Materials for today


Policy analysis

Economic framing of policy analysis: cost-benefit analysis
Policy analysis

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Two main concerns:

1. efficiency: with are the highest priority items?
Policy analysis

Economic framing of policy analysis: cost-benefit analysis

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2. equity: is the distribution of benefits and costs fair?
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Broader concerns:
- risks: resilience to disasters (wildfire, COVID)
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- total budget, resources
- implementation: who, how, where?
- growth, speed
- geography: does this work the same in all places?
Policy analysis

Three case studies:

- global aviation
- walking, bicycling, and transit in Philadelphia
- Los Angeles’ efforts towards clean air (leading to CARB)
World passenger traffic collapses with unprecedented decline in history

World passenger traffic evolution
1945 – 2021*

-47 to -49%
decline in world total passengers in 2021* vs. 2019

-60%
decline in world total passengers in 2020

Source: ICAO Air Transport Reporting Form A and A-S plus ICAO estimates.

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Economist: “flygskam”

It’s a flying shame
Sweden, airline passengers*
% change on a year earlier

Source: Swedavia

*At Sweden’s ten busiest airports

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Aviation is 3.5% of radiative forcing (oft-quoted 2%; large non-CO2 effect)
Table 1
Theoretical maximum share of flying population.

<table>
<thead>
<tr>
<th></th>
<th>Population 2018 (million)*</th>
<th>Passengers 2018 (million)*</th>
<th>Passengers per capita of the population</th>
<th>Flying population (%)</th>
<th>Maximum flying population (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>705</td>
<td>23</td>
<td>0.03</td>
<td>1.63</td>
<td>11</td>
</tr>
<tr>
<td>Lower middle</td>
<td>3,023</td>
<td>454</td>
<td>0.15</td>
<td>7.51</td>
<td>227</td>
</tr>
<tr>
<td>Upper middle</td>
<td>2,656</td>
<td>1,313</td>
<td>0.49</td>
<td>24.72</td>
<td>657</td>
</tr>
<tr>
<td>High income</td>
<td>1,210</td>
<td>2,442</td>
<td>2.02</td>
<td>100.00</td>
<td>1,210</td>
</tr>
<tr>
<td>Total</td>
<td>7,594</td>
<td>4,233</td>
<td></td>
<td>100.00</td>
<td>2,105</td>
</tr>
</tbody>
</table>

The “theoretical maximum” assumes that each individual participates in exactly one trip per year.

Table 2
Share of flying population adjusted for non-flying share of population, 2018.

<table>
<thead>
<tr>
<th></th>
<th>Population (million)*</th>
<th>Passengers(million)*</th>
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<th>Flying population (%)</th>
<th>Flying population (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>705</td>
<td>23</td>
<td>0.03</td>
<td>0.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Lower middle</td>
<td>3,023</td>
<td>454</td>
<td>0.15</td>
<td>3</td>
<td>90.7</td>
</tr>
<tr>
<td>Upper middle</td>
<td>2,656</td>
<td>1,313</td>
<td>0.49</td>
<td>10</td>
<td>265.6</td>
</tr>
<tr>
<td>High income</td>
<td>1,210</td>
<td>2,442</td>
<td>2.02</td>
<td>40</td>
<td>484.0</td>
</tr>
<tr>
<td>Total</td>
<td>7,594</td>
<td>4,233</td>
<td></td>
<td>845.2</td>
<td></td>
</tr>
</tbody>
</table>

Source: own calculations, based on World Bank (2020b)*. Flying population: The share/number of the population/people in each income group that flies at least once per year.
Distributions in Table 1 do not consider that there is a significant share of the population in every country that does not fly, while some air travelers participate in one, two, or multiple trips. For example, data for the USA suggests that 53% of the adult population do not fly (Airlines for America, 2018). In Germany, 65% of the population do not fly (IFD Allensbach, 2019), while this share is 66% in Taiwan (Tourism Bureau Taiwan, 2019). In the UK, the non-flying share of the population 16 years or older is 59% (DEFRA, 2009). These national surveys indicate that in high income countries, between 53% and 65% of the population will not fly in a given year. The share of non-fliers is likely larger in low-income, lower-middle and upper-middle income countries. For a
Fig. 6. Air transport demand distribution in the USA. Source: based on ICCT (2019).

No flights: 53% of adults

1 to 5 trips: 35% of adults

6 trips or more: 12% of adults

Courtesy of Gössling and Humpe. License: CC BY.
### Table 4

Total and per capita emissions from commercial air passenger transport.

<table>
<thead>
<tr>
<th>Region</th>
<th>CO₂ global (Mt, 2018)</th>
<th>CO₂ global (Mt, 2050)</th>
<th>CO₂ per capita (kg, 2018)</th>
<th>CO₂ per capita (kg, 2050)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>14</td>
<td>53</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>241</td>
<td>956</td>
<td>57</td>
<td>196</td>
</tr>
<tr>
<td>CIS</td>
<td>19</td>
<td>41</td>
<td>78</td>
<td>160</td>
</tr>
<tr>
<td>Europe</td>
<td>169</td>
<td>363</td>
<td>250</td>
<td>546</td>
</tr>
<tr>
<td>Latin America</td>
<td>44</td>
<td>158</td>
<td>69</td>
<td>207</td>
</tr>
<tr>
<td>Middle-East</td>
<td>47</td>
<td>182</td>
<td>278</td>
<td>683</td>
</tr>
<tr>
<td>North America</td>
<td>190</td>
<td>366</td>
<td>521</td>
<td>860</td>
</tr>
<tr>
<td>Rest of world</td>
<td>19</td>
<td>51</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Average/Total</td>
<td>743</td>
<td>2,169</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mackay figure 20.23 – vertical axis in kWh / p-100 km!

Figure courtesy of David MacKay.
Homework problem: time-distance

Key assumptions: turboprop, 670 km/h; high-speed train, 200 km/h

From the train’s perspective:

\[ 670 \left( \frac{\text{km}}{\text{hours}} \right) (x - 3) \left( \frac{\text{hours}}{} \right) = 200(x) \left( \frac{\text{km}}{\text{hours}} \right) \left( \frac{\text{hours}}{} \right) \]
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\[
670 \left( \frac{\text{km}}{\text{hours}} \right)(x - 3) \text{ (hours)} = 200(x) \left( \frac{\text{km}}{\text{hours}} \right) \text{ (hours)}
\]

\[
670x - 2010 = 200x
\]

\[
470x = 2010
\]

\[
x = 4.27 \text{ hours by train}
\]

\[
\therefore 200x = 855 \text{ kilometers}
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\[
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\]

From the plane’s perspective:

\[
670x = 200(x + 3)
\]

\[
470x = 600
\]

\[
x = 1.27 \text{ hours by plane}
\]

\[
\therefore 670x = 855 \text{ kilometers}
\]
Homework problem: energy-speed

Key assumptions:
- turboprop, 38 kWh/p-100 km, 670 km/h
- high-speed train, 4 kWh/p-100 km, 200 km/h
Homework problem: energy-speed

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For a turboprop:

\[
38 \frac{\text{kWh}}{\text{p-100 km}} \times 856 \text{ km} = 325.3 \frac{\text{kWh}}{\text{p}}
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Or see quickly that it is a \(\sim 10X \ (9.5X)\) difference (key numbers: \(\approx 38, 4\)).
Can planes be improved?

If engine efficiency can be boosted only a tiny bit by technological progress, and if the shape of the plane has already been essentially perfected, then there is little that can be done about the dimensionless quantity. The transport efficiency is close to its physical limit. The aerodynamics community say that the shape of planes could be improved a little by a switch to blended-wing bodies, and that the drag coefficient could be reduced a little by laminar flow control, a technology that reduces the growth of turbulence over a wing by sucking a little air through small perforations in the surface (Braslow, 1999). Adding laminar flow control to existing planes would deliver a 15% improvement in drag coefficient, and the change of shape to blended-wing bodies is predicted to improve the drag coefficient by about 18% (Green, 2006). And equation (C.26) says that the transport cost is proportional to the square root of the drag coefficient, so improvements of $c_d$ by 15% or 18% would improve transport cost by 7.5% and 9% respectively.

Text courtesy of David MacKay.
18-25* miles per gallon compared to 2-3 miles for a comparable (small) jet.

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Factor in the new Celera 500L!

Private jet, 2-3 mpg:

\[
\frac{10\text{kWH}}{1\text{l}} \times \frac{\text{gal}}{2.5\text{ miles}} \times \frac{1}{0.26\text{ gal}} \times \frac{\text{mile}}{1.6\text{ km}} \times \frac{100}{100} = \frac{961\text{kWH}}{100\text{ km}}
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Internal combustion engine SUV, 22 mpg:

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\frac{10 \text{kWh}}{1 \text{l}} \times \frac{\text{gal}}{22 \text{ miles}} \times \frac{1 \text{l}}{0.26 \text{ gal}} \times \frac{\text{mile}}{1.6 \text{ km}} \times \frac{100}{100} = \frac{109 \text{ kWh}}{100 \text{ km}}
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\]

All carry about six people, so divide by six to get kW\cdot\text{h}/\text{p-km}.
Homework problem: energy

How do our various modes compare?

- **Private jet**: $961 \left[ \frac{\text{kWh}}{6 \text{ p.-100 km}} \right] \times 856 \text{ km} = 1371.0 \frac{\text{kWh}}{\text{p}}$

- **Turboprop**: $38 \left[ \frac{\text{kWh}}{\text{p-100 km}} \right] \times 856 \text{ km} = 325.3 \frac{\text{kWh}}{\text{p}}$

- **Celera 500L or SUV**: $109 \left[ \frac{\text{kWh}}{6 \text{ p.-100 km}} \right] \times 856 \text{ km} = 155.5 \frac{\text{kWh}}{\text{p}}$

- **High-speed train**: $4 \left[ \frac{\text{kWh}}{\text{p-100 km}} \right] \times 856 \text{ km} = 34.2 \frac{\text{kWh}}{\text{p}}$
History of policy actions on aviation

- **1997 Kyoto Protocol**: all countries reduce by 5% from 1990-2012
- **2009 Waxman-Markey bill**: (fails in Senate)
O’Leary, “Aviation” chapter

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- 2011 US Congress passes the EU-ETS Prohibition Act of 2011
O’Leary, “Aviation” chapter

History of policy actions on aviation

- 1997 Kyoto Protocol: all countries reduce by 5% from 1990-2012
- 2009 Waxman-Markey bill (fails in Senate)
- 2012 European Union introduces Emissions Trading Scheme (ETS)
- 2011 US Congress passes the EU-ETS Prohibition Act of 2011
- 2016 EPA endangerment finding (under the Clean Air Act)
- 2016 ICAO develops CORSIA, a carbon cap and offsetting scheme from 2020
- 2017 ICAO adopts a CO2 standard for aircraft
- 2017 EU decides this only applies to intra-EU flights
Options

1. improve vehicle efficiency
2. biofuel use
3. operational measures
4. demand reduction

US policy options

1. carbon tax including aviation emissions
2. increase taxes on aviation specifically
3. introduce an emissions standard
4. require or encourage use of biofuels
5. reduce emissions at airports
6. voluntary emissions reductions measures
7. enable or encourage less flying
8. individuals purchase high-quality offsets
9. reduce freight emissions
Is aviation a moral or individual issue?

A: Red herring, canard, waste of time

1. product of corporate marketing campaigns (BP)
2. 70% of fossil fuels have been sold by 30 companies, etc. (Guardian)
Is aviation a moral or individual issue?

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B: Necessary, essential

1. FF companies sell products to consumers . . . e.g., us
2. rich countries consume much more than poor ones
3. rich people consume much more than poor ones
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4. Aviation will be very hard to decarbonize
5. People want to participate
6. Advocates not taken seriously unless they abide by their advocacy
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Sheller 2015 paper

Title: “Racialized Mobility Transitions in Philadelphia: Connecting Urban Sustainability and Transport Justice”, City & Society
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Analogous questions:

- how do we think about lower-emitting transportation technologies?
- what we would have to do to make them equitable, fair, just?
Title: “Racialized Mobility Transitions in Philadelphia: Connecting Urban Sustainability and Transport Justice”, *City & Society*

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- how do we think about lower-emitting transportation technologies?
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Consider the following transportation transitions, who and how can these be accessed?

- cars (ICE to EVs)
- e-bikes
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- subways and light rail
- walking
- buses
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- buses
- land use and living patterns?
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The saga of making long-term changes in the auto system, land use, regional governance:

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- what changes do we have to start making now?
- how do we sustain those changes and efforts?
Tuesday 9/27 class

We’ll talk about how to achieve justice / fairness / equity in different urban modes of transport. It may help to think about the various readings from previous classes.

For all of the modes on the previous slide, you should be able to argue for:
- the existing status quo or trajectory of the system we have OR
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*The test of a first-rate intelligence is the ability to hold two opposed ideas in the mind at the same time, and still retain the ability to function . . . One should, for example, be able to see that things are hopeless and yet be determined to make them otherwise.*

F. Scott Fitzgerald, 1936?