Modelling Freight Vehicle Type and Shipment Size Choice

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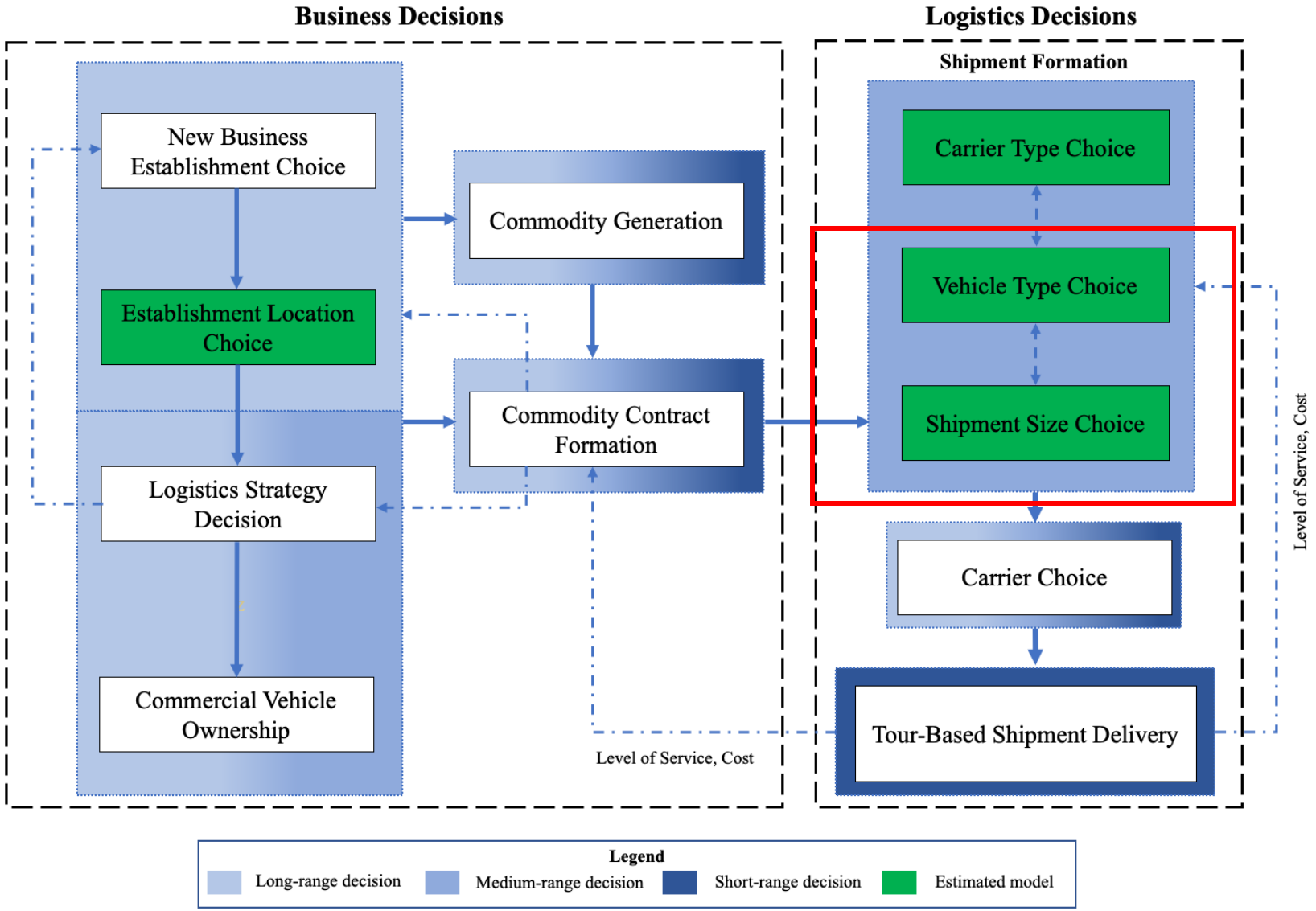
City Logistics for the Urban Economy

CLUE

SMART FREIGHT CENTRE

Freight Business and Logistics Decisions Simulation Framework



Freight Mode v/s Vehicle Type

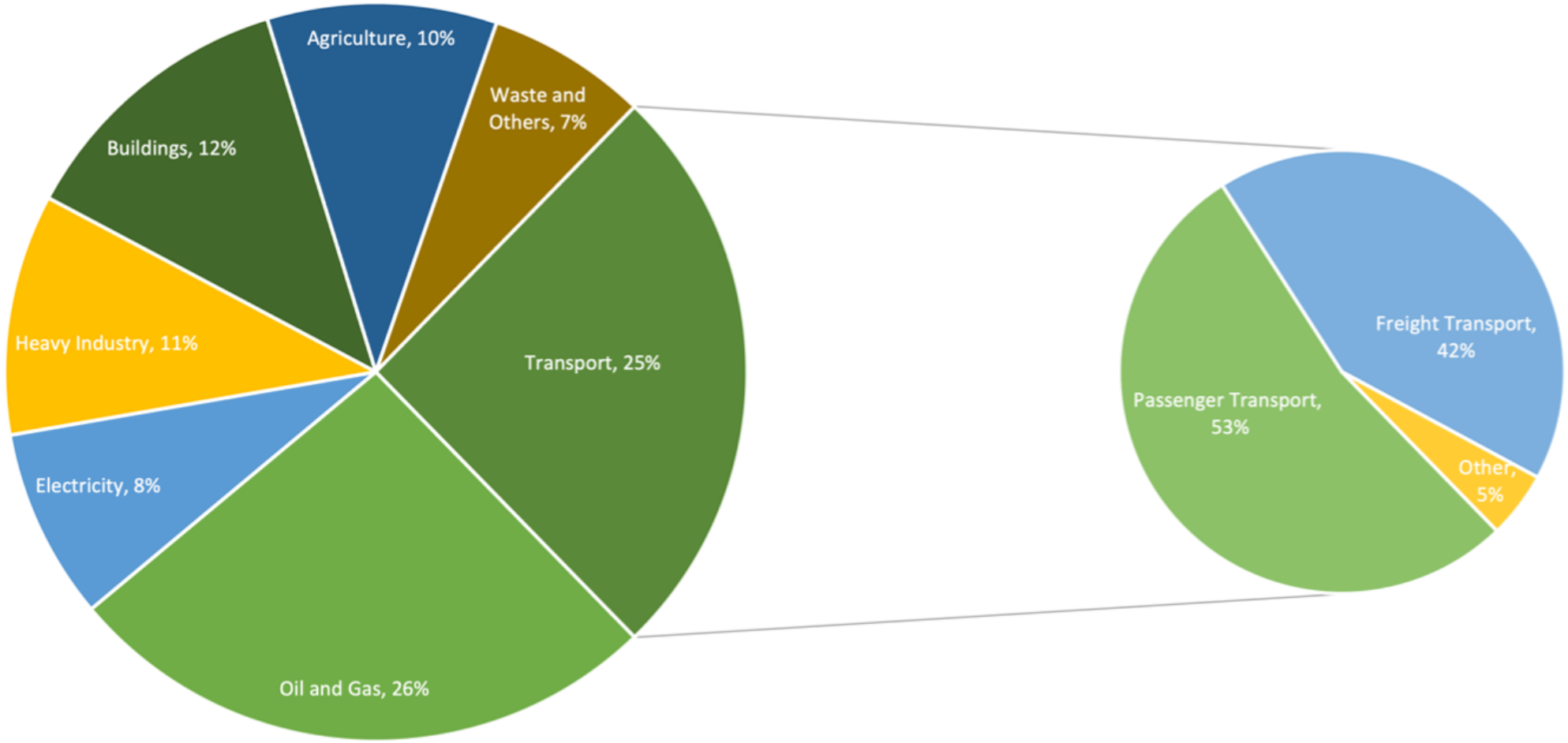
- Mode Choice:
  - Road, rail, air, water
  - Most relevant for inter-city, statewide, and national level studies

- Vehicle Type Choice:
  - Road-based mode: Passenger car, trucks, vans, etc.
  - Most relevant for city or metropolitan area level studies

Background and Motivation

- Freight flows have been increasing in Canada.
  - 16.7% increase in freight shipments from 2011 to 2017 (Statistics Canada 2020)
- Economic development of regions
- Global competitiveness of industries
- Changing trends in supply chain and logistics
- Major contribution to greenhouse gas emissions!

Background and Motivation



Background and Motivation

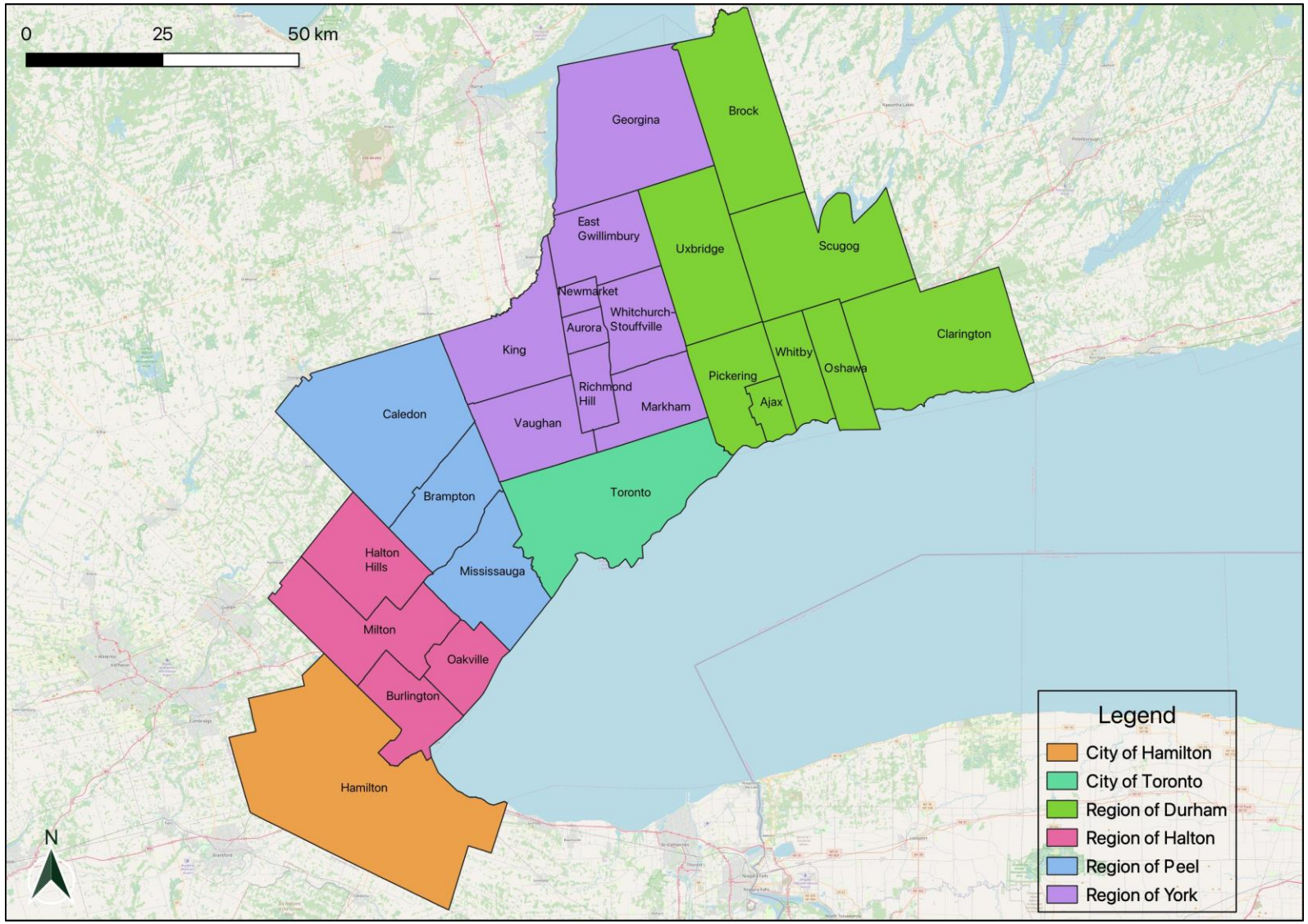
- Implications on quality of life of urban residents
  - Noise pollution
  - Traffic congestion
  - Safety impacts
  - Parking problems
  - Pavement damage

Study Objectives

- Study the factors behind freight vehicle type and shipment size choice

- Comparison of independent v/s joint (correlated) choices
  - Substitution patterns

Study Area


0
25
50 km
Georgina
Brock
East Gwillimbury
Uxbridge
Scugog
Newmarket
Whitchurch-Stouffville
Aurora
King
Clarington
Whitby
Oshawa
Pickering
Ajax
Richmond Hill
Markham
Vaughan
Caledon
Toronto
Brampton
Halton Hills
Mississauga
Milton
Oakville
Burlington
Hamilton
N
Legend
City of Hamilton
City of Toronto
Region of Durham
Region of Halton
Region of Peel
Region of York

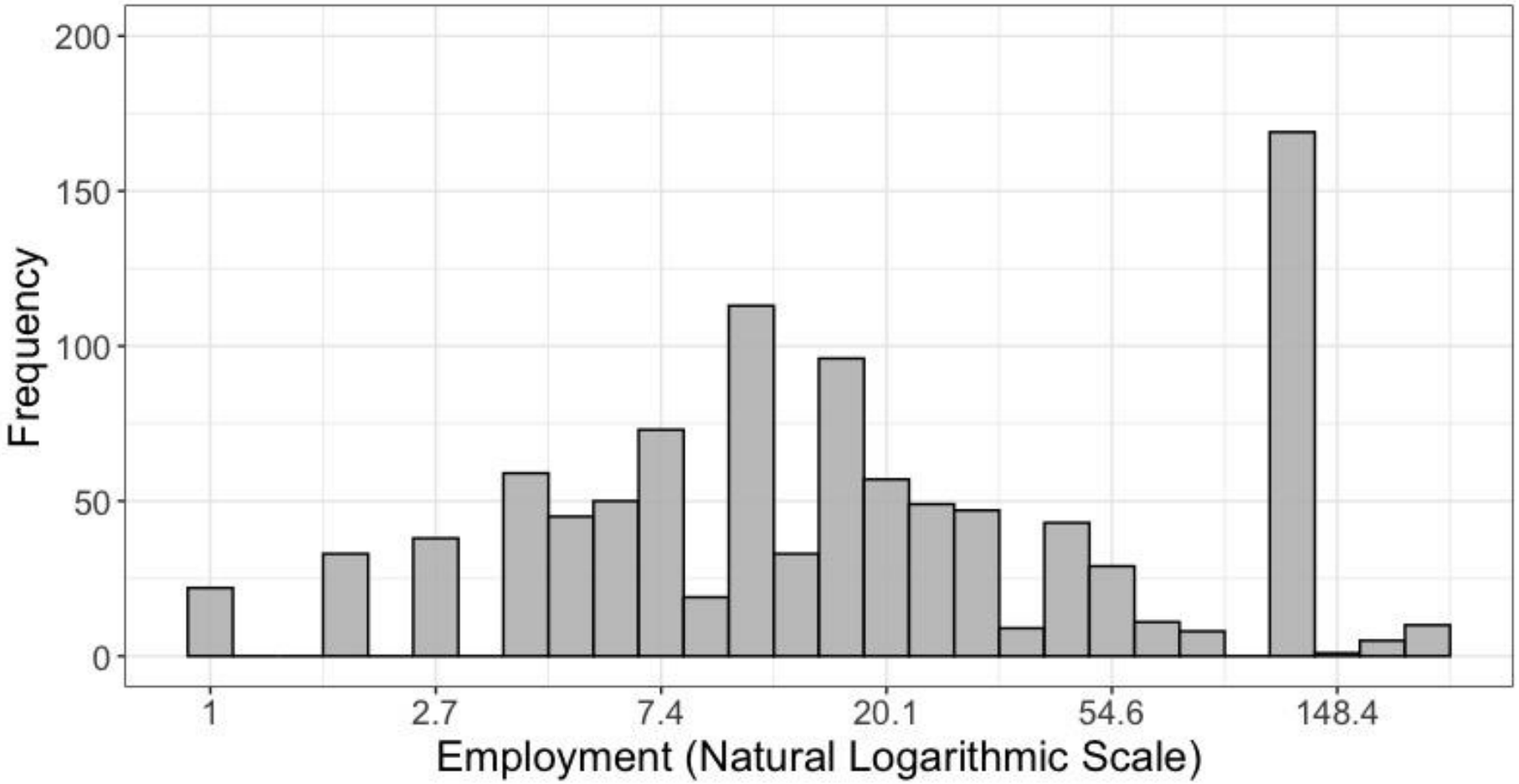
Data Source

- Commercial Travel Survey
  - Region of Peel (2006/07), Region of Durham (2010), Toronto Area (2012)

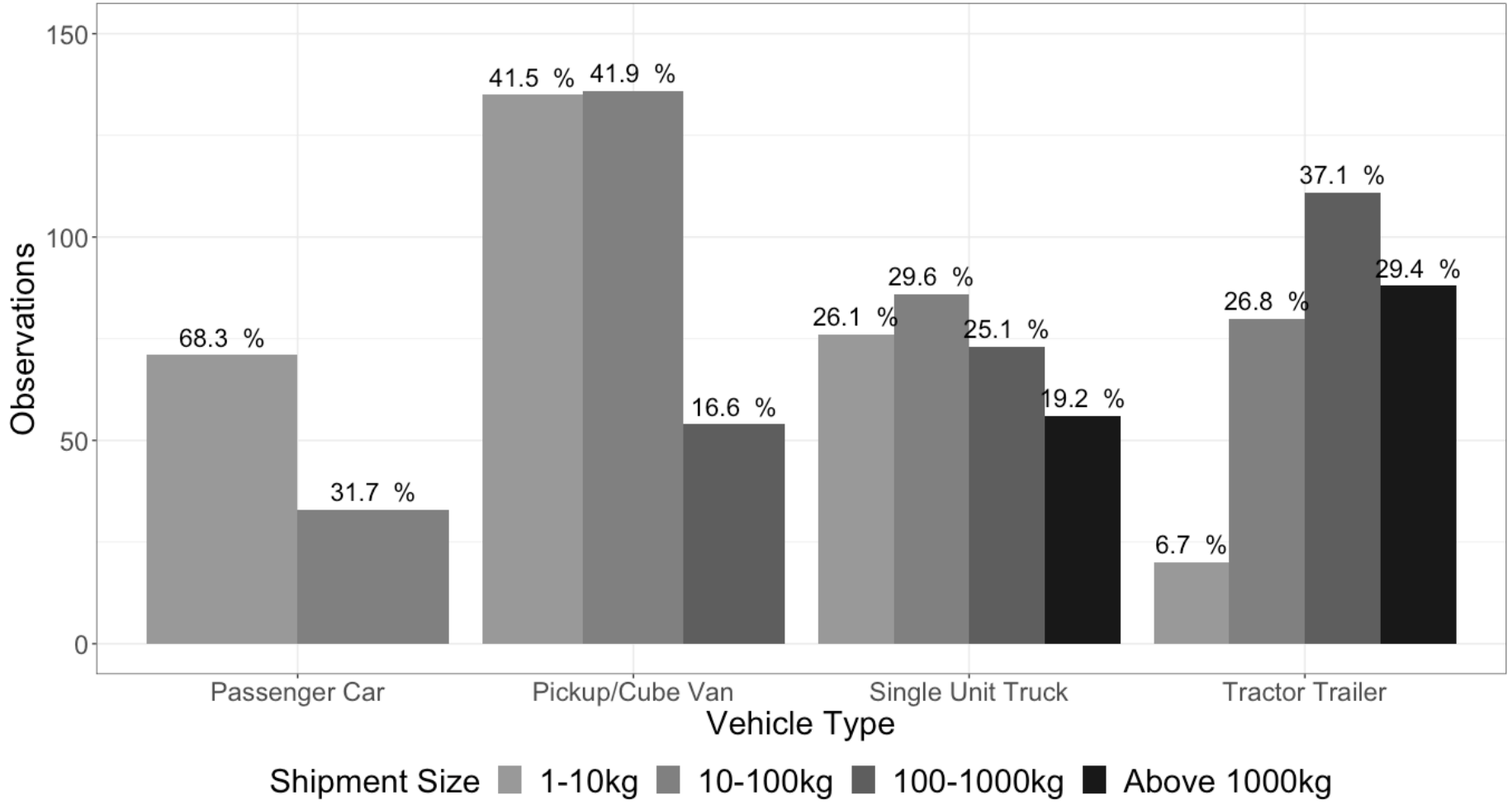
- Outbound Shipments
  - 1,019 shipments
  - 292 firms

- Explanatory Variables
  - Industry type, commodity type
  - Shipment origin and destination (cities)
  - Employment and shipment value

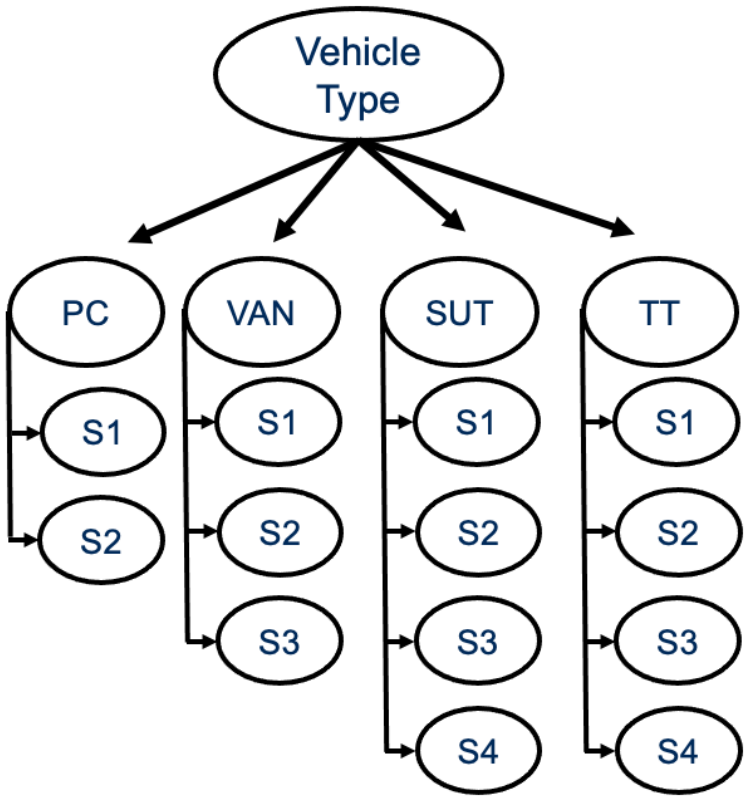
Data Source

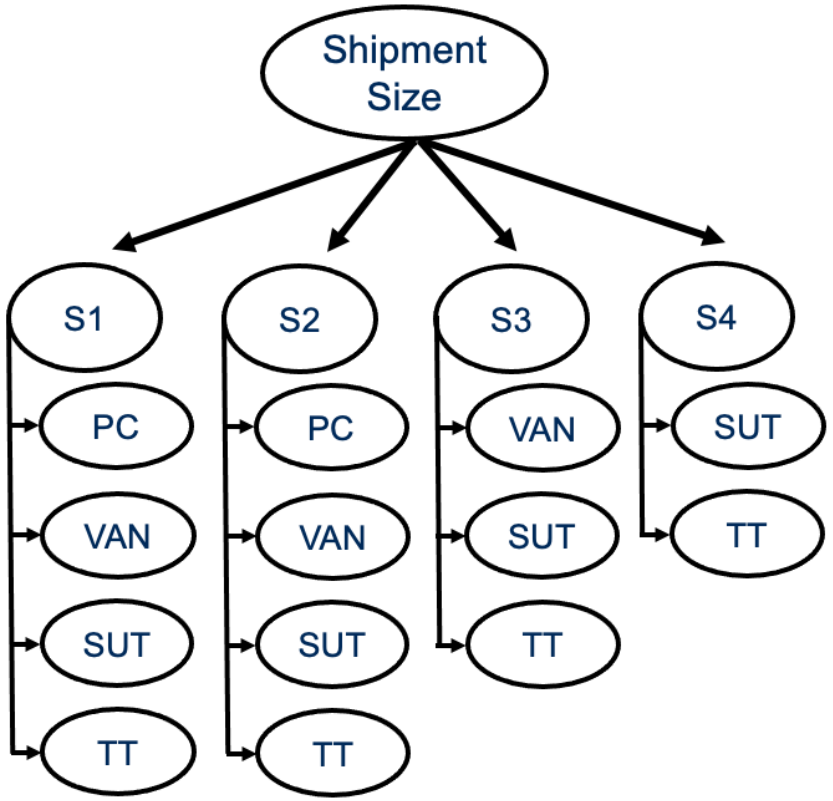

200
150
100
50
0
Frequency
1
2.7
7.4
20.1
54.6
148.4
Employment (Natural Logarithmic Scale)

Data Source


150
100
50
0
Observations
68.3 %
31.7 %
41.5 %
41.9 %
16.6 %
26.1 %
29.6 %
25.1 %
19.2 %
6.7 %
26.8 %
37.1 %
29.4 %
Passenger Car
Pickup/Cube Van
Single Unit Truck
Tractor Trailer
Vehicle Type
Shipment Size
1-10kg
10-100kg
100-1000kg
Above 1000kg

Methodology





Methodology

- Methods
  - Sequential logit
  - Nested logit
  - Models developed for both structures

Results

Results

- Larger firms are more likely to use larger vehicles
- Intracity shipments are more likely to be transported using smaller vehicles
- Larger vehicles are more likely to be used for shipments destined outside of Toronto Area
- High density value shipments are more likely to be smaller in size and are transported using smaller vehicles

Model Fit Results

Parameter	Vehicle – Shipment (VS)		Shipment – Vehicle (SV)	
	Nested Logit	Sequential Logit	Nested Logit	Sequential Logit
Log-Likelihood (0)	-2613.68	-2659.68	-2613.68	-2656.99
Log-Likelihood (final)	-2150.16	-2118.31	-2043.70	-2033.18
ρ^2	0.18	0.20	0.22	0.23
Adjusted ρ^2	0.17	0.19	0.21	0.22
BIC	4501.19	4458.27	4274.42	4267.24
Estimated Parameters	29	32	27	29

Choice Correlation

Nested Logit Model	Nesting Coefficient (λ)
Vehicle – Shipment (VS)	0.62
Shipment – Vehicle (SV)	0.20

Conclusion

- Applications in policy analysis
  - Demand for parking facilities, loading bays
  - Greenhouse gas emissions
  - E-commerce, same-day deliveries

Conclusion

- Significant correlation found in the choice of vehicle type and shipment size
- Both model structures are possible
- A latent class model with both model structures should be tested

More about this work!

- More details about models and results can be found in:

Ahmed, U., & Roorda, M. J. (2022). Joint and sequential models for freight vehicle type and shipment size choice. Transportation, 1-17.