

Are Decisionmakers at Home on the Range? Communicating Uncertainties in Regulatory Impact Analyses

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Expert Judgment Workshop

March 13, 2006

“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*

Why Introduce Uncertainty in Regulatory Analyses?

- OMB says so: Circular A-4 calls for incorporating uncertainty in RIAs (\$1 billion or more in cost) (Monte Carlo simulation)
- Permits more explicit judgment about risk aversion
- Eliminates false sense of security with point estimates
- Introduces more transparency to public
- Help guide research priorities (VOI)

State of Play

- EPA already active in this area: SAB, 812 studies, various RIAs, although significant shortcomings remain
- But less activity in examining communicating uncertainty to DMs
- NRC, SAB and others calling for more and better treatment of uncertainty

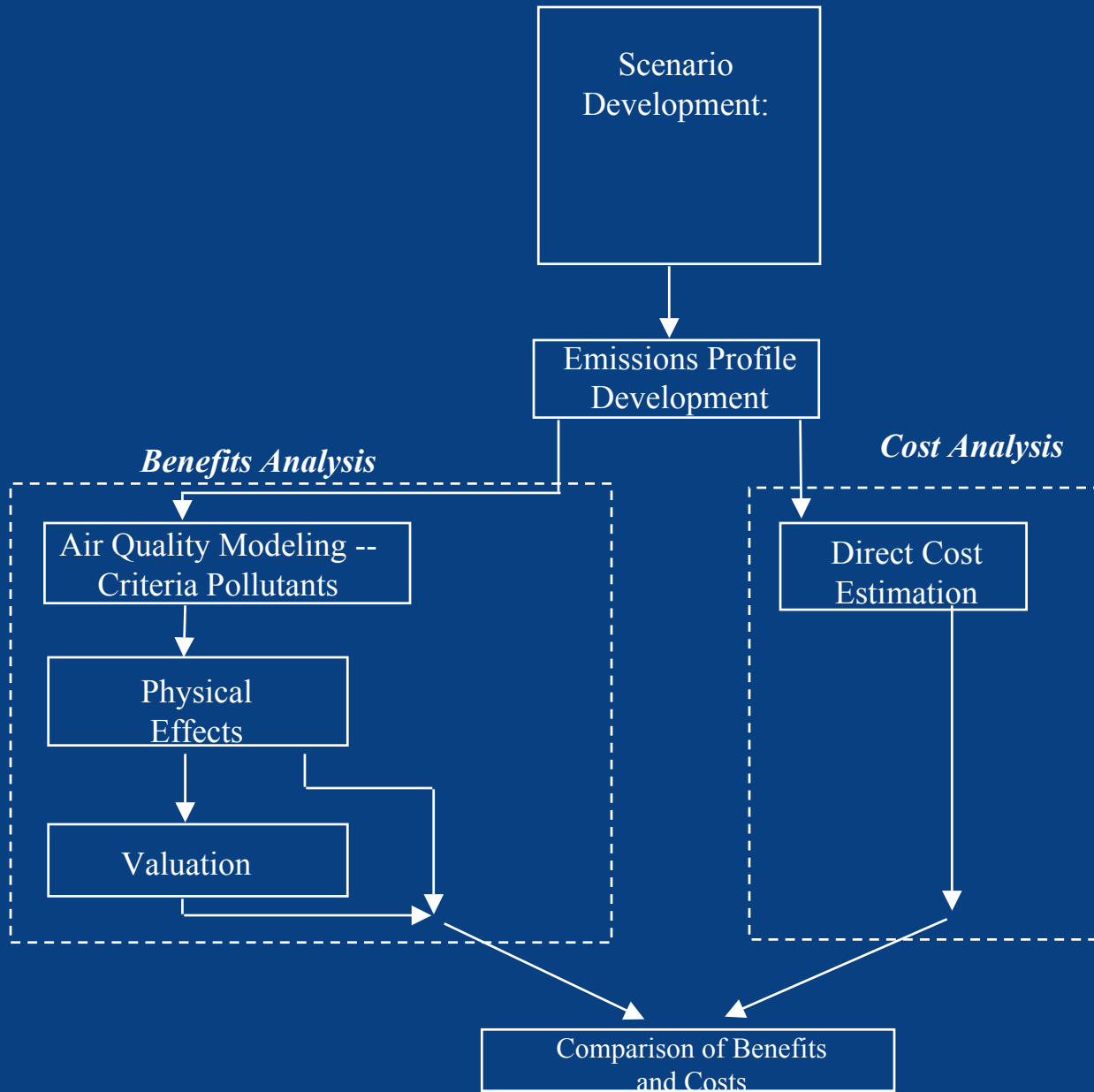
Our Motivation

- Even though trends in analytical techniques and software making it easier to incorporate uncertainty in regulatory analyses...
- Better, more complete (and more complex) information can confound and paralyze rather than improve decisions.
- So improvements in capturing uncertainty analytically must be matched with improvements in communication

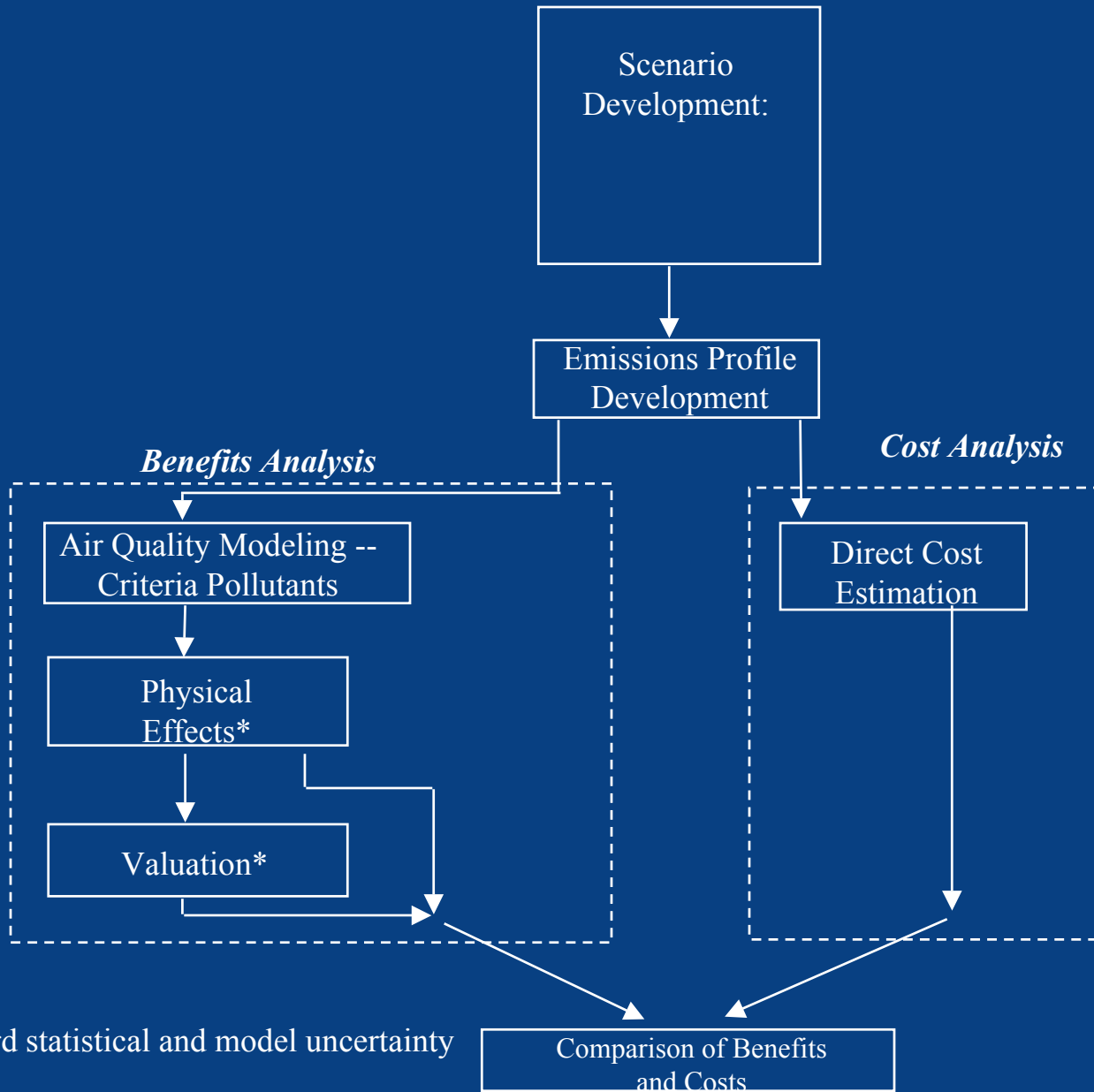
What we did

- Developed detailed analytical case study pushing the “frontier” of RIAs
 - Addressed statistical uncertainties in “standard” and new areas, including both cost and benefit sides
 - Quantified model uncertainties
- Communicated results to seven high level ex-EPA DMs

ANALYTIC SEQUENCE FOR RIAs

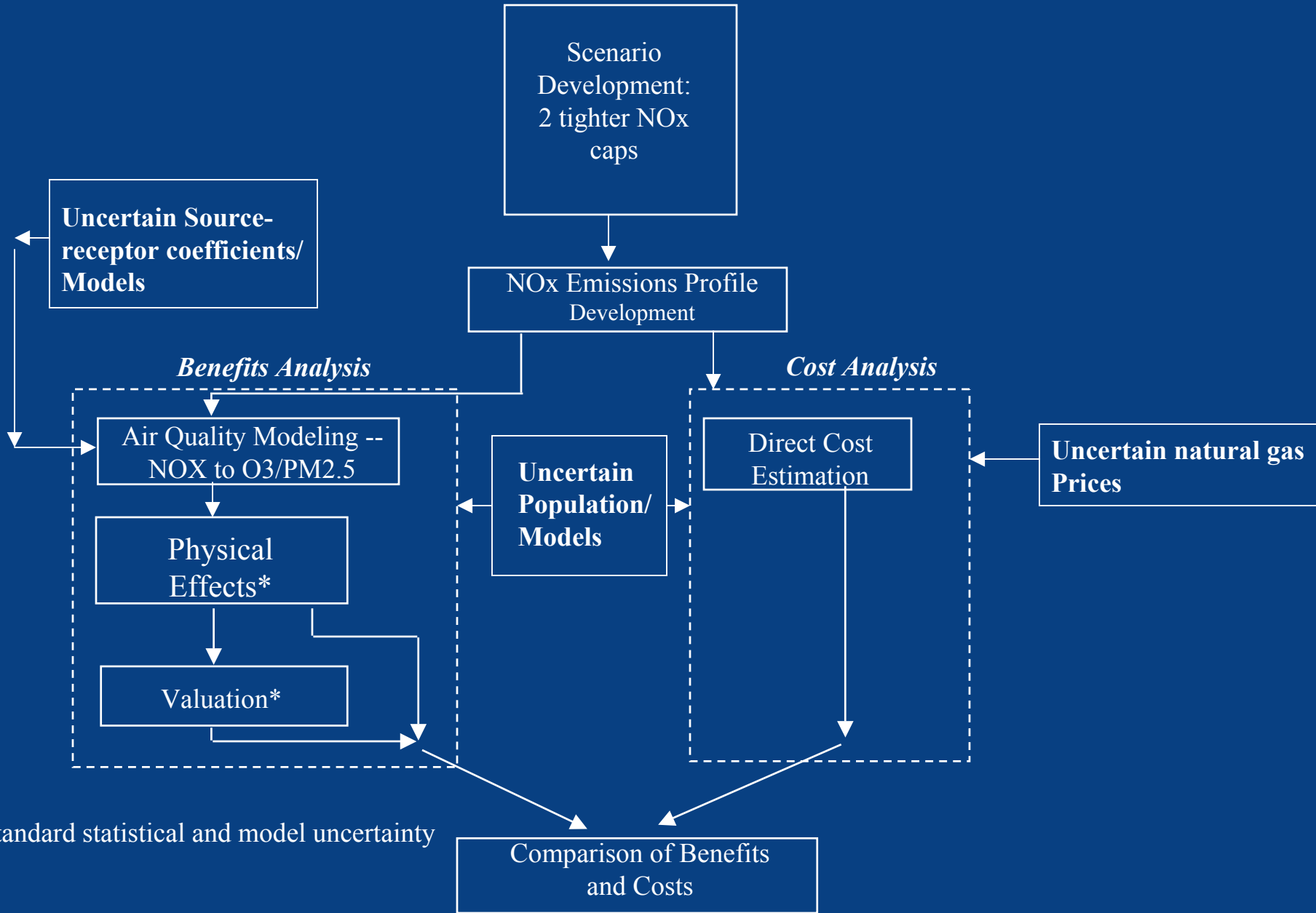


ANALYTIC SEQUENCE FOR RIAs

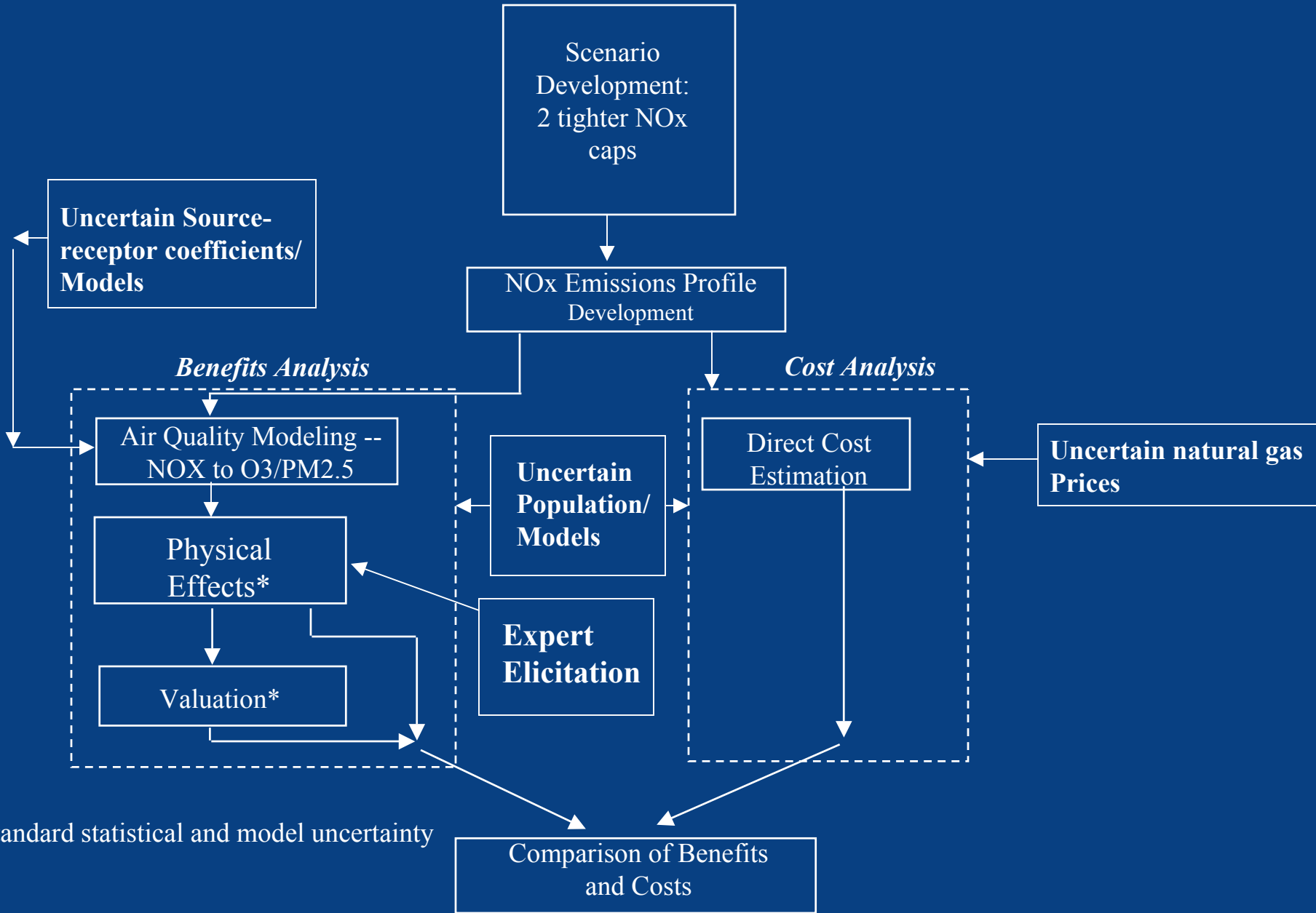


* Standard statistical and model uncertainty

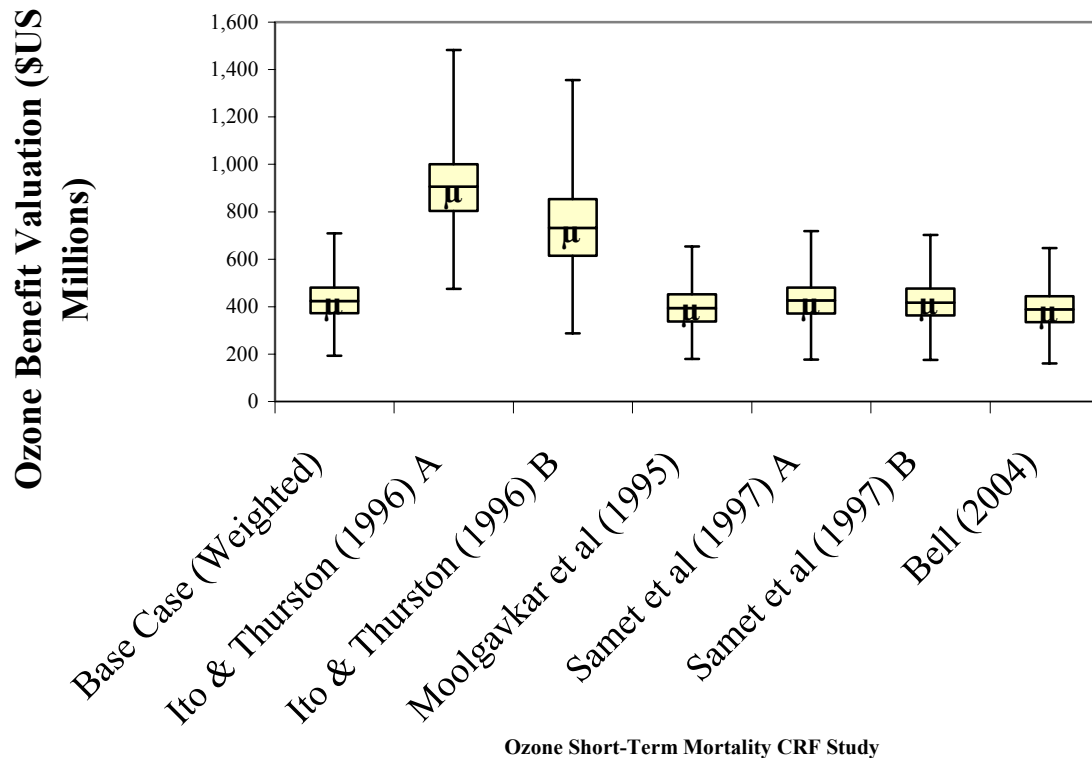
ANALYTIC SEQUENCE FOR CASE STUDY



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2025 – Benefits of Large NO_x Reduction Policy From CAIR Baseline Using Alternative Ozone Mortality Concentration Response Functions



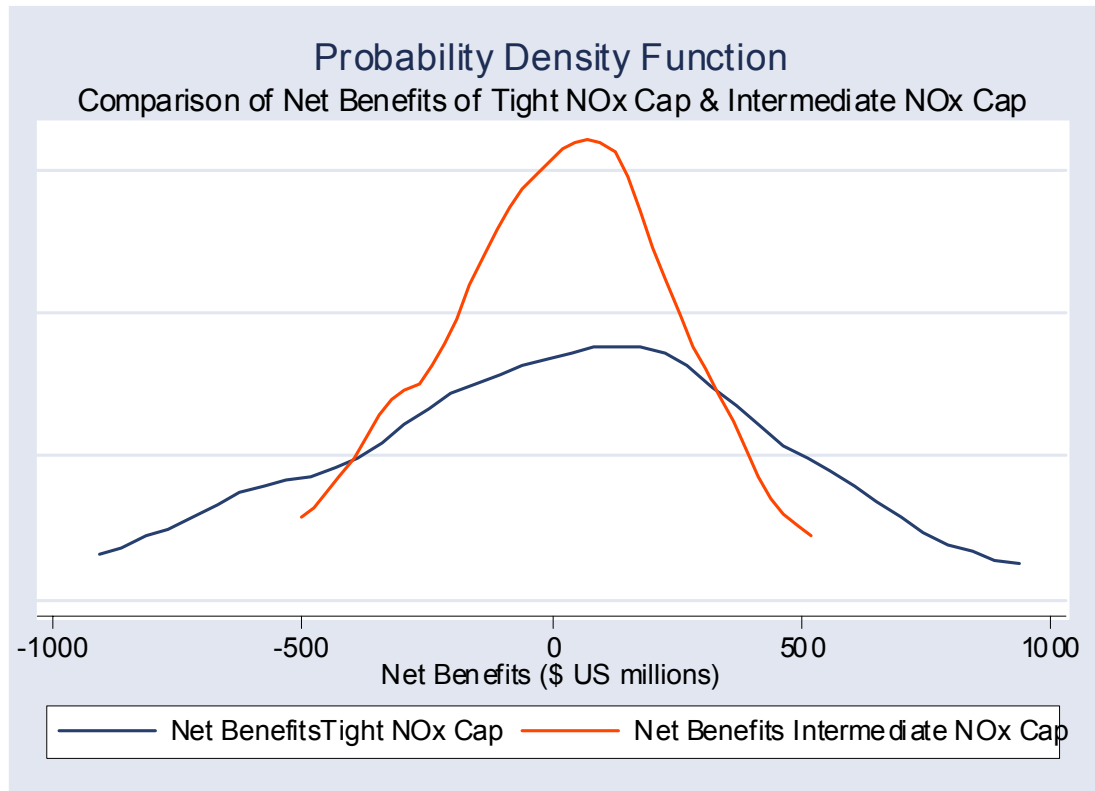
Literature Review on Communicating Uncertainty to DMs

- Large body of research contradicts principle of decision invariance (different representations of the same problem should yield the same preferences) (Tversky and Kahneman)
- Some research shows that presenting uncertainty can cause people to discount the entire analysis (“ambiguity avoidance”).
- Experts have been shown to be as susceptible to these problems as the general public.

Literature on Visual Presentations

- Bar graphs lead to less bias than pie charts and symbols (USA Today)
- Graphics tend to make respondents more risk averse than numeric presentations (pdf's: greater focus on the tails)

FIGURE 3



Interviews with Former EPA DMs

- 7 former DAs, AAs interviewed, using simplified version of case study
- Each choice (tight cap, intermediate cap, do nothing) picked by at least one DM
- Two favored tight option, one favored doing nothing; three favored the intermediate option; one ruled out the do nothing option and said to decide he would need more info.
- All said an uncertainty presentation was useful and helped them get an idea of the confidence they should have in their decision and better prepare them to defend against critics.

Findings

- Different DMs have different learning styles, but...all wanted more info for a “real” decision → Present technical information in context
- Tables OK
- PDF a preferred graphic
 - but may push to intermediate option
 - permits thoughtful discussion
- Some felt in real life they got analyses with pre-ordained outcome
- They often “don’t know what they don’t know”

TABLE 1

	Comparison of Tight NOx Cap and Intermediate NOx Cap Policies					
	Averted Physical Impacts in 2025					
	Tight NOx Cap			Intermediate NOx Cap		
	Mean	95% CI lower bound	95% CI upper bound	Mean	95% CI lower bound	95% CI upper bound
Mortality	466	122	810	254	65	443
Cardiovascular Hospital Admissions Admissions/Year	409	47	771	230	27	434
Non-Fatal Heart Attacks Cases/Year	995	338	1652	543	187	900
Respiratory Hospital Admissions Admissions/Year	2611	1550	3672	841	512	1169
Cardiovascular Hospital Admissions Admissions/Year	338	204	471	197	123	272
Asthma Emergency Room Visits/Year	598	358	838	265	150	380
Cost (millions \$)	1340			710		

TABLE 2

	Comparison of Tight NOx Cap and Intermediate NOx Cap Policies					
	Net Benefits in 2025					
	Tight NOx Cap			Intermediate NOx Cap		
	Mean	95% CI lower bound	95% CI upper bound	Mean	95% CI lower bound	95% CI upper bound
Total Benefits (\$ US millions)	1351	509	2194	720	255	1184
Costs (\$ US millions)	1340			710		
Net Benefits (\$ US millions)	11	-831	854	10	-455	474

FIGURE 1

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

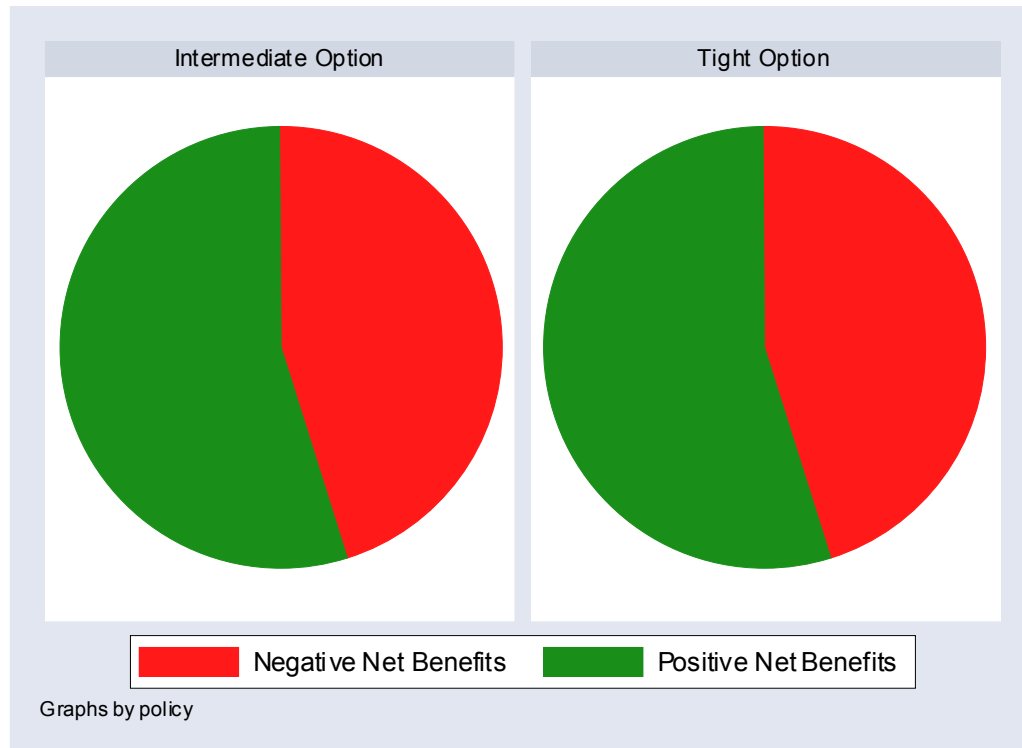


FIGURE 2

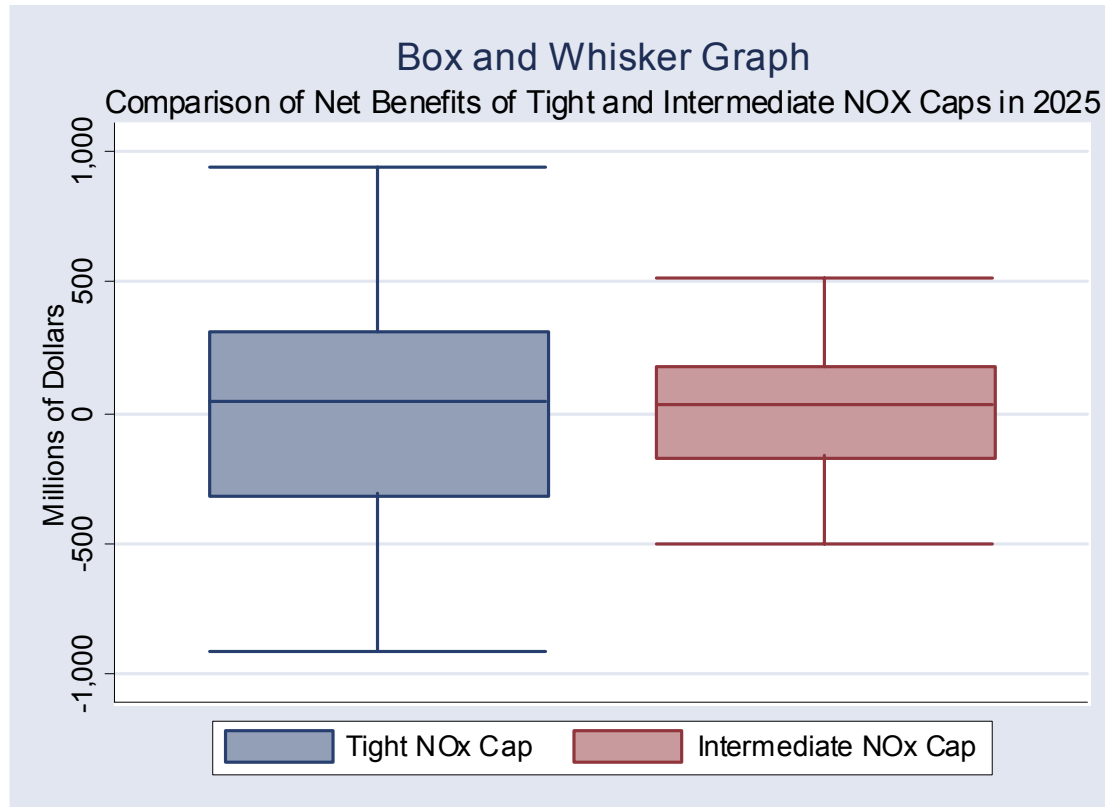


FIGURE 3

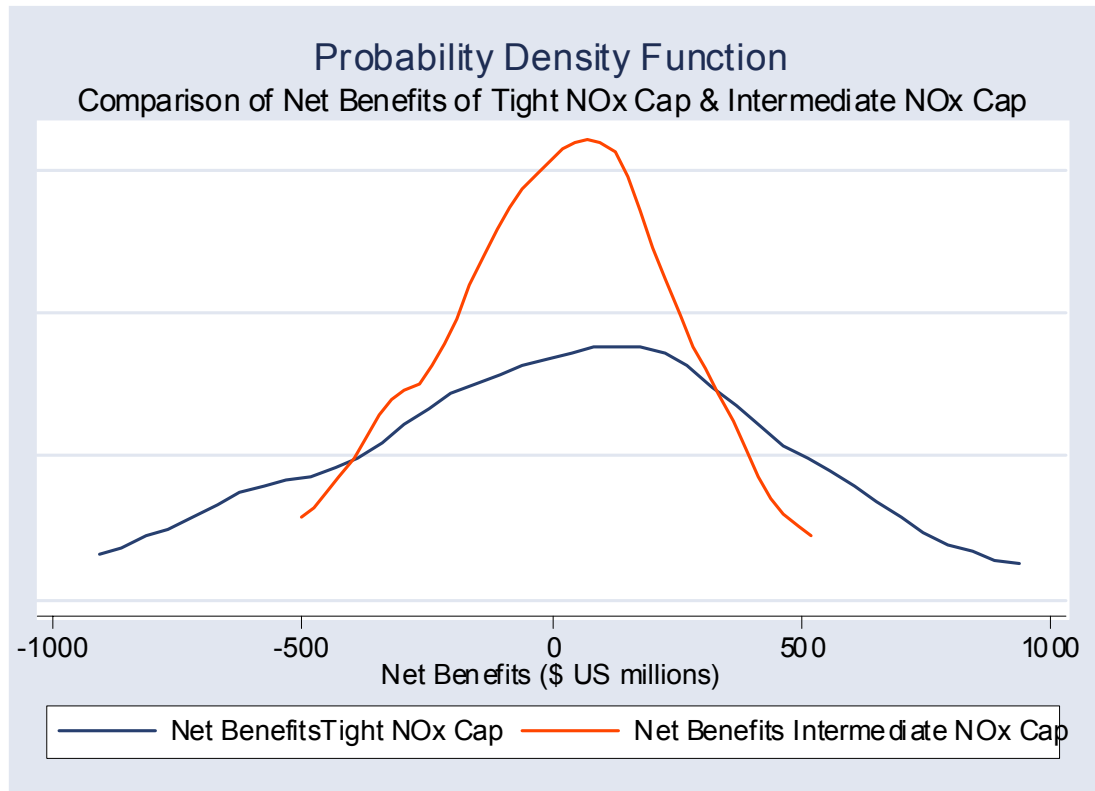


FIGURE 4

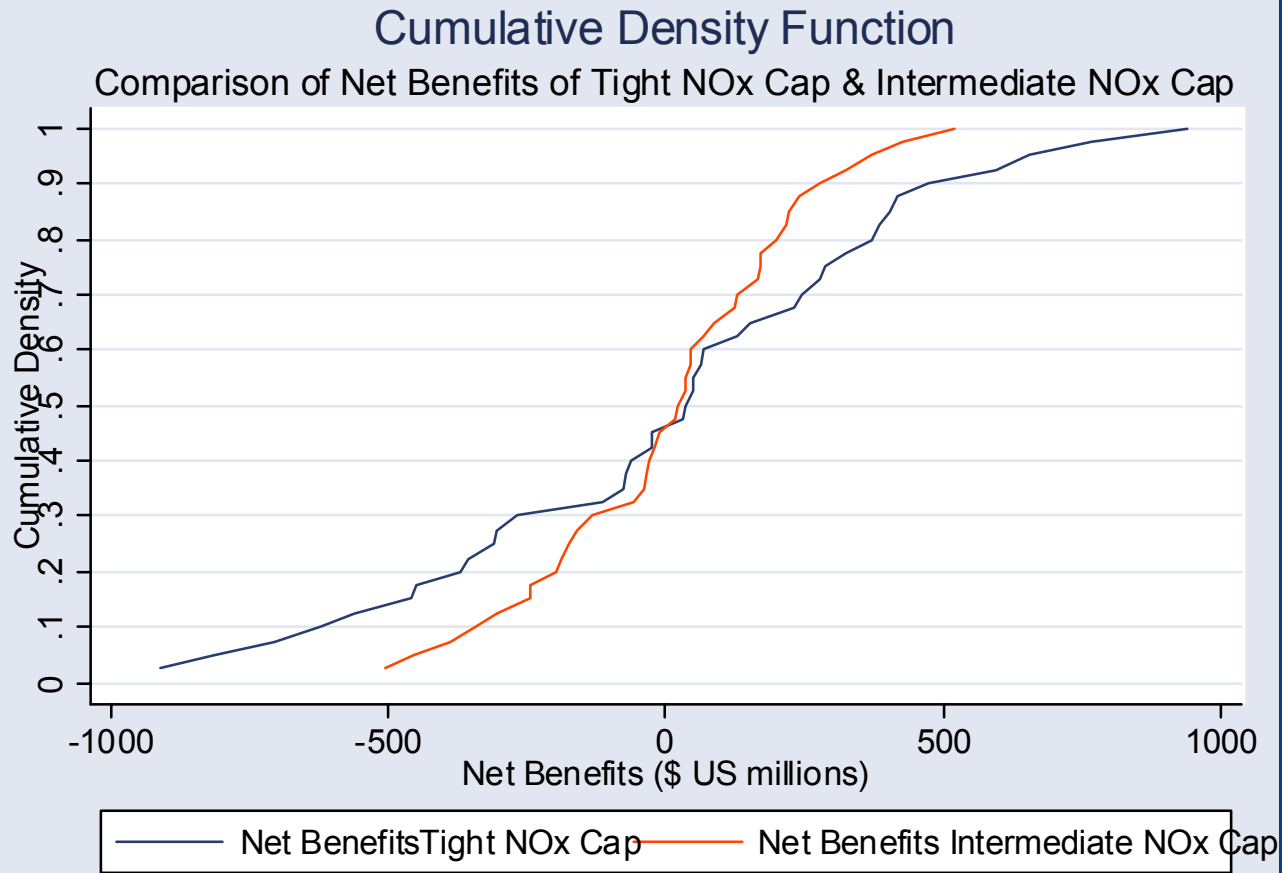
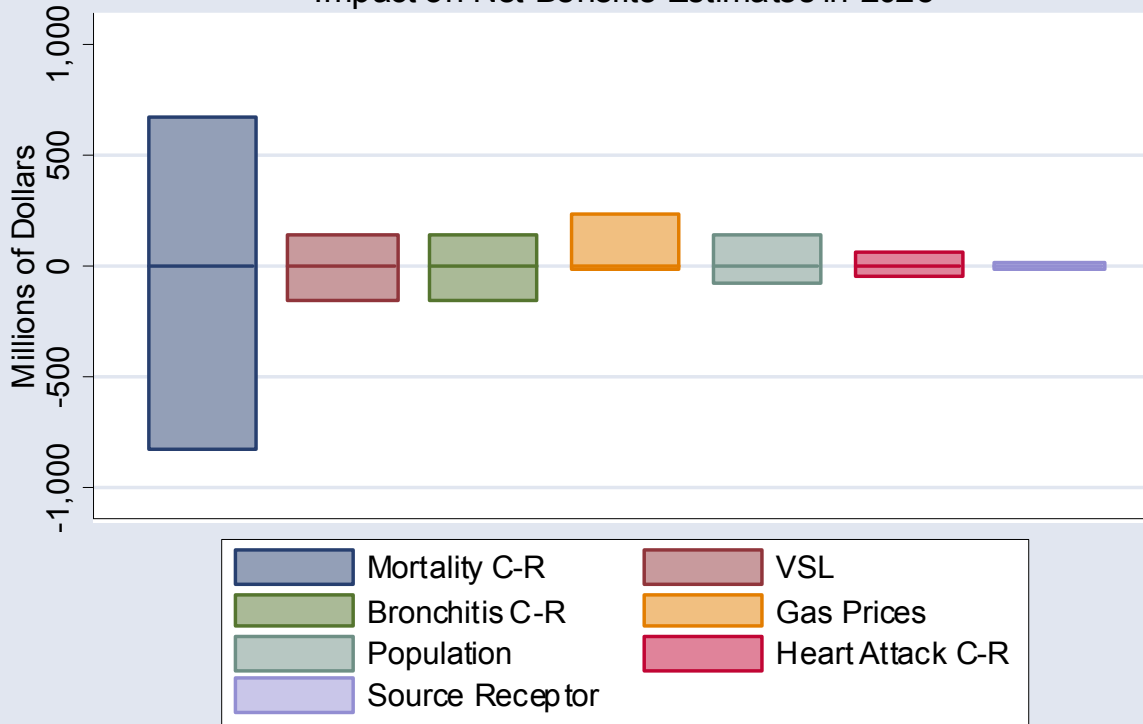


FIGURE 5

Sources of Uncertainty Impact on Net Benefits Estimates in 2025



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To Do Better

- Develop internal processes for insuring unbiased presentation of results
- Have SAB/OMB develop detailed approaches
 - Form for pros and cons
- Need research on data reduction step
- Need more research on communicating to DMs (N>7, more systematic empirical treatment)
- Training DMs