

Capturing, Measuring and Response to Changes that Influence Demand for Transportation and Travel Behaviour

Professor Khandker Nurul Habib



UTTRI University of Toronto Transportation Research Institute

Location: M-5519 des pavillons
Lassonde de Polytechnique

Date/Time: 9:30 pm, Dec 1st 2016

ICI RADIO-CANADA  .caICI  GRAND MONTRÉAL
+ DE RÉGIONS ▾

ACCUEIL | ENVIRONNEMENT

Gens d'affaires, industriels et écologistes interpellent Québec sur le transport durable

PUBLIÉ AUJOURD'HUI À 8 H 05



Des voitures avançant à pas de tortue sur une autoroute. Photo : iStock / iStock

Le poids du secteur des transports dans le bilan environnemental du Québec est tel qu'il provoque d'improbables alliances entre des leaders du monde des affaires, de l'industrie et des écologistes.

Le Conseil du patronat du Québec (CPQ), l'Association du camionnage du Québec, Équiterre et la Fondation David Suzuki s'unissent ainsi pour réclamer du gouvernement des investissements massifs dans le transport collectif et les infrastructures pour stimuler l'économie, lutter contre les changements climatiques et réduire la congestion routière.

« Au Québec, le transport en commun génère près de trois fois plus d'emplois et de retombées que les investissements en transport automobile », avancent les signataires. « Même l'Ontario, qui ne dispose pas

CPEQ  Conseil Patronal de
l'Environnement du Québec
Le Développement durable à l'oeuvre depuis 1972

 Chambre de commerce
et d'industrie de Québec

 Association du
Camionnage du
Québec

 CPQ
S'ALLIER POUR LA PROSPÉRITÉ

 Équiterre

 RNCREQ

Regroupement des
conseils régionaux

 VIVRE EN VILLE
la voie des collectivités viables

Symposium annuel Trottier sur l'ingénierie,
l'énergie et la conception durables



Annual Trottier Symposium on Sustainable
Engineering, Energy and Design

Transport : à quoi carbure la
transition ?

11 – 12 avril 2017
Polytechnique Montréal

Transportation : What's Fuelling
the Transition ?

April 11 – 12, 2017
Polytechnique Montréal





IET
INSTITUT
DE L'ÉNERGIE
TROTTIER

BOURSES TROTTIER 2017

Maîtrise
recherche
25 000 \$ / 2 ans

Doctorat
48 000 \$ / 3 ans

Concours ouvert aux étudiants
débutant un programme
d'études supérieures à
HEC MONTRÉAL
UNIVERSITÉ DE MONTRÉAL
POLYTECHNIQUE MONTRÉAL

dont le domaine de recherche
est en lien avec les enjeux énergétiques



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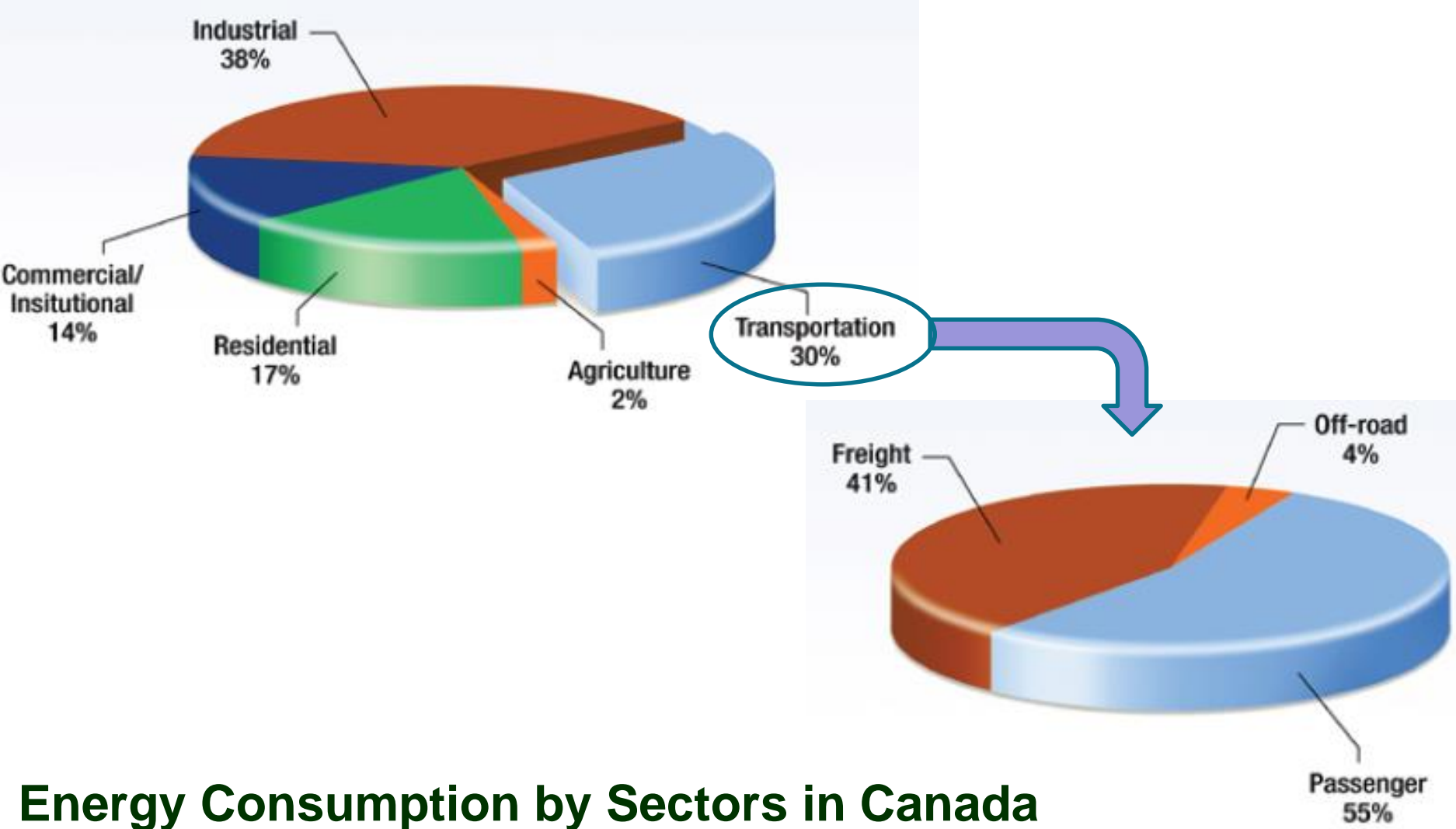
Date/Time: 9:30 pm, Dec 1st 2016

Outline

- Current trends in energy demand and the role of transportation
- Determinants transportation energy demand
- Transportation Demand: devils in the details
- Understanding, modelling and data needs
- Research collaborations

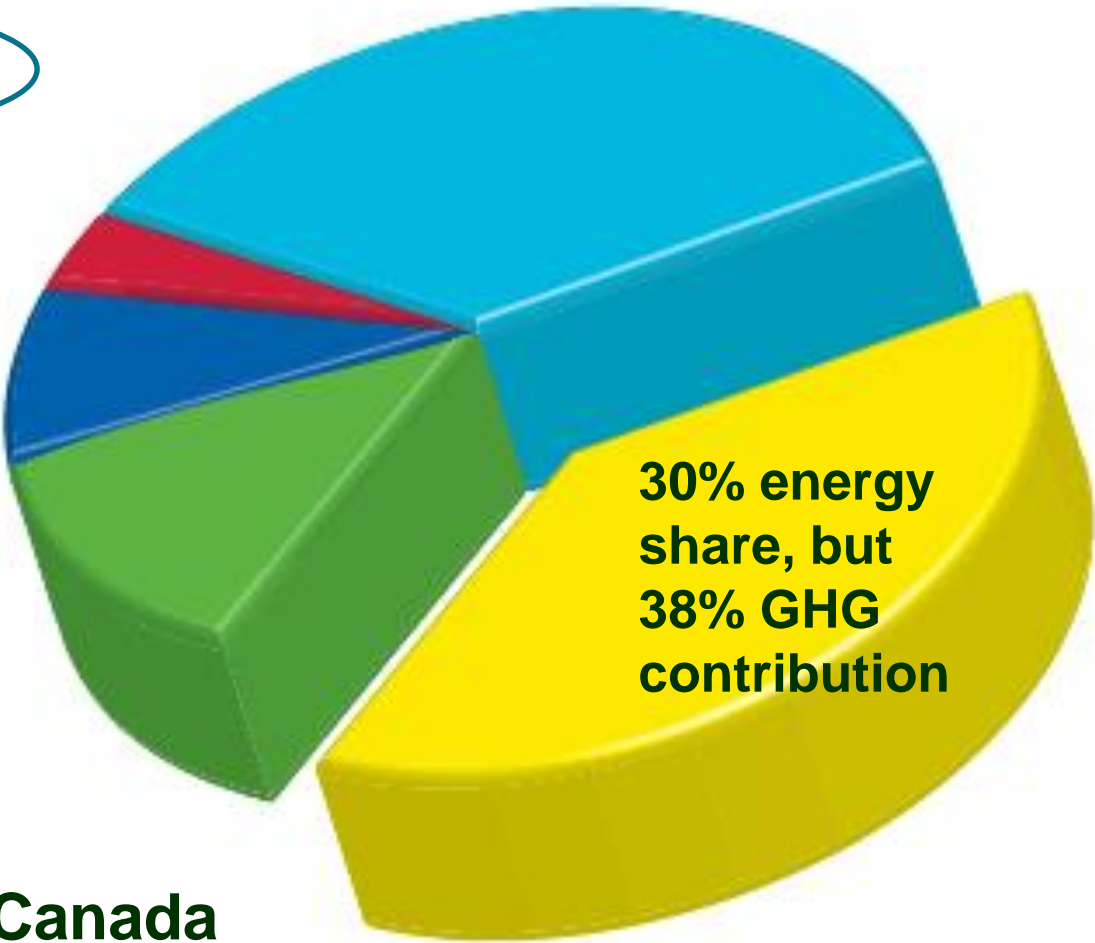
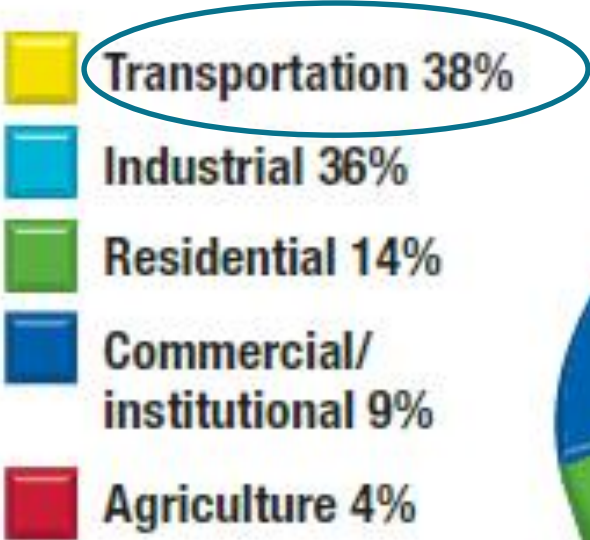


Introduction



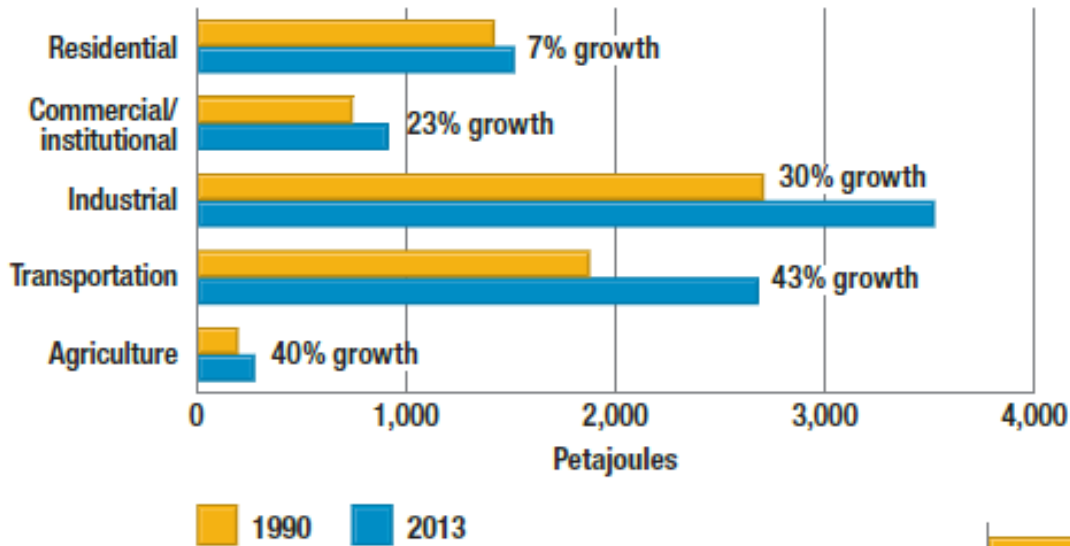
Energy Consumption by Sectors in Canada

Why Should We Care?



GHG Emissions in Canada

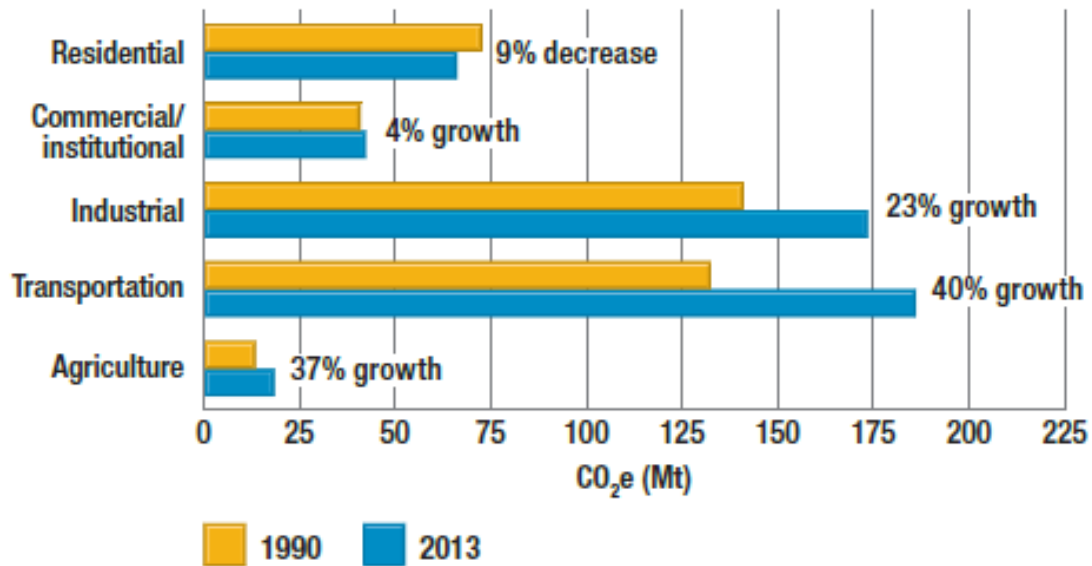
What Do We Observe?



Growth in Energy Usage in Canada
 (Source: Transport Canada)



Growth in GHG Emission in Canada
 (Source: Transport Canada)



What Do We Observe?

Between 1990 to 2013

- Energy efficiency in transportation sector improved 29%
 - ✓ Total transportation energy use increased 43%

- Passenger transportation energy efficiency improved 27%
 - ✓ Transportation energy use increased by 20%

 - ✓ It would have increased 46% without efficiency gains

What Drives the Growths in Passenger Transport?

1990



- 14.2 million vehicles
- 19.4 percent are light trucks
- 17,246 km/year on average per vehicle
- 378.3 billion Pkm covered
- 0.68 vehicles per person aged 18 years and over

Increasing private car ownership

&

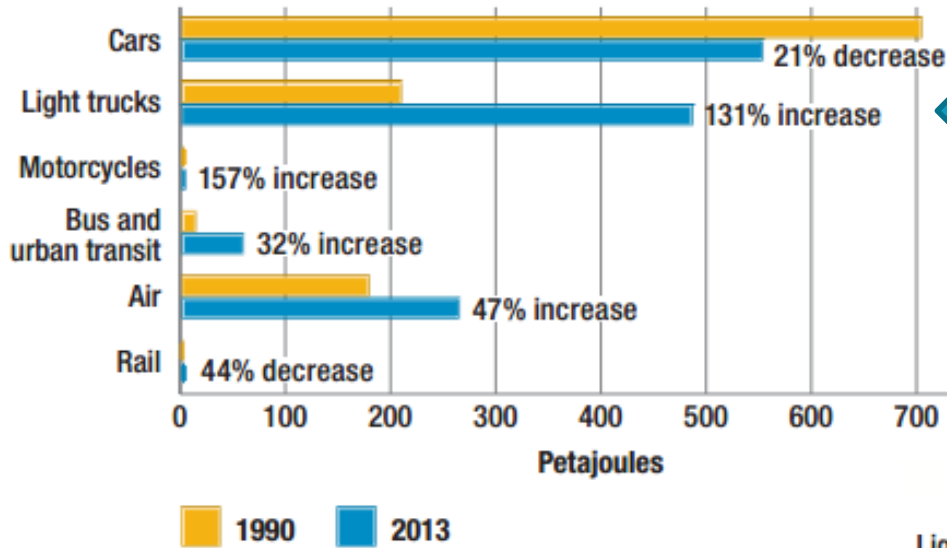
2013



- 20.5 million vehicles
- 37.2 percent are light trucks
- 15,552 km/year on average per vehicle
- 519.7 billion Pkm covered
- 0.73 vehicles per person aged 18 years and over

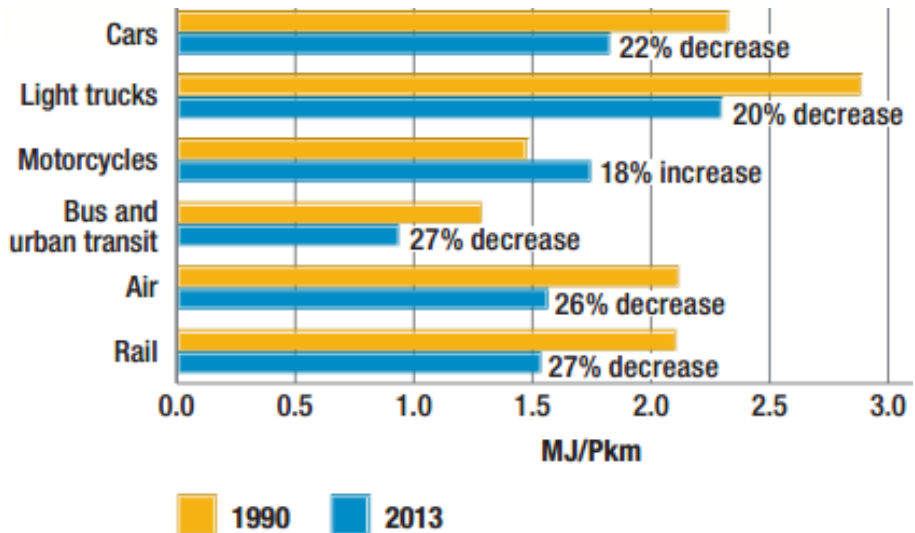
Increasing use of private cars for transportation

What Drives the Growths in Passenger Transport?

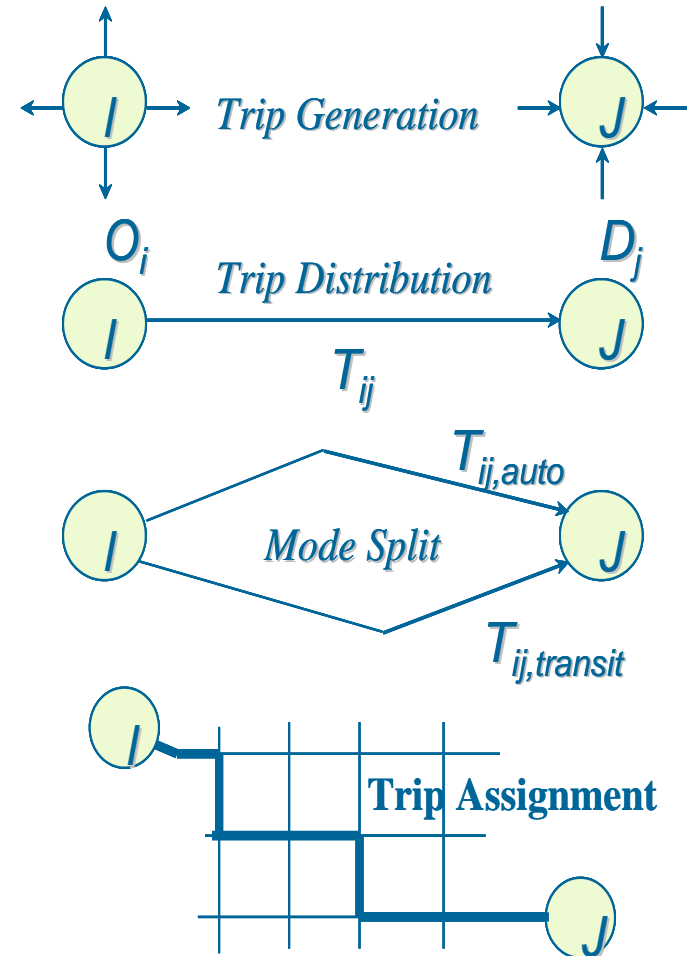
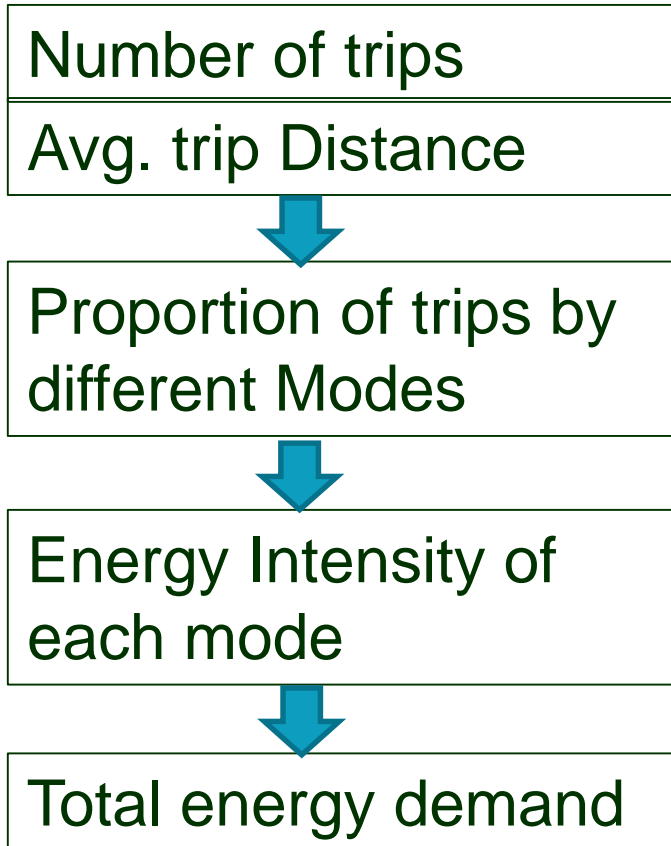


Higher rate of increasing light truck (SUV)

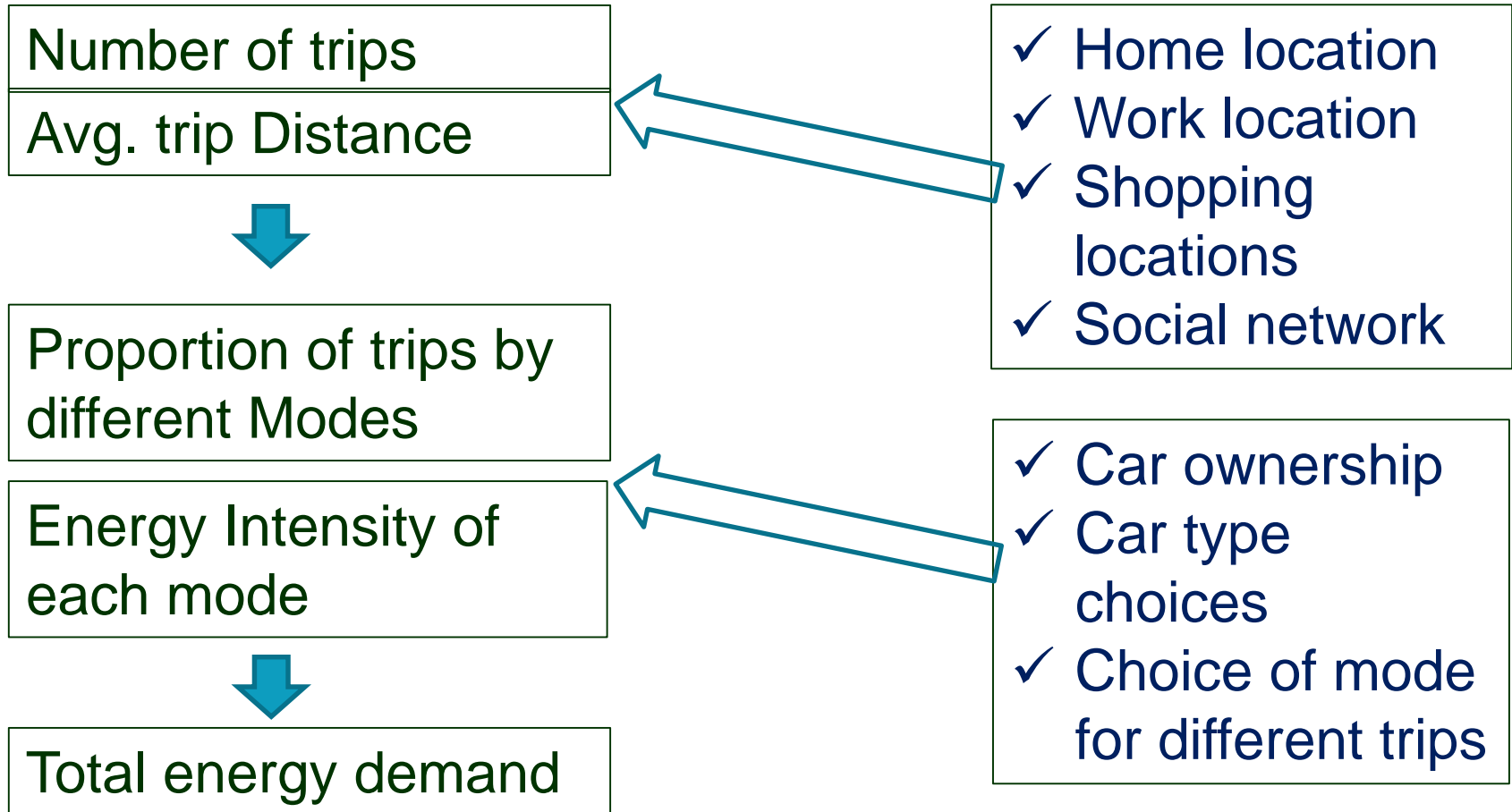
With lower rate of energy intensity gain for light trucks (SUV)



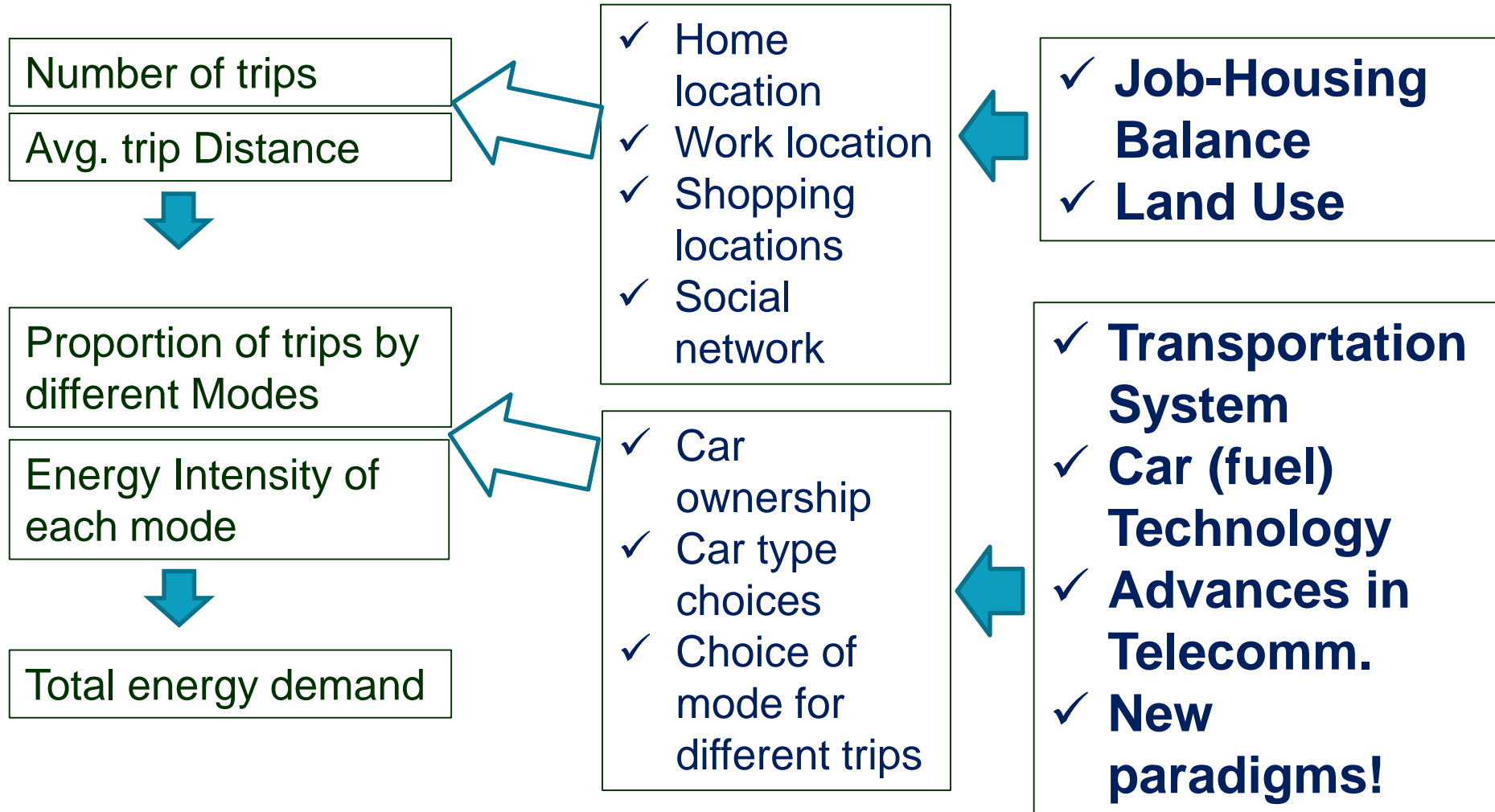
Measuring Passenger Transportation Energy Demand



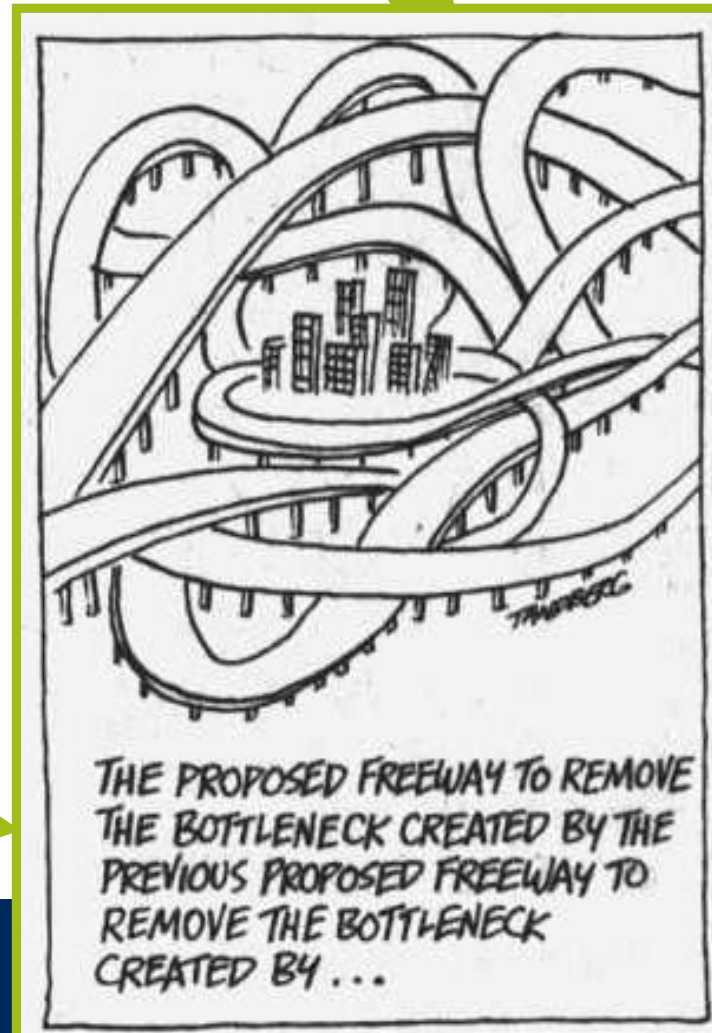
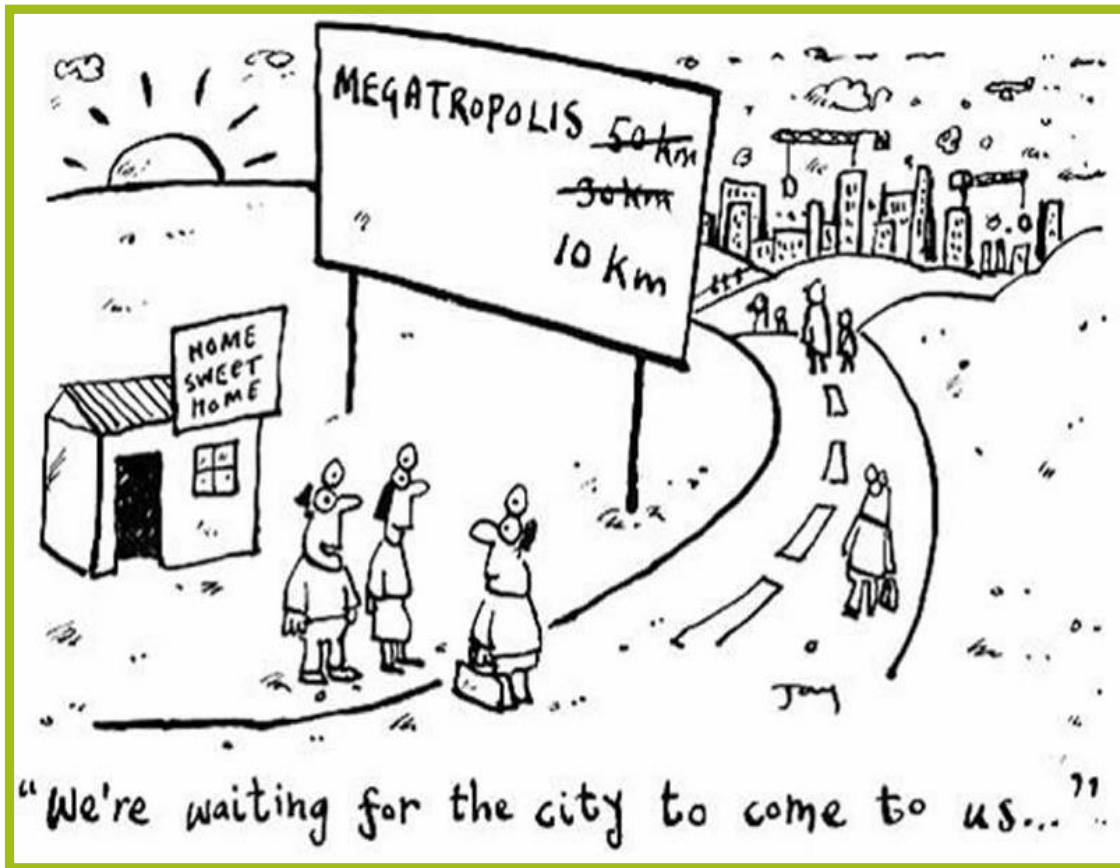
Measuring Passenger Transportation Energy Demand: Key Determinants



Measuring Passenger Transportation Energy Demand: Key Determinants



Car-Oriented Urban Growth & Transportation



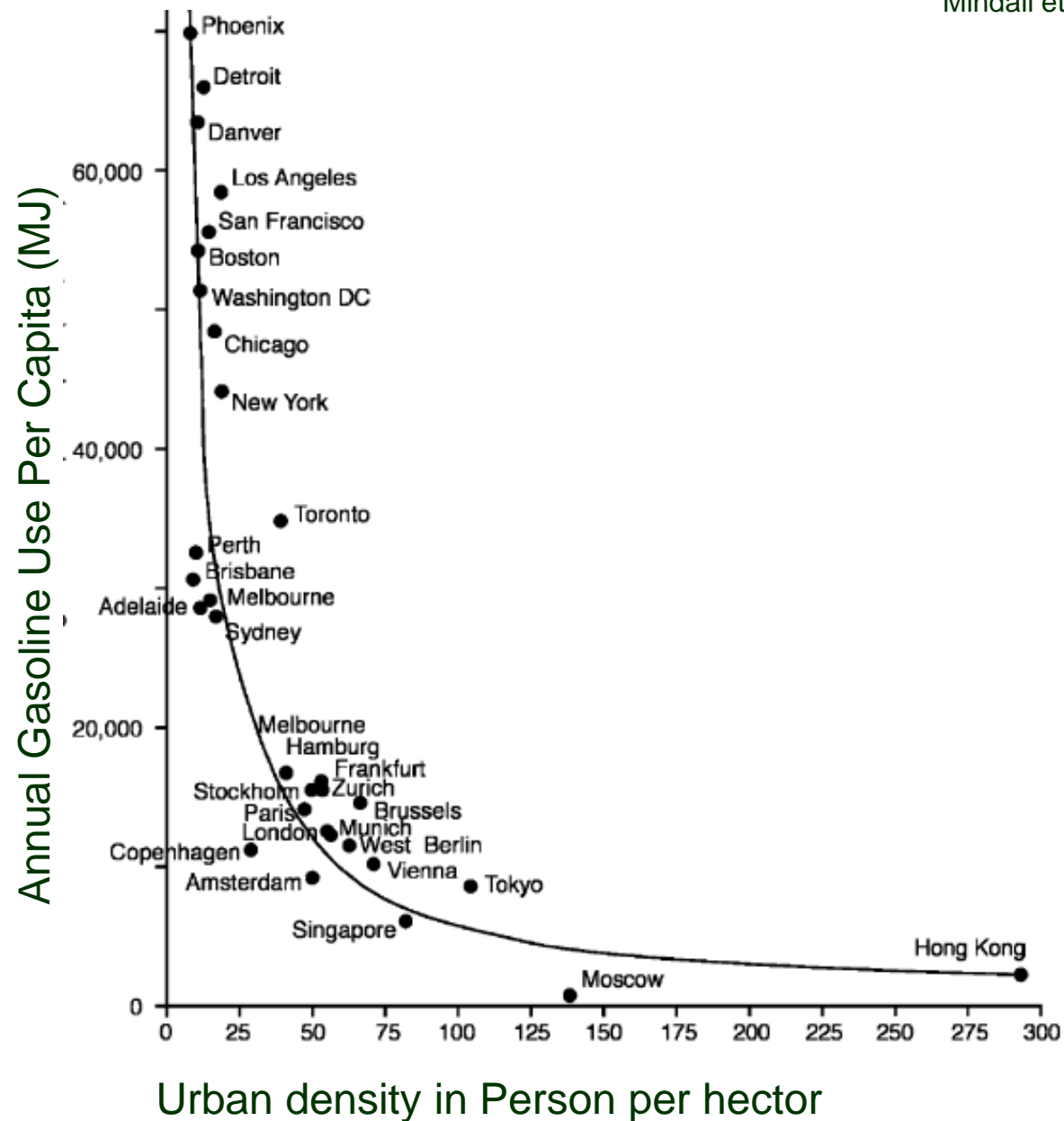


- **Transportation and urban form are fundamentally linked.**
- **How we build our city directly determines travel needs, viability of alternative travel modes, etc.**

- **Transportation, in turn, influences land development and location choices of people & firms.**



Urban Form and Transport Energy



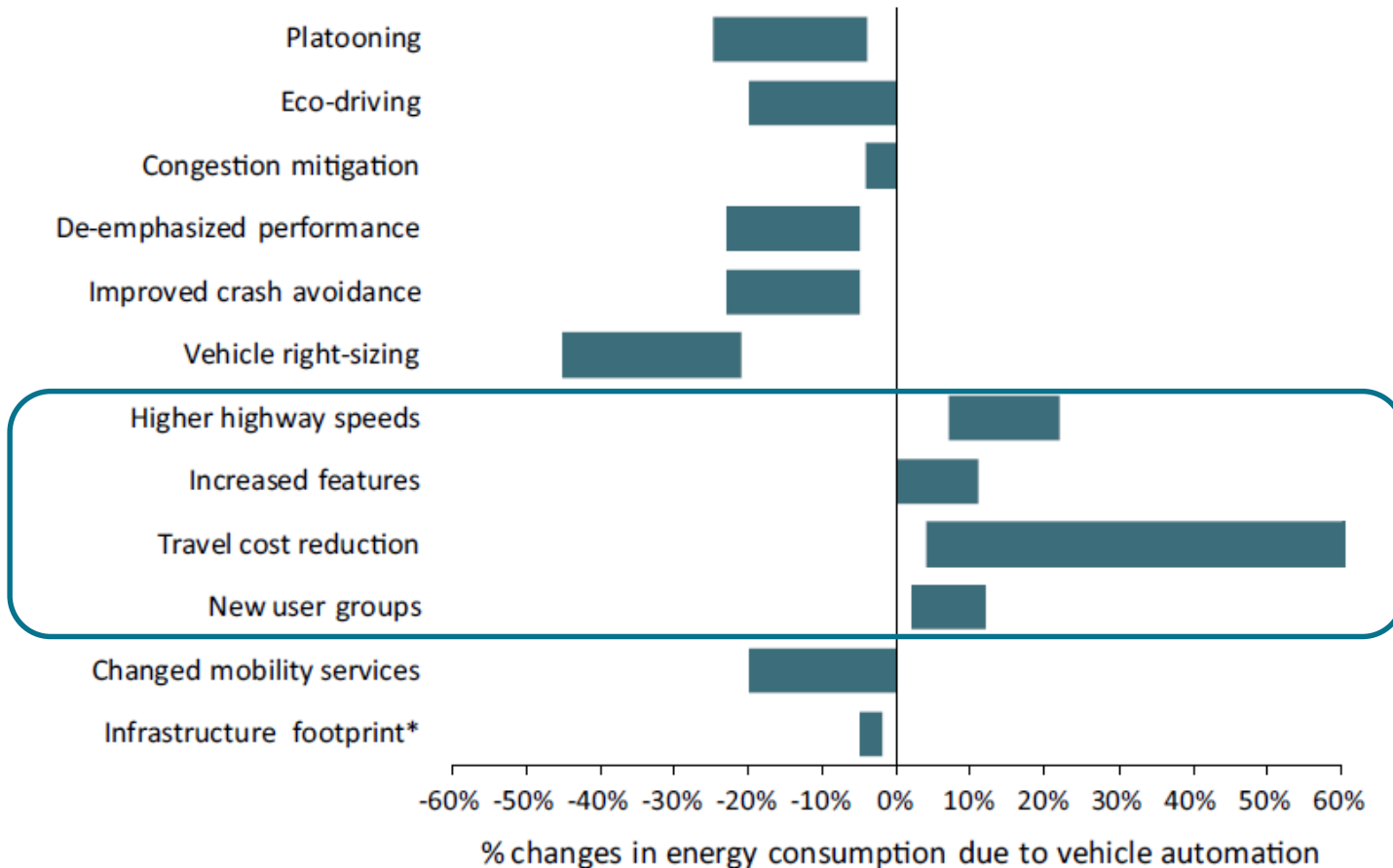
Truth about Transportation Demand and Travel Behaviour

- Demand for transportation is always more than what we observe:
 - ✓ However, building new roads does not reduce congestion in the long-run

- There is no one silver bullet to develop sustainable transportation
 - ✓ A portfolio of approaches that combined technological advances, regulations and regional planning approaches



Transportation Energy Demand in Highly Automated System

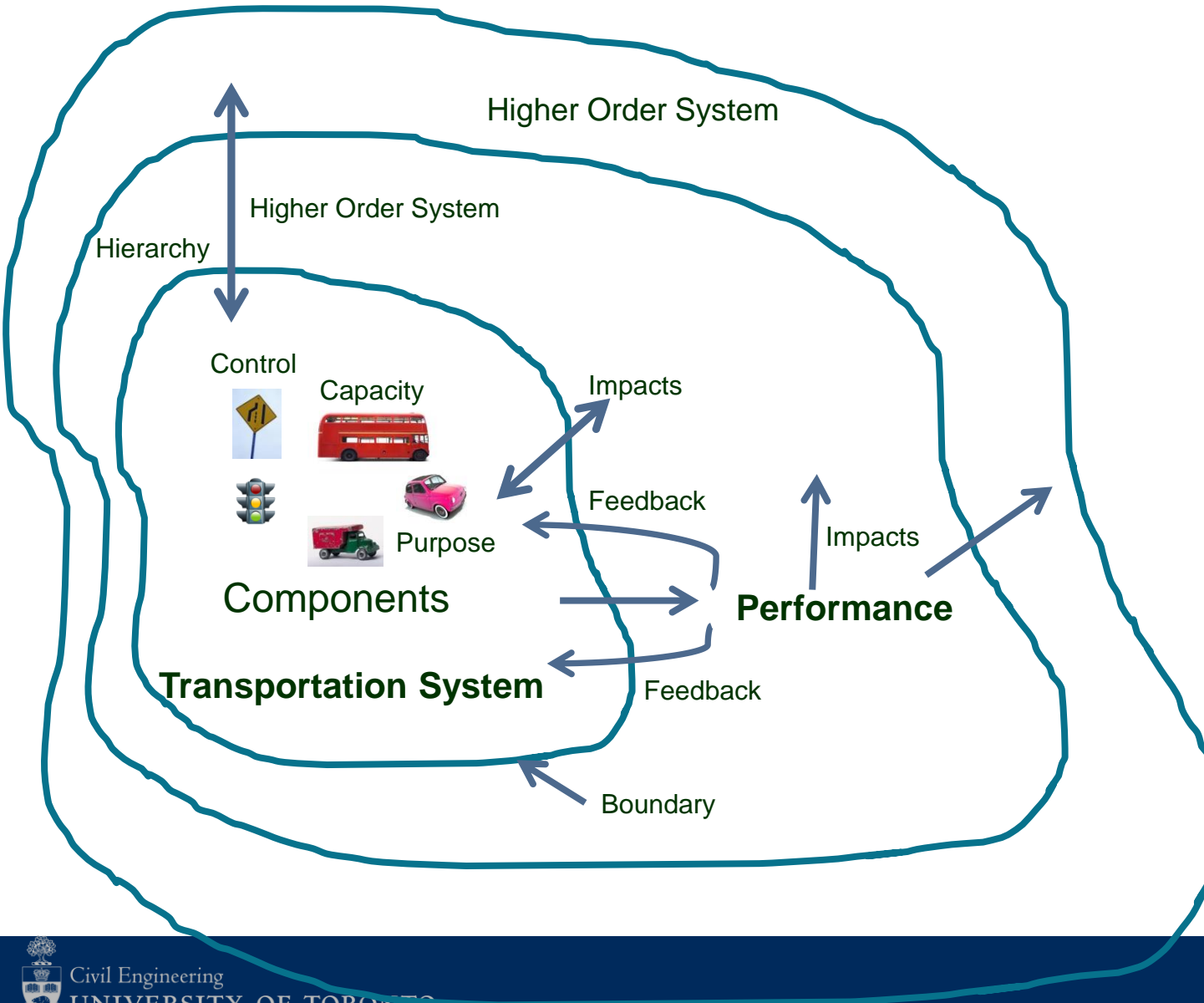


Wadud et al, 2016

- ✓ Proper Understanding Requires better Measurement of Travel Behaviour
- ✓ Better Measurement Requires Precise Specification
- ✓ Better Measurement & Precise Specification Allows Accurate Modelling



System Perspective of Transportation



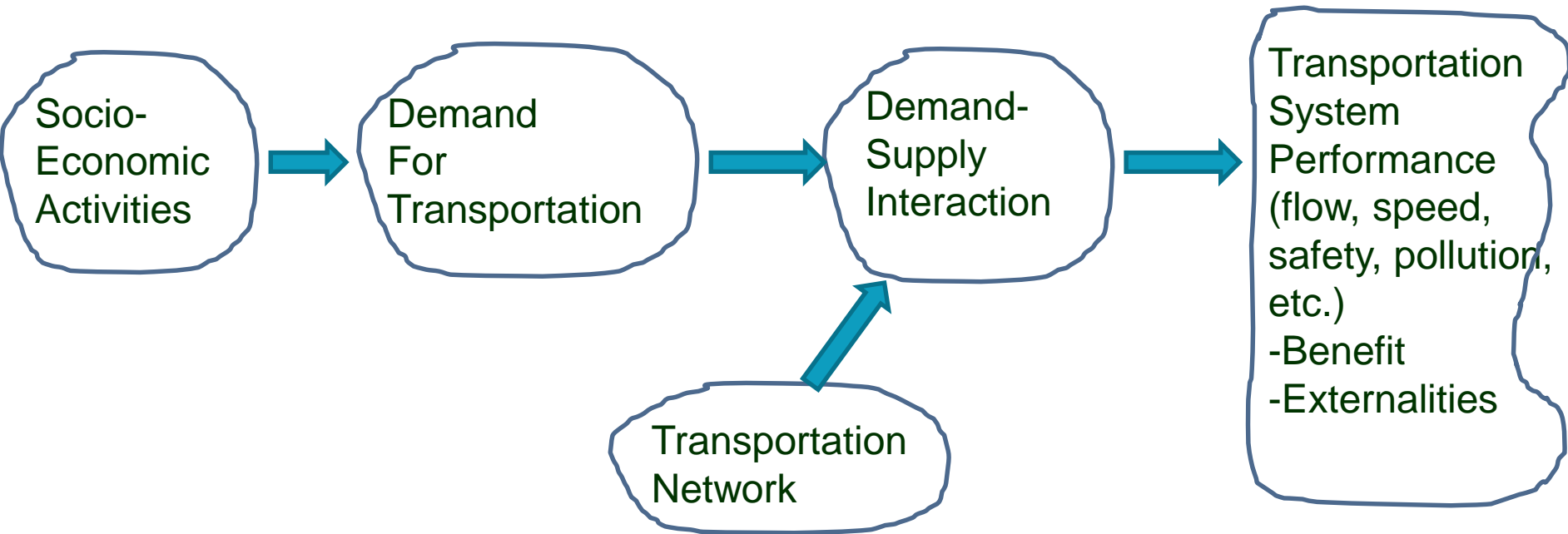
➤ a group of interrelated components.

➤ form a complicated and unified whole.

➤ intended to serve some purposes.

➤ through the performance of its interactive parts.

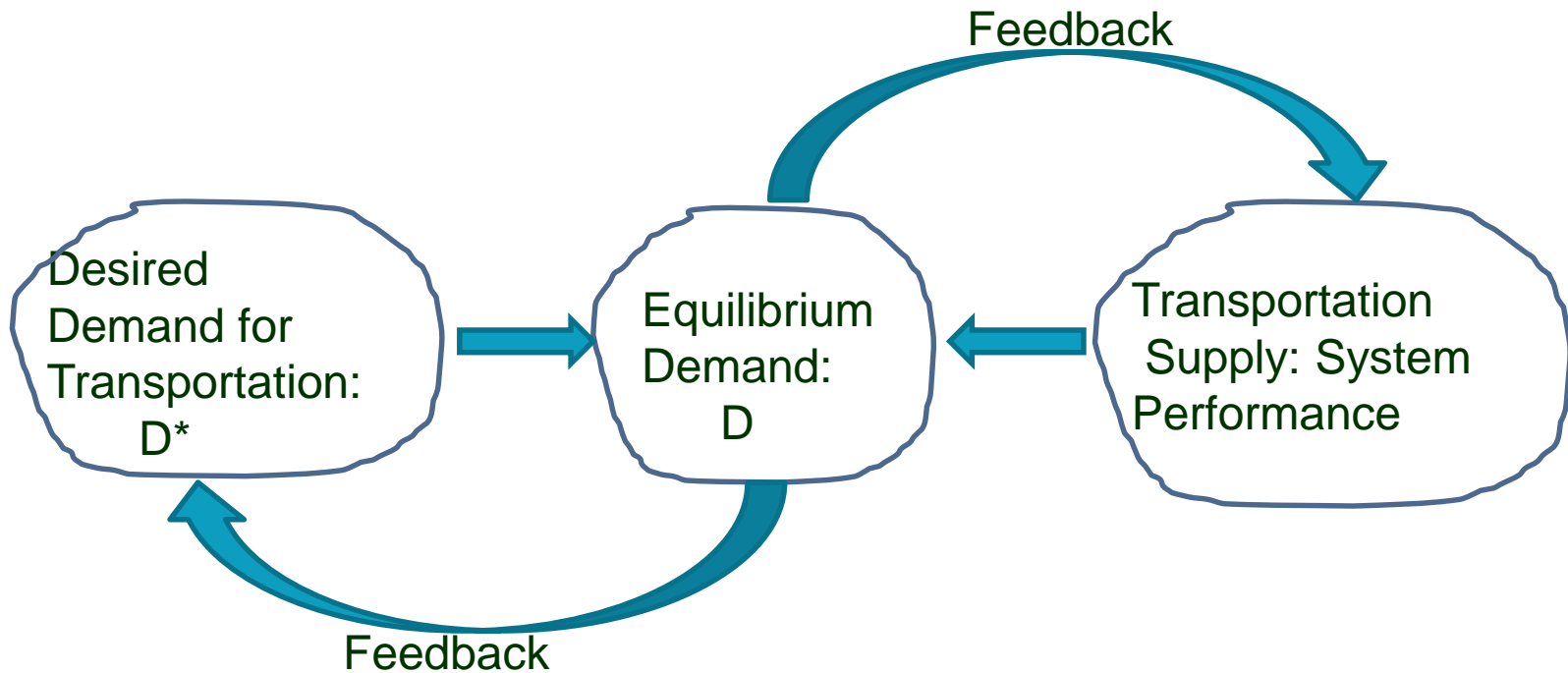
Transportation: Demand-Supply Perspective



System Performance:

- An important consideration guiding the definition of problems and opportunities that become focus of planning efforts.
- System performance measures are necessary for the decision-making process in transportation planning.
- System performance measures should be defined not only as outputs, but also as the outcomes on society.

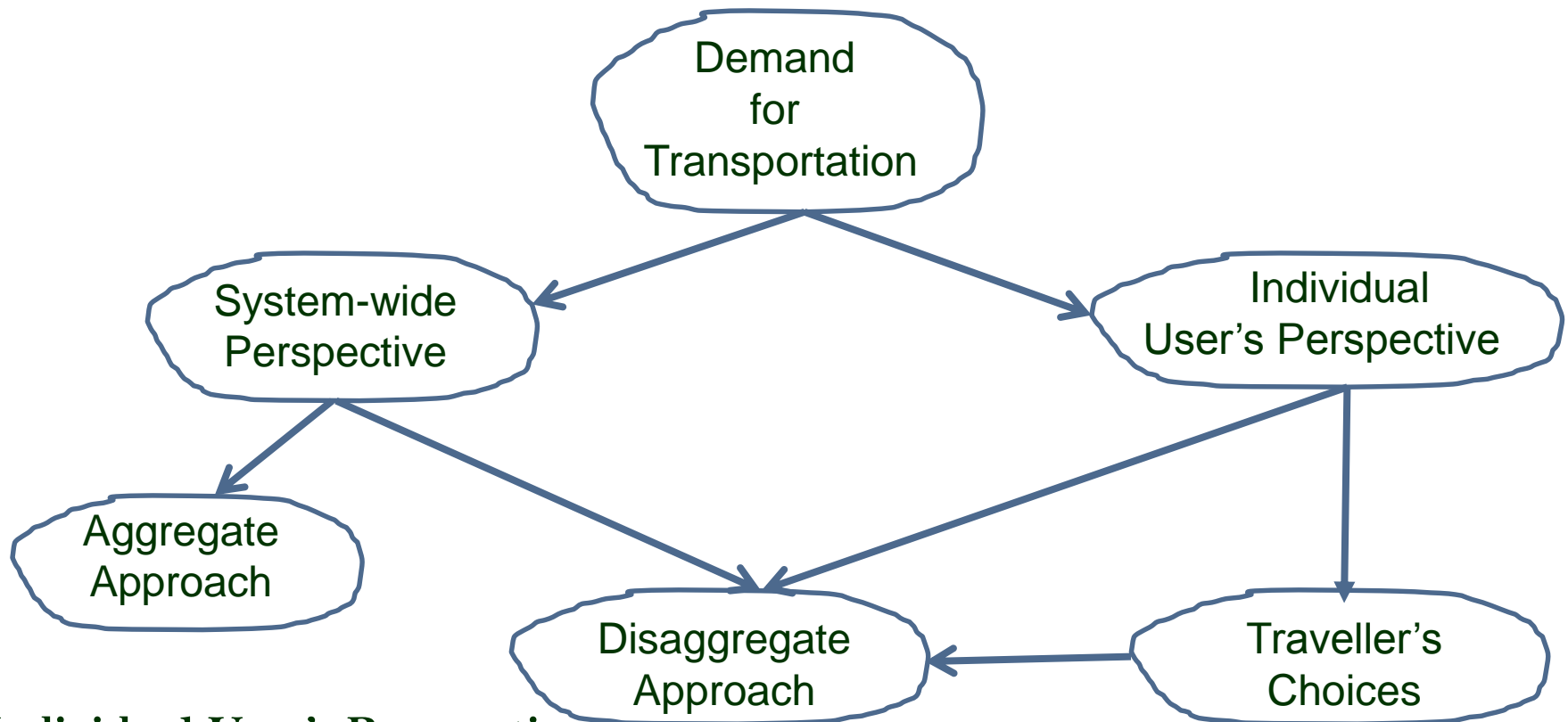
System Performance \leftrightarrow Feedback



Dynamics of Demand-Supply Interaction:

- Observed demand is equilibrium demand.
- Desired demand is always higher than the equilibrium demand.
- Changes in system performance affects demand as well as system performance.
- Truly dynamic and two-way interaction and feedback.

Measuring Demand: Users' Perspective



Individual User's Perspective:

- Understanding urban spatial and socio-economic context.
- Understanding preferences or options.
- Understanding choice making behaviour.
- Evaluating elasticity of demands.



“Demand” vs “Behavior”

Demand

- Aggregate
- Forecast
- Transportation Demand Forecasting



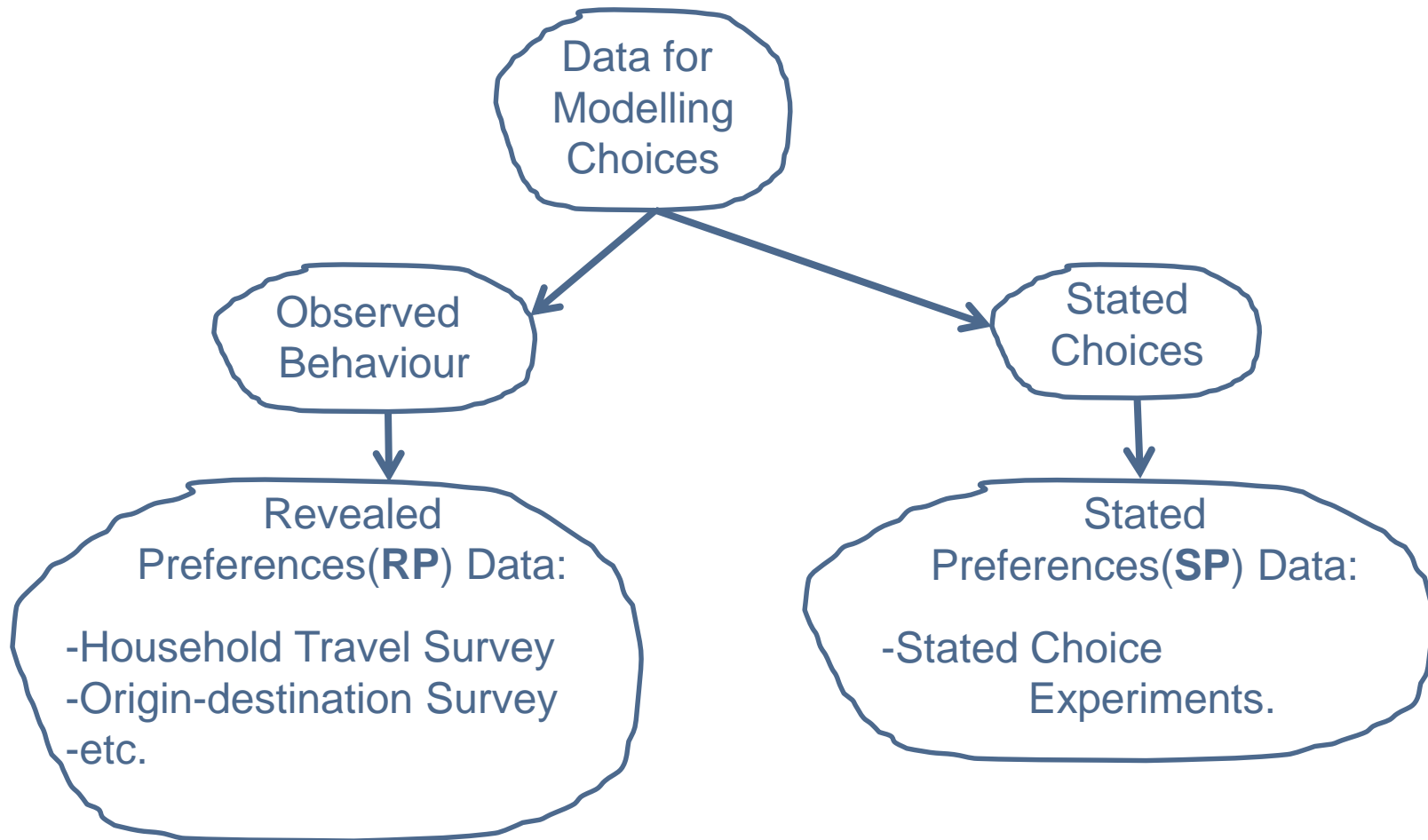
Behavior/Choice

- Disaggregate
- Explain
- Traveler Behavior and Values

Understanding Necessary

- Need to know what is the current demand situation and peoples' travel behaviour?
- Need to know what was going on? Recent past
- Need to understand where are you moving towards?
- Need analytical tools to deal with all of these – Models !

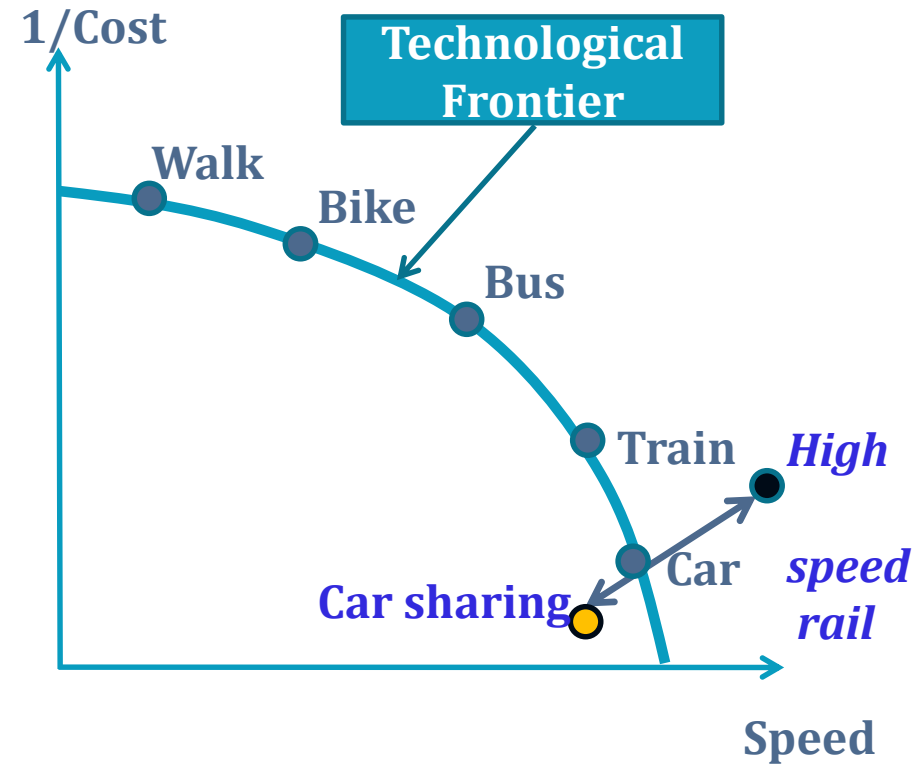
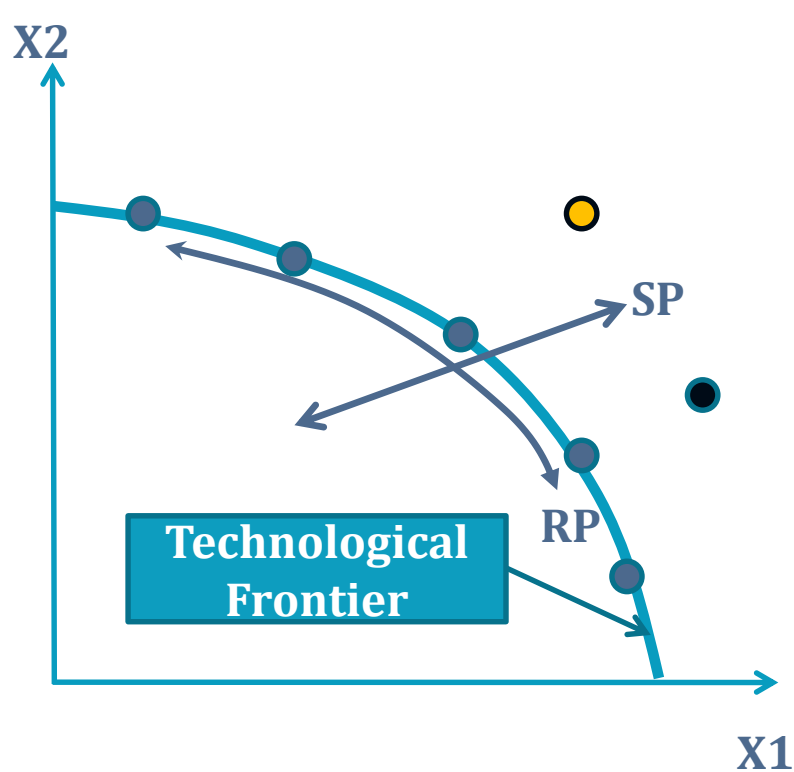
Data: The Fundamental Building Block



➤ Identifying the data underlying data generation process is important for appropriate modelling



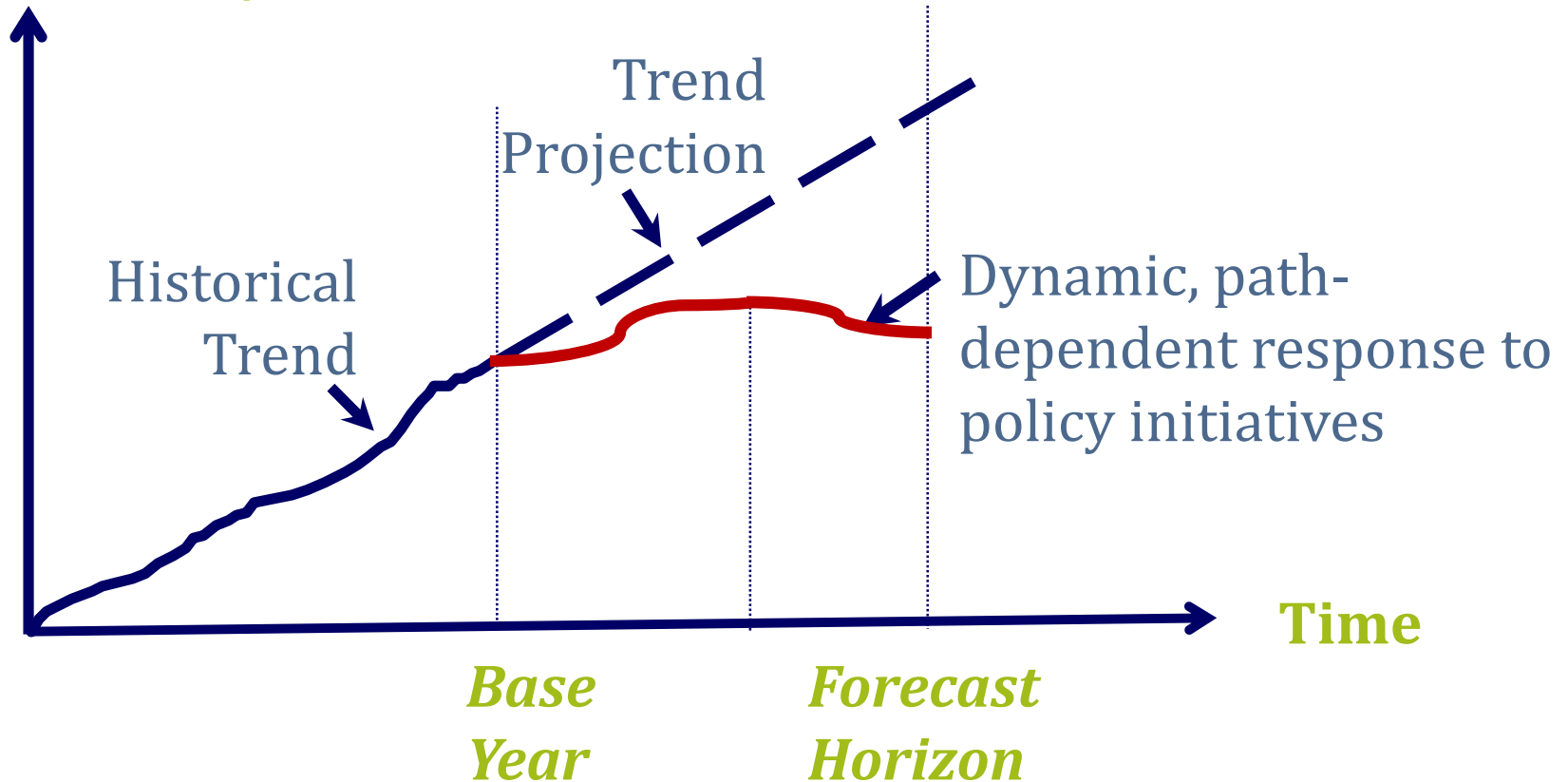
Observed Data are not Enough: Need Experiments



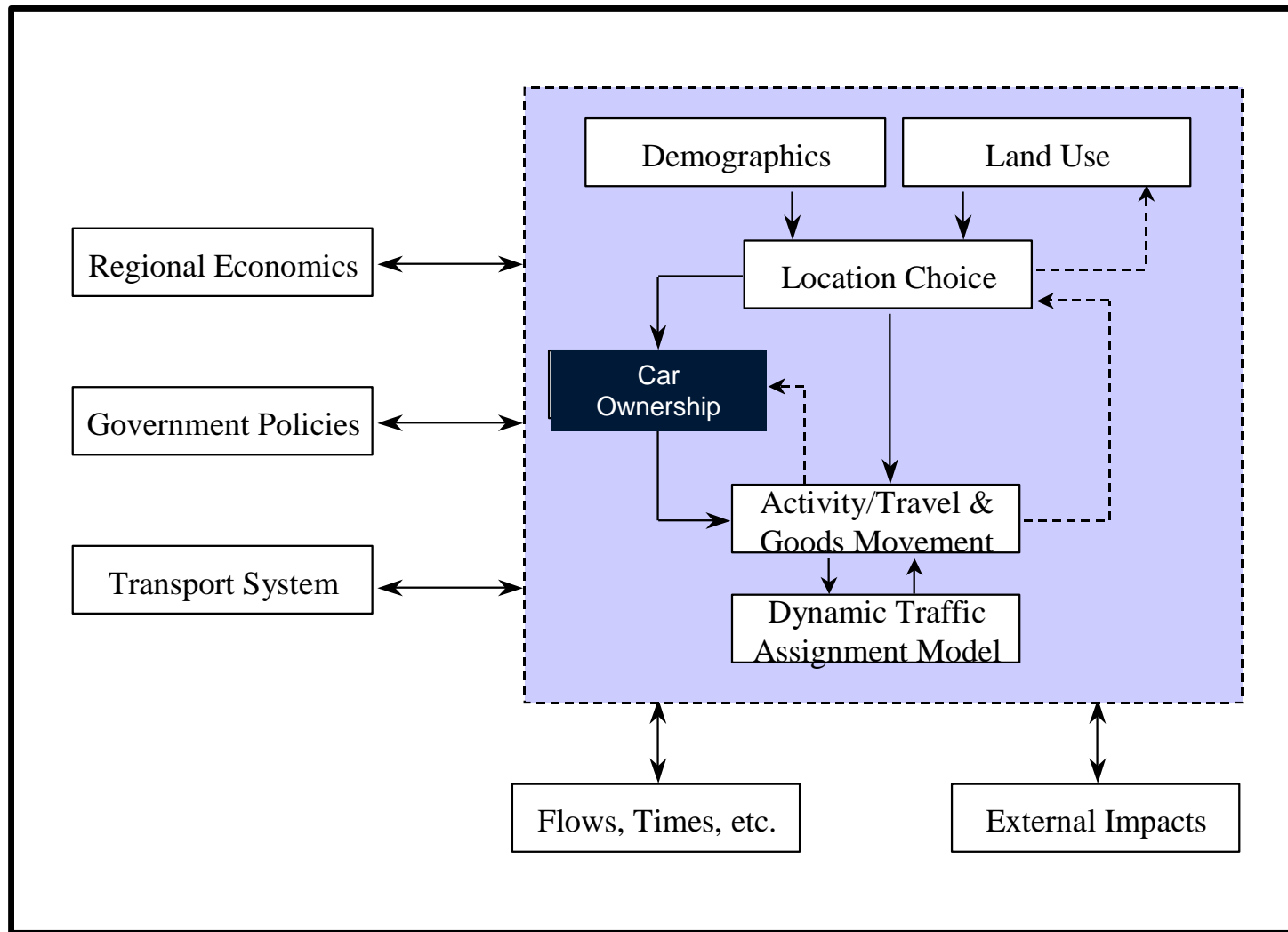
➤ Harnessing the power of joint RP-SP data is an interesting challenge for modelling travellers' choices.

Importance of Advanced Methodology

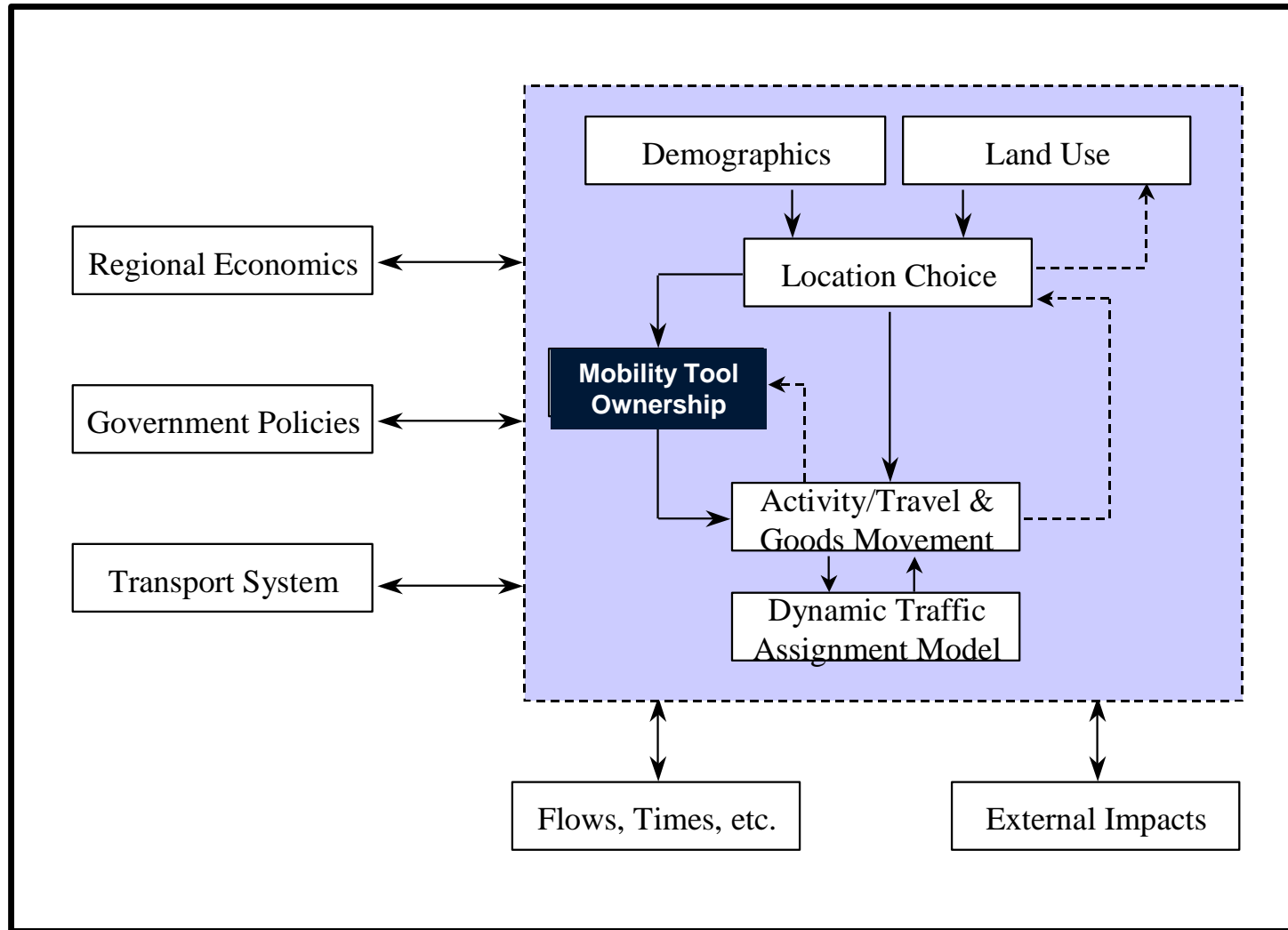
Land Use / Travel Demand



Integrated Transportation & Urban system



Integrated Transportation & Urban system



Collaborative Research with

Polytechnique Montréal - IET

Catherine Morency

Martin Trepanier

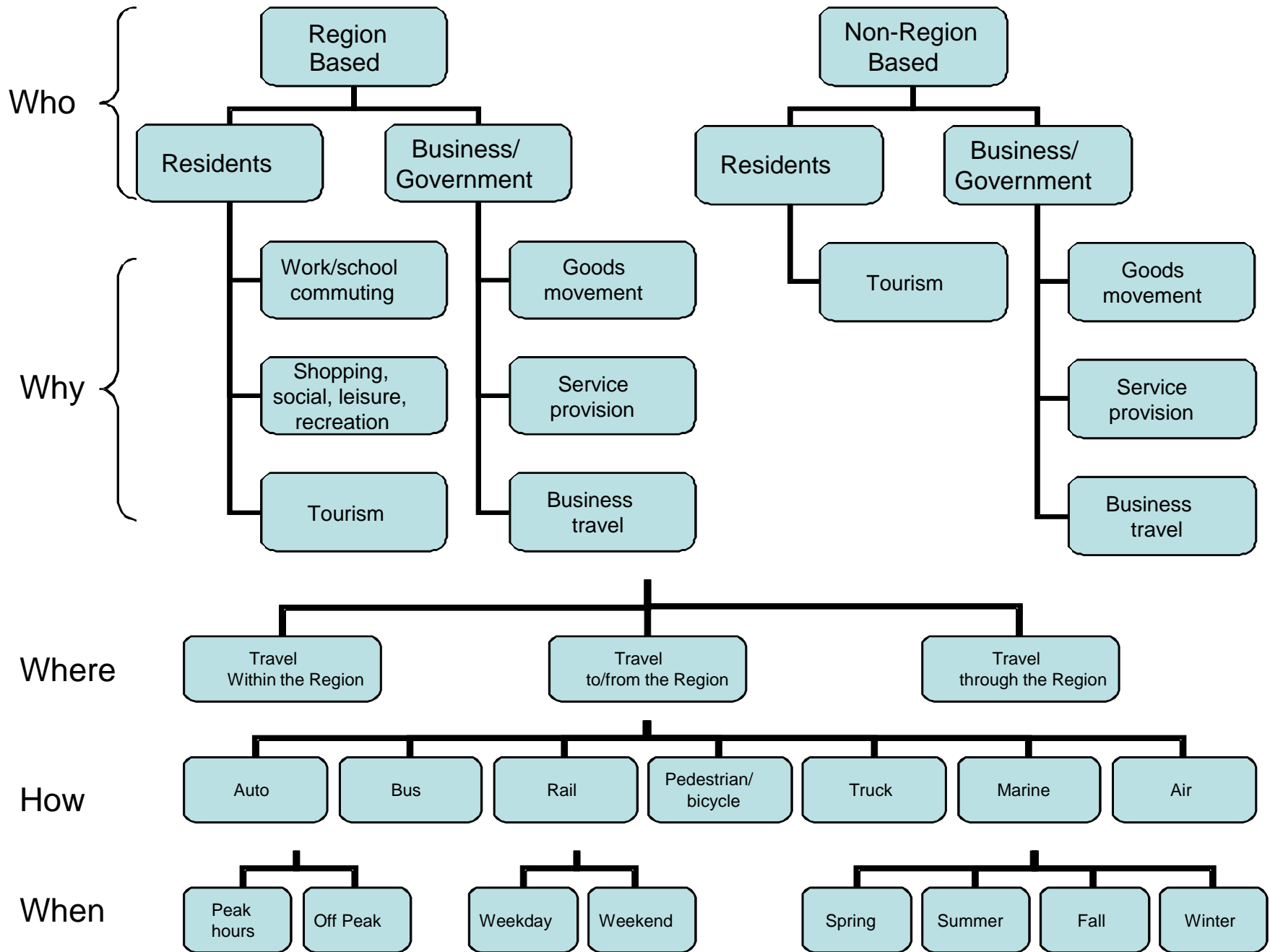
1. Advanced Data Collection Program Design: **TTS2.0** project
2. Advanced Travel Demand Modelling: **CUSTOM**
3. Shared mobility: Investigating **Carsharing**
4. Modelling **Mobility Tool Ownership**
5. ***Integrated Modelling Framework for Transporting Energy and Emission***



Transportation Tomorrow Survey-TTS 2.0:

A Multi University R&D project on Travel Data Collection



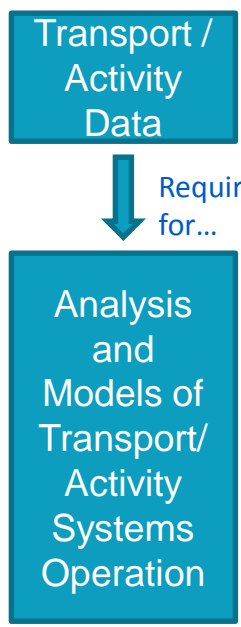


Data and Modelling in Planning Process

Planning process



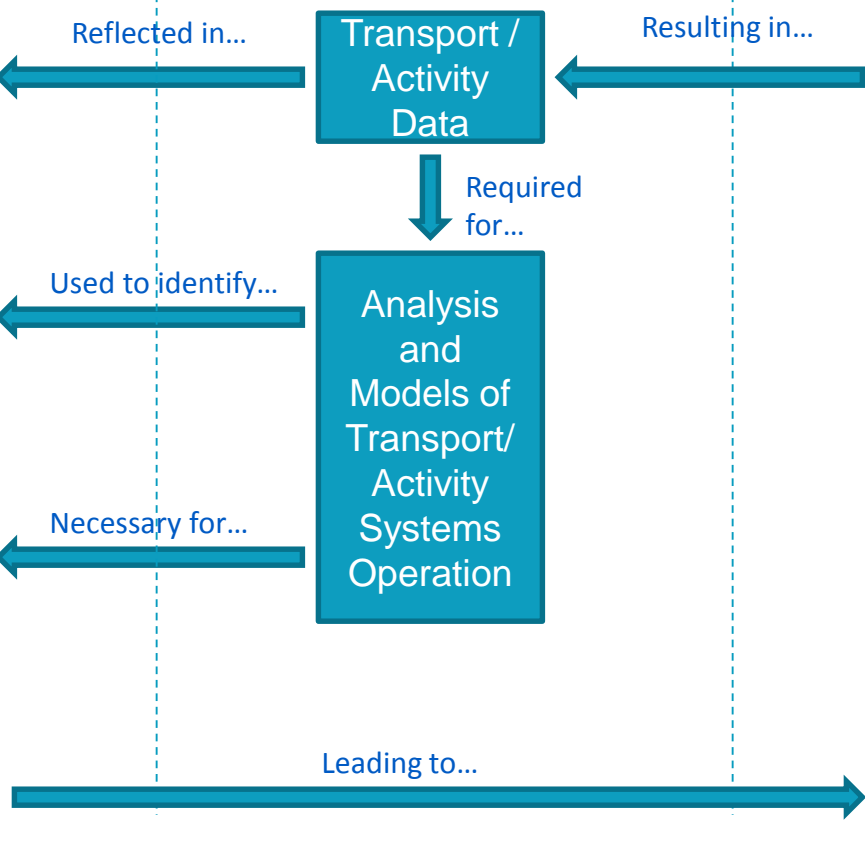
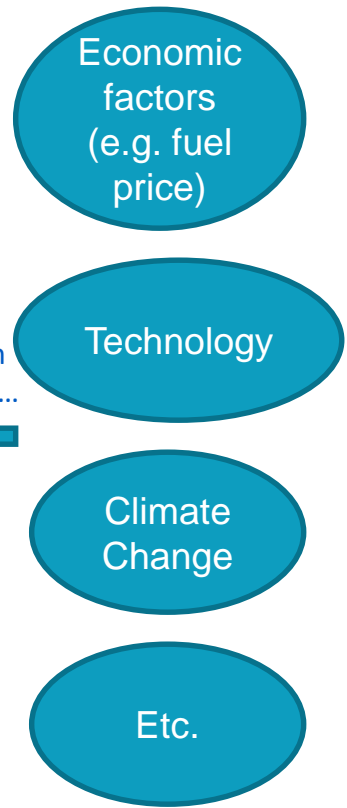
Data and Modelling/ Analysis



Real World



External Factors



Major Transportation Data Categories

Data

Population,
Employment
Car
ownership,
etc.

Road
network,
Transit
network,
Schedules,
etc.

OD demand
by mode,
by purpose,
by time of
day,
etc.

Travel times,
speeds,
pollution,
safety

Fuel prices,
interest rates,
weather,

Data
Collection
Systems

Census, Inventories, surveys, counts,
passive data, impact monitoring, etc.

Transport/
Activity
Systems
Operations

Activity
System

Transportation
Supply

Travel
Demand

Performance
and Impacts

External
Factors

System Characteristics

System Behaviour

Collection of Personal Travel Data

Household Travel Surveys

- Telephone, web-based
- Face-to-face, mail back

Choice based Surveys

- Road side interview
- On-board surveys

Standard Technology based Surveys

- GPS, roadside detectors
- Smart card, mobile phones

Emerging Technology based Surveys

- Remote sensing, accelerometer
- Social network, Big data



Evolving Practice: Developing a “R&D Mentality”

- Understanding data needs; how these needs are changing over time
- Pro-actively & systematically experiment with new methods to update/improve their practice over time
- Instill an ability/willingness to innovate in an environment of risk. Find ways to reduce this risk:
 - Collaborative efforts.
 - Subsidies from senior gov’t, demonstration projects.
 - Share findings with & learn from the experiences of others across the country and internationally.
 - “Side-by-side” experimentation (new tested in parallel with current).



Core-Satellite Design for Urban Travel Demand Modelling

Screenline counts, all vehicle types

Transit boarding counts

Roadway speed-time studies

Transit line headways, speeds, etc.; transit fare policies

Parking supply & price

Auto operating costs, including tolls

Road segment capacities, speeds, etc.

Census data

Vehicles by type, vintage, fuel type, etc.

Capital & operating costs of vehicles by type, vintage, fuel type, etc.

HOV lane inventory, rules, ...

Satellite 1
HOV Usage

Satellite 2
Bicycle Usage

Bicycle facilities inventory (bike lanes, bike parking, ...)

Bike-share services & usage

Inventory of major facilities for seniors: community centres, health care facilities, etc.

CORE SURVEY:

Home Interview Survey

- Large sample
- Key/core variables
- Key household & person variables
- Trips by mode, purpose & time of day

Satellite 4
Auto Ownership & Usage

Satellite 3
Elderly Travel Needs

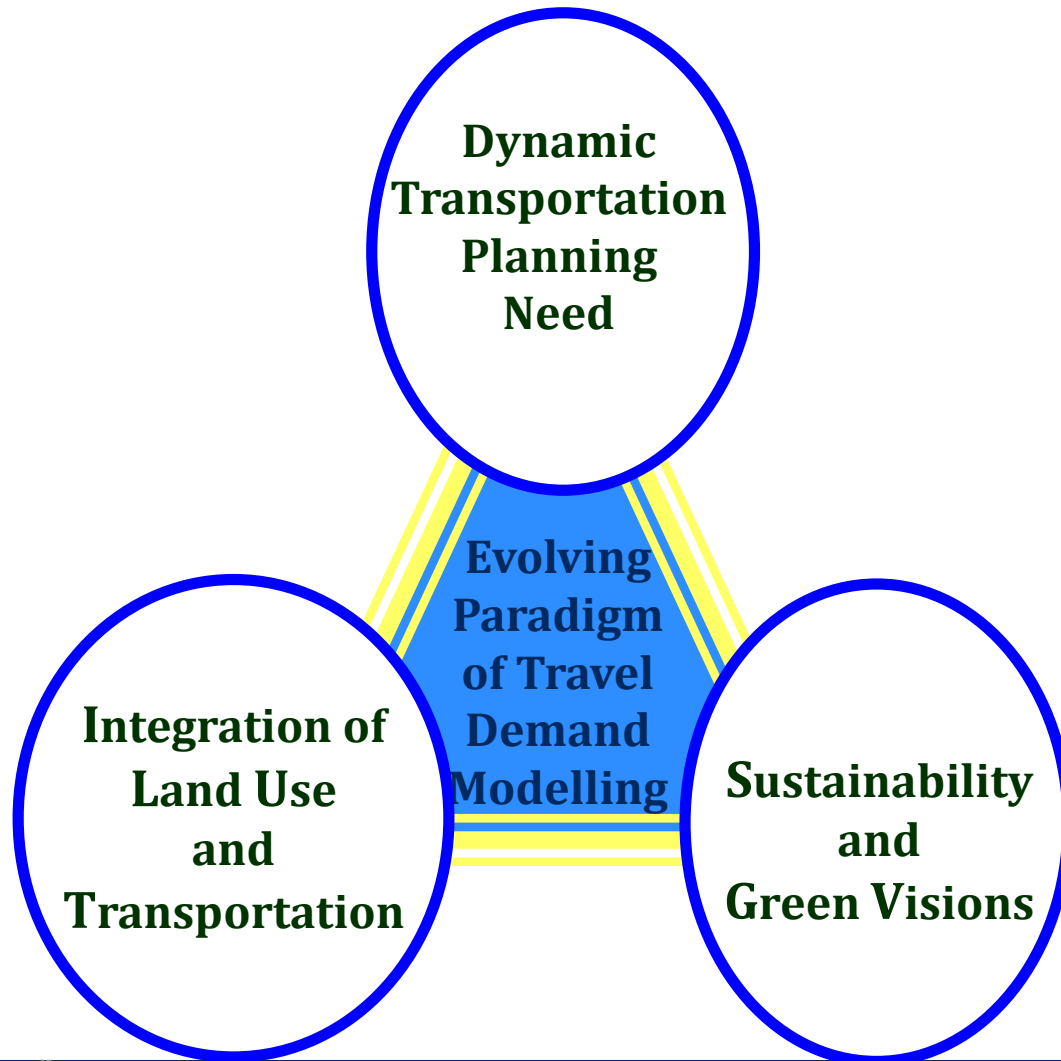
No	Task/Report	Time Line	Status
1	Land-Line-Based Survey Methods	May-Sept, 2015	Completed
2	Web-Based Survey Methods	May-Sept, 2015	Completed
3	Smart phone -Based Survey Methods	May-Sept, 2015	Completed
4	Continuous Survey Review	May-Nov, 2015	Completed
5	Draft Round 1 Pilot Test Design	Jan, 2016	
6	Final Round 1 Pilot Test Design	Feb-Mar, 2016	
7	Conduct Round 1 of Pilot Tests	Apr-Aug, 2016	Permissions/agreements
7	Draft Round 1 Field Test Design	June-Aug, 2016	
8	Presto Card Data for Planning & Modelling	Apr-Sept, 2016	Data agreements
9	Passive Dataset Applications	Apr-Oct, 2016	Data agreements
10	Satellite Survey Options	Apr-Nov, 2016	
11	Analysis & Evaluation of Round 1 Pilot Tests	Dec 31, 2016	
12	Design & Conduct of Round 1 Field Tests	January 31. 2017	
13	Analysis & Evaluation of Round 1 Field Tests	March 31, 2017	
14	Round 2 Pilot Test Design	April 30, 2017	
15	Draft Round 2 Field Test Design	July 31, 2017	
16	Analysis & Evaluation of Round 2 Pilot Tests	August 31, 2017	
17	Data Fusion Methods & Applications	October 31, 2017	
18	Design & Conduct of Round 2 Field Tests	January 31, 2018	
19	Analysis & Evaluation of Round 2 Field Tests	February 28, 2018	
20	TTS 2.0 Final Project Report	March 31, 2018	

Activity-Based Travel Demand Modelling

Comprehensive **U**tility-maximizing **S**ystem of Travel **O**ptions **M**odelling (CUSTOM)



Travel Demand Modelling: Three Pillars of Shifting Paradigm

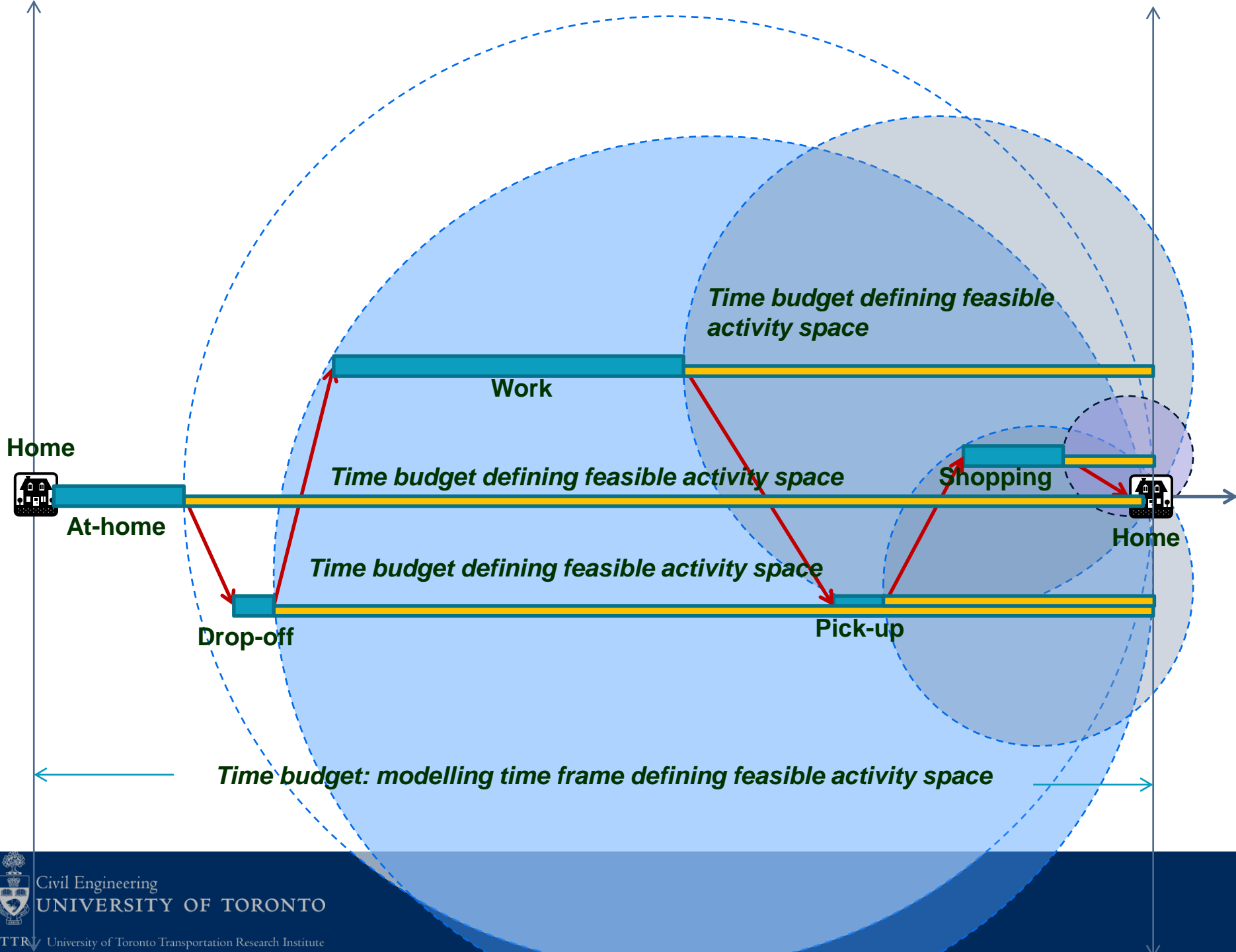


**Trip-based
Aggregate
Demand Model**



**Activity-based
Dynamic
Disaggregate
Demand Model**





Modelling Traveller's Choices

Travellers are rational human being:

- Travellers make decision/choice that satisfy their need/bring benefit/reduce grief.
- Travellers are intelligent: learning and adaptation, short-term versus long-term responses.
- Difficult to force people to change behaviour, unless system performance and/or urban contexts (application of policies) force people to do.
- Psychological factors: habit, inertia, liking, etc.



Modelling for Informed Planning

- Modelling Approach: A contextual decision.
- Modelling challenges: data availability & appropriate mathematical formulation to capture travellers' behaviour.
- Issues related to modelling travellers' behaviour:
 - Response biases in data.
 - Heterogeneity/Heteroskedasticity
 - Choice context
 - Available options and perceptions
 - Psychological factors: habit, inertia, etc.

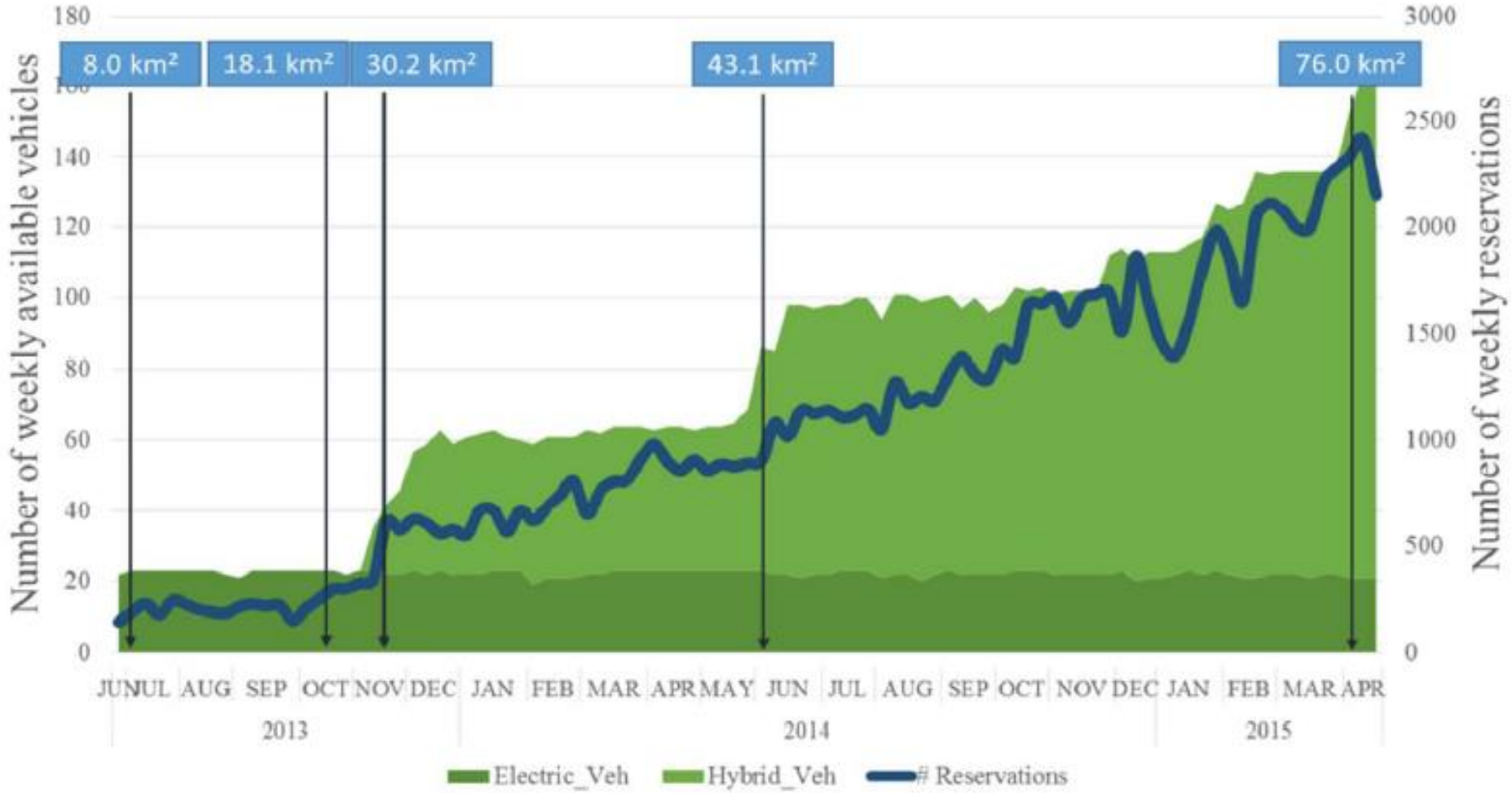


Shared Mobility: **Carsharing** as an Alternative to Car Ownership

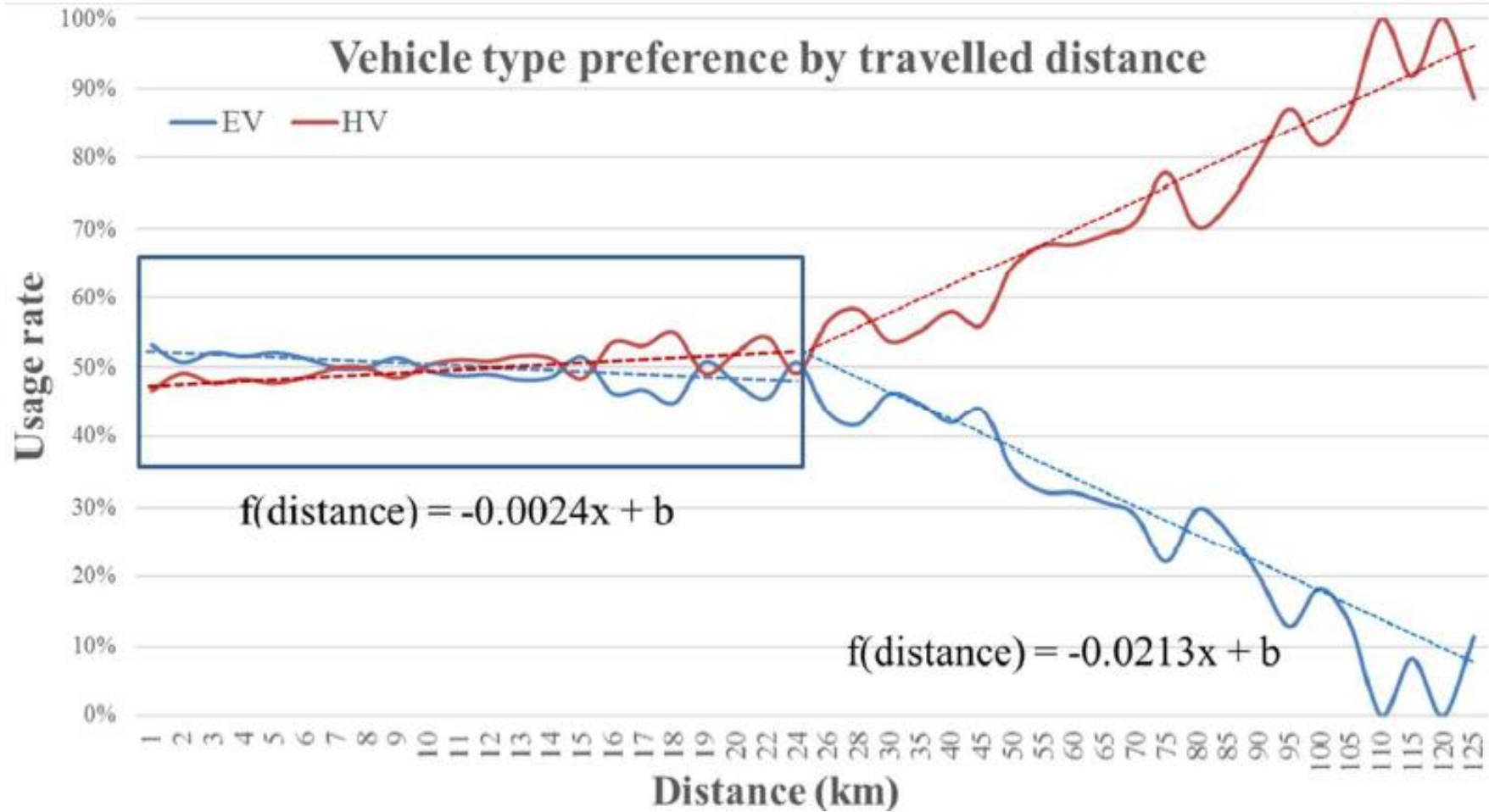


Carsharing in Montreal

Auto-mobile car fleet evolution



Vehicle Technology and Carsharing in Montreal



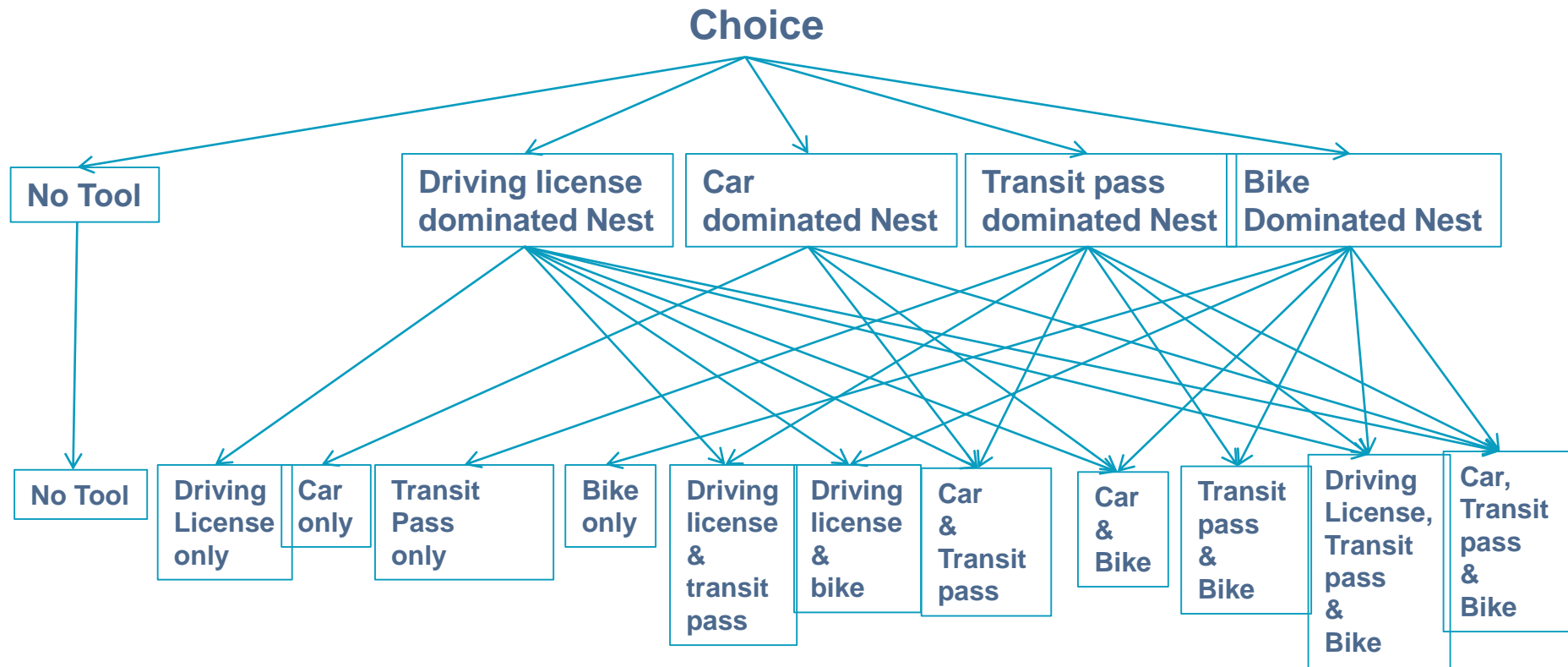
Modelling Mobility Tool Ownership



Mobility Tool Ownership of Post- Secondary students in Toronto

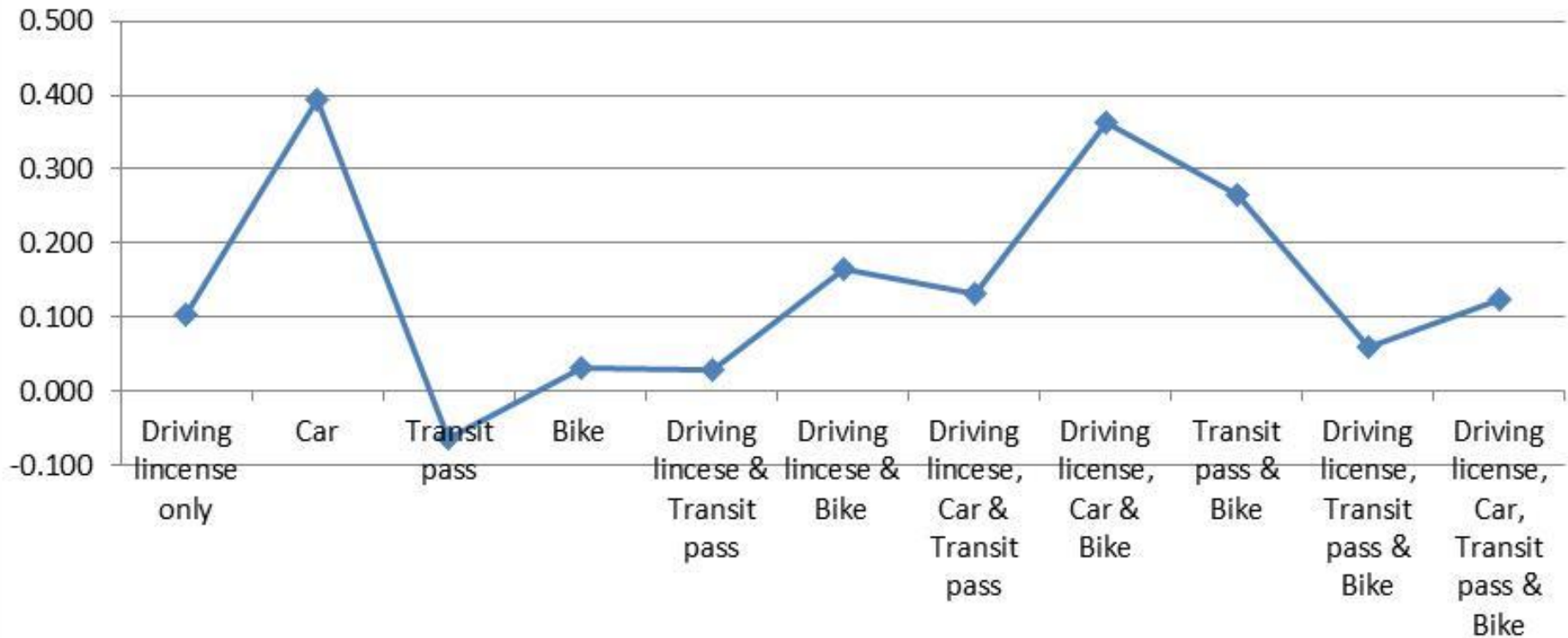
Choice Alternatives	Observed %
No tools	12.32
Driving lincense only	11.67
Car	6.04
Transit pass	11.54
Bike	8.83
Driving lincese & Transit pass	8.38
Driving lincese & Bike	13.93
Car & Transit pass	2.44
Car & Bike	7.21
Transit pass & Bike	7.43
Driving license, Transit pass & Bike	7.92
Car, Transit pass & Bike	2.30

Mobility Tool Choice: Cross-Nested Structure



What Defines the Choice?

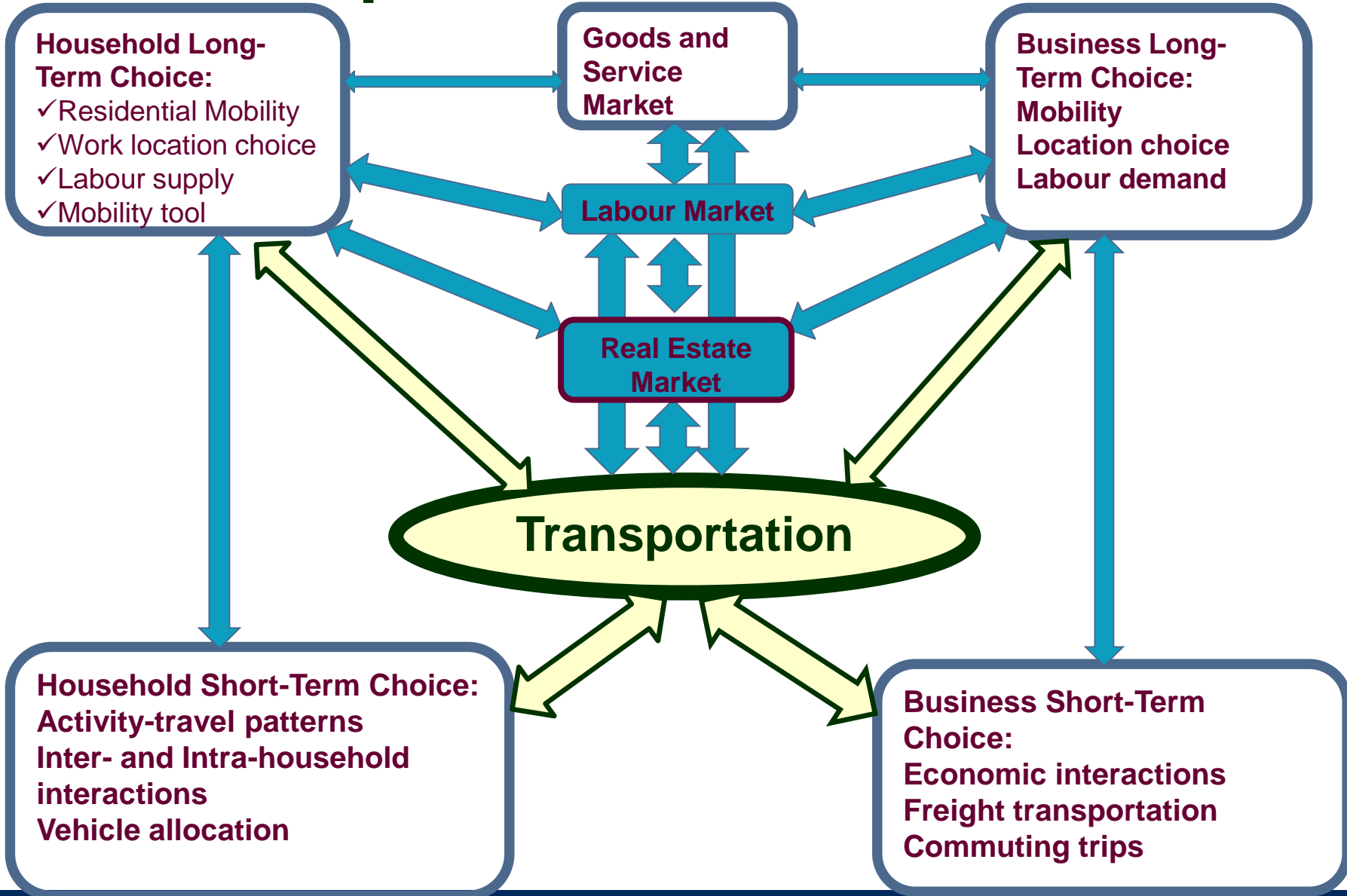
Marginal Effect of Household Car Ownership Level



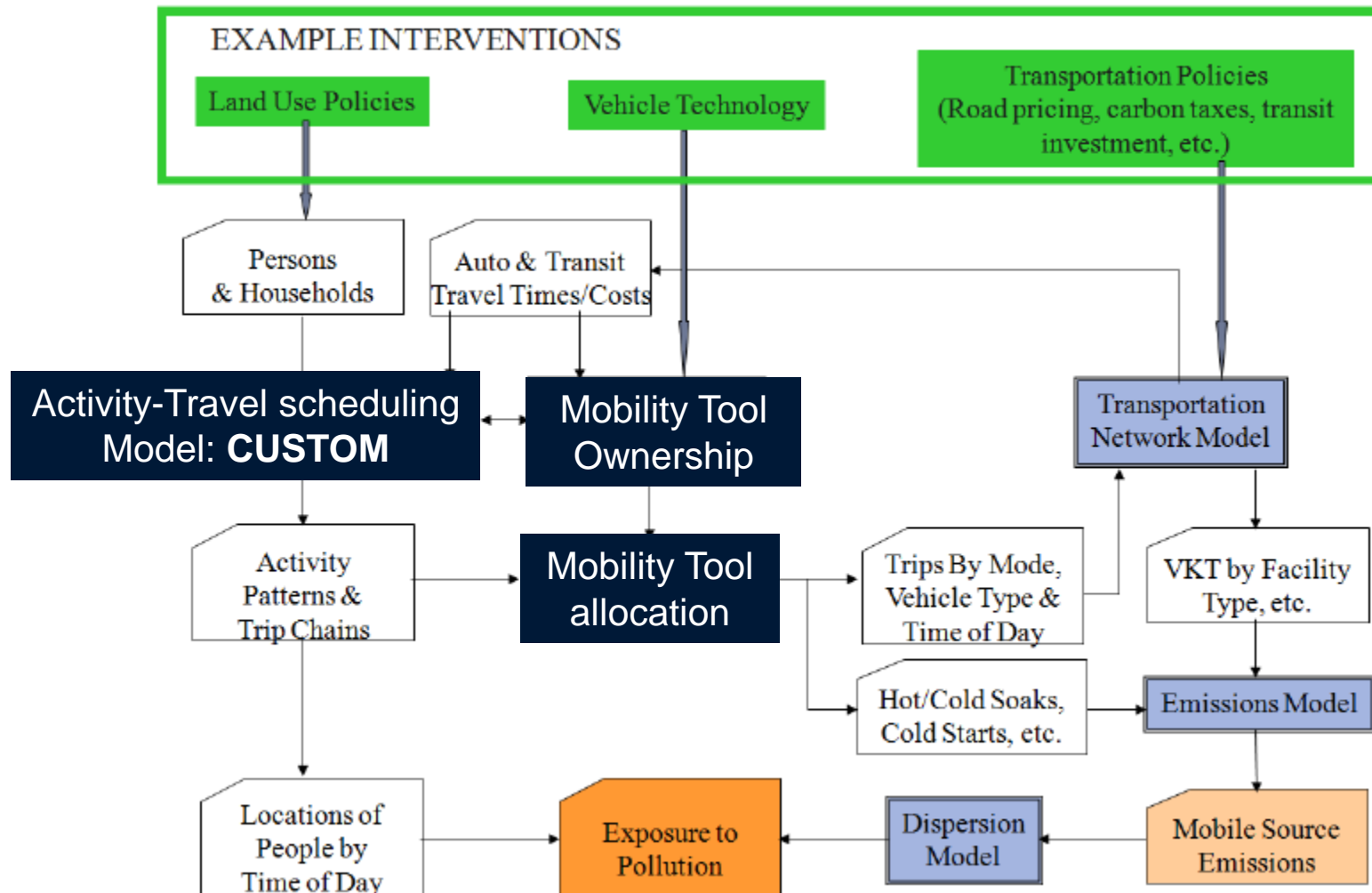
Looking ahead



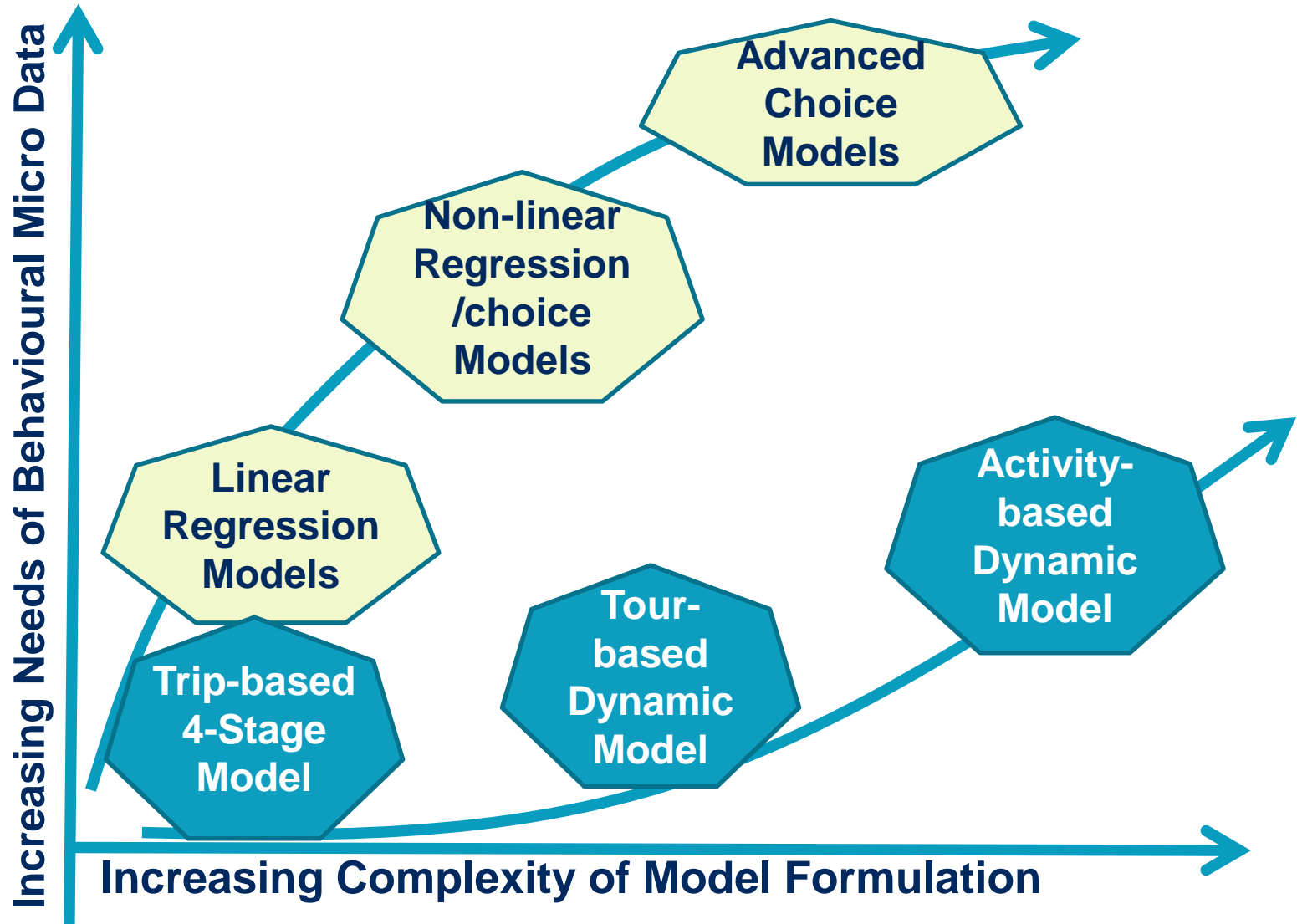
Urban Transportation: A Holistic View



Integrated Transportation Energy and Emissions Modelling



Data Need and Advances in Demand Models



Requires research funding for
-Data Collection
-Graduate students



Questions ?

