ACCOUNTING FOR TRANSPORT IMPACTS ON THE ECONOMY: AN INTEGRATED COMPUTABLE GENERAL EQUILIBRIUM AND TRANSPORT MODEL

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MOTIVATION
- Using separate transport and economic models in urban planning restricts the testing of network design options and lengthens the planning process.
- Standard economic appraisals assume partial economic equilibrium and cannot determine the distribution of impacts to households and firms.

AIMS
- Develop a spatial computable general equilibrium (CGE) model with an embedded transport network model for appraisals.
- Implement the model for the Sydney urban area.
- Demonstrate the model with proposed changes to the Sydney road network and compare with conventional appraisals.

RESULTS
- Commuting, shopping and leisure trips are generated by household activity, which are assigned according to user equilibrium.
- Households account for travel times in sourcing goods and allocating time, and firms account for travel times in sourcing inputs.
- The formulation is a nonlinear complementarity model solved in GAMS.

APPLICATIONS
- The model provides a unified platform for the strategic-level appraisal of road projects, including travel time savings and productivity improvements.
- Nearly any welfare measure can be derived from the model, e.g. consumer surplus or GDP enabling comparisons with competing government investments.

MODEL FORMULATION
Contribution
Most CGE models for transport either do not incorporate leisure, or do not simulate household and freight transport together. Our main contribution is the development of a general equilibrium framework for transport appraisal that can be calibrated to strategic transport models, with both discretionary and non-discretionary trips.

Structure
The static model comprises spatial CGE and traffic assignment submodels formulated together as a nonlinear complementarity problem. The CGE submodel represents a production economy of households and firms. Household activities generate commuting, shopping and leisure trips, which form an origin–destination matrix. The trips then feed into the traffic assignment submodel to determine travel times, which are returned to the CGE submodel. Changes to parameters in the transport network result in the calculation of counterfactual equilibria.

Future research
- Expansion of the embedded network to additional modes and freight generation.
- Inclusion of housing and job search.
- Incorporation of household travel preferences and monetary costs of travel.

MODEL DEMONSTRATION
The integrated model was demonstrated with an abstraction of the Sydney road network. The urban area was divided into 14 regions according to the SA4 standard, and the economy was aggregated to two industries: (1) transport, and (2) all others. Three network improvements were tested:
- Test 1. Capacity increase of 50% on links (3,6) and (6,3).
- Test 2. Free-flow travel time reduction of 25% on links (6,11) and (11,6).
- Test 3. Express links of 30 min travel time and 100,000 vehicle capacity added between links (10,11) and (11,10).

Implementation
The demonstration was implemented in GAMS/PATH on the NEOS server. Data sources for calibration included:
- Input–output (IO) tables from IELab, an online regional and sectoral disaggregator of national IO tables for Australia.
- Population, workforce, employment and trip counts from the Bureau of Transport Statistics.
- Elasticities of substitution from the ORANI model and by assumption.

Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Equivalent variation</th>
<th>Value of travel time savings</th>
<th>Welfare loss from congestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>$118</td>
<td>$71</td>
<td>$6</td>
</tr>
<tr>
<td>Test 2</td>
<td>$324</td>
<td>$148</td>
<td>$19</td>
</tr>
<tr>
<td>Test 3</td>
<td>$831</td>
<td>$397</td>
<td>$15</td>
</tr>
</tbody>
</table>

*All values are in million AUD per year.