Impact of Trade Agreements on Canada's Transportation System

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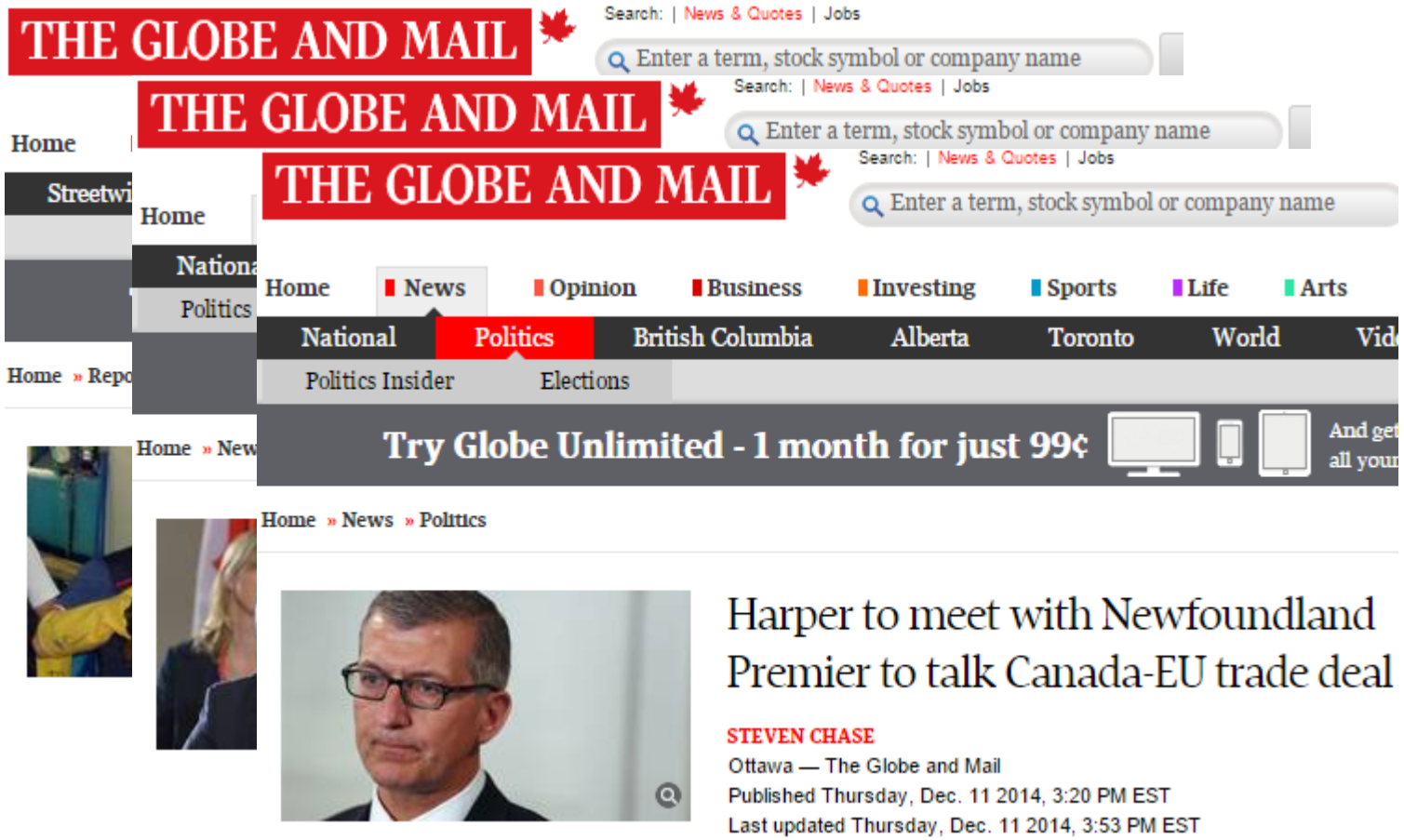
Civil Engineering
UNIVERSITY OF TORONTO

UTTRI University of Toronto Transportation Research Institute

Background

- Objectives:
  1. Review research related to trade and transportation interactions
  2. Identify potential models
  3. Describe the pros, cons, risks and results of the alternatives
  4. Provide detailed implementation requirements for the proposed modelling framework
- Sponsor:
  - Transport Canada
- Researchers:
  - Chris Bachmann
  - Matthew J. Roorda
  - Chris Kennedy

Motivation



- Trade relative to GDP increased by over 1,000% in some sectors between 1988 and 1999 (following CUSFTA and NAFTA)

Analysis Requirements

- Functions
  1. Predict how Canada's economy will perform in the future as a consequence of a trade agreement
  2. Predict how Canada's transportation system will perform in the future as a consequence of changes in trade, production, and consumption
- Objectives and Constraints
  - Assumptions should be conceptually and theoretically consistent
  - Implementation requirements must be reasonable
  - …

Literature Review

	Ex-ante ("before the event")	Ex-post ("after the event")
Impact of Trade Agreements on Transportation Systems	• A couple of recent studies (2013, 2014) • Focus on emissions	• A few older studies discussing NAFTA • Difficult to attribute temporal changes to trade agreements
Impact of Transportation Costs on Trade Flows	• Very large literature • Multiple methods in parallel development	• Large literature using gravity models • Recent studies using innovative approaches

Potential Trade Models

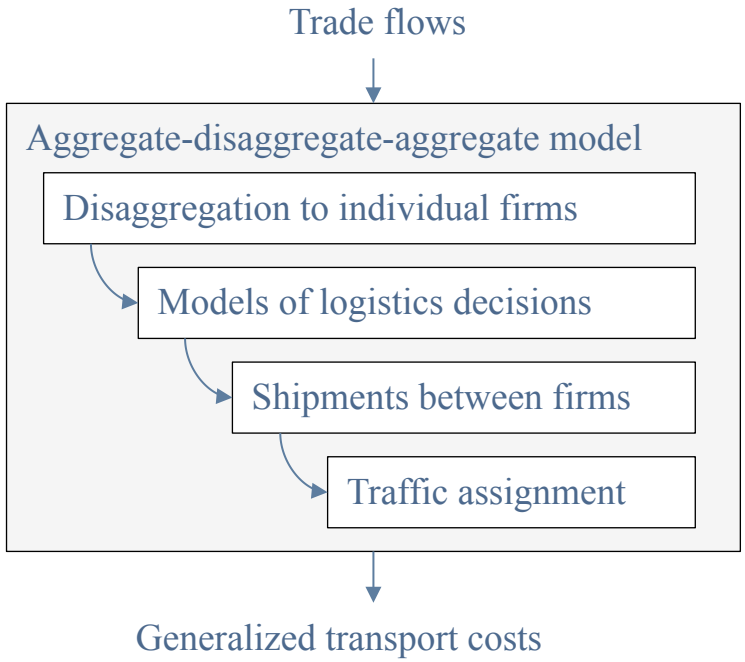
- Partial Equilibrium (PE) models
- Computable General Equilibrium (CGE) models
- Random-Utility-Based Multi-Region Input-Output (RUBMRIO) models
- Gravity models

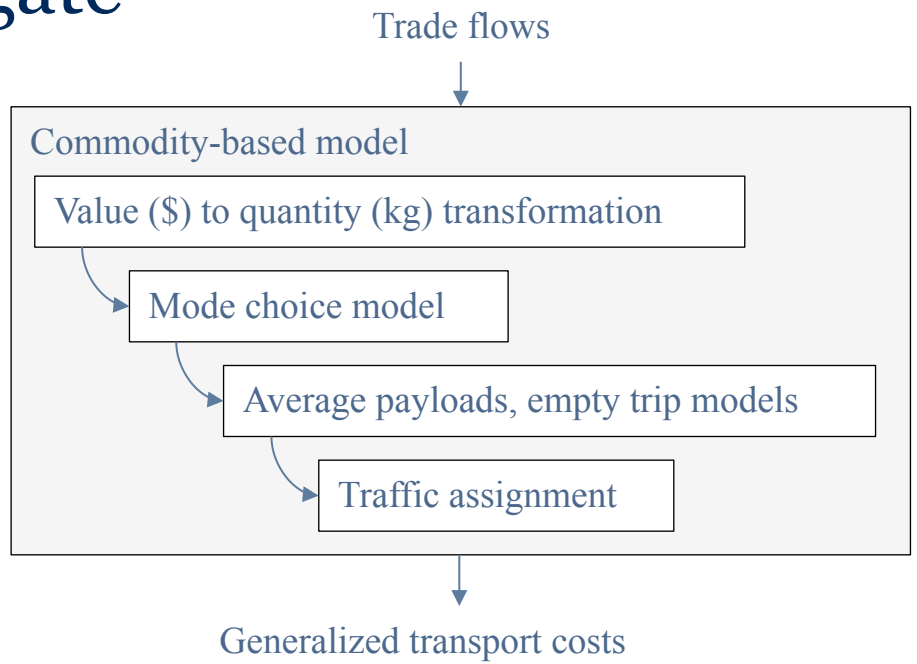
Trade Model Trade-Offs

Criterion	CGE Models	PE Models
Captures economy-wide linkages among producers and consumers	✓	
Conceptual consistency that recognizes resource and budget constraints	✓	
Consistent with economic theory	✓	
Avoids complexity in data and parameters		✓
Disaggregates sectors into fine categories		✓
Uses timely data		✓
Captures short- and medium-run effects		✓
Captures long-run effects	✓	

Potential Freight Models

- Aggregate/Disaggregate
- Aggregate



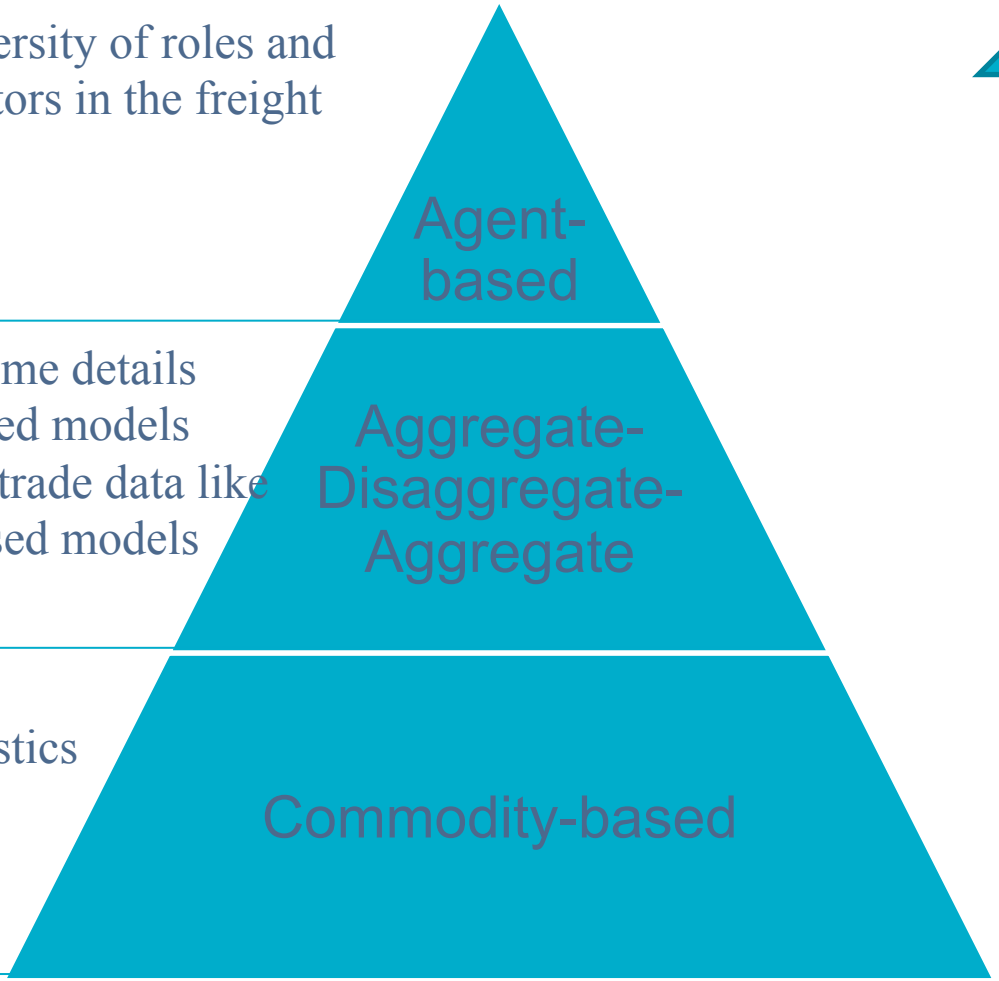


Freight Model Trade-offs

- Represents diversity of roles and functions of actors in the freight system

- Incorporates some details from agent-based models
- Uses available trade data like commodity-based models

- Ignores supply chains and logistics



Trade Models Assessment

	CGE	PE	RUBMRIO	Gravity
Functions				
Simulate the effects of complicated trade policy mechanisms observed in practice	●	◉	◉	○
Disaggregate sectors and regions to a degree that represents important underlying relationships	◉	●	◉	●
Include the consequences of trade policy changes by multiple countries	●	◉	●	◉
Incorporate the interdependency of important economic variables	●	○	◉	○

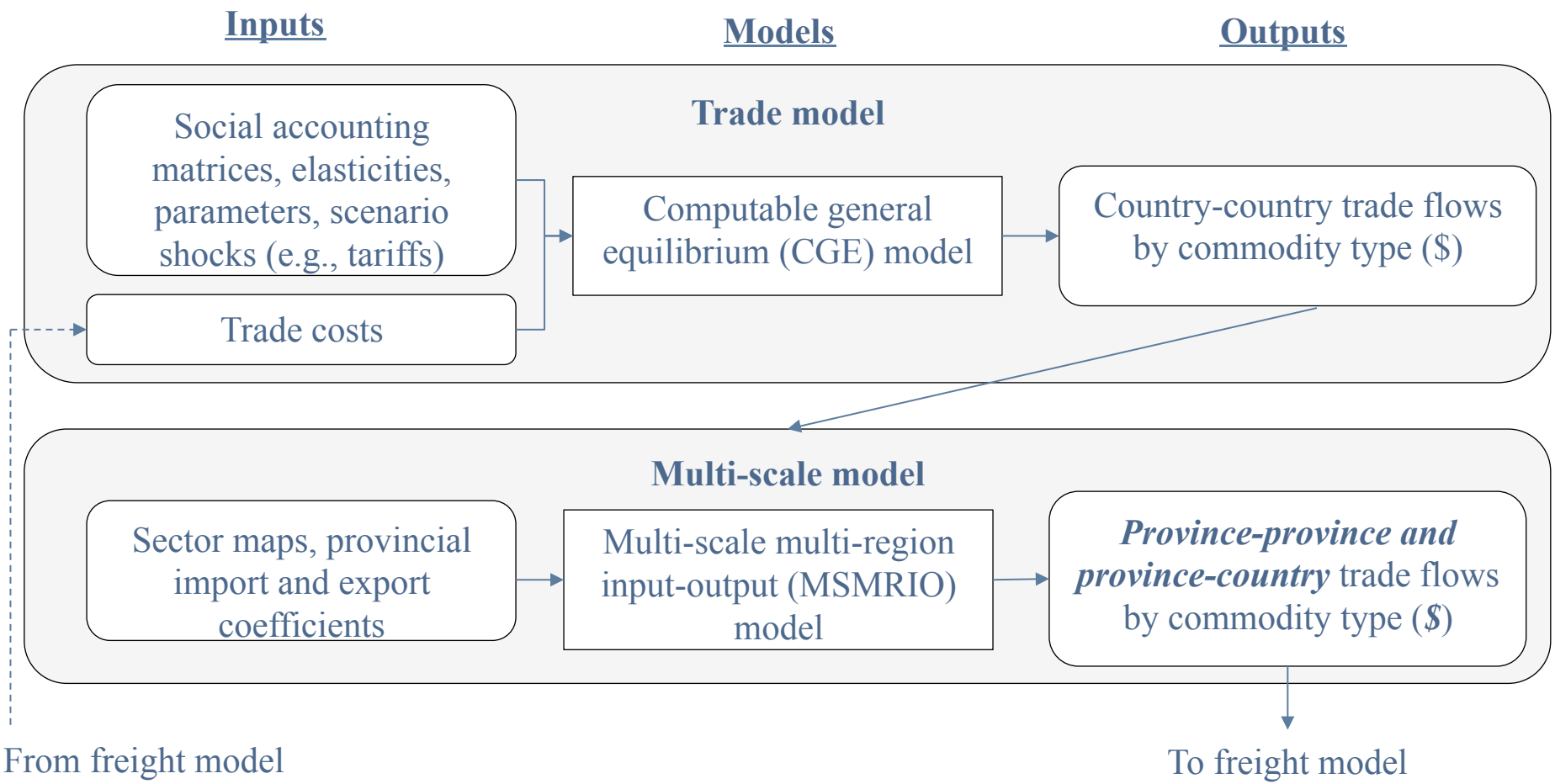
**Legend: Poor ○○◉◉● Excellent*

Freight Models Assessment

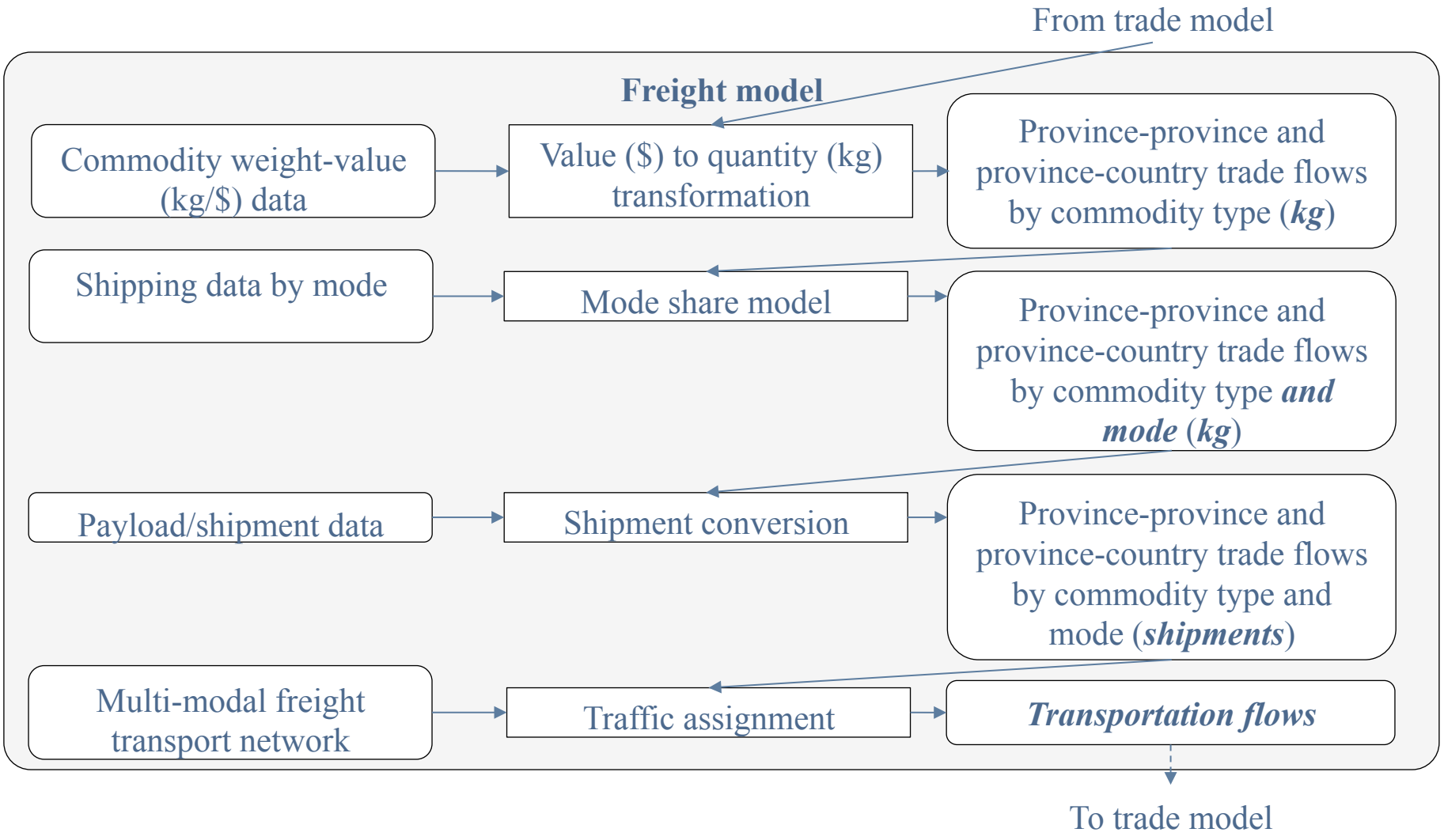
Functions	Commodity	Agent	ADA
Convert resulting trade flows into multi-modal vehicle flows (i.e., conversion from production-consumption matrices to origin-destination trip matrices)	●	●	●
Include explicit treatment of various decisions that firms make (e.g., routing of flows through distribution centers)	○	●	◉
Estimate origin-destination vehicle flows on a seamless multimodal network	●	●	●
Calculate generalized transportation costs throughout the transport network model	●	●	●

**Legend: Poor ○○◉◉● Excellent*

Proposed Modelling Framework (part 1)



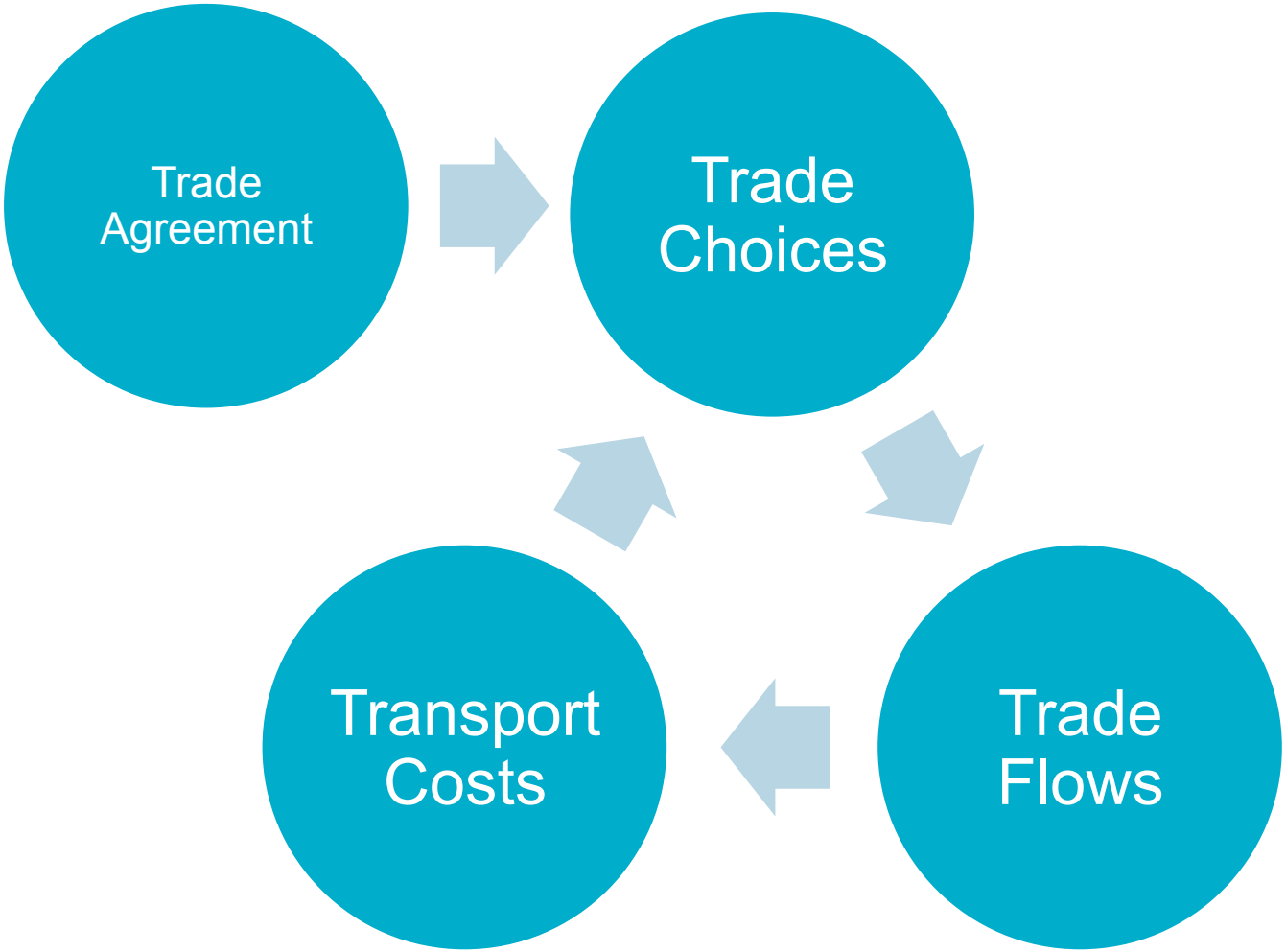
Proposed Modelling Framework (part 2)



Implementation Requirements

1. Simulate the changes in the global economy
2. Apportion changes in Canadian production, consumption, and trade to Canada's ten provinces and three territories
3. Convert trade flows from monetary values to quantities
4. Split trade flows among transportation modes
5. Convert mode-specific trade flow quantities into shipments [*optional*]
6. Assign transportation demands to a freight network model
7. **Feedback new transportation costs to the economic simulation and repeat until trade flows and trade costs converge [*optional*]**
8. **Conduct verification and validation**
9. **Conduct a sensitivity analysis [*optional*]**

Step 7: Feedbacks



Step 8: Verification and Validation

- Establish model **correctness and credibility**
- Verification
  - Determines if the model was 'built right'
  - Compare the model's base case outputs with the base case data
  - Check code regularly to ensure the model has been programmed as intended
- Validation
  - Determines if the 'right thing was built'
  - Compare model outputs to real-world observations for the current year and/or for a forecast year that has passed
  - Transportation models can be validated with external data such as traffic counts

Step 9: Sensitivity Analysis

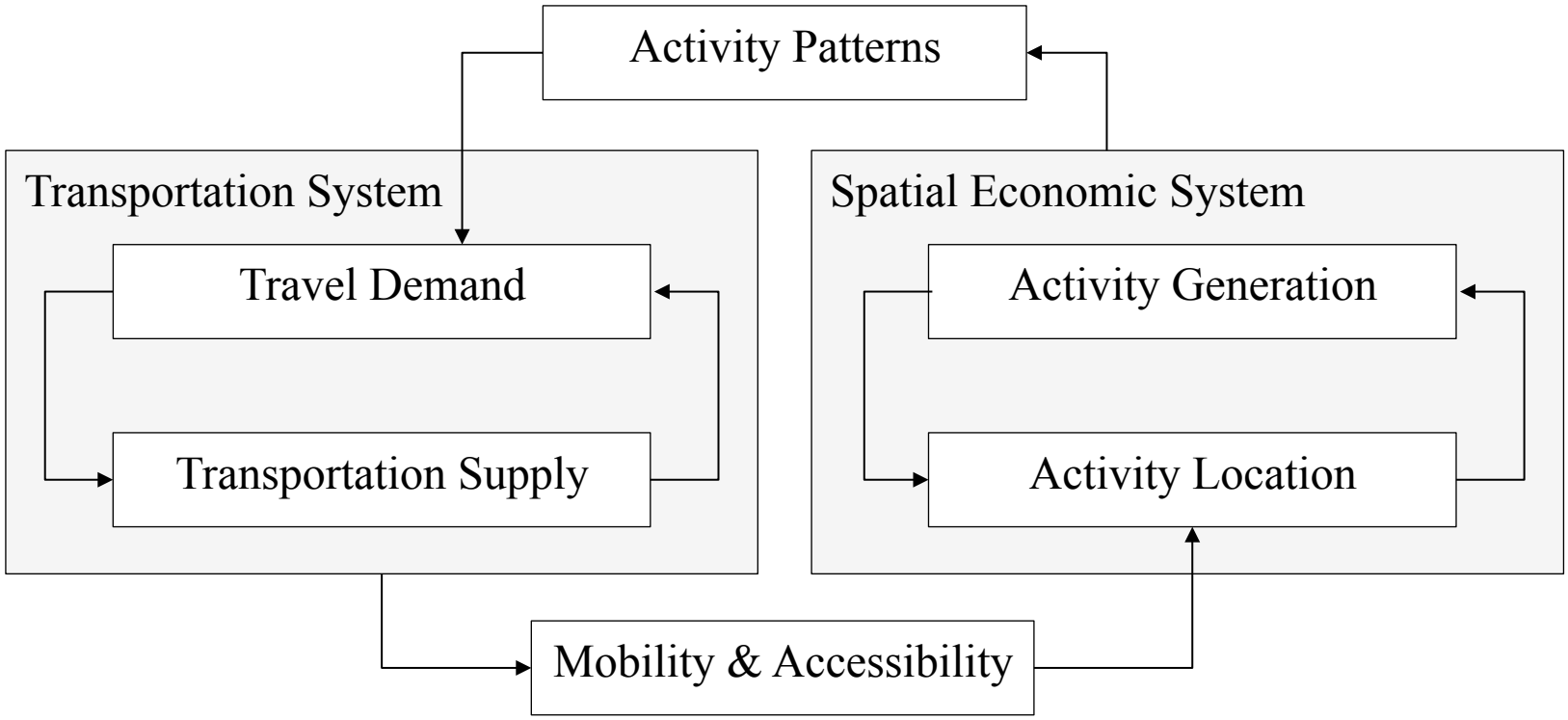
- Determine the **robustness** of the model results
- Start with the most plausible assumptions and most realistic specifications
  - Make reasonable changes in model assumptions and parameter values
  - Or sample from a distribution of parameter values and produce a distribution of model results
  - Assess confidence in important results

Concluding Remarks

- No previous studies of a potential free trade agreement's impacts on a country's domestic infrastructure
- A spatial economic and transportation interaction modelling framework is required
- A computable general equilibrium (CGE) model and a commodity-based freight model are recommended
- Models need to be designed and applied carefully – they are imperfect simplifications of the real world and are subject to inaccuracies

Transportation Economic Center (TEC) at the University of Waterloo (UW)

- Big picture



Transportation Economic Center (TEC) at the University of Waterloo (UW)

- Mission Statement
  1. Conduct transportation economics research to address timely transportation projects and policies
  2. Advance the state-of-the-art in transportation economics by undertaking ongoing data collection and methodological research
  3. Assist government agencies and private industry by providing state-of-the-art modelling capabilities
  4. Provide education and training to undergraduate and graduate students in transportation economics
  5. Facilitate the sharing of information and best practices through a collaborative research network, journal publications, conference presentations, a website, and other communication techniques

Transportation Economic Center (TEC) at the University of Waterloo (UW)

- Prospective Research Activities
  - Economics:
    - Modelling Spatial Economic Transportation Interactions (SETI), optimizing infrastructure investments, measuring and maximizing social welfare, infrastructure valuation and resiliency, globalization
  - Finance:
    - Internal Rates of Return (IRR), Public Private Partnerships (PPP), equitable financing mechanisms, value of time, quantification of risk, congestion and transit fare pricing, willingness to pay (WTP)

- Methods/Models
  - Input-Output (IO) and Computable General Equilibrium (CGE) analysis, Agent-based Computational Economics (ACE), Cost-Benefit Analysis (CBA), Random Utility Maximization (RUM) models, Revealed Preference (RP) and Stated Preference (SP) surveys

Question and Discussion