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Institute for Aviation and the Environment

An Analysis of the Impact of Aircraft Lifecycles on Aviation Emissions Mitigation Policies

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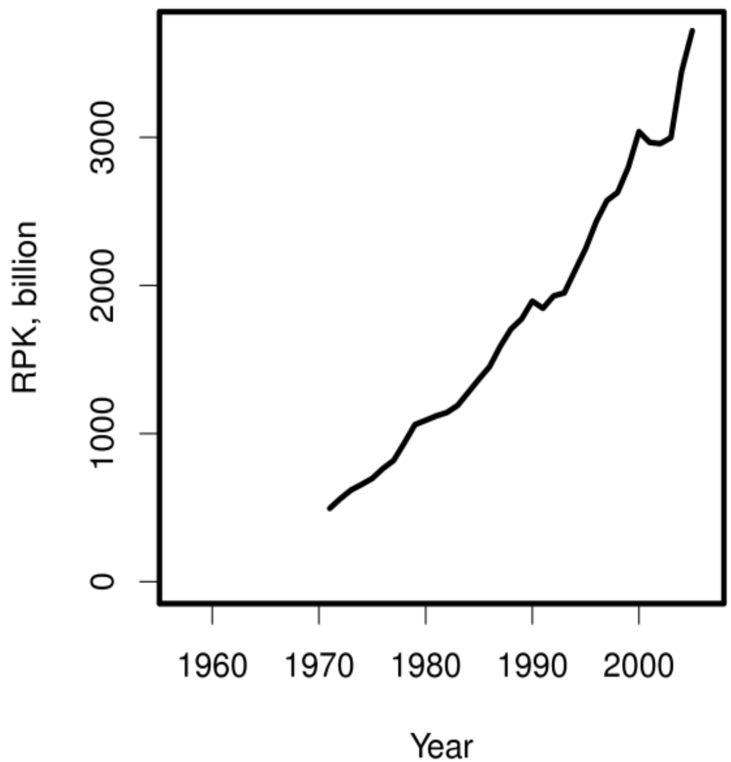
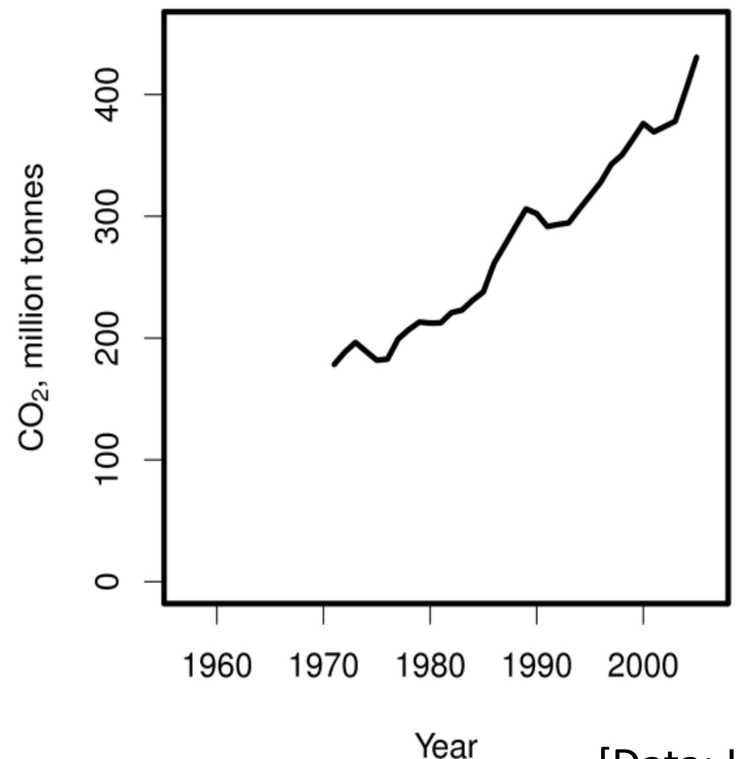
Introduction

- Strategies to reduce aviation emissions often include introduction of new technology
  - E.g. Open rotor engines, BWBs, ACARE targets
- Implementation affected by fleet turnover
  - Greater timescale than for economic/operational policy measures
- Useful to look at historical data on fleet composition
  - Investigate which factors affect emissions reduction timescales
  - Estimate simple models where possible
  - Consider effect on policymaking

RPK and emissions

- Historical strong growth in RPK (5.7%/year 1975-2005)
- Fuel burnt per RPK has declined (0.5-1.5%/year depending on type) → emissions growth slower

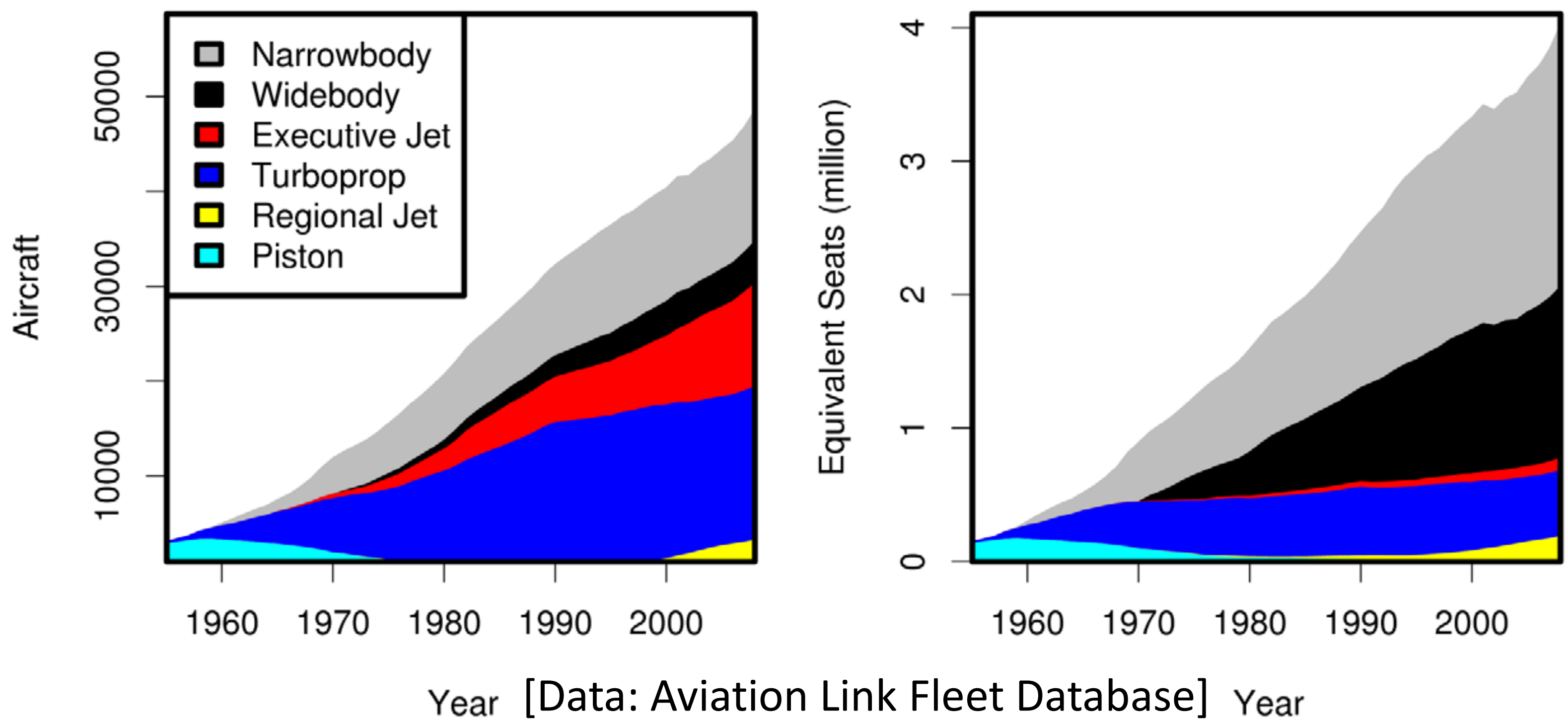




[Data: IEA]

Global Fleet

- Fleet growth 1975-2005: 3.5% per year
  - Average aircraft size has increased
  - Growth in RPK → **more aircraft purchased to serve new demand than as replacements for retirements**

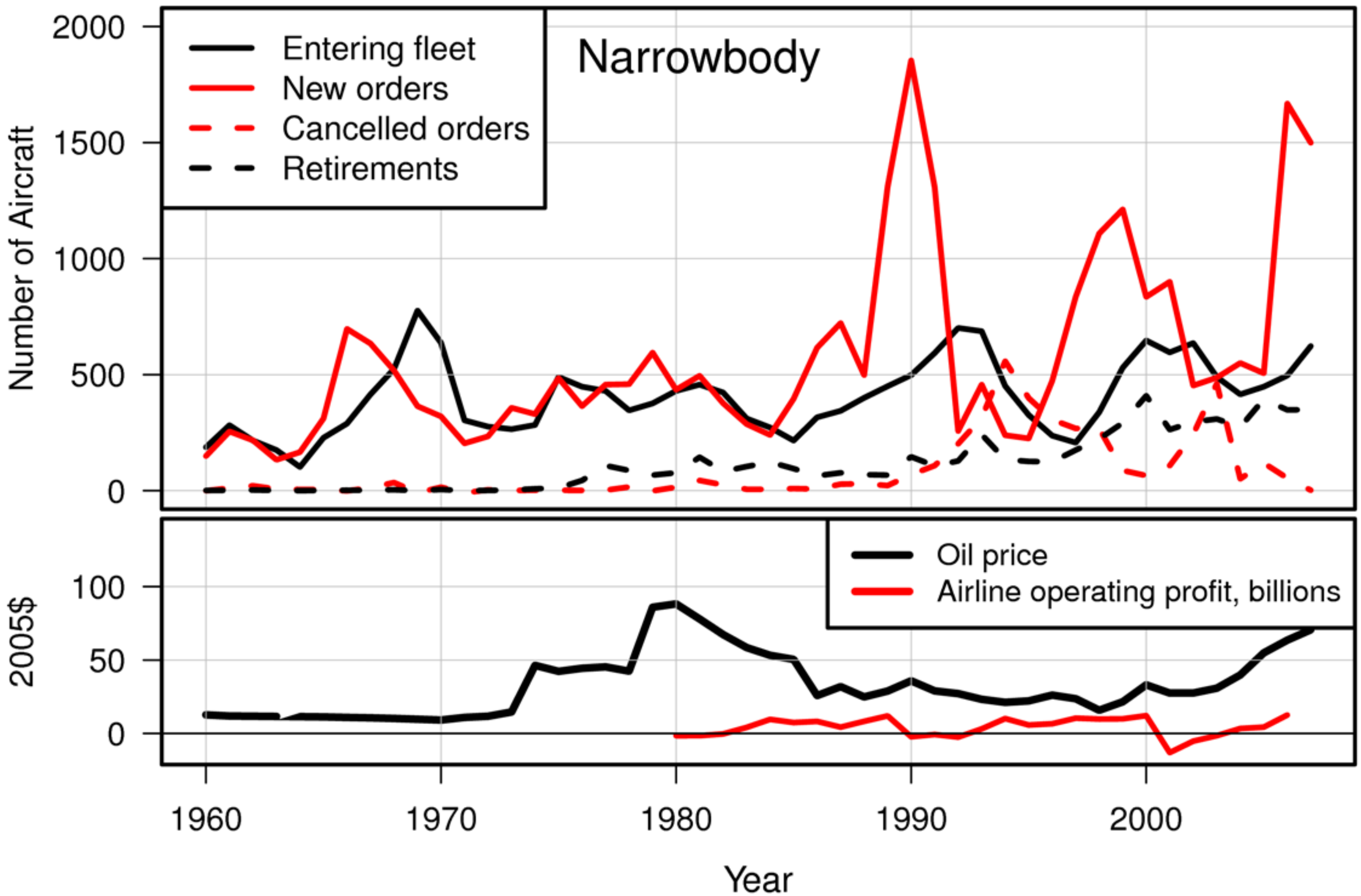


[Data: Aviation Link Fleet Database]

Aircraft Entering the Fleet

- When are aircraft purchased?
  - Orders peak during periods of airline profit/expansion
  - ~10-year economic cycles → potential delay if technology policy applied at wrong point in cycle
  - Sensitivity tests suggest effect is small

Aircraft Entering the Fleet



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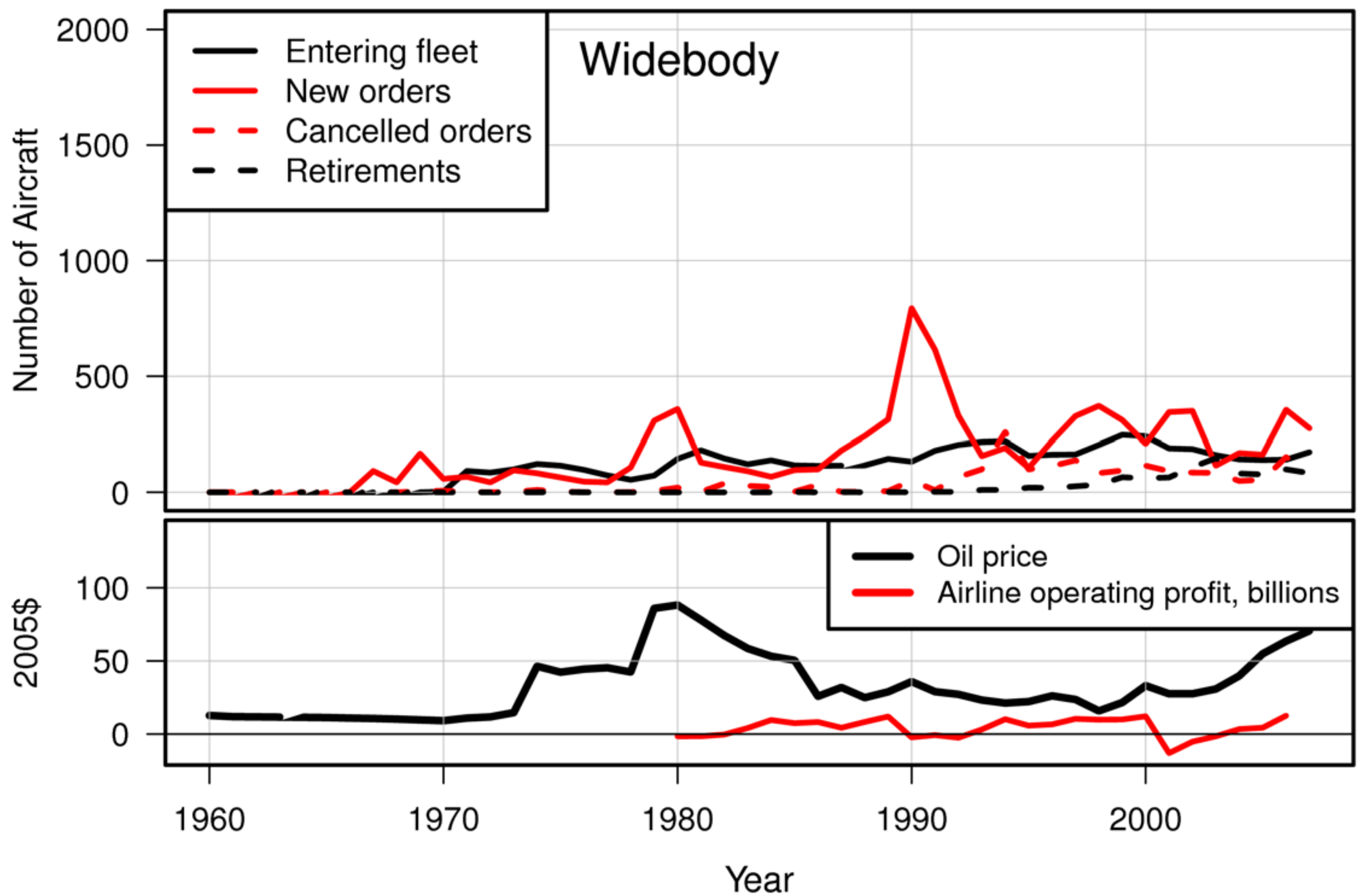

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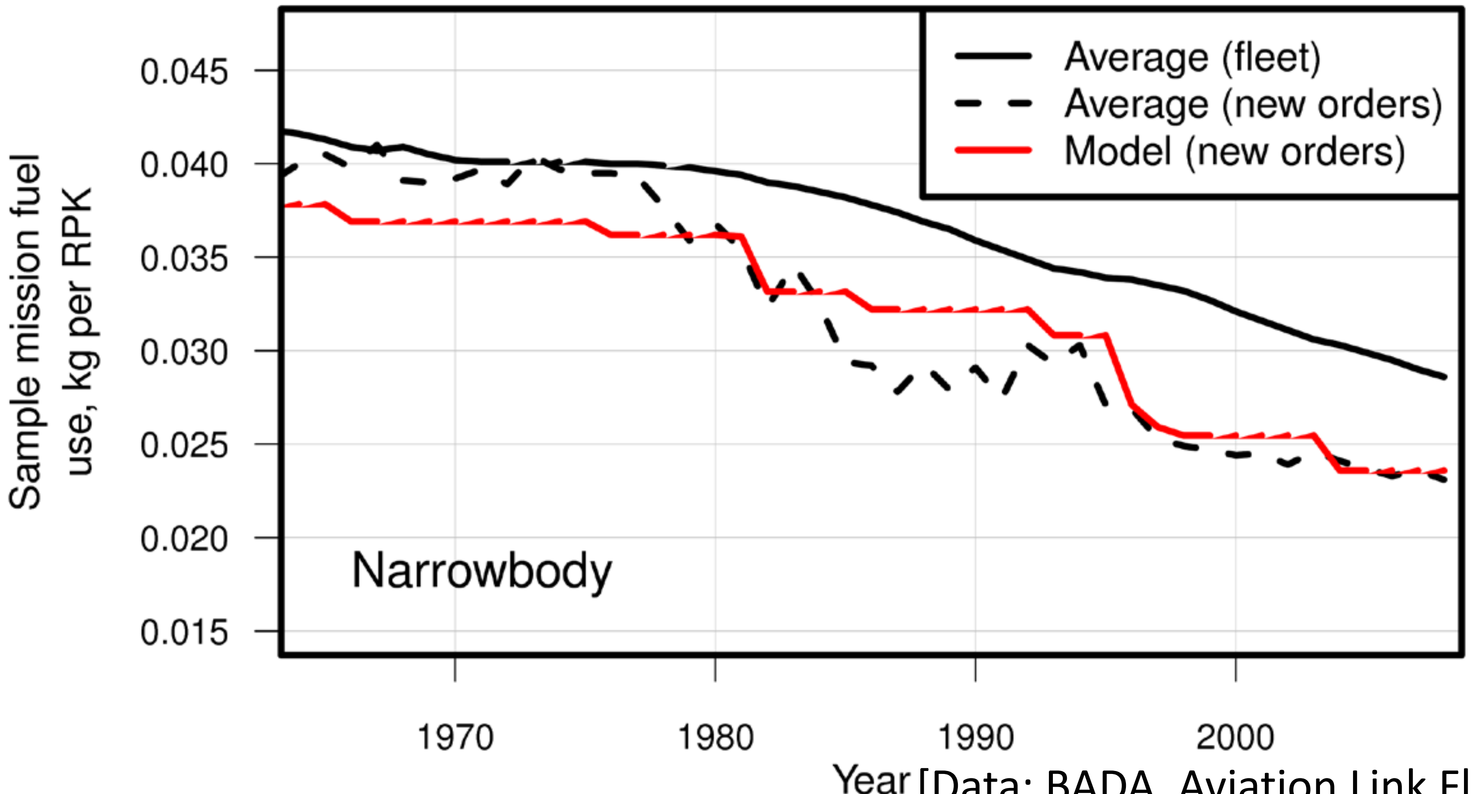
Aircraft Entering the Fleet

- When are aircraft purchased?
  - Orders peak during periods of airline profit/expansion
  - ~10-year economic cycles → potential delay if technology policy applied at wrong point in cycle
  - Sensitivity tests suggest this effect is small
- Which aircraft are purchased?
  - Choice of aircraft available can be influenced by R&D-based policy (e.g. subsidies)
  - Airlines' choice of aircraft from those available depends on many factors
    - Potential fuel cost savings not necessarily the most important

Aircraft Entering the Fleet

- No unambiguous relationship between historical technology choice and fuel price
  - Model as simple function of available aircraft fuel burn range



[Data: BADA, Aviation Link Fleet Database]

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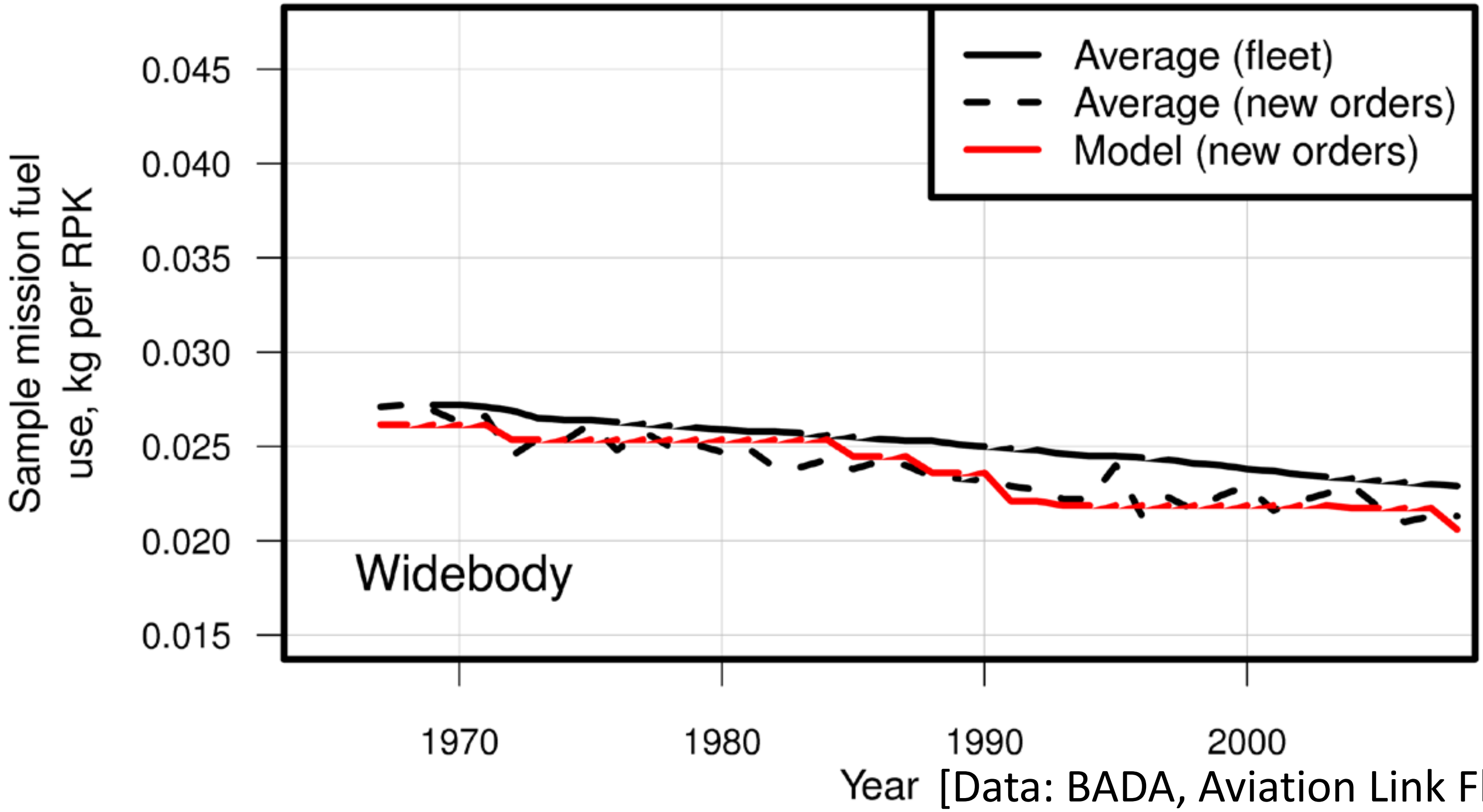

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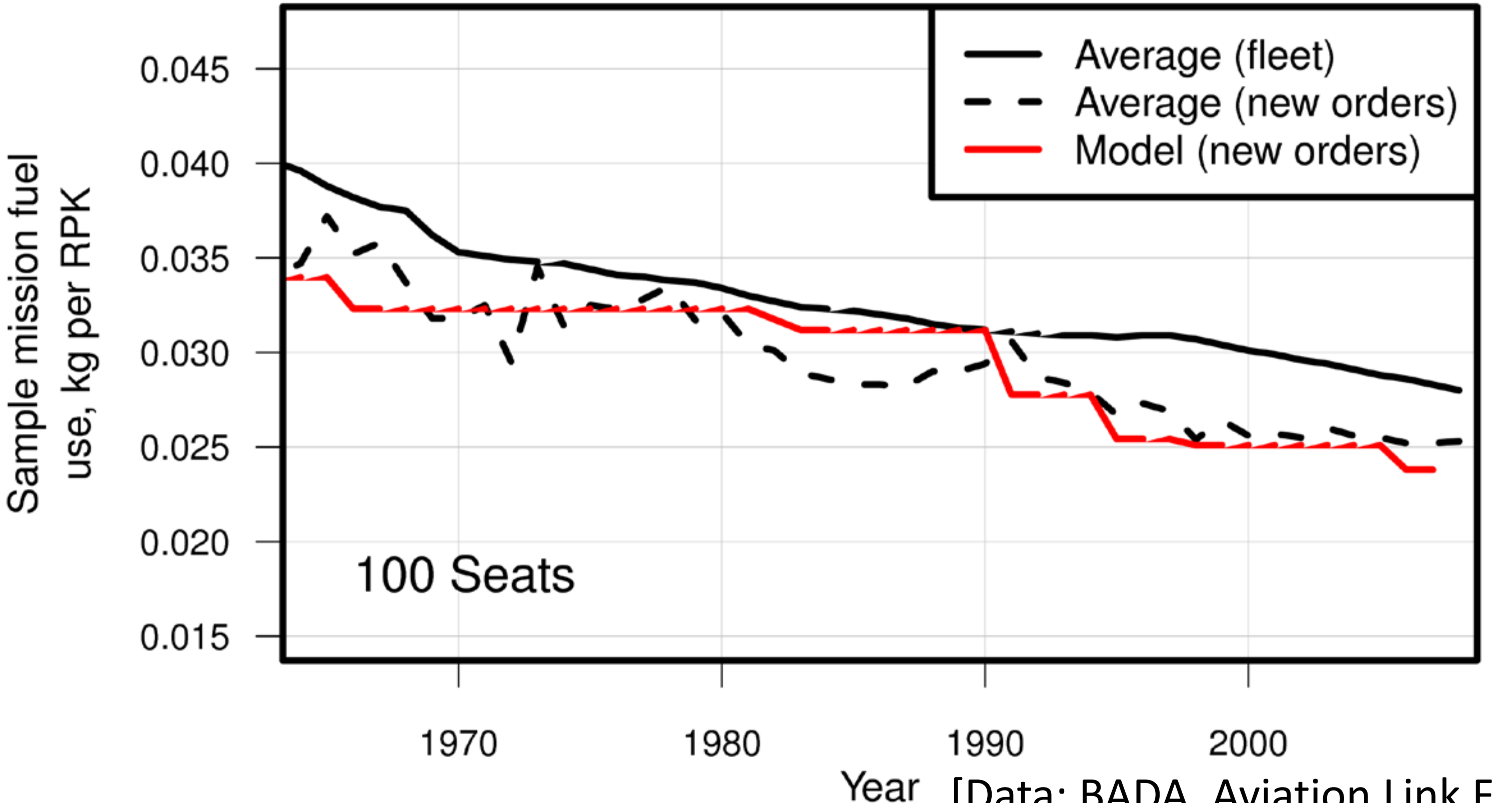
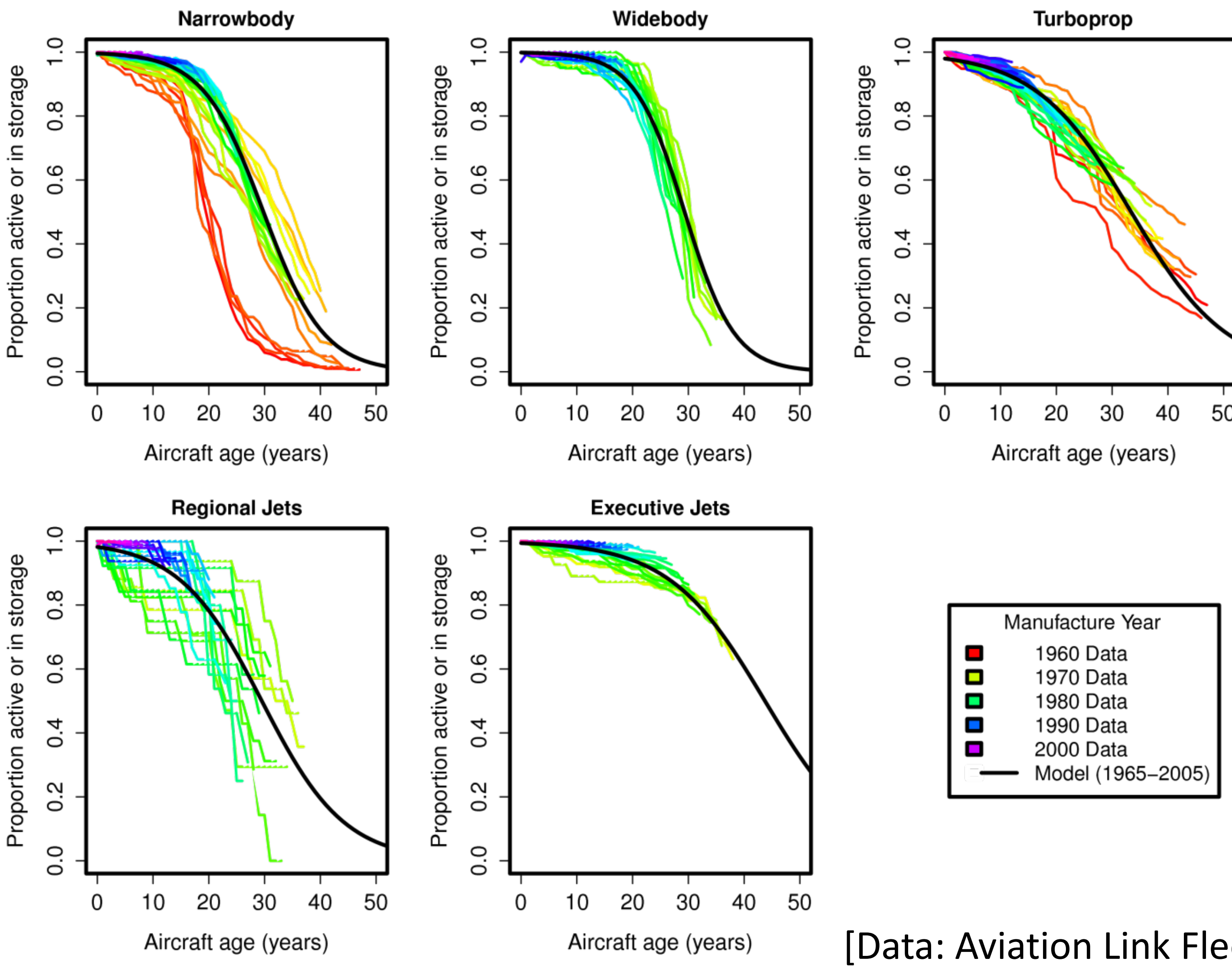


[Data: BADA, Aviation Link Fleet Database]

Retirements

- Aircraft lifetimes around 30 years
- Retirement behaviour remarkably consistent over time...

Retirement Curves



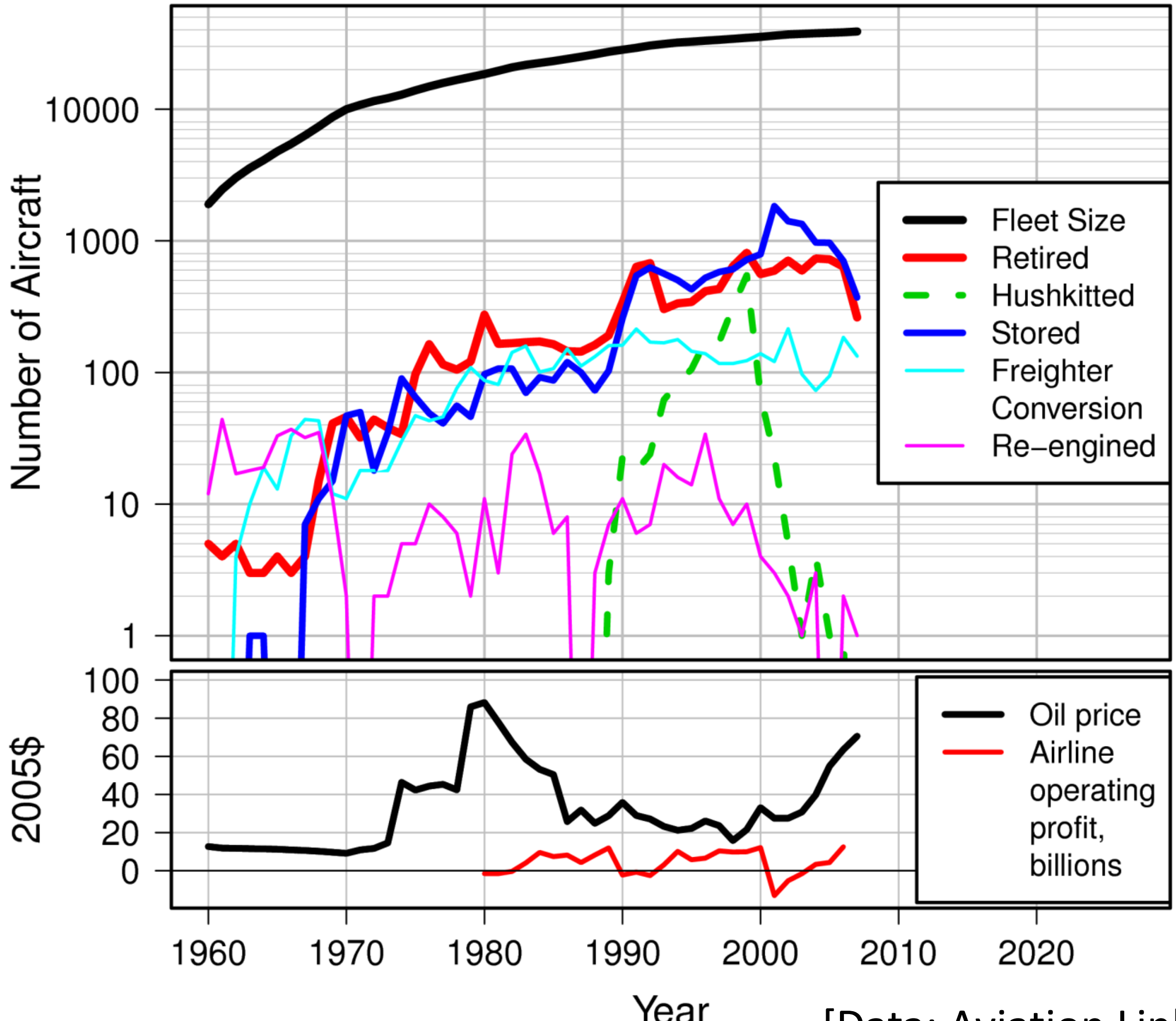
[Data: Aviation Link Fleet Database]

Retirements

- Aircraft lifetimes around 30 years
- Retirement behaviour remarkably consistent over time...

  apart from 1960-1965 manufactured narrowbodies
  - Replaced in early 1980s
  - Not due to noise regulations – very few were Stage 1
  - Likely due to combination of effects
    - US recession → difficult to sell second-hand
    - New aircraft models available with much lower fuel burn
    - High fuel price
- Reducing historical peak retirement age by 1 year → 2005 emissions 0.35% lower (for same RPK)

Changes to Operating Aircraft



[Data: Aviation Link Fleet Database]

Changes to Operating Aircraft

Several possibilities:

- Retrofits to reduce fuel use and costs
  - E.g. Winglets, re-engining, engine upgrade kits, etc.
  - Often limited applicability and/or cost-effectiveness
    - E.g. Very few historical re-enginings
- Freighter conversion, hushkitting
  - Can extend life of older aircraft – higher emissions?
  - If all historical freighters were bought new → 0.9% lower emissions in 2005
    - However, this is not a realistic scenario at current costs
- Storage

Conclusions & Policy Interventions

- Changing fuel price within limits of past variation
  - Study suggests only small effect on fleet
  - Similar to behaviour of other transport modes
- Environmental landing charges
  - Minimal effect (e.g. ICAO 2007)
- Changing available-for-purchase aircraft types
  - Does affect fleet fuel burn
  - If post-1960 decrease of best-available new aircraft fuel burn/RPK per year was 0.1% greater → emissions savings of around 1.5% now
  - Long timescales
  - A320/737 replacement most important

Conclusions & Policy Interventions

- Influencing retirements
  - Fast-growing fleet – retirements are relatively unimportant compared to demand for new aircraft
  - Historical analysis suggests good candidate replacement aircraft needed
  - Relatively short timescale
- Retrofits
  - Historically only a small effect on emissions
    - E.g. 0.1% lower global fuel burn due to all historical re-enginings
  - Limited applicability
  - Relatively short timescale

Questions?