

SUSTAINABLE
TOURISM



CRC

Aviation's Indirect Carbon Emissions: Measurement and Implications

Peter Forsyth,

Thiep Van Ho

**Department of Economics, Tourism Research Unit
and STCRC Centre for Economics and Policy,
Monash University**

**GARS Climate Change Workshop, Amsterdam, July
2008**



Key Issues:

- How large are aviation's indirect carbon emissions?
- How can we measure them?
- What implications arise from indirect emissions?



Outline

- Measuring indirect carbon emissions
- Model and data requirements
- Indirect emissions from Australian international aviation
- Implications
- Conclusions



Direct and Indirect Emissions

- Nearly all discussion of aviation emissions focuses exclusively on direct emissions
- These are high compared to those of other industries
- Aviation uses fuel directly
- Fairly straightforward to calculate direct emissions (DLR estimates, recent ICAO Carbon Calculator)
- But aviation also produces emissions *indirectly*
- These pose much more severe measurement problems



Indirect Emissions

- All industries produce indirect emissions
- Input purchases require that inputs be produced
- This production leads to emissions
- E.g. Aluminium is indirectly quite emissions intensive
- Aviation purchases inputs (about 70% of total output)
- This implies that total indirect emissions could be quite significant



Estimating Indirect Emissions

- Need to know what industries are supplying the focus industry, both directly and indirectly
- Infinite chain: airlines purchase IT services, IT services require electricity, electricity requires coal etc
- Need to know the Input-Output structure of the economy
- Will yield the ultimate pattern of production
- Need to know the emissions from every industry and its relationship to output

Accounting (Static) Measures

- Matter of making an estimate of the emissions associated with the production of a product, such as aviation
- Can be used to assess the emissions intensity of the industry- can compare with other industries
- Estimates do NOT provide an impact measure- e.g. the impact on national emissions of a specified increase in aviation output
- Cannot multiply the carbon price by the total direct and indirect emissions to determine the impact on the costs of the industry from a carbon mitigation policy



Adding Up

- Values of the production of the inputs (and imports) must add up to the value of the inputs purchased
- Inputs- come from home production and imports
- Sum of value added in supplier industries plus the value of imports must sum to the value of purchases
- Need to estimate the pattern of production and imports which will supply the input vector for the industry



Inputs

- Aviation indirectly requires inputs
- Input production creates emissions in home countries
- Direct and indirect emissions from production of imports in other countries is assumed to be the same as in the home country
- For Australia, this could be an overestimate if Australia is a relatively carbon intensive economy



Modelling Requirements

- Need aviation's pattern of input purchases
- Need economy's Input Output (I-O) structure
- These can yield the indirect pattern of production and imports required to supply aviation
- Need the relationship of emissions (of CO₂ /CO₂ equivalent) to real output for all industries in the economy
- Then can calculate indirect emissions



“Green” Computable Equilibrium Models

- Computable General Equilibrium (CGE) models usually do not have any emissions data or relationships
- Green models, such as MMRF Green, do have
- E.g. Changing the output of coal based electricity will result in increased emissions
- MMRF Green has about 50 industries, 8 states and Australia as a whole
- Disaggregated into energy intensive industries, including coal fired electricity, gas fired electricity etc
- Embodies an I-O structure



Australian International Aviation

- Seek to measure the carbon emissions from the international sector of the Australian aviation industry (mainly Qantas) for 2003-04
- Includes inbound and outbound operations of Australian carriers
- Not considering domestic aviation here
- Also interested in total inbound aviation, both on home and foreign carriers
- Flow on from a study of the Carbon Footprint of Australian tourism
- Results in terms of CO₂ equivalents



Modelling Experiment

- Using model data and I-O structure, estimate emissions for the whole of Australian tourism, including all international traffic of home carriers
- Estimate emissions after reducing air transport industry outbound by the amount of output of outbound international aviation
- Estimate difference in emissions, and attribute to outbound international aviation
- Total Output \$10.855bn
- Outbound output \$2.376bn
- Residual output \$8.479bn



Australian Outbound International Aviation Indirect Emissions

- From home production 0.438 m tonnes
- From imports 0.226 m tonnes
- Total 0.664 m tonnes



Australian International Emissions

- Indirect:
 - Outbound 0.664 m tonnes
 - Inbound 0.622 m tonnes
 - Total 1.286 m tonnes
- Direct Total 4.7 m tonnes
- Indirect as % of direct 27.4%



Sources of Indirect Emissions (in m tonnes)

	Home Production	Imports
Oil	0.016	0.031
Petroleum Refining	0.113	0.020
Electricity Coal	0.147	0.041
Chemical Production	0.014	0.038



Emissions from Inbound Aviation

- Can estimate emissions from all inbound aviation
- Include home and foreign carriers
- Assume ratio of emissions to output same for foreign as for Australian carriers
- Direct emissions estimated on a route by route basis, not including cargo, allowing for multiple journey trips
- S Haul 0.126 gm/pkm; L Haul 0.085gm/pkm



Inbound Emissions (in m tonnes)

	Australian Airlines	Foreign Airlines	Total Airlines
Direct	2.0	5.3	7.3
Indirect (incl imports)	0.6	1.4	2.0
Total Direct and Indirect	2.6	6.7	9.3



Allowing for Radiative Forcing

- CO₂ emissions from aviation may be much more damaging than terrestrial emissions
- Indirect emissions are nearly all terrestrial
- Hence no adjustment factor needed
- Thus may represent less than 27% of damage



Estimates: How General?

- Based on Australian industry technologies, and emissions intensities
- Industry technology- similar to that of other countries
- Some industries may be more carbon intensive (e.g. use of coal for electricity)
- But not all- Australian agriculture is less carbon intensive than European agriculture
- Estimates are probably fairly transferrable



Emissions Trading Schemes

- EU is implementing an ETS for energy industries and aviation
- Plan to include international aviation directly for all flights (home and foreign)
- So far, motor vehicle fuel not included
- New Zealand- has left international aviation out so far
- Australia is likely to leave international out of its ETS but include nearly all other industries



Indirect Cost of an ETS

- Direct cost to the Australian international aviation sector
- Carbon price- say, \$40 per tonne
- Indirect emissions- 1.286 m tonnes
- Cost increase- around \$50m
- On revenues of about \$5bn
- I.e. 1% of costs



ETS and Competitive Neutrality of Airlines: Partial Equilibrium Perspective

- Suppose EU or Australia imposes an economy wide ETS
- Home and foreign airlines will be treated comparably for direct emissions
- But will be treated differently for indirect emissions
- Home county airlines automatically pay the indirect carbon price, through their input purchases
- Foreign airlines (in countries without and ETS) do not
- Will this disadvantage home airlines?

ETS and Competitive Neutrality of Airlines: General Equilibrium Perspective

- Not necessarily
- ETS will bring about many price changes in the home economy
- Export costs will rise, lowering exports (especially for emissions intensive exports)
- Home exchange rate falls, making export and import competing industries more competitive internationally
- Relatively emissions intensive export industries will be less internationally competitive
- Is aviation indirectly relatively emissions intensive
- Probably about average
- On balance, home airlines will probably not lose out from an ETS due to their indirect emissions



Carbon Neutrality

- Airlines seek to offer carbon offsets, to give the traveller a “carbon neutral” flight
- But carbon calculators and offset schemes only factor in the direct emissions
- But indirect emissions are also present
- Should add about 25-30% to the direct CO₂ emissions estimates for flights
- Offset schemes should take account of indirect emissions to offer truly “carbon neutral” flights



Conclusions

- Air transport contributes directly and indirectly to emissions
- Most attention is on direct emissions
- Should calculate both
- Can do this with information about industrial structures of economies and the emissions from all industries
- Estimates for Australian international aviation suggest that indirect emissions are about 25-30% of direct
- I.e. they are quite significant
- Australian measures are probably fairly typical
- ETSs are not likely to make home airlines less competitive on international markets
- Carbon offset schemes should allow for indirect emissions

SUSTAINABLE
TOURISM



CRC

Thank You!

peter.forsyth@buseco.monash.edu.au