Environmental Costs of Aviation: Review of Literature

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Motivation

- Aviation brings benefits to the economy
- … but also puts pressure on the environment .. Costs!
- Policy makers need a common basis to compare …..
  - Benefits of aviation with costs
  - Mitigation opportunities within aviation sector
  - Costs of different transport modes
  - Mitigation opportunities between different modes

  ……. such that *efficient* decision can be made
- The common basis is often in monetary terms

Objective

Omega

- To review existing literature to better understand the methods to determine aviation's environmental costs
- To review the range of the published costs
- To review damages per unit exposure and costs per unit damage
- To identify major cost items

PARTNER

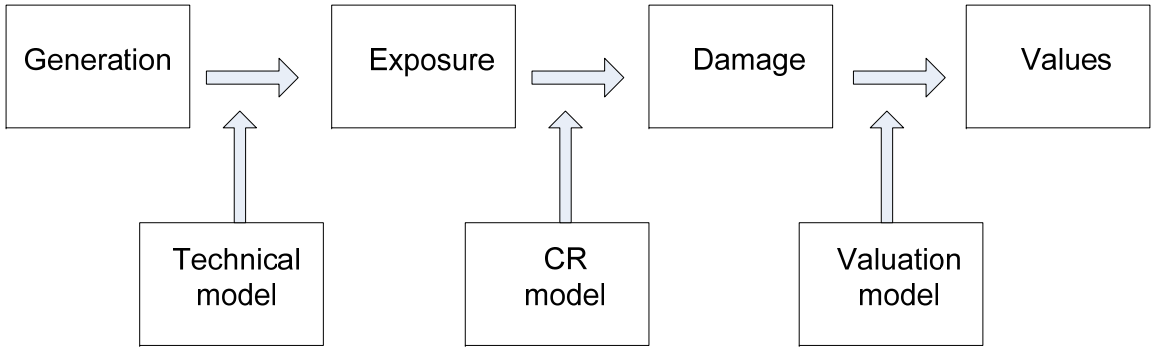
- To compare environmental costs of aviation with other modes of transportation

Scope

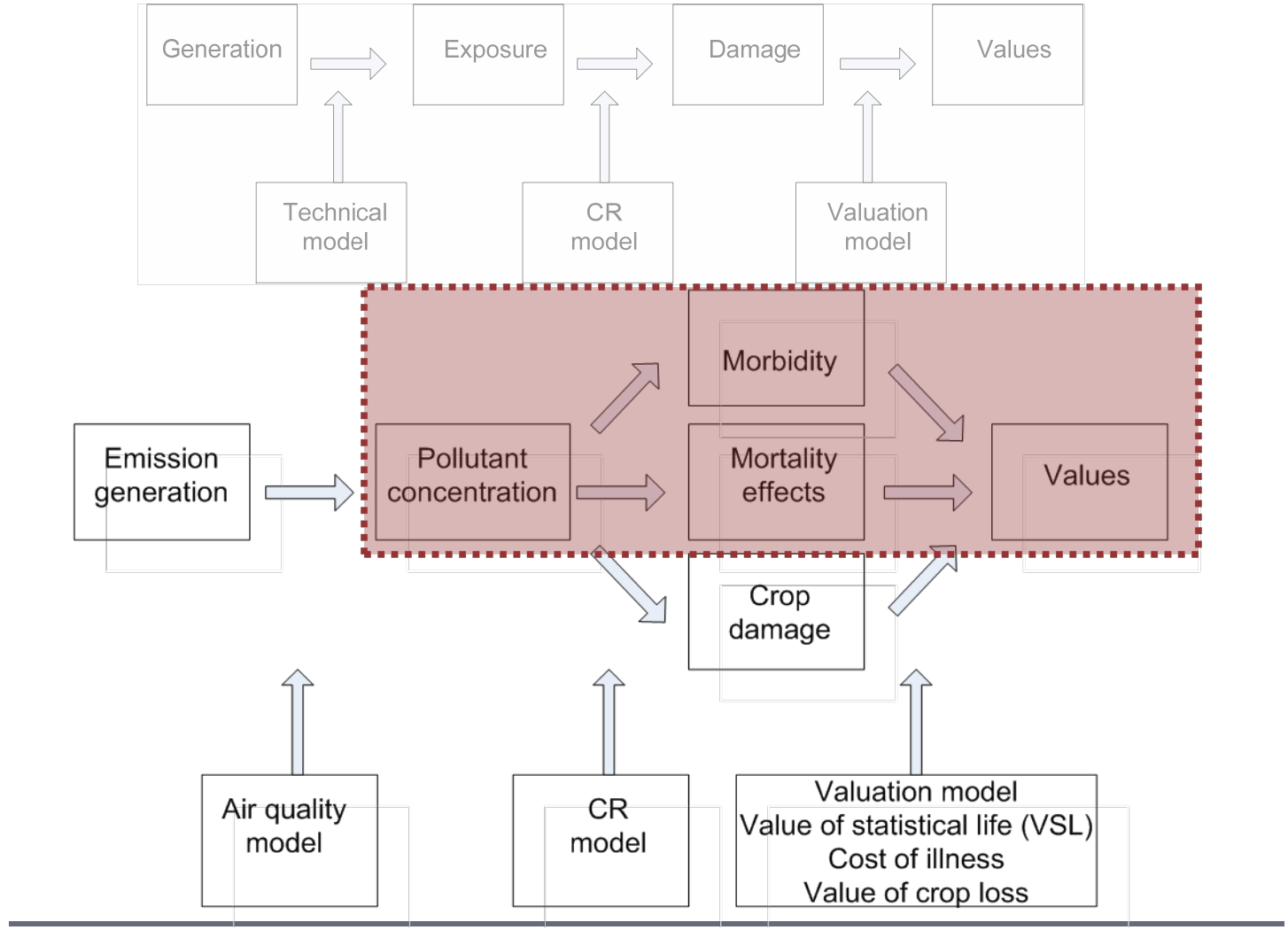
- Climate change
- Noise
- Air Pollution
  - Local (LTO)
  - Regional (non-LTO)
- Others:
  - Visual intrusion
  - Land degradation
  - Water pollution

Valuation Methods

- Different methods
- Top-down (allocation of national costs)
- Bottom-up (impact pathway) => Better approach



Valuation Methods: Example



Published Costs

- Beware: Marginal vs. Average Costs
- Air pollution: Marginal ≈ Average
- Noise: Marginal < Average
- Whether marginal or average, depends on context

Published Costs

- Noise no longer the dominant cost item
- Air pollution costs same order of magnitude as noise
- Quieter aircrafts & higher health effects
- Climate change costs: at least an order of magnitude higher than health or noise costs

Study	Year	Noise	Local Air Quality	Climate Change
INFRAS, EU17, 2000 €	2000	3100M	4235M	11419M-79931M
DfT, UK, 2000 £	2000	25M	119-236M	1400M

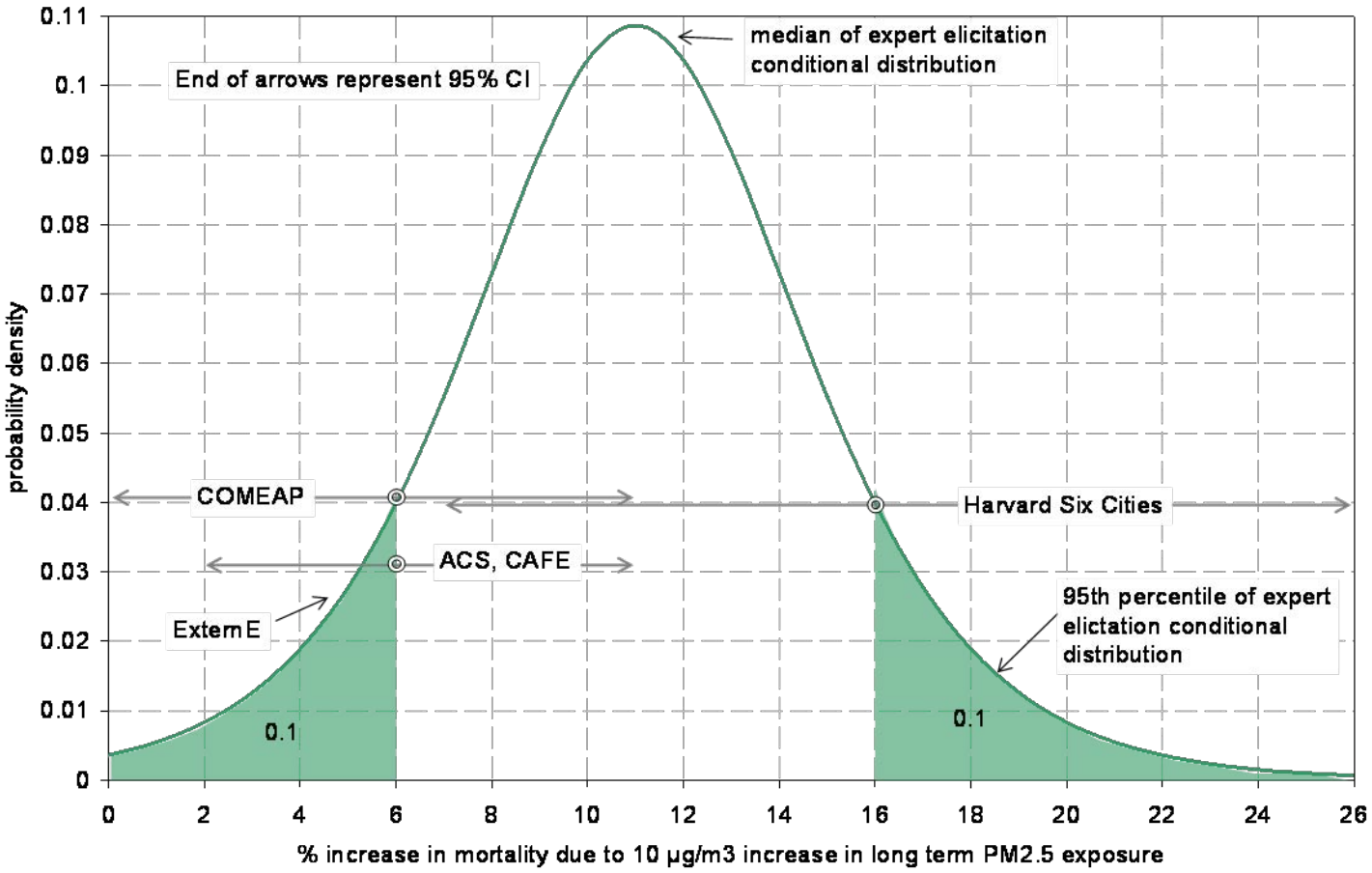
- Uncertainties?

Major Air Pollution Costs

- Premature mortality major cost: 85%-95% of health costs
- Two different methods of valuation: Loss of Life Year and Deaths Attributable (factor of 4 difference in UK)
- The method has consequence on policy decisions !!
- Rather large uncertainty on mortality valuation (factor of 10 or more)
- Chronic Bronchitis and Myocardial Infarctions next two important cost items
- These three items capture the pollution related costs
- Add? Material damage costs

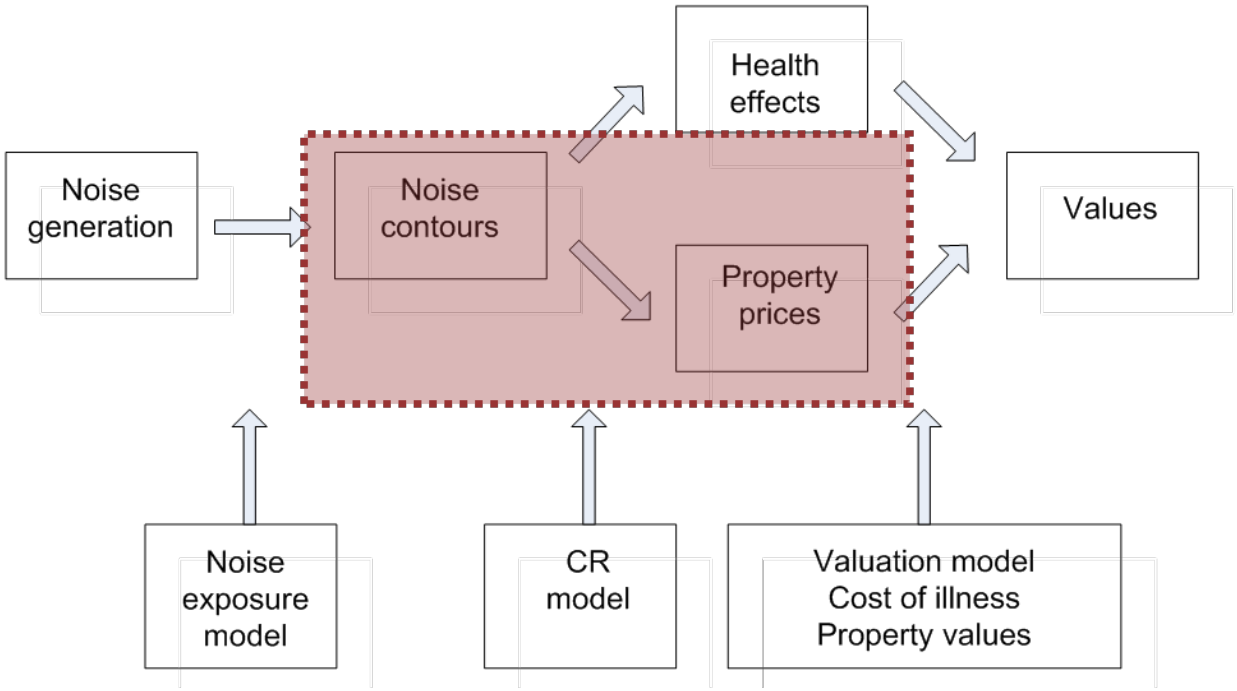
Air Pollution C-R

Premature mortality:



Major Noise Costs

- Property price devaluation



Major Noise Costs

- Property price devaluation
- Range of Noise Depreciation Indices (NDI): 0% to 2.3%
- Meta-Analysis undertaken using 56 NDI estimates
- Functional form and property prices significantly influence reported NDI estimates

$$NDI = 0.367 + 1.49\times10^{-6}\times\text{Property Price} \quad [+ 0.184 \text{ Canada}]$$

(0.119) (4.1×10^{-7}) (0.184)

- Add? Health costs, but not annoyance costs
- CR for noise related health effects not robust enough (except hypertension, which is well documented)

Qualitative Uncertainty

Model component	Individual Uncertainty	Contribution to Costs
Emission inventory	N/E	Medium
Dispersion model	N/E	Medium
PM-CR	Medium	Medium
O3-CR	Medium	Small to Medium
PM- Chronic Bronch.	Large	Small
Other health effects	Medium to Large	Small
Baseline health incidence	Small to Medium	Small to Medium
Mortality valuation metric	Large	-
VSL/VOLY	Large	Medium

Qualitative Uncertainty

Model component	Individual Uncertainty	Contribution to Costs
NDI	Small to Medium	Medium
Property prices	N/E, Possibly Small	Large
Background noise	N/E, Possibly Small - Medium	Large
Noise model	N/E, Possibly Small-Medium	Large
Noise health CR	Large	Medium
Discount rate	N/E, Possibly Medium	Large

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Scope

- Air Pollution and Noise
- Four modes: Road, rail, water, aviation
- For air pollution: only premature mortality compared
  - One level of uncertainty removed
- For noise: exposure of people to different noise levels

Results: Air Pollution

Number of premature deaths attributable

	Road	> Shipping	> Rail	> Aviation
USA	42330-62290	3444-5506	1900	537-1280
EU	107721	16530-26710	2589	218-1033

- Road worst, Aviation best

Results: Air Pollution

- What happens on a productivity (ton-mile) basis?

USA: Number of deaths per unit productivity (billion t-m)

Road	> Aviation	> Shipping	> Rail
7.5-25.2	5.6-13.4	1.2-2.0	1.2

- Road still worst, Aviation almost as bad!!
- Rail and Shipping best
- Passenger rail> Personal road> Heavy road> Aviation > Shipping> Freight rail
- Passenger rail the worst on a productivity basis in USA!

Results: Noise

Number of people exposed to 65dBA Ldn:

	Road	> Rail	> Aviation
• USA	19.5-30.3	2.92	0.15-0.35
• EU	48.64	5.85	2.97

- Road worst, Aviation best

- Productivity basis: Road > Aviation> Rail

Summary

Omega

- Noise costs have been falling
- Health costs of aviation at least equally important as noise, possibly more important
- Valuation method and value of premature mortality major source of uncertainty
- Mortality valuation metric can have important policy implications

Summary

- Road air pollution related mortality largest, Aviation smallest
- Per ton mile basis, however, Aviation is almost as bad as Road, Rail the best
- Noise exposure: Road worst, Aviation best
- Per ton mile basis: Aviation 2nd worst

Thank you