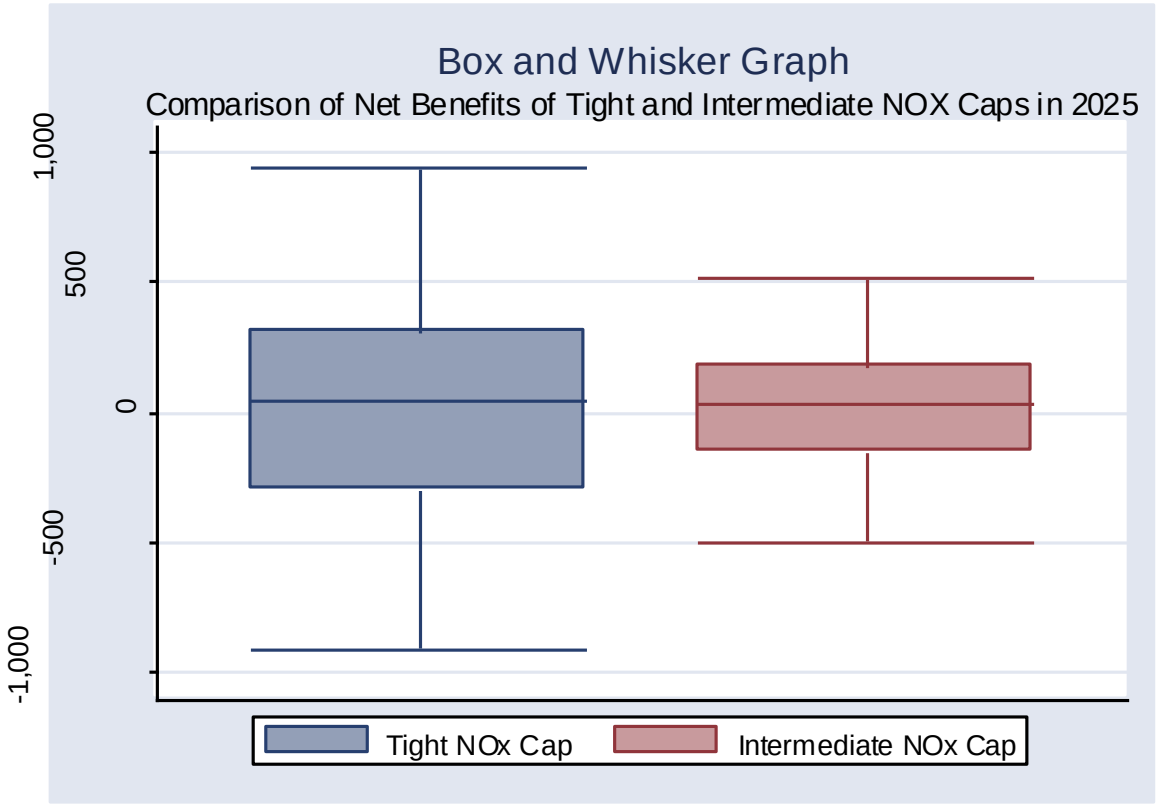
# FIGURE 1

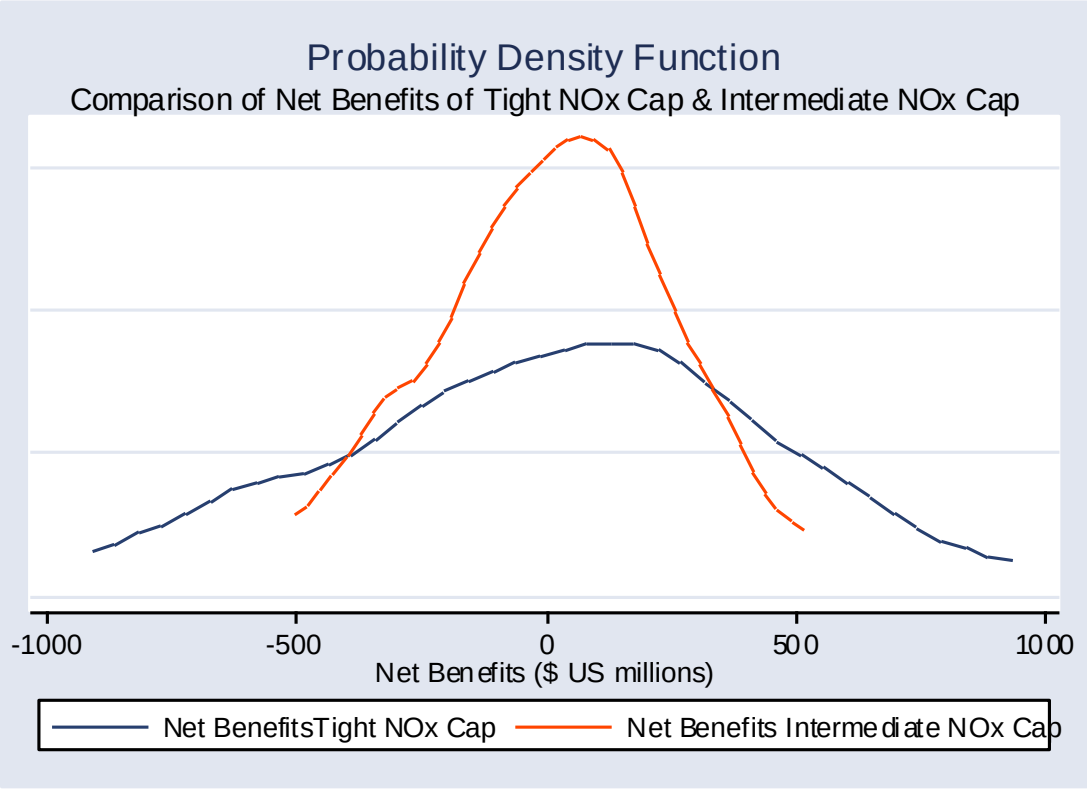
## Probability that Policies Produce Net Benefits in 2025
## Comparison of Tight and Intermediate NOx Caps



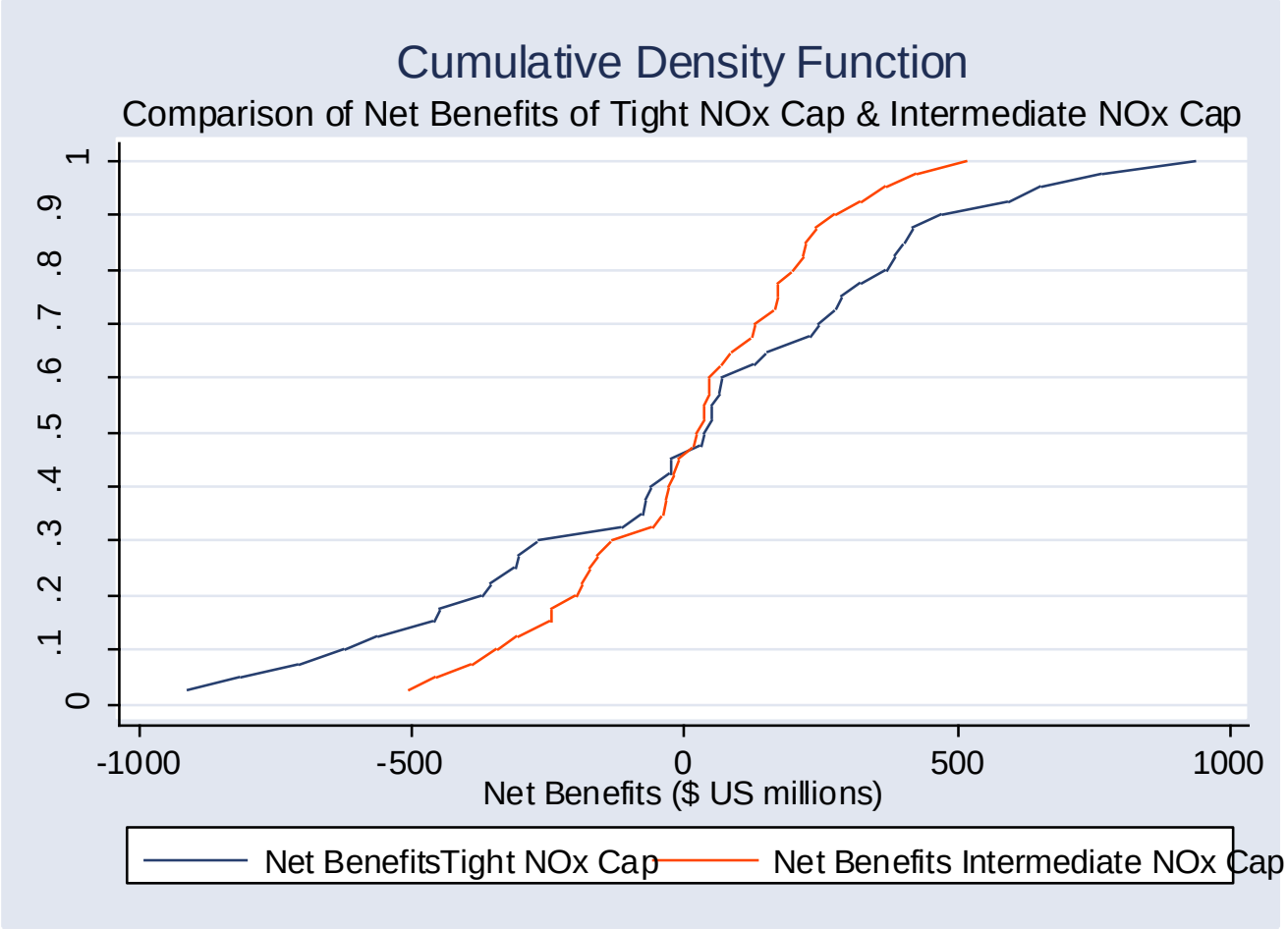
# FIGURE 2


Box and Whisker Graph
Comparison of Net Benefits of Tight and Intermediate NOX Caps in 2025
Millions of Dollars
1,000
500
0
-500
-1,000
Tight NOx Cap
Intermediate NOx Cap

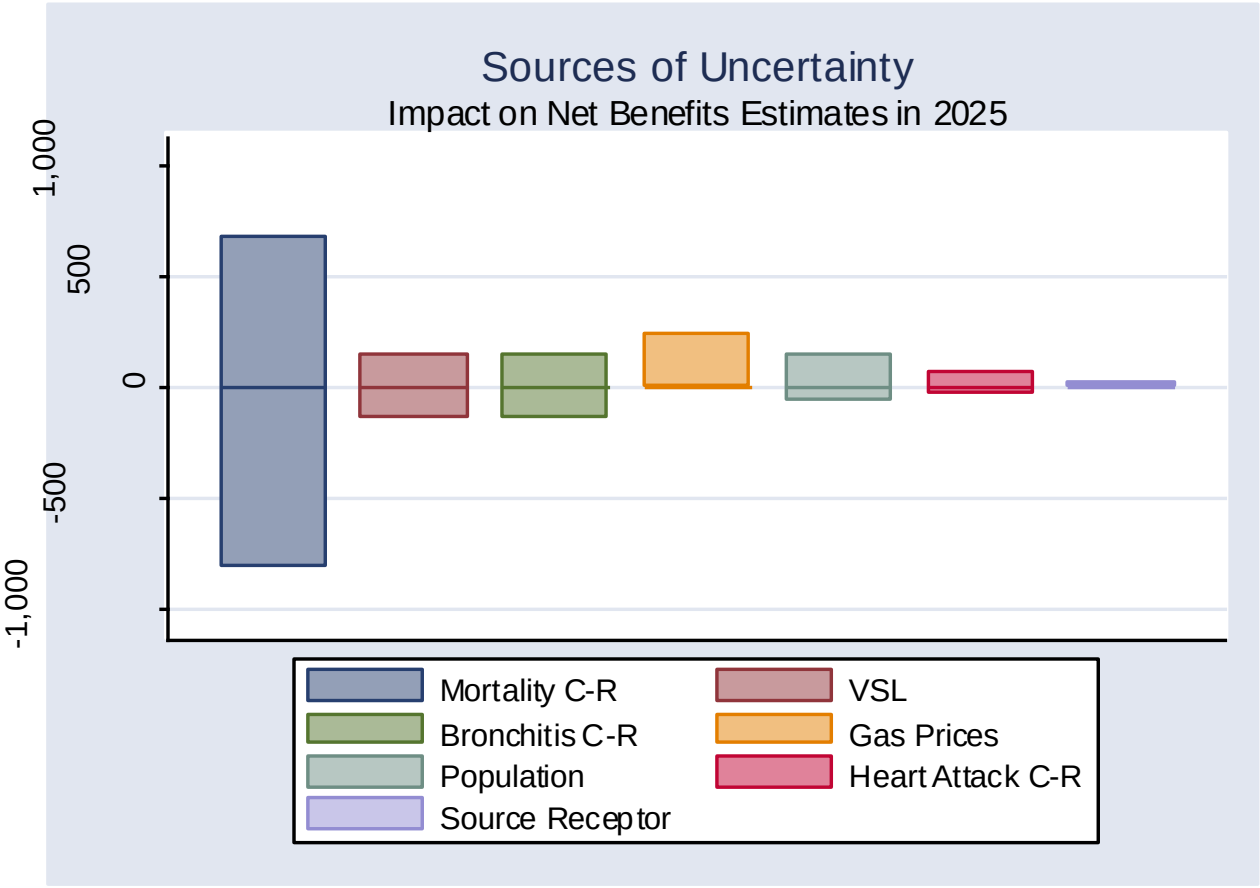
# FIGURE 3


Probability Density Function
Comparison of Net Benefits of Tight NOx Cap & Intermediate NOx Cap
-1000
-500
0
500
1000
Net Benefits ($ US millions)
Net BenefitsTight NOx Cap
Net Benefits Intermediate NOx Cap

# FIGURE 4


Cumulative Density Function
Comparison of Net Benefits of Tight NOx Cap & Intermediate NOx Cap
Cumulative Density
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
-1000
-500
0
500
1000
Net Benefits ($ US millions)
Net BenefitsTight NOx Cap
Net Benefits Intermediate NOx Cap

# FIGURE 5


Sources of Uncertainty
Impact on Net Benefits Estimates in 2025
Millions of Dollars
1,000
500
0
-500
-1,000
Mortality C-R
Bronchitis C-R
Population
Source Receptor
VSL
Gas Prices
Heart Attack C-R

# Communicating uncertainty - conclusions

- Pdf preferred
- CDF did not fare well
- Tables preferred over box and whisker
- Sources of uncertainty not of equal weight
- Preference for CEA or even discussion

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# RIA for CPP (EPA, 2015)

**Table ES-9. Monetized Benefits, Compliance Costs, and Net Benefits Under the Rate-based Illustrative Plan Approach (billions of 2011$) [a]**

| | Rate-Based Approach | | |
|---|---|---|---|
| | **2020** | **2025** | **2030** |
| **Climate Benefits [b]** | | | |
| 5% discount rate | $0.80 | $3.1 | $6.4 |
| 3% discount rate | $2.8 | $10 | $20 |
| 2.5% discount rate | $4.1 | $15 | $29 |
| 95th percentile at 3% discount rate | $8.2 | $31 | $61 |

| | Air Quality Co-benefits Discount Rate | | | | | |
|---|---|---|---|---|---|---|
| | 3% | 7% | 3% | 7% | 3% | 7% |
| **Air Quality Health Co-benefits [c]** | $0.70 to $1.8 | $0.64 to $1.7 | $7.4 to $18 | $6.7 to $16 | $14 to $34 | $13 to $31 |
| **Compliance Costs [d]** | $2.5 | | $1.0 | | $8.4 | |
| **Net Benefits [e]** | $1.0 to $2.1 | $1.0 to $2.0 | $17 to $27 | $16 to $25 | $26 to $45 | $25 to $43 |

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Domestic SCC: 7-23% of global value

# What “we” do but shouldn’t

- “We do so little, so we better keep doing it.” Arthur Fraas, formerly of OMB

- RP dominant over SP (a US problem)
- Casual approach to “unknown costs”

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# “Process” recommendations/suggestions

1. Need clear decision rules for CBA and legislative requirements where necessary.  EO12291 issue
2. Outside peer review; linking to literature; raising standards to academic levels
3. CBA early in process even dictating info needed (matching RA)
4. Expand set of policy options
5. More money for analysis
6. Emphasize best estimates (not worst cases) of physical consequences and also emphasize CEA in certain cases
7. More retrospective analyses

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# Triumphs and Troubles

Triumphs

- BCA becoming ever more legitimate within governments
- Health valuation becoming more legitimate – primarily because of huge valuation benefits – environmental community sold
  - BUT: Health science community is a tough sell

Troubles

- Continued Issues with VSL/VSLY in many directions
- Equity
- Institutional Issues
- tribulation

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Questions?  Contact Krupnick@RFF.org

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