The Challenges of Measuring Transportation Efficiency

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The Challenges of Measuring Transportation Efficiency

- Motivation
- Literature Review
- Definition of Transportation Efficiency (TE)
- The Challenges of Measuring TE
- Hopeful Examples
- Conclusions
Motivation

- Oil dependence and fuel prices
  - “Peak oil” and Summer 2008 gasoline prices
  - 95% of global transportation energy is oil
- Emissions and global warming
  - 28% of GHG emissions in the US in 2006
- Rural and non-traditional region applications
Literature Review

• Ambiguity in the use of term “transportation efficiency”
  – Transportation-Energy Efficiency
  – Transportation-System Efficiency

• Strategies Associated with TE
  – Capacity-utilization
  – Emissions reductions
  – Land-use improvements
• *Derived* Measures of TE
  – Utility Models
  – Macroeconomic Models
  – Data Envelopment Analyses
  – Multiple-Criteria Analyses
  – Least-Cost Planning
Definition of Transportation Efficiency

- Common Variables/Criteria
- Common Themes:
  - Maximization of Service
  - Minimization of Cost
- Derived models attempt to assimilate a variety of variables to make:
  - Spatial comparisons
  - “System” comparisons
  - Temporal comparisons

<table>
<thead>
<tr>
<th>Category</th>
<th>“Cost” Variables</th>
<th>“Service” Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Prices for the user²</td>
<td>Cost savings⁴</td>
</tr>
<tr>
<td></td>
<td>Prices for the operator¹</td>
<td>Economic development and productivity²</td>
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<tr>
<td>Environmental</td>
<td>Carbon emitted per mile travelled¹</td>
<td>Reduced impact on the environment⁴</td>
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<td>GHG emissions¹</td>
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<td></td>
<td>Noise¹</td>
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<tr>
<td></td>
<td>Fuel used per mile travelled¹</td>
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<tr>
<td>Energy</td>
<td>BTUs per mile travelled¹</td>
<td>Decreased dependence on fossil fuels⁴</td>
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<td>Energy used per capita¹</td>
<td>Robust energy portfolio¹⁹</td>
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<td>Energy used per person-mile of travel¹¹</td>
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<td></td>
<td>Total energy use¹⁵</td>
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<tr>
<td>Human</td>
<td>Fatality²</td>
<td>Improved safety⁷</td>
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<td></td>
<td>Serious injury⁹</td>
<td>Basic human needs met¹¹</td>
</tr>
<tr>
<td>Operations</td>
<td>Time spent travelling²</td>
<td>All travel demand satisfied¹¹</td>
</tr>
<tr>
<td></td>
<td>Time wasted in congested travel¹</td>
<td></td>
</tr>
</tbody>
</table>

Citations
1. Manikonda et al, 2001
2. Southworth et al, 2004
3. Kavage et al, 2005
4. Barth et al, 2004
5. Moudon et al, 2005
7. Johnston, 2006
8. Rubin, 2009
9. Vucic, 1999
10. VDSR, 1998
11. Added by the authors
Definition of Transportation Efficiency

Spatial or “System” Comparisons:

Temporal Comparisons:

Motivation | Literature Review | Definition | Challenges | Hopeful Examples | Conclusions
The Challenges of Measuring Transportation Efficiency

• The “Rebound” Effect
  – Energy demand
  – Transportation demand (generated traffic, or induced demand)
  – A temporal boundary problem

• The “Shifting” Effect
  – A spatial or “system” boundary problem
Hopeful Examples

• Least-Cost Planning
  – Useful parallels between electricity and transportation:
    • Critical public infrastructure
    • Efficiency is important
    • Efficiency viewed as a provider of supply
  – Complications related to LCP in transportation:
    • No single service variable, like kW
    • No central control of service, more stakeholders

• Multiple-Criteria Analysis
  – Limitless inclusiveness
  – Provides the opportunity to weight criteria
  – Flexible boundaries
Conclusions

• Importance of dealing with “rebound” effects and “shifting” effects
• Importance of using an assimilative model, like LCP or MCA
Thank You
Questions?