A Tale of Two cities and Five Benefit-Cost Analyses

Australia’s Inland Rail between Melbourne and Brisbane

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Research Problem

- Since 1996, multiple BCAs of the Inland Rail (freight)
- BCAs have varied widely in methodologies and findings.
- What can be learned from the differences in approach?
- How to deal with severe data limitations?
Interstate Rail Network - Australia

Track government owned
Freight services privately operated (except Queensland Rail)

Source: www.railpage.org.au
Bureau of Transport Economics (1996)

Inland Rail Options Evaluated

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Cost (AUD)</th>
<th>Max Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>$8.5 B</td>
<td>62 mph</td>
</tr>
<tr>
<td>Enhanced</td>
<td>$9.7 B</td>
<td>68 mph</td>
</tr>
</tbody>
</table>

Benefits evaluated separately for:
- Mining/Agricultural transport in Darling Downs/New England regions.
- Other freight transport (main focus here)
Data from Queensland Rail

• For Origin-Destination pairs:
  – Rail freight volume in base year & future projections
  – Rail operating costs in base year (per ton-km).

• Average freight transport charges in base year (per ton-km):
  – 4.0 cents for rail transport
  – 6.8 cents for truck transport
Rail Freight Demand Projections

Inland Rail projected to increase rail share of land freight volumes

$$\Delta \text{Rail Share} = \frac{\Delta \text{Rail Transit Time}}{| \text{Diff Transit Time, Rail vs Truck times} |}$$

(Maximum Potential Mode Share – Current Mode Share)

where Maximum Potential Market Share achieved when rail matches trucking transit time based on haul length, 40% at 1000 km and 80% at 4,000 km

Example: Basic Option, Melbourne to Brisbane (1,940 km)

- Δ Rail transit time= 8 hours (down from current 33)
- Truck transit time = 20 hours
- Maximum Potential Market Share = 53%

$$\Delta \text{Rail Share} = \frac{8}{13} \times (53\% - 30\%) = 14.2\%$$
Benefit Accounting

1) $\Delta$Rail Operating Surplus
2) $\Delta$Consumer Surplus
3) $\Delta$Externality Costs

Reference year = 1994-95
## Rail Operating Cost

<table>
<thead>
<tr>
<th>OPERATING COST PER TON</th>
<th>Current</th>
<th>Basic Option</th>
<th>Enhanced Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane-Melbourne</td>
<td>$23.16</td>
<td>$17.56</td>
<td>$17.30</td>
</tr>
<tr>
<td>Brisbane-Sydney</td>
<td>$12.73</td>
<td>$13.82</td>
<td>$13.11</td>
</tr>
<tr>
<td>Brisbane-Adelaide</td>
<td>$36.08</td>
<td>$23.38</td>
<td>$22.90</td>
</tr>
<tr>
<td>Brisbane-Perth</td>
<td>$66.57</td>
<td>$46.57</td>
<td>$45.63</td>
</tr>
<tr>
<td>Sydney-Melbourne</td>
<td>$11.38</td>
<td>$11.40</td>
<td>$11.40</td>
</tr>
</tbody>
</table>

Source: BTE 1996
Freight Charges

- Assumed rates per ton-km:
  - Rail: 4.0 cents
  - Trucking: 6.9 cents
- Inland Rail assumed to change rail charges in proportion to changes in rail distance.
  - Melbourne-Brisbane, 9% reduction
Consumer Surplus- Data Gaps

For valuing benefits to rail service users, **major data gaps**:

1. No estimates of the value of transit time savings.
2. No estimates of value of transit time reliability.
3. No estimates of levels of transit time reliability.
Consumer Surplus Benefit

Assumptions for deriving an upper bound

1. Trucking outperforms rail in service quality even in the project case (with Inland Rail).
2. Demand curves for rail freight services in the project case are linear.
3. Service quality has a lower value for existing rail freight than for new rail freight that would be attracted by a reduction in rail freight charges.
Figure 1: User benefits from a quality improvement with price unchanged and rotation of the demand curve.

From assumption 3, previous slide, the demand curve for rail freight services is steeper in the project case than in base case.

Source: Adapted from BTE 1996
Figure 2: User benefits from a quality improvement with price unchanged and parallel shift of the demand curve

Source: Adapted from BTE 1996
Figure 3: User benefits from a quality improvement with price reduced and parallel shift of the demand curve

Upper bound on $\Delta$consumer surplus = shaded areas combined

Source: Adapted from BTE 1996
Externality Effects from Modal Diversion

Analysis mainly qualitative, hard to quantify.

- Effects on air quality and road congestion not necessarily beneficial.
  - Geography of population and logistics important.
- Accident reductions would add at most 4% to benefits.
- Pavement damage savings likely significant, but including them would be double counting.
Discount rate

• Real discount of 11% assumed based on precedent and relative riskiness of the investment.
• Should risk factor into the discount rate?
Overall Evaluation of Inland Rail

- Benefit-cost ratios
  - Basic Option 1.01
  - Enhanced Option 1.15

- “...an investment of uncertain merit for implementation in the near future”

Source: BTE 1996
Subsequent Analyses

Wider scope and more sophisticated modeling

• Estimation of externality benefits.
• Stated/Revealed preference modeling of mode choice.
• Modeling of other sources of induced demand.
• Options with double-stacked containers.

But some loss of transparency.
Subsequent Analyses: Methodology

- Gradual increase in scope and modeling sophistication, e.g.
  - Stated choice surveys of shippers
  - Modeling of access charges by track owners
  - Inland Rail options that would allow double stacking

- Externality benefits included simplistically.

- Transparency sometimes lacking

Source: BTE 2000

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## Estimated values of time

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Value ($/ton-hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Containers</td>
<td>1.60</td>
</tr>
<tr>
<td>Chemicals &amp; Fertilizer</td>
<td>1.60</td>
</tr>
<tr>
<td>Steel &amp; Building products</td>
<td>1.20</td>
</tr>
<tr>
<td>Domestic Fruit</td>
<td>2.40</td>
</tr>
<tr>
<td>Motor Vehicles</td>
<td>2.99</td>
</tr>
<tr>
<td>General Freight</td>
<td>1.60</td>
</tr>
<tr>
<td>Coal &amp; Minerals</td>
<td>0.36</td>
</tr>
<tr>
<td>Bulk Ag. Products</td>
<td>0.00</td>
</tr>
<tr>
<td>Petroleum</td>
<td>1.67</td>
</tr>
</tbody>
</table>

Source: BTE 2000
Likely a minor source of benefit from Inland Rail because:

1) Transport cost reductions would be proportionally small - for regional grain producers, under 3%.

2) Transport costs are small as % of revenue - for regional grain producers, only about 12%.
   Transport savings from Inland Rail would equate to price increase of < 1%.

3) Trucking has service quality advantages over rail.

4) Natural & environmental constraints - e.g. supply of irrigation water limits regional cotton production.
## Benefit-Cost Ratios Compared

<table>
<thead>
<tr>
<th>Discount rate</th>
<th>4%</th>
<th>7-8%</th>
<th>10 - 11%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCA #1</td>
<td></td>
<td>1.5 to 1.7</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>BCA #2</td>
<td>6.1 to 8.5</td>
<td>3.6 to 5.1</td>
<td></td>
</tr>
<tr>
<td>BCA #3</td>
<td></td>
<td>&lt;1.0</td>
<td></td>
</tr>
<tr>
<td>BCA #4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations Start:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>1.52</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>2040</td>
<td>1.93</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>BCA #5 (Ops. Start 2025)</td>
<td>2.6</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>
Lessons from BCA Comparisons

• Extent of modal shift is hard to predict.
  – Significant variation among study predictions.

• Simple modeling frameworks can correctly anticipate the findings of far more elaborate efforts.
  – The findings of the most recent two analyses look broadly consistent with those of the initial, sketch-level analysis.

• Regional industry development effects uncertain and may be small part of the picture.
References

3. Ernst & Young 2006, North-South Rail Corridor Study, prepared for Department of Transport and Regional Services.
5. Australian Road Track Corporation 2015, Inland Rail Programme Business Case.