

# Assessing the Impact of CETA on Canada's Transportation System



Mahyar Jahangiriesmaili (MAsc Candidate)  
Supervisor: Professor Matthew Roorda

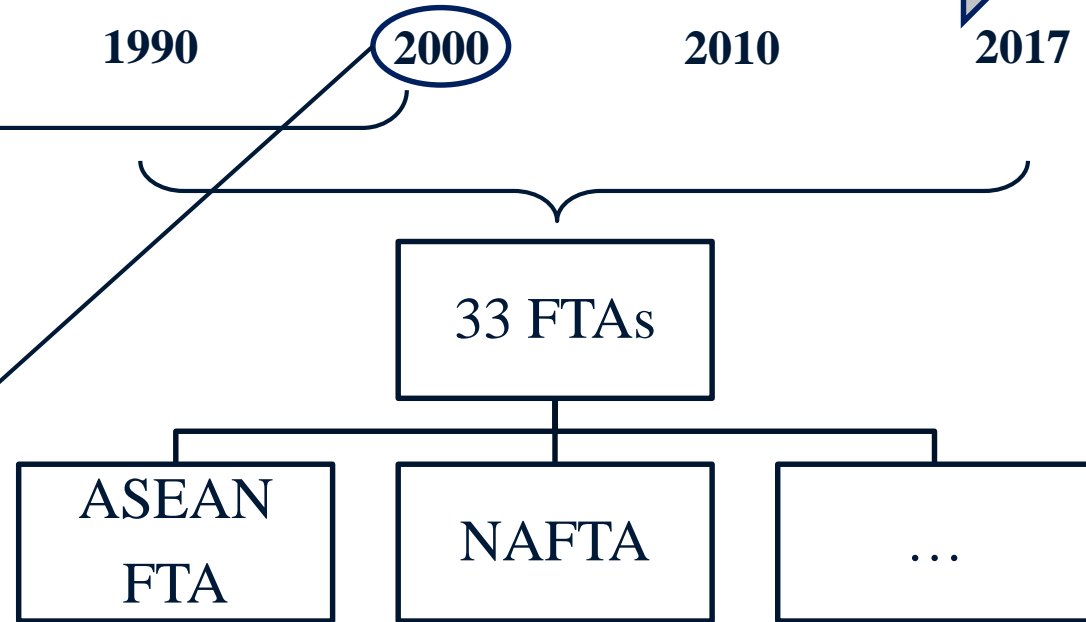
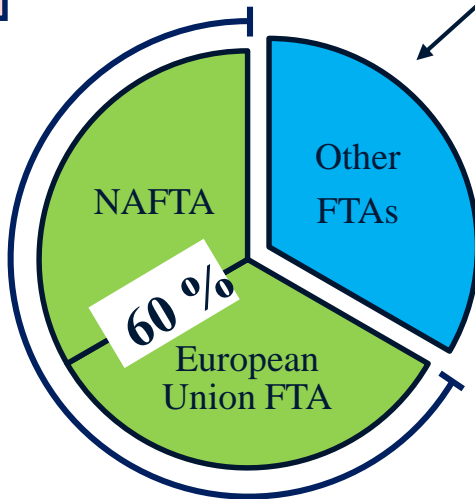
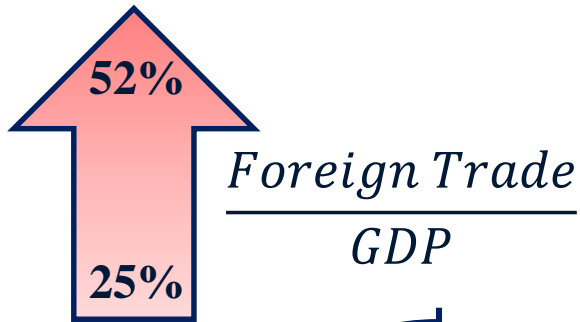


Civil Engineering  
UNIVERSITY OF TORONTO

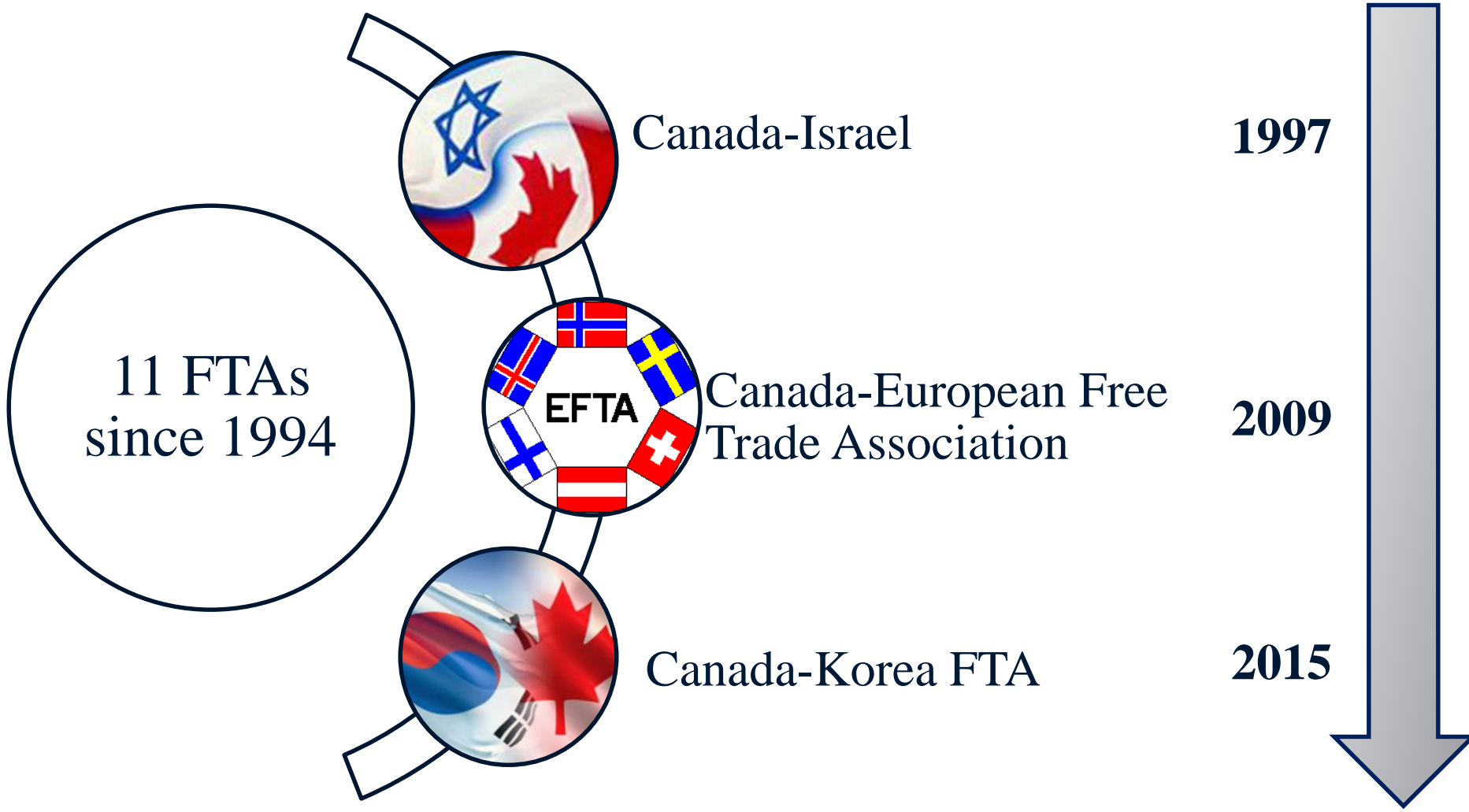
UTTRI University of Toronto Transportation Research Institute

July 21, 2017

# Global Trade



# Canada's Trade



# CETA

(Comprehensive Economic and Trade Agreement)



- Signed in October, 2016
- Ratified by the European Parliament in February 2017

# CETA

- ❑ Eliminates Tariff Barriers
- ❑ Provides Better Access to EU Market
- ❑ Adjusts Shipping Standards & Regulations
- ❑ Fosters Global Investments & Innovations
- ❑ Encourages Global Competition

# CETA

Many measures are undertaken about :

- ✓ Economy
- ✓ Regulations
- ✓ Society
- ✓ Employment



What are the impacts on Transportation System???

# Research Objective

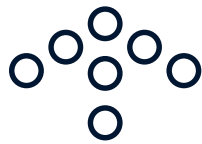
## Change in commodity movements across the Canadian transportation network under CETA

1. Model intercity freight flows before the enforcement of CETA on Canada's transportation system
2. Model intercity freight flows after the enforcement of CETA on Canada's transportation system
3. Compare the two scenarios



# Research Limitations

Little work contributed to intercity freight modeling  
unlike passenger travel modeling



**Data Availability**

1-Freight transportation surveys

2-Lack of communication between public & private

3-Competition & confidentiality agreements

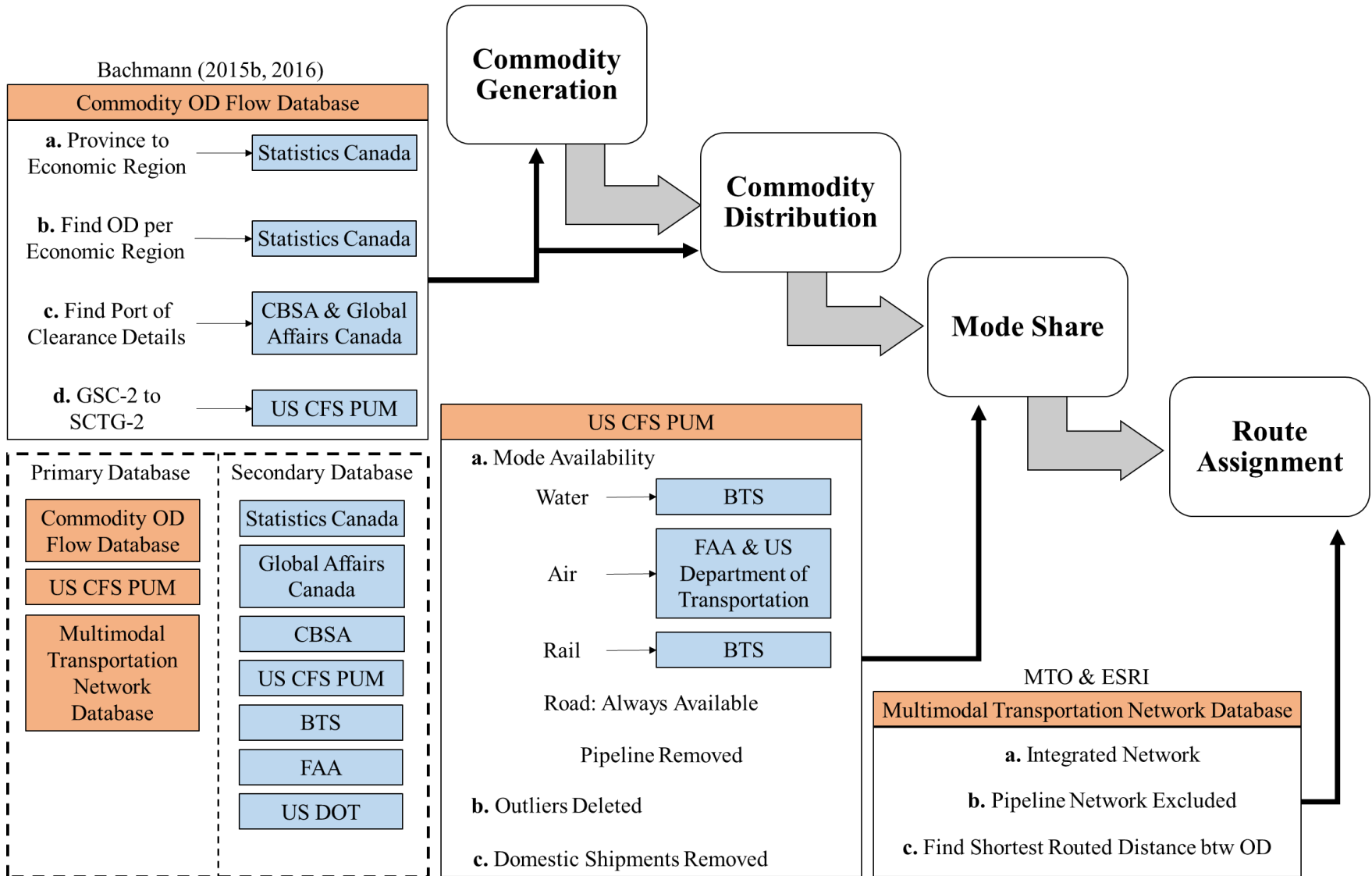


**Complexity**



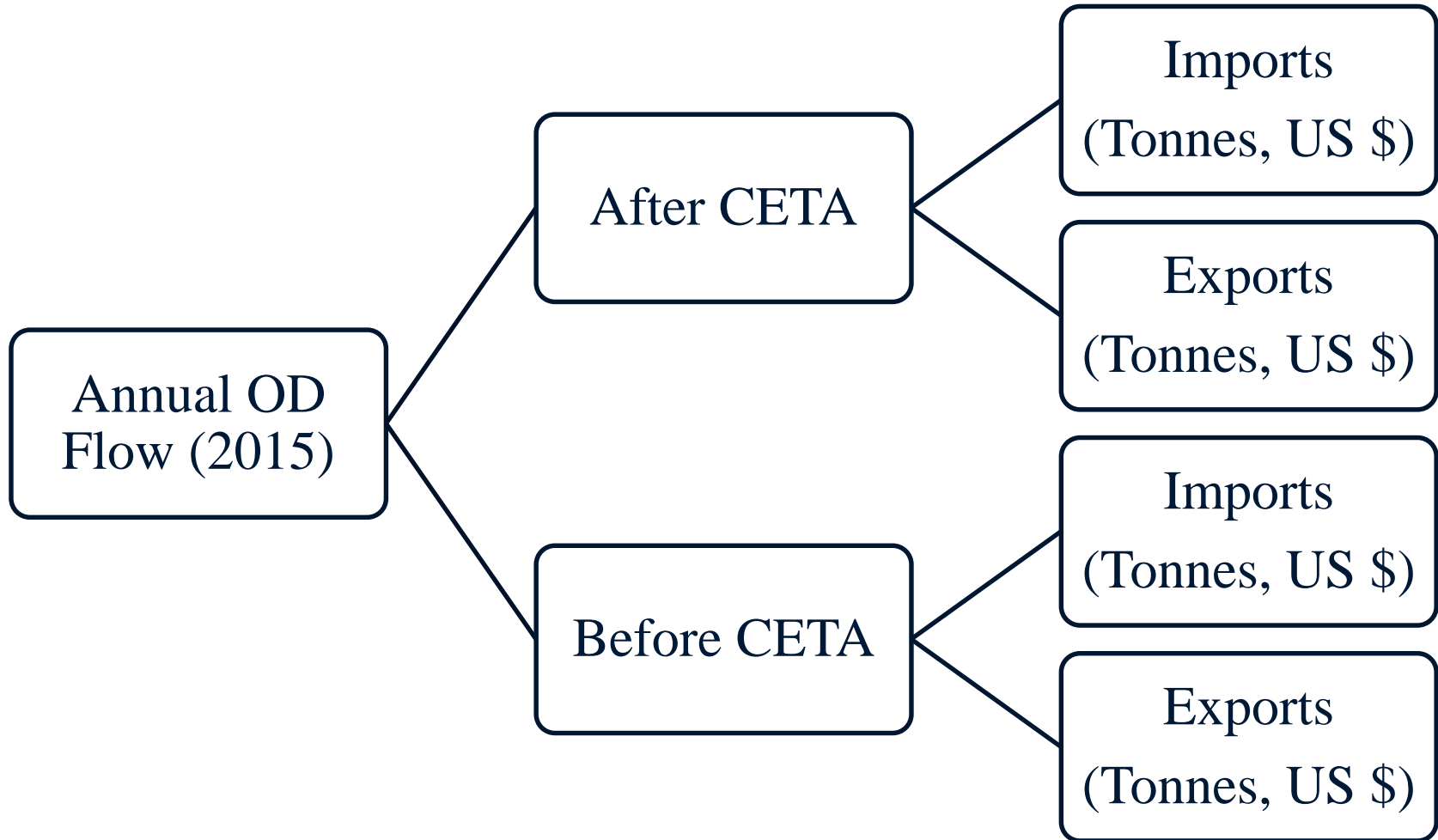


# Data Acquisition



# Commodity OD Flow Database

(Chris Bachmann, Assistant Professor, University of Waterloo)



# Commodity OD Flow Database

---

Import/Export

GSC-2 Commodity Group

---

Before/After

Province of Origin/Destination

---

CETA

Trade Partner

---

International Mode of Transport

---

Port of Clearance

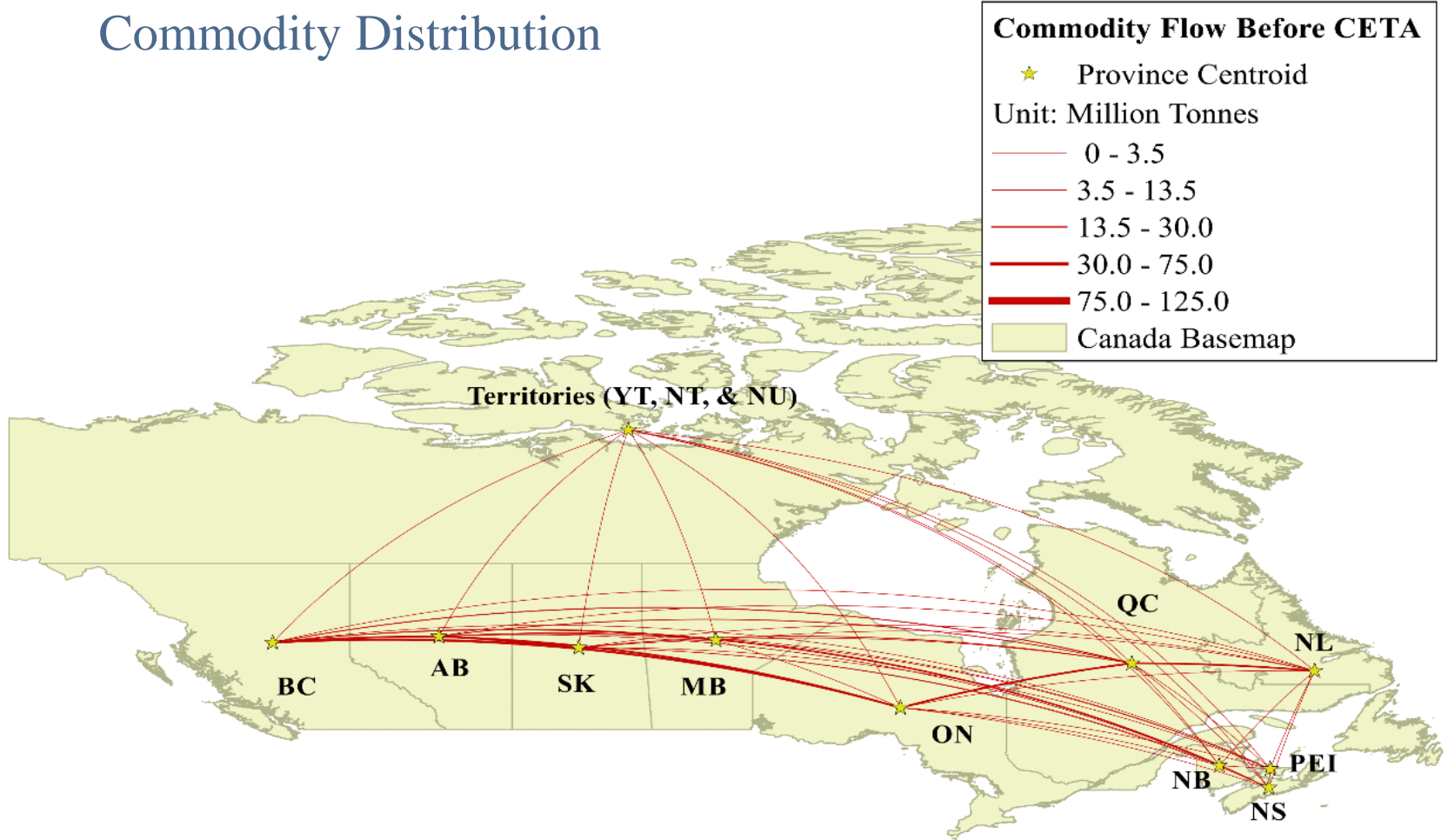
---

Province of Entry/Exit

---

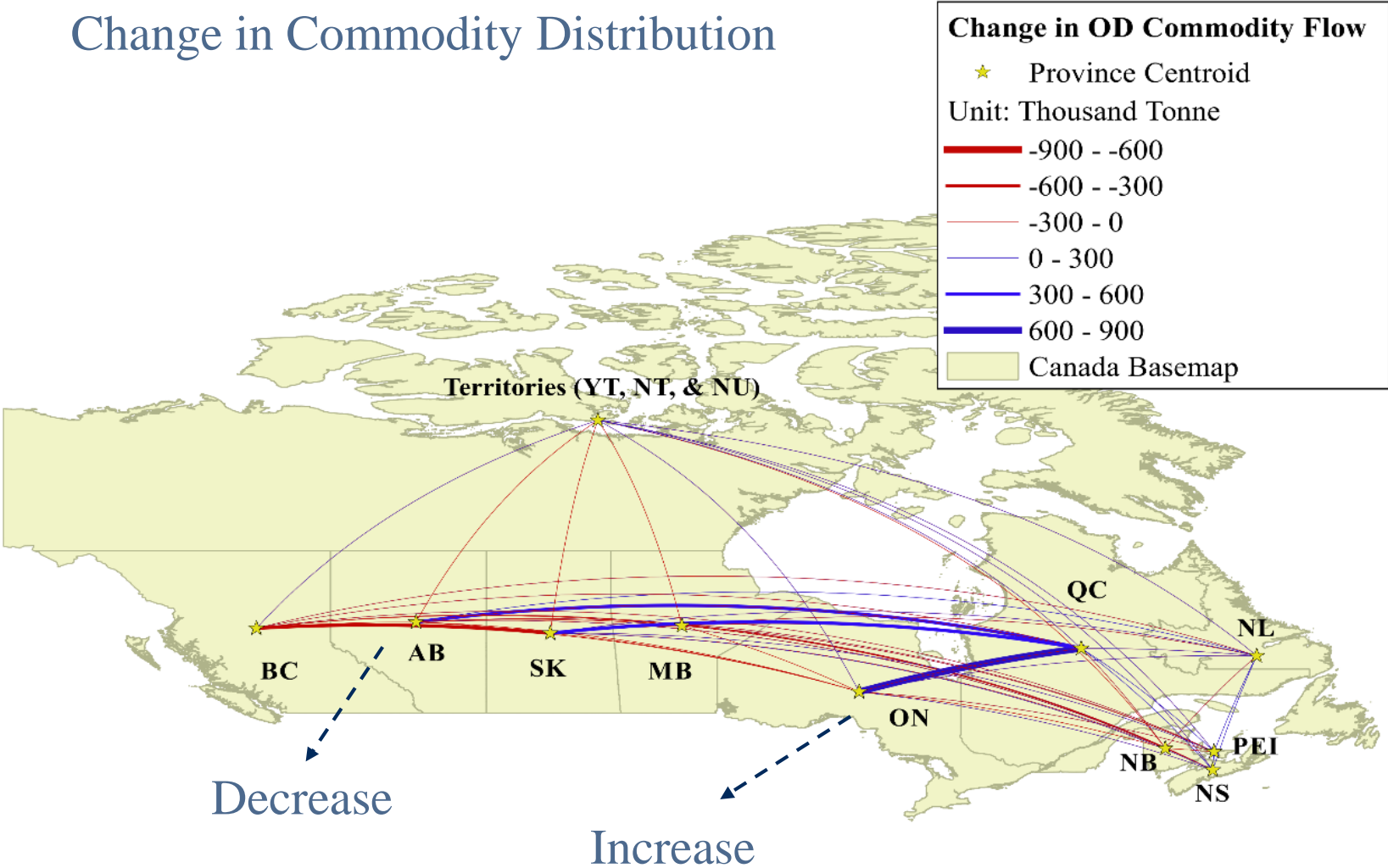
# Commodity OD Flow Database

## Commodity Distribution



# Commodity OD Flow Database

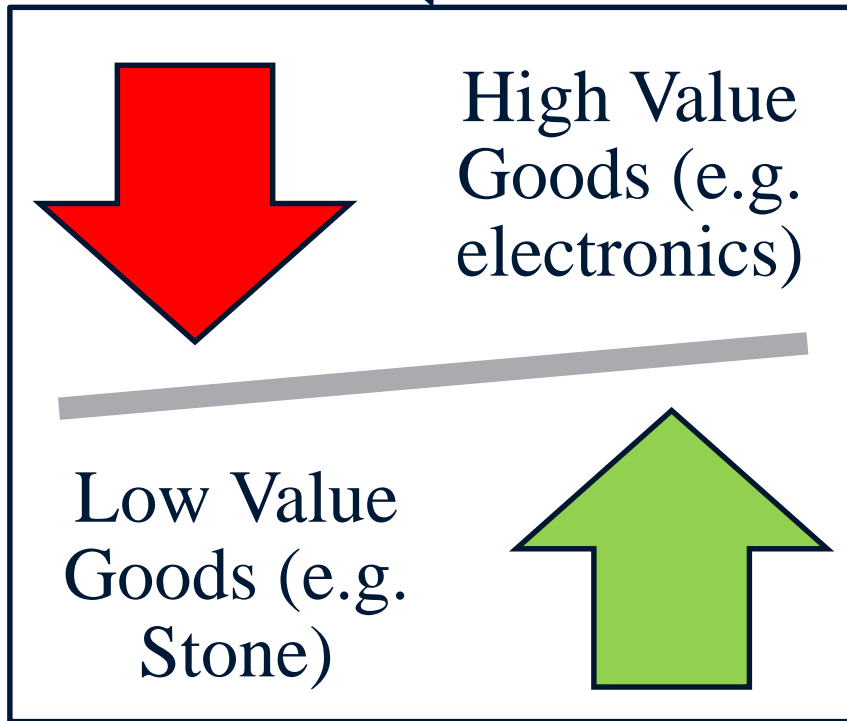
## Change in Commodity Distribution



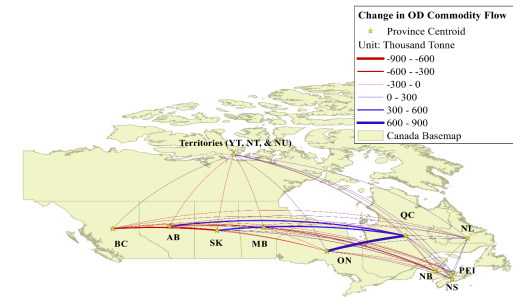
# Commodity OD Flow Database

Tariff Elimination

Shift Trade Flows toward EU



- 1) Decrease in freight flows across Western Canada
- 2) Increase in freight flows across Eastern Canada



# 2012 CFS Microdata

4,547,661 shipments shipped by approximately 60,000

OD area

NAICS  
industry Class

Quarter of the  
year

SCTG  
commodity  
group

Domestic  
mode of  
transport

Shipment  
value

Shipment  
Weight

Distance  
(Great-Circle  
and routed)

Hazard  
material

Local vs.  
Export

Country of  
destination

Temperature  
control  
commodity



# 2012 CFS Microdata

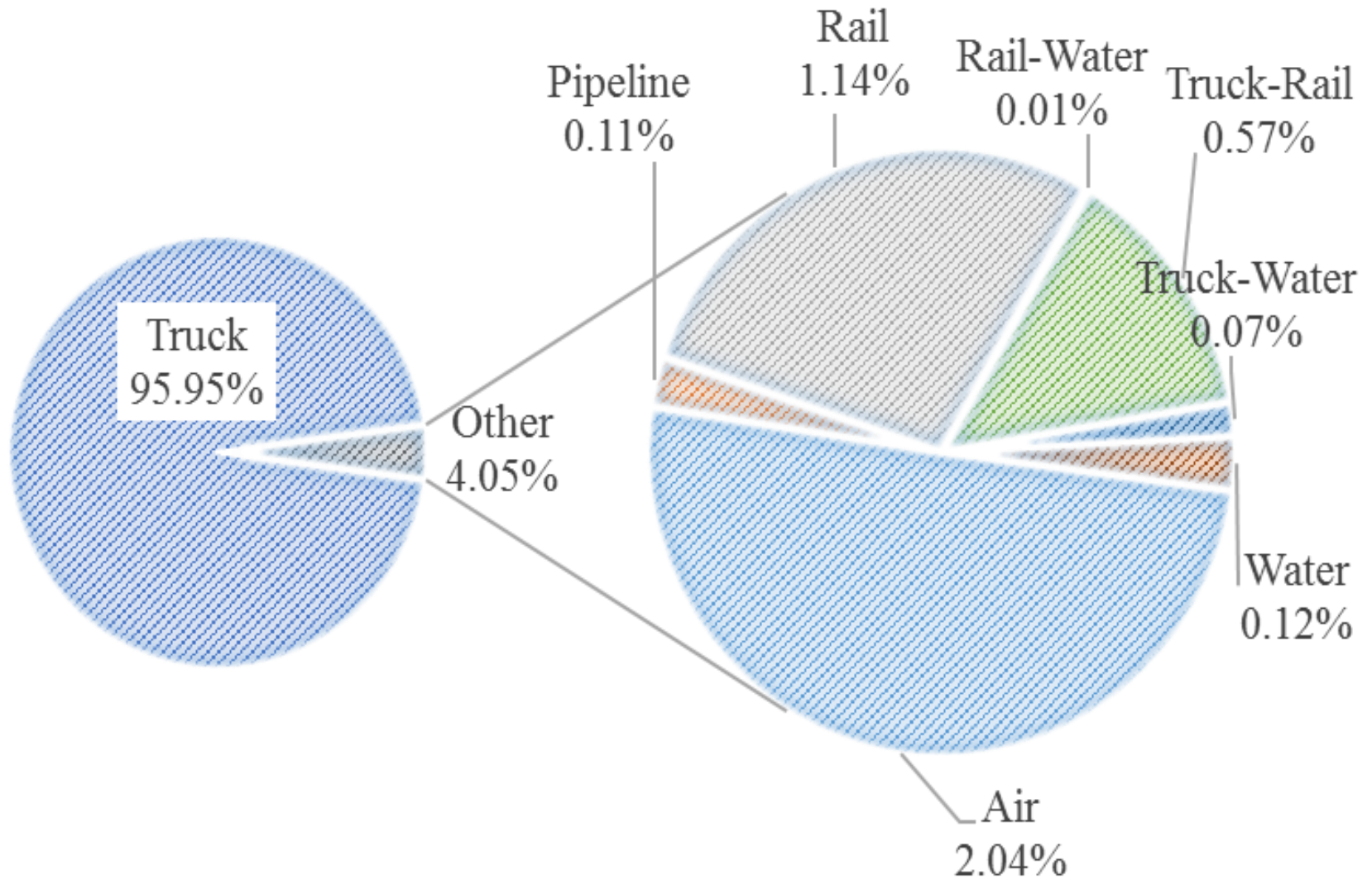
## Collaboration of:

- US Bureau of Transportation Statistics
- US Census Bureau
- US Department of Commerce

## Data collected in three steps:

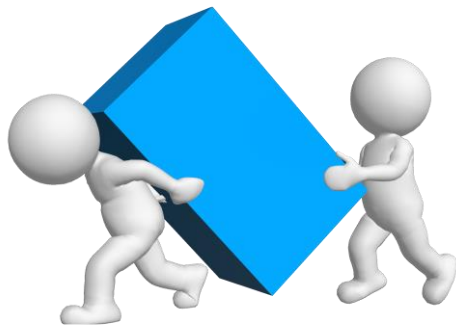
1. Sample of establishment
  - Mining, Manufacturing, Retail, Publishing, and Support services
2. Establishment are assigned to a sampling week
3. Questionnaires were sent out to establishment for 4 sampling weeks

# 2012 CFS Microdata



# 2012 CFS Microdata

1. **Discrepancies** (e.g. Missing/Suppressed codes, Unmatched results)
2. **Transport mode set adjustment** (Truck, Rail, Water, Air, Pipeline, Truck-Rail, Truck-Water, and Rail-Water)
3. **Measurement:**



Rail, Water,  
and Rail-  
Water



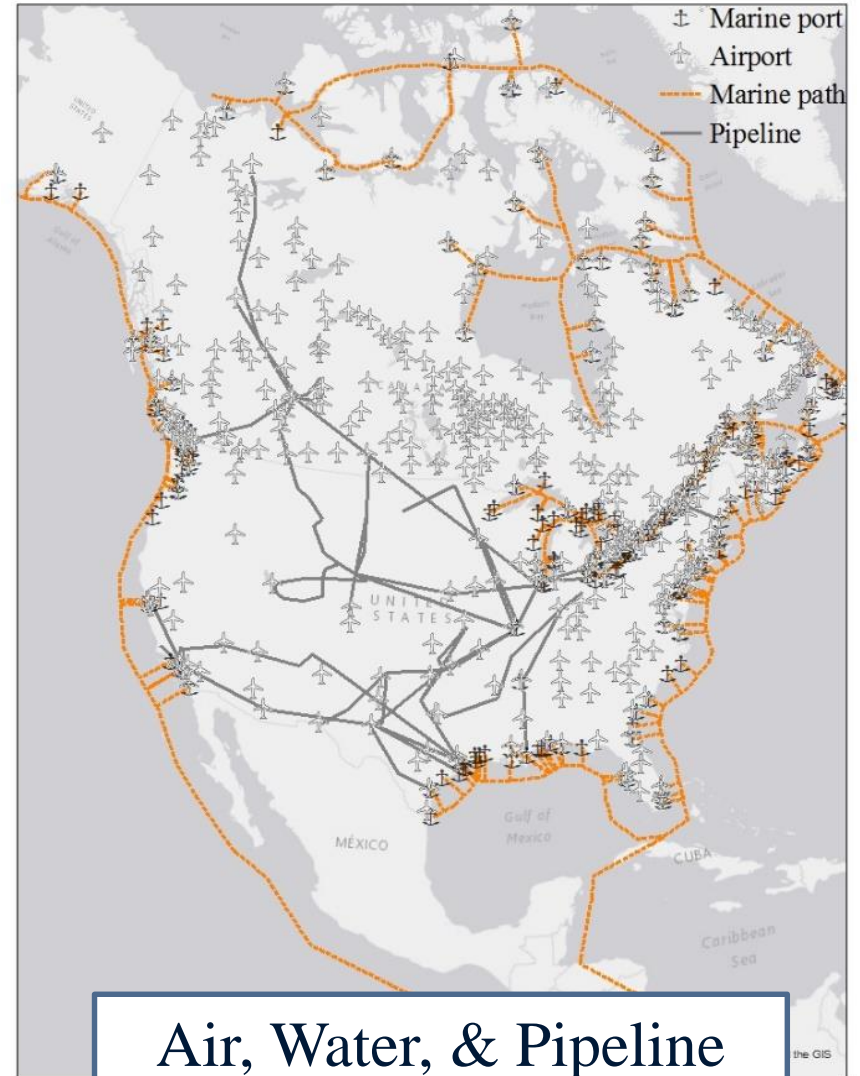
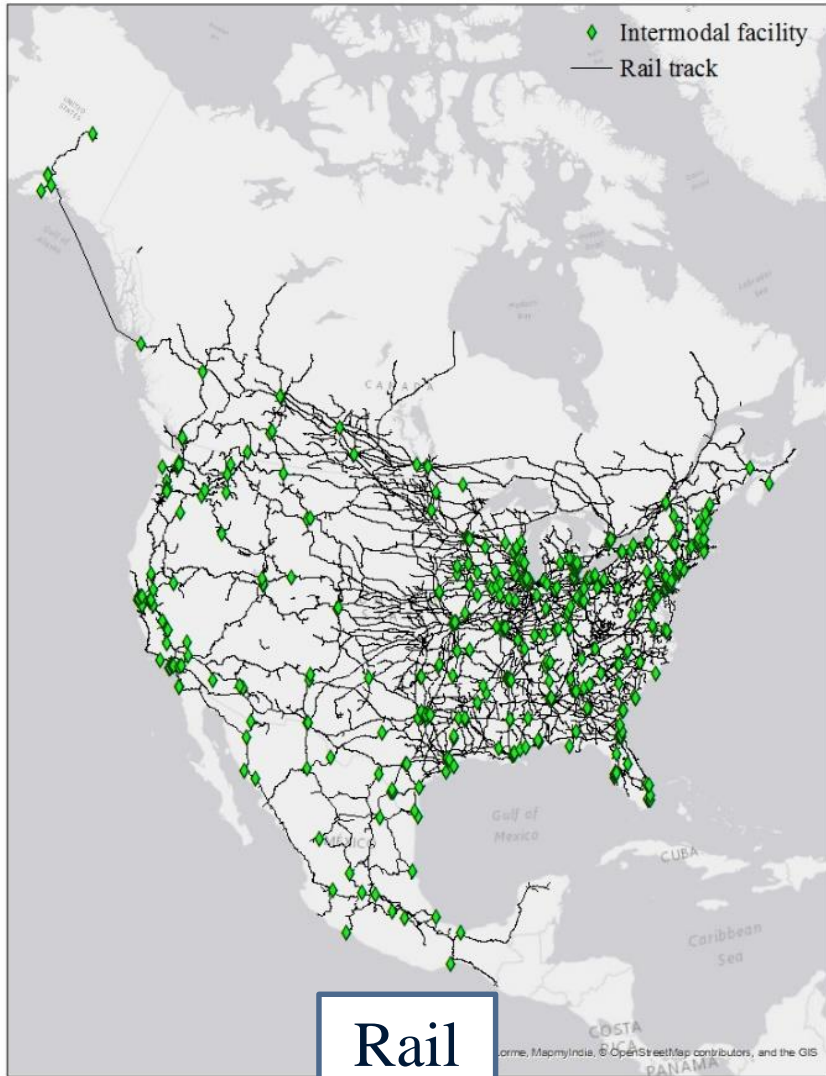
Rail and  
Multi-  
modes



Water

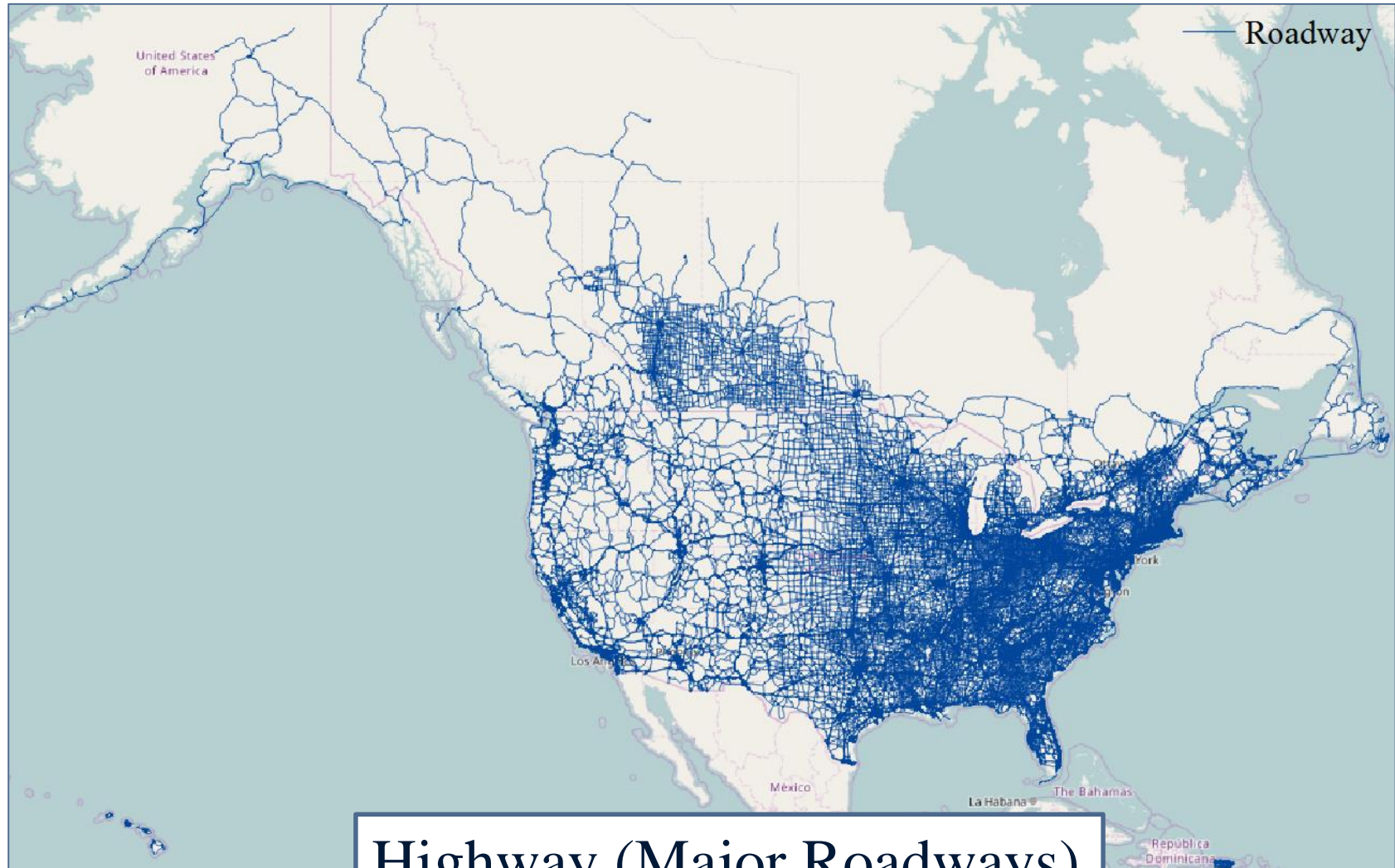
# Multimodal Transportation Network Database

(Provided by MTO)





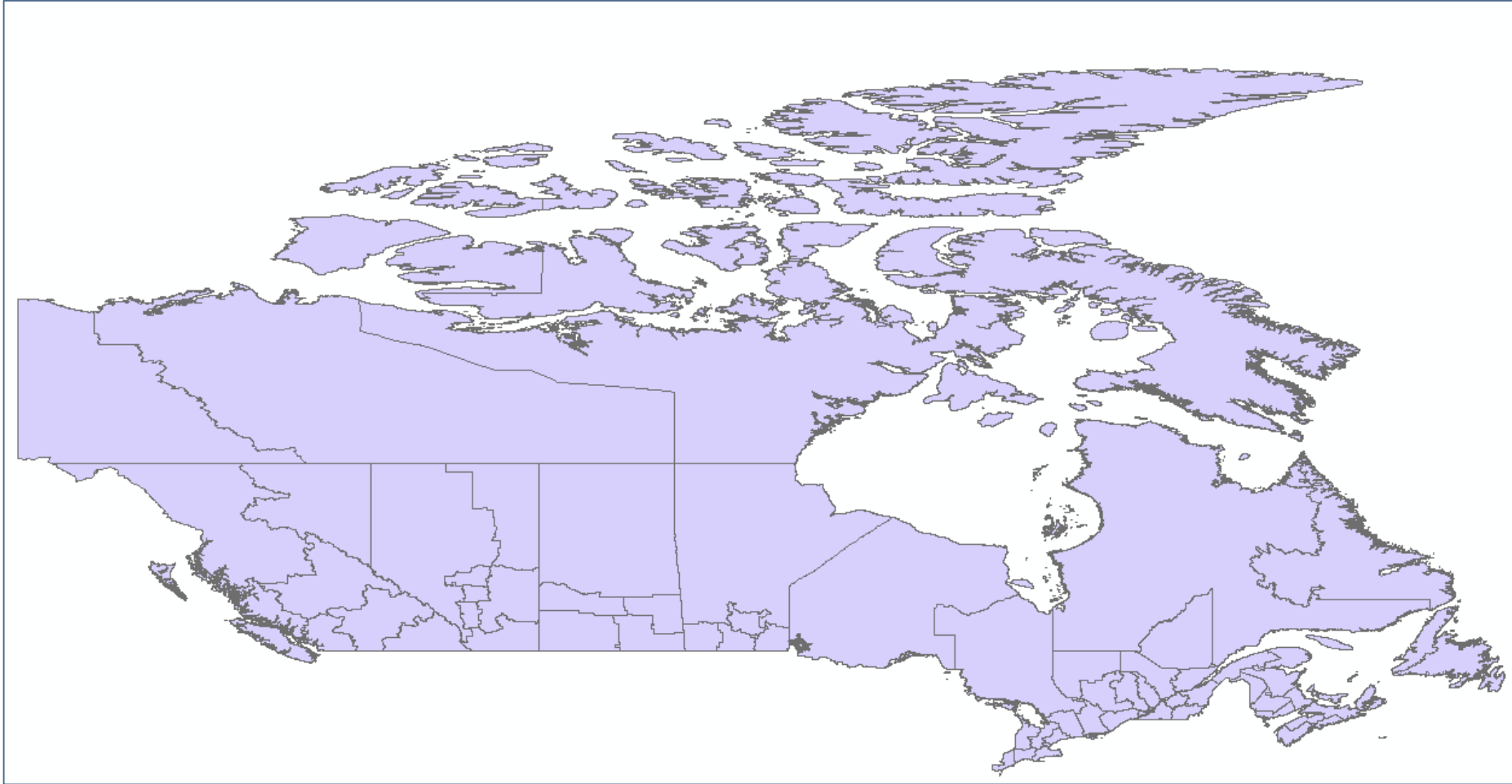
# Multimodal Transportation Network Database (ESRI)



# Data Refinement

## Commodity OD Flow Database

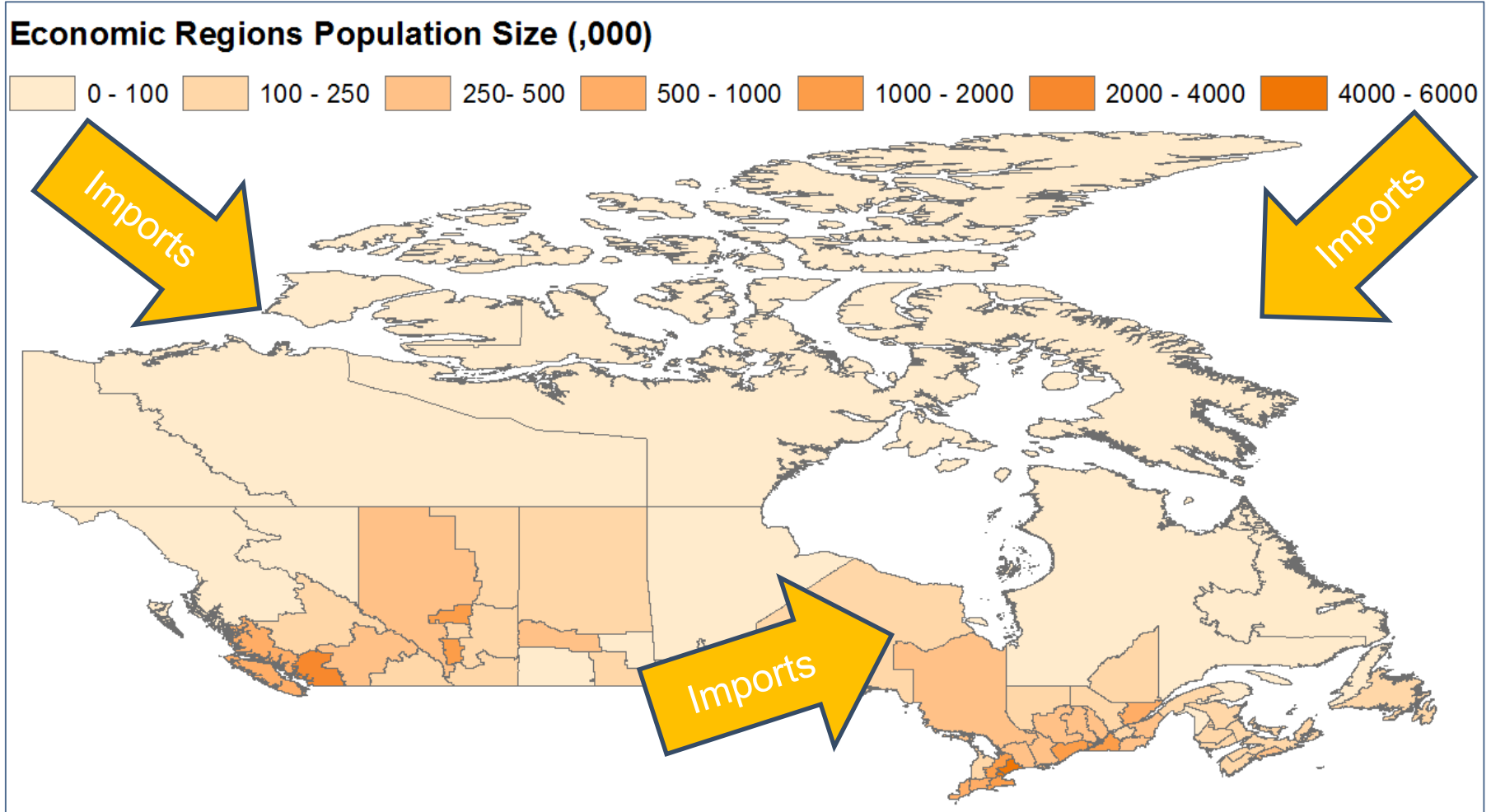
### 1. Province to Economic Region



# Data Refinement

## Commodity OD Flow Database

### 2. Commodity Flow Disaggregation

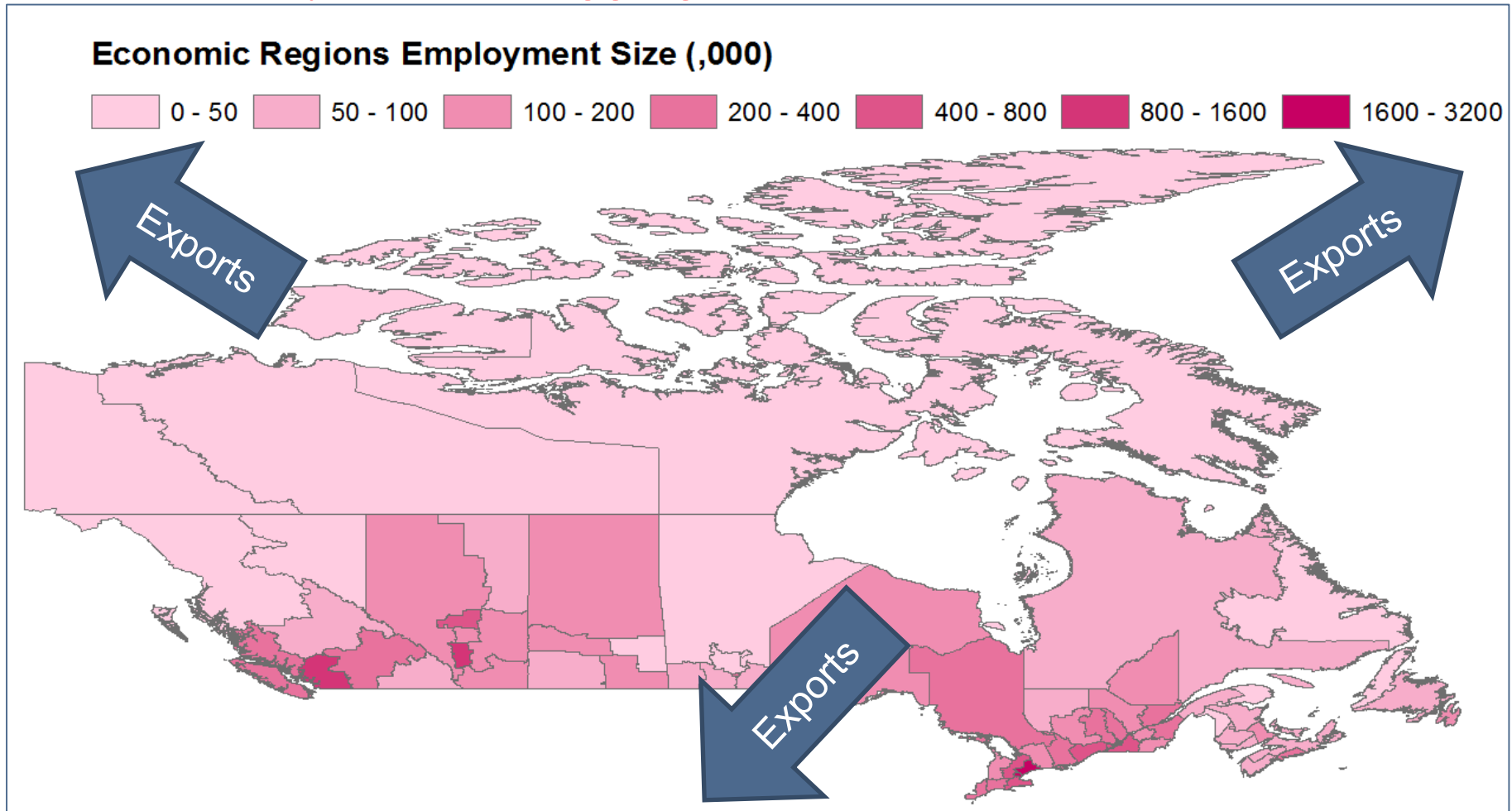




# Data Refinement

## Commodity OD Flow Database

### 2. Commodity Flow Disaggregation



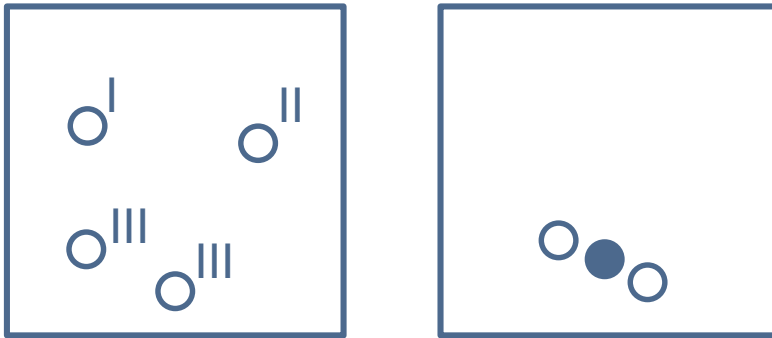
# Data Refinement

## Commodity OD Flow Database

### 3. Selection of Economic Region Representative Point

Statistics Canada identify 947 Population Centres

- I. Small population centre (population 1,000 to 29,999)
- II. Medium population centre (population 30,000 to 99,999)
- III. Large urban population centre (population 100,000 or greater)



Method of Kulin and Kuenne (1962)

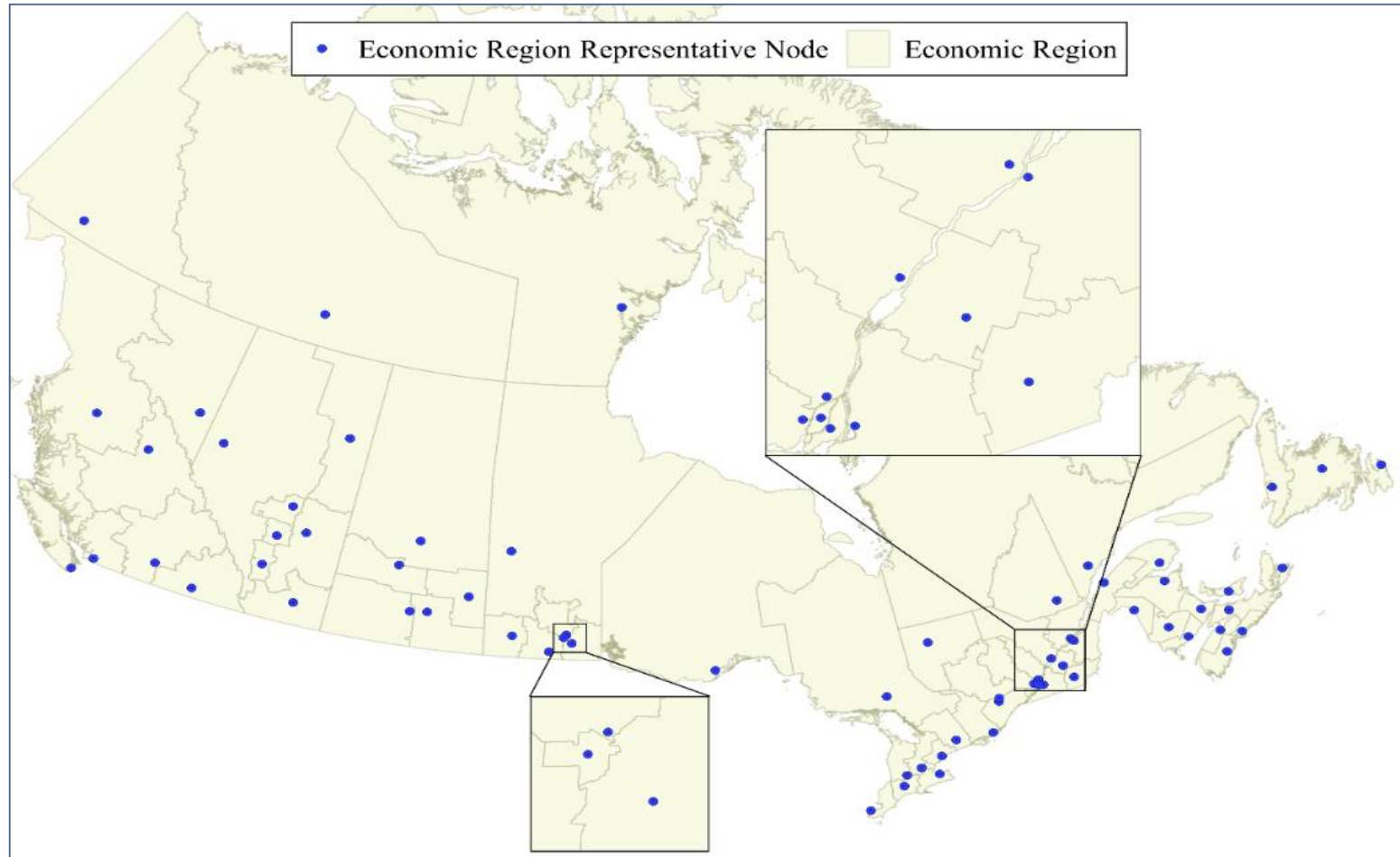
$$d_i^t = \sqrt{(X_i - X^t)^2 + (Y_i - Y^t)^2 + (Z_i - Z^t)^2}$$

- Economic region boundary
- Centroid of population centers
- Representative Location

# Data Refinement

## Commodity OD Flow Database

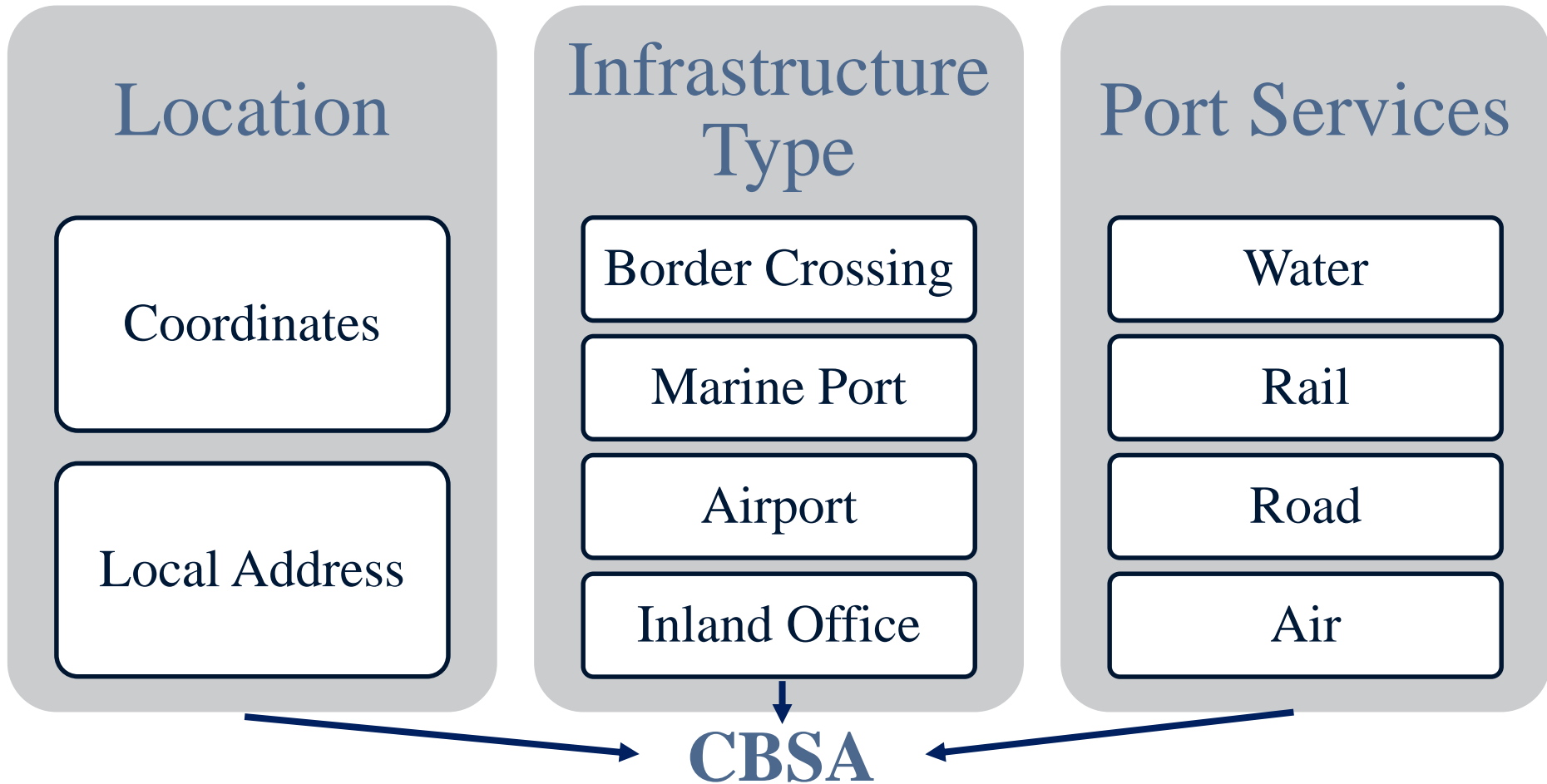
### 3. Selection of Economic Region Representative Point



# Data Refinement

Commodity OD Flow Database

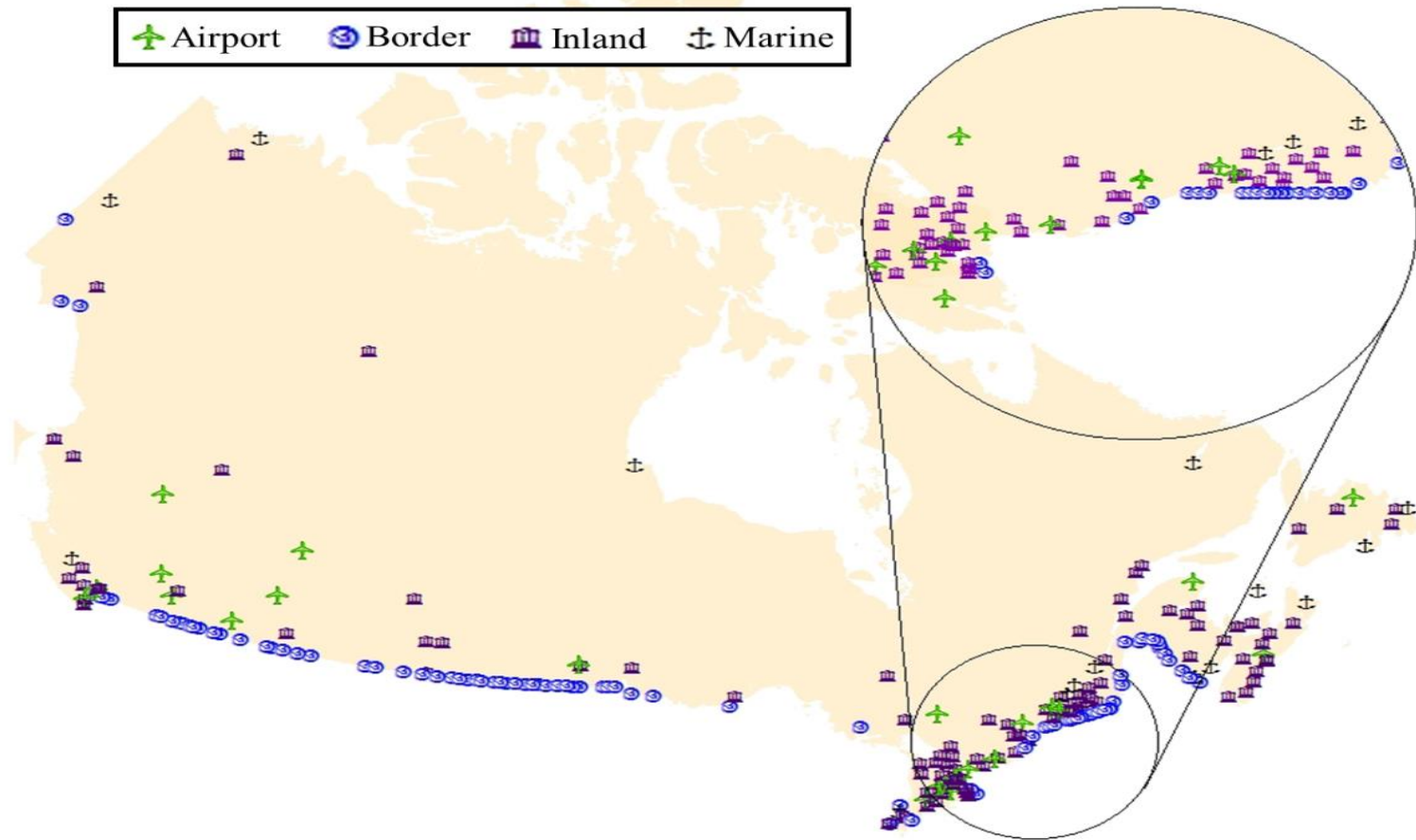
## 4. Port of Clearance (PC) Specification



# Data Refinement

## Commodity OD Flow Database

### 4. Port of Clearance (PC) Specification



# Data Refinement

## Commodity OD Flow Database

### 5. Concordance between SCTG-2, GSC-2, and SCTG Group

SCTG Group	SCTG Group description	SCTG-2	GSC-2
A	Agricultural & fish products	1,2,3,4,5	1,2,3,4,5,6,7,8,9,10,12,14,19,20
B	Grains, alcohol, & tobacco products	6,7,8,9	11,21,22,23,24,25,26,45
C	Stone, nonmetallic minerals, & metallic ores	10,11,12,13,14	18
D	Coal & petroleum products	15,16,17,18,19	15,16,17,32,44
E	Basic chemicals, chemical & pharmaceutical products	20,21,22,23,24	33
F	Logs, wood products, textiles & leather	25,26,27,28,29,30	13,27,28,29,30,31
G	Base metals & machinery	31,32,33,34	34,35,36,37
H	Electronics, motorized vehicles, & precision instruments	35,36,37,38	38,39,40,41
I	Furniture, mixed freight, & manufactured products	39,40,41,43	42



# Data Refinement

## 2012 CFS Microdata

### i. Mode Accessibility

#### Accessibility to Water

- Marine Port at Origin
- Marine Port at Destination
- Port's location identified by BTS

#### Accessibility to Air

- FAA annually ranks US busiest airports
- Validated against the US DOT database
- Locations found using Locids
- At least one major airport bounded by the CFS area

#### Accessibility to Rail

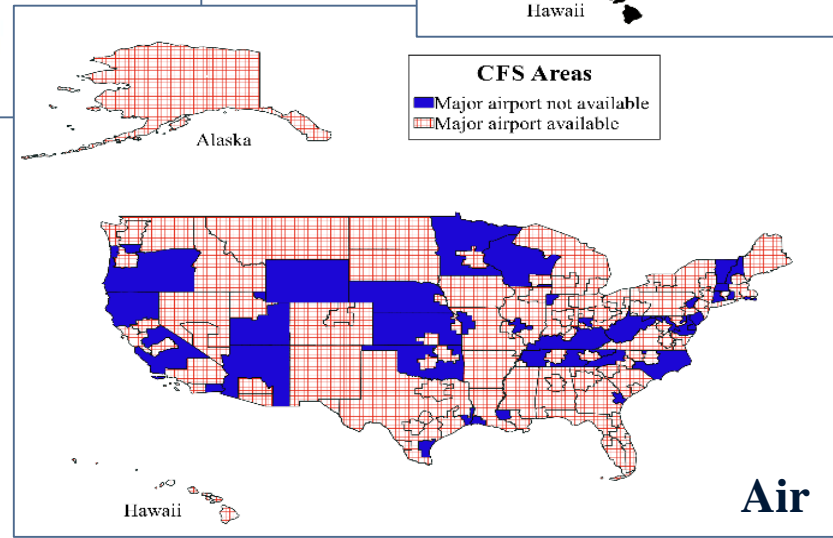
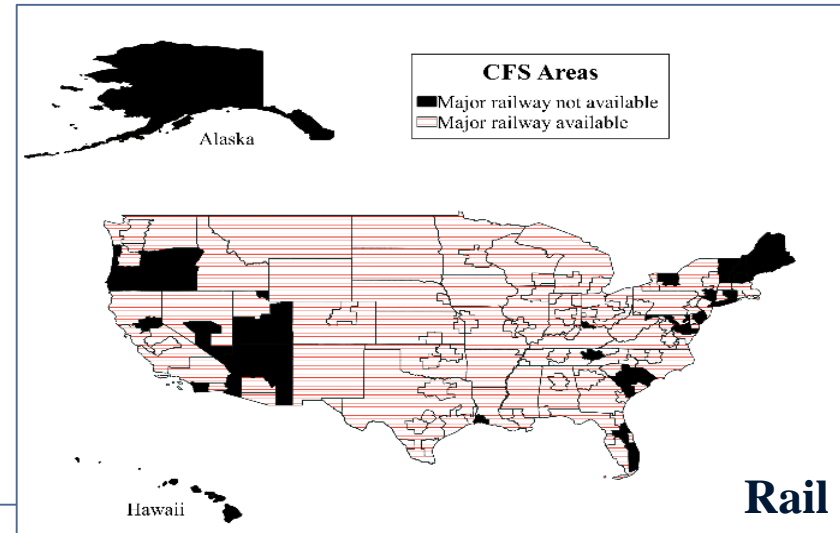
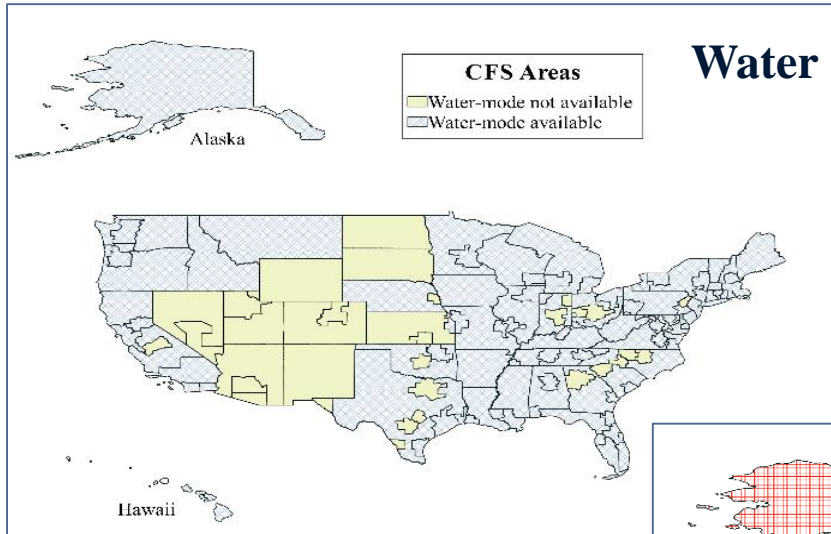
- Finding major rail lines
  - BNSF, UP, NS, CN, CP, KCS, CSX, USG
- Intermodal facilities located within a radius of 250 meters from the major rail lines are selected
- At least one major intermodal facility bounded by CFS area
- Data acquire from BTS



# Data Refinement

## 2012 CFS Microdata

### i. Mode Accessibility



# Data Refinement

## 2012 CFS Microdata

### ii. Mode Availability (Outliers)

Extreme Outliers  $>$  Third Quartile  $+ 3 * \text{IQR}$

$\text{IQR} = 75^{\text{th}}$  Percentile  $- 25^{\text{th}}$  Percentile

Extreme Outliers  $<$  First Quartile  $- 3 * \text{IQR}$

### Range of Availability

Mode	Distance Routed (Mile)	Circular Distance (Mile)	Shipment Value (US Dollars)	Shipment Weight (lb)
<b>Truck</b>	0-4280	0-3490	0-148000	0-156000
<b>Rail</b>	0-3990	0-2940	0-440000	0-620000
<b>Truck-Rail</b>	0-3770	0-2840	0-256000	0-103000
<b>Water</b>	0-2290	0-1370	0-11400000	0-72900000
<b>Truck-water</b>	0-5210	0-2090	0-149000	0-148000
<b>Air</b>	0-4940	0-2890	0-75500	0-1460
<b>Rail-water</b>	0-5390	0-2790	0-488000	0-4960000
<b>Pipeline</b>	0-146	0-146	0-55500000	0-149000000

# Data Refinement

## 2012 CFS Microdata

### iii. Final Clean up

- ❑ **Remove Domestic Shipments (Select only US Exports)**
  - Commodity OD flow database reports only international flows
  
- ❑ **Pipeline shipments are excluded**
  - Definition of pipeline shipment is unclear (Power of operators)
  - CFS discards the shipments transported via the combination of intermodal and pipes
  - CFS does not fully collect information about petroleum shipments carried by pipelines
  
- ❑ **Size of the refined CFS dataset: 117,847 shipments**

# Modeling Approach

## Predict the domestic mode of transport:

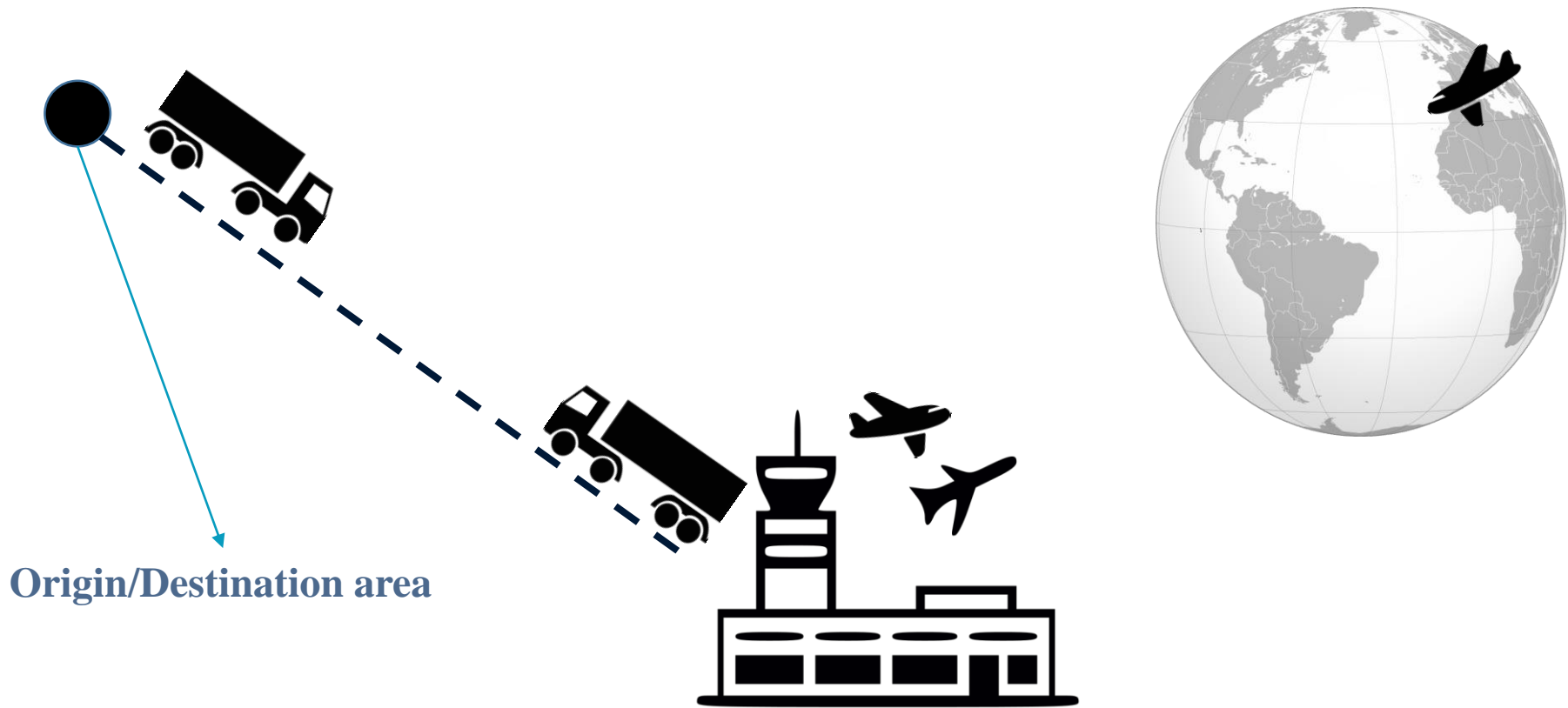
- Port of Clearance offered services
- International Mode of Transport
- US CFS Microdata

Port of clearance offered service	Domestic mode of transport
Air-only	Truck
Rail-only	Truck-Rail
Road-only	Truck
Marine-only	Truck & Truck-Rail
Multimode	Based on international mode of transport

# Modeling Approach

(Mode Split)

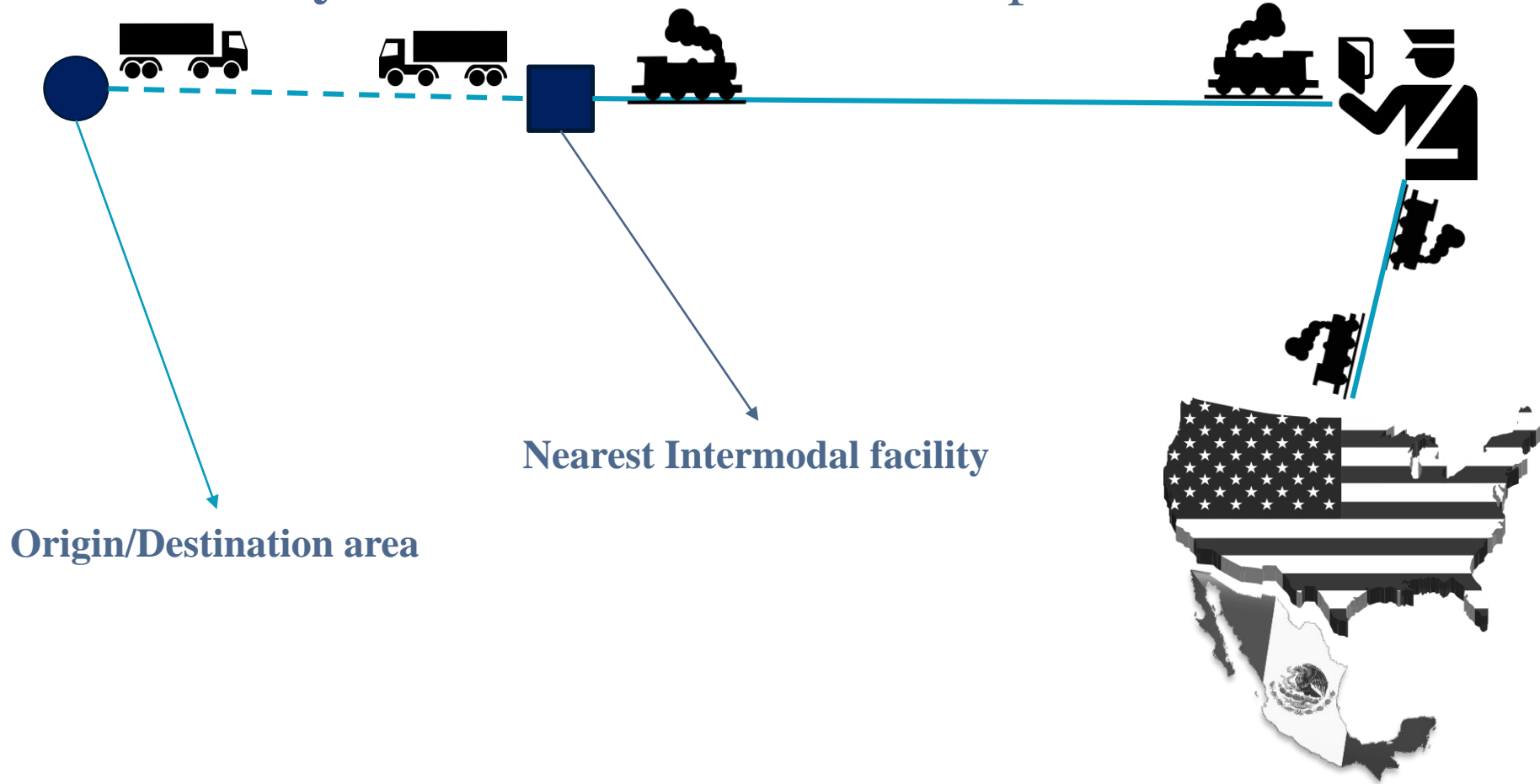
## 1. Air-only: Domestic Mode of Transport is **Truck**



# Modeling Approach

(Mode Split)

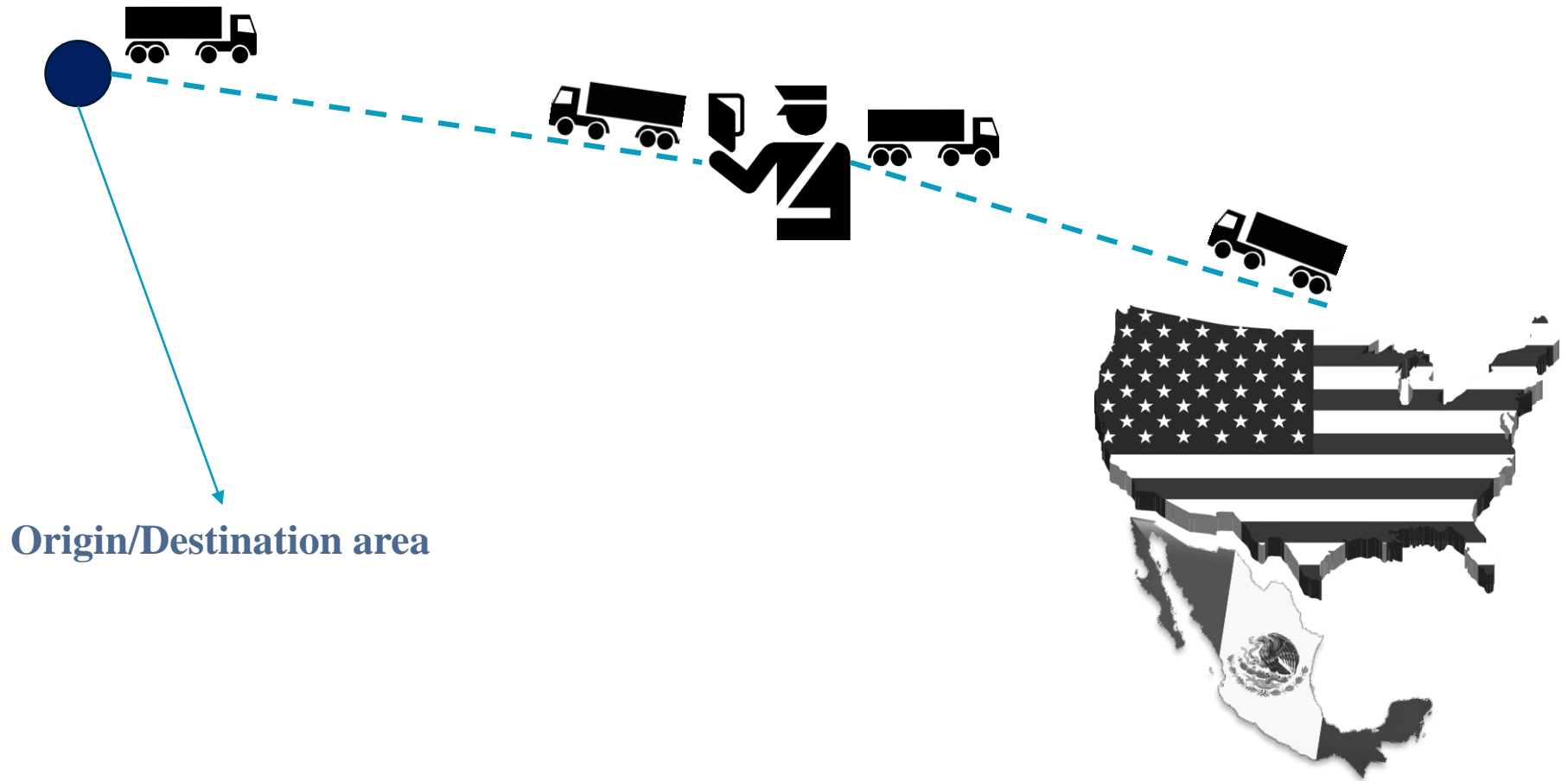
## 2. Rail-only: Domestic Mode of Transport is Truck-Rail



# Modeling Approach

(Mode Split)

## 3. Road-only: Domestic Mode of Transport is **Truck**



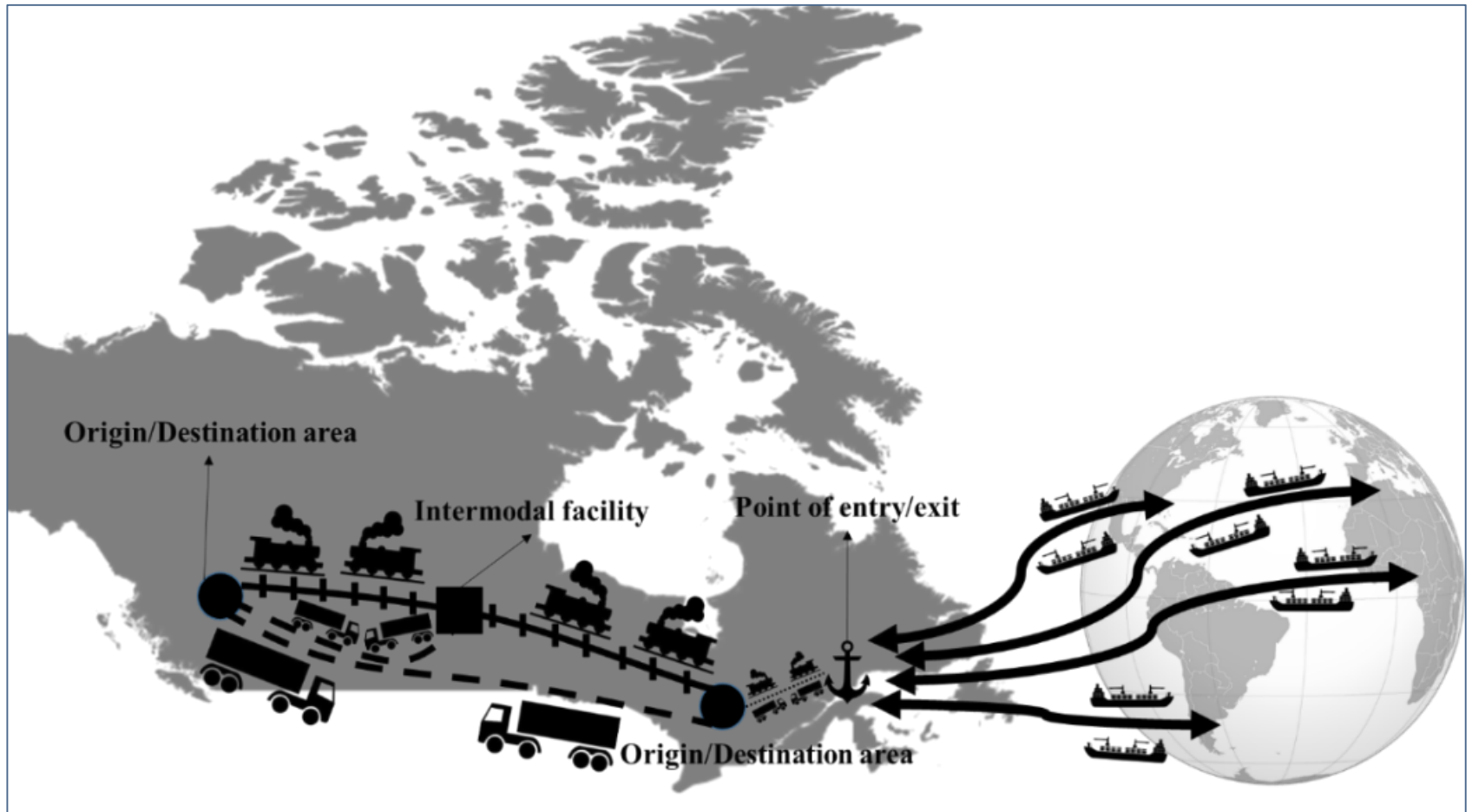
Origin/Destination area



# Modeling Approach

(Mode Split)

## 4. Marine-only: Domestic Mode of Transport is a) Truck b) Truck-Rail

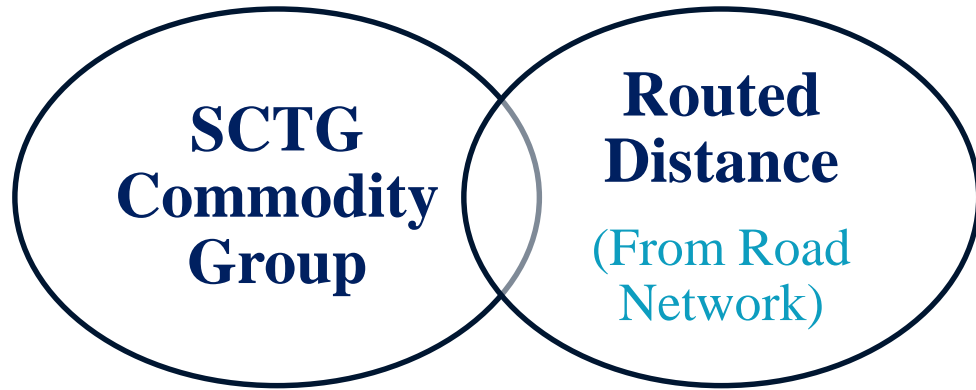


# Modeling Approach

(Mode Split)

## 4. Marine-only: Domestic Mode of Transport is a) Truck b) Truck-Rail

Frequency: % Annual Tonnage
SCTG Group

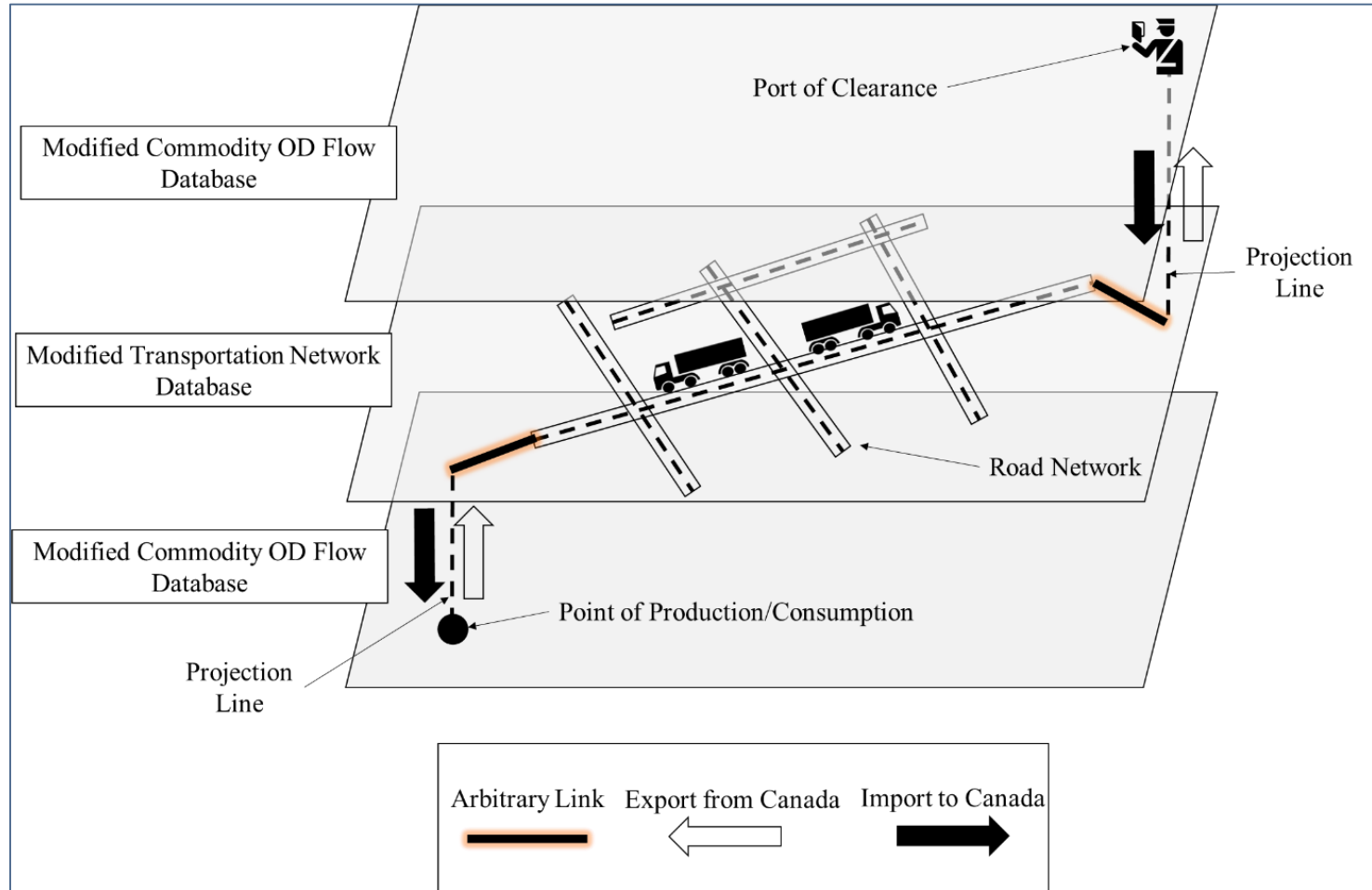


Frequency: % Annual Tonnage	CFS-Routed Distance (Km)											
	0-250		250-500		500-750		750-1000		1000-1750		>1750	
	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck
SCTG Group												
A	0.10%	99.90%	14.66%	85.34%	18.28%	81.72%	53.25%	46.75%	17.88%	82.12%	31.74%	68.26%
B	1.49%	98.51%	15.03%	84.97%	16.19%	83.81%	24.81%	75.19%	40.28%	59.72%	61.89%	38.11%
C	36.16%	63.84%	7.05%	92.95%	62.88%	37.12%	57.98%	42.02%	72.08%	27.92%	74.04%	25.96%
D	1.38%	98.62%	19.98%	80.02%	15.16%	84.84%	31.12%	68.88%	22.85%	77.15%	61.99%	38.01%
E	8.81%	91.19%	19.24%	80.76%	58.51%	41.49%	51.33%	48.67%	31.26%	68.74%	55.41%	44.59%
F	3.68%	96.32%	18.41%	81.59%	12.78%	87.22%	30.54%	69.46%	33.84%	66.16%	27.84%	72.16%
G	0.44%	99.56%	15.14%	84.86%	9.29%	90.71%	13.07%	86.93%	28.36%	71.64%	19.50%	80.50%
H	8.87%	91.13%	17.51%	82.49%	6.48%	93.52%	6.16%	93.84%	21.81%	78.19%	20.65%	79.35%
I	6.31%	93.69%	35.73%	64.27%	6.14%	93.86%	7.96%	92.04%	30.47%	69.53%	40.77%	59.23%

# Modeling Approach

(Route Assignment)

i. Domestic Mode of Transport is **Truck**

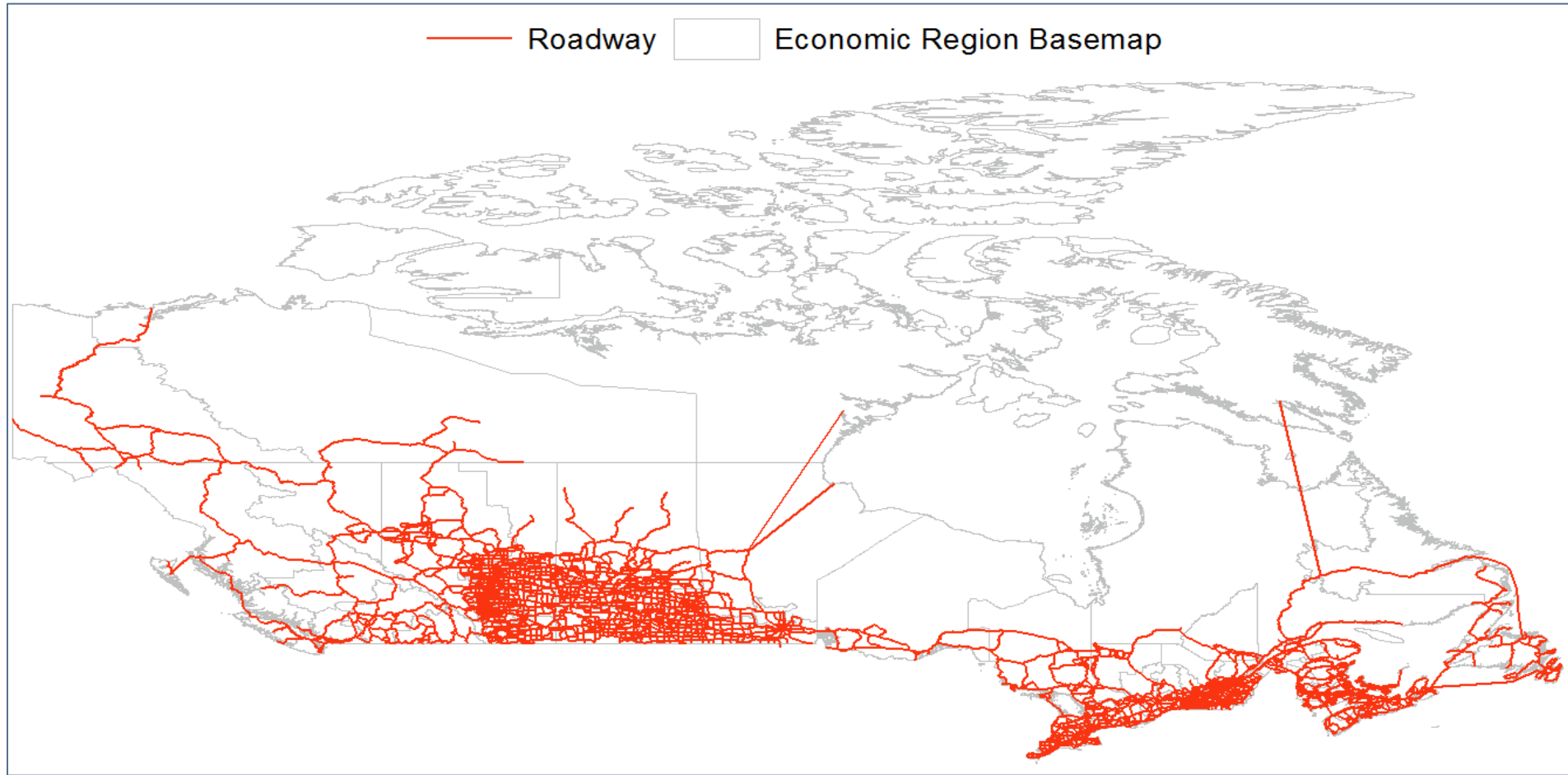


# Modeling Approach

(Route Assignment)

i. Domestic Mode of Transport is **Truck**

— Roadway    Economic Region Basemap

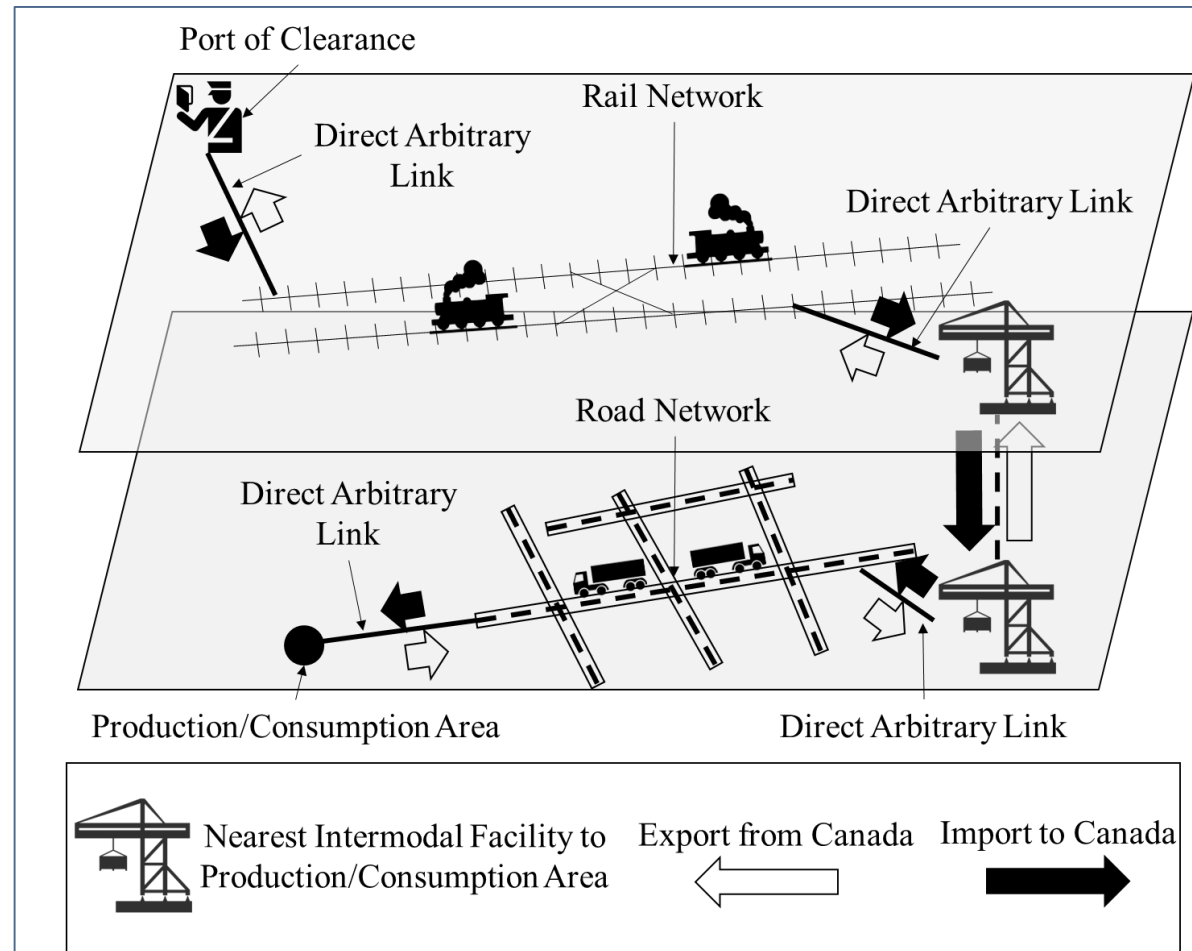


# Modeling Approach

(Route Assignment)

ii. Domestic Mode of Transport is **Truck-Rail (Rail)**

Adapted from the  
method of:  
Southworth and  
Peterson (2000)

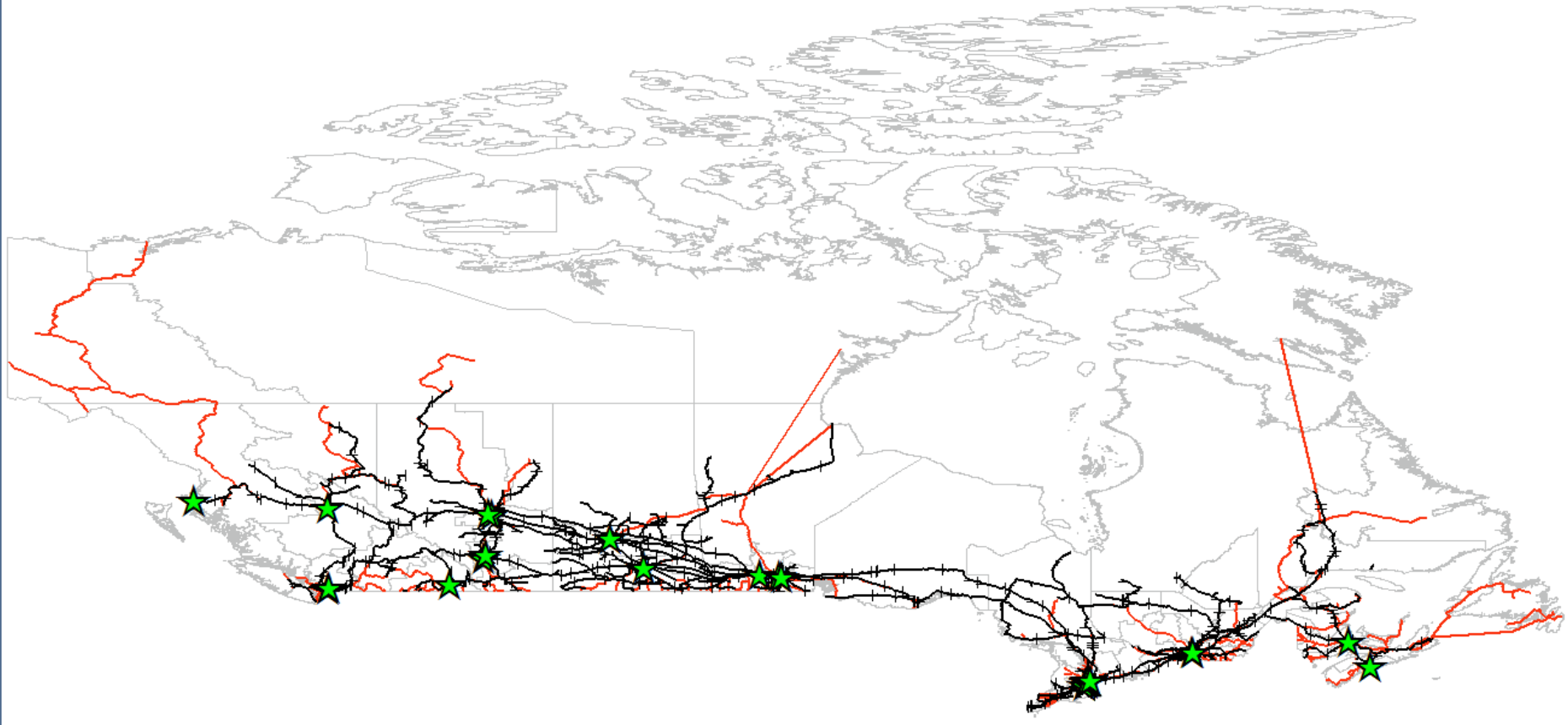


# Modeling Approach

(Route Assignment)

ii. Domestic Mode of Transport is **Truck-Rail (Rail)**

★ Intermodal Facility    —+— Railway    — Roadway    Economic Region Basemap



# Mode Share

		Annual Weight (Tonnes)	Difference (Tonnes)		Difference (%)	
			Rail	Truck	Rail	Truck
Exports	Province of Production	<b>Alberta</b>	-66700	<b>-485500</b>	-0.7%	<b>-0.5%</b>
		<b>British Columbia</b>	<b>-291100</b>	<b>-639000</b>	<b>-0.8%</b>	<b>-0.7%</b>
		Manitoba	-20600	-58500	-1.0%	-1.0%
		New Brunswick	-24700	-65400	-1.1%	-0.5%
		<b>Newfoundland and Labrador</b>	<b>-207800</b>	-146700	<b>-0.7%</b>	-0.6%
		Nova Scotia	-87100	-362700	-0.7%	-0.6%
		<b>Ontario</b>	-12400	<b>-545100</b>	-0.2%	<b>-0.7%</b>
		Prince Edward Island	0	1500	0.6%	0.6%
		Quebec	-129000	-163300	-0.8%	-0.5%
		Saskatchewan	22000	-3600	0.2%	0.0%
		Yukon, Northwest Territories, Nunavut	-200	-400	-0.7%	-0.7%
<b>Total</b>		<b>817600</b>	<b>2468700</b>	<b>0.7%</b>	<b>0.6%</b>	
Imports	Province of Consumption	<b>Alberta</b>	<b>78100</b>	136200	<b>2.1%</b>	1.0%
		<b>British Columbia</b>	<b>100600</b>	116300	<b>2.3%</b>	0.9%
		Manitoba	21500	31600	2.1%	1.0%
		New Brunswick	5700	22300	0.5%	0.6%
		Newfoundland and Labrador	6900	15800	1.5%	0.9%
		Nova Scotia	7600	22200	1.1%	0.9%
		<b>Ontario</b>	<b>212200</b>	<b>627200</b>	<b>1.2%</b>	<b>1.1%</b>
		Prince Edward Island	800	2500	2.0%	1.5%
		Quebec	26700	269200	0.4%	1.0%
		Saskatchewan	21200	31100	2.5%	1.0%
		Yukon, Northwest Territories, Nunavut	4700	5900	1.9%	1.3%
<b>Total</b>		<b>485900</b>	<b>1280200</b>	<b>1.3%</b>	<b>1.0%</b>	



# Mode Share

		Annual Weight (Tonnes)	Difference (Tonnes)		Difference (%)	
			Rail	Truck	Rail	Truck
Exports	SCTG Group	A Agricultural & fish products	78900	52000	1.0%	0.2%
		B Grains, alcohol, & tobacco products	2000	79000	0.1%	1.0%
		<b>C Stone, nonmetallic minerals, &amp; metallic ores</b>	<b>-579000</b>	<b>-1235000</b>	<b>-0.7%</b>	<b>-0.7%</b>
		<b>D Coal &amp; petroleum products</b>	<b>-19100</b>	<b>-511500</b>	<b>-0.3%</b>	<b>-0.4%</b>
		E Basic chemicals, chemical & pharmaceutical products	-58600	-175700	-0.8%	-0.8%
		<b>F Logs, wood items, textiles &amp; leather</b>	<b>-230300</b>	<b>-510200</b>	<b>-1.7%</b>	<b>-1.3%</b>
		G Base metals & machinery	-15300	-168900	-1.2%	-1.1%
		H Electronics, motorized vehicles, & precision instruments	3300	2600	3.7%	0.0%
		I Furniture, mixed freight, & miscellaneous manufactured products	400	-900	4.2%	-0.4%
		<b>Total</b>		<b>-817600</b>	<b>-2468700</b>	<b>-0.7%</b>
Imports	SCTG Group	A Agricultural & fish products	13100	50000	0.9%	0.7%
		<b>B Grains, alcohol, &amp; tobacco products</b>	<b>134500</b>	24000	<b>5.6%</b>	0.3%
		<b>C Stone, nonmetallic minerals, &amp; metallic ores</b>	<b>157600</b>	185500	<b>2.0%</b>	2.0%
		D Coal & petroleum products	5400	2300	0.1%	0.0%
		E Basic chemicals, chemical & pharmaceutical products	-49100	-151200	-0.6%	-0.8%
		<b>F Logs, wood items, textiles &amp; leather</b>	66800	<b>307200</b>	1.2%	<b>2.0%</b>
		<b>G Base metals &amp; machinery</b>	<b>128600</b>	<b>728500</b>	<b>2.9%</b>	<b>2.1%</b>
		H Electronics, motorized vehicles, & precision instruments	26700	127800	5.0%	0.9%
		I Furniture, mixed freight, & miscellaneous manufactured products	2400	6000	3.0%	1.3%
		<b>Total</b>		<b>485900</b>	<b>1280200</b>	<b>1.3%</b>

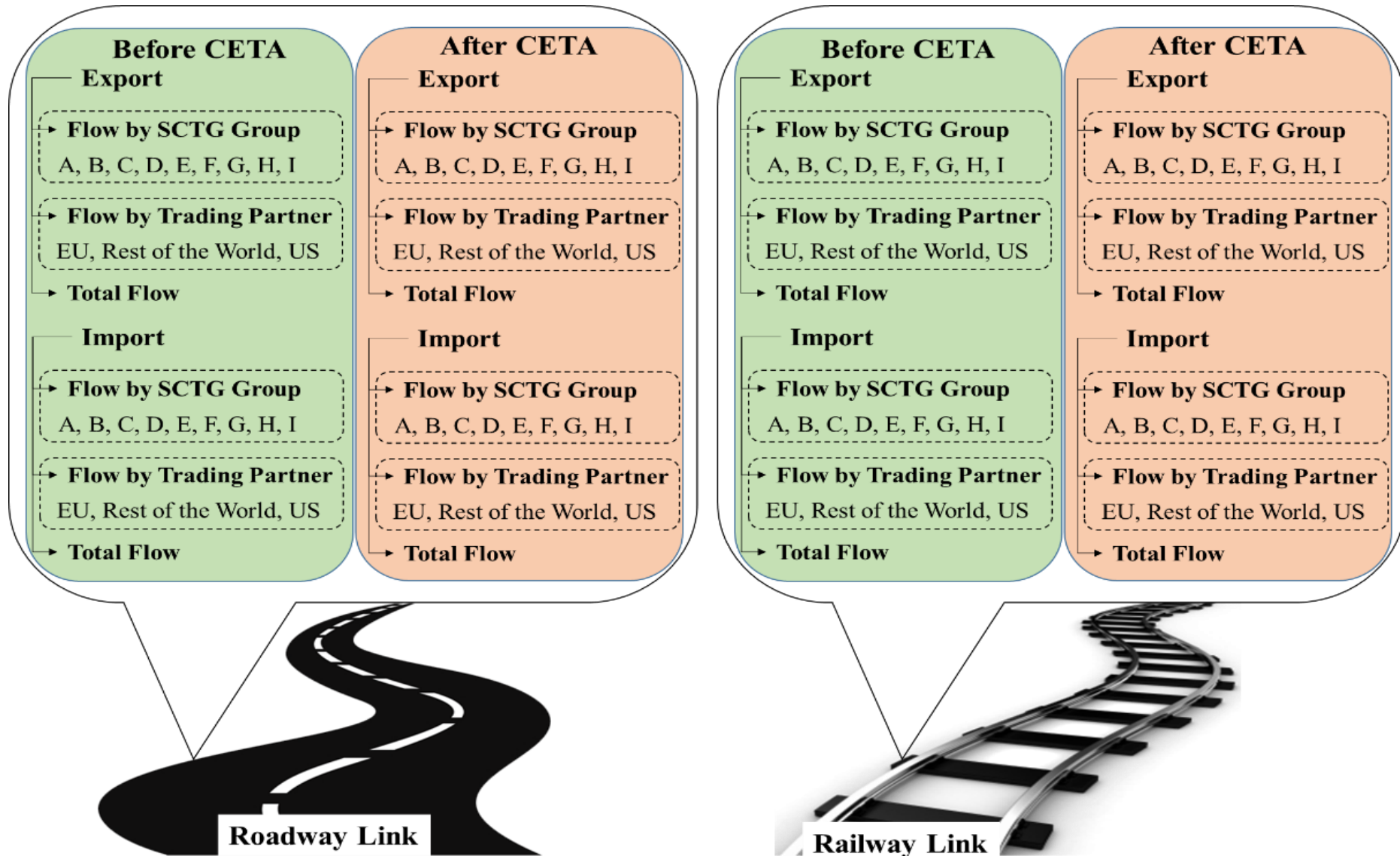




# Port of Clearance

	Port of Clearance Infrastructure Type	Difference (Tonnes)	Difference (%)
Export	Airport	59300	2.0%
	Border Crossing	-2060000	-0.9%
	Inland Office	-1244500	-0.4%
	Marine Port	-41100	-0.1%
Import	Airport	274700	3.3%
	Border Crossing	-787800	-0.9%
	Inland Office	2190300	4.0%
	Marine Port	88900	0.8%
Total	Airport	334100	3.0%
	Border Crossing	-2847800	-0.9%
	Inland Office	945800	0.3%
	Marine Port	47700	0.1%





# Route Assignment



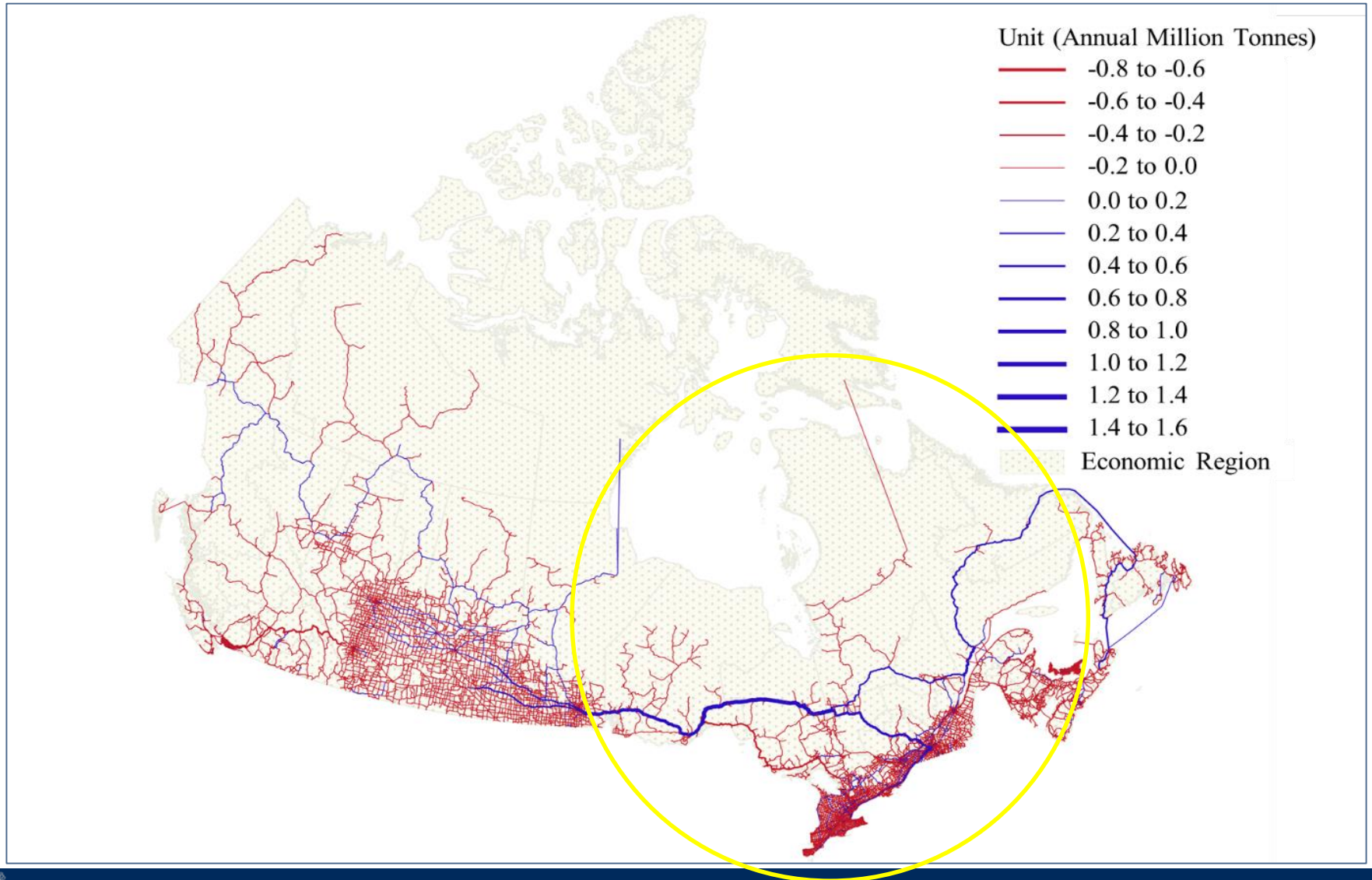
# Route Assignment

(Tonne-km by Mode )

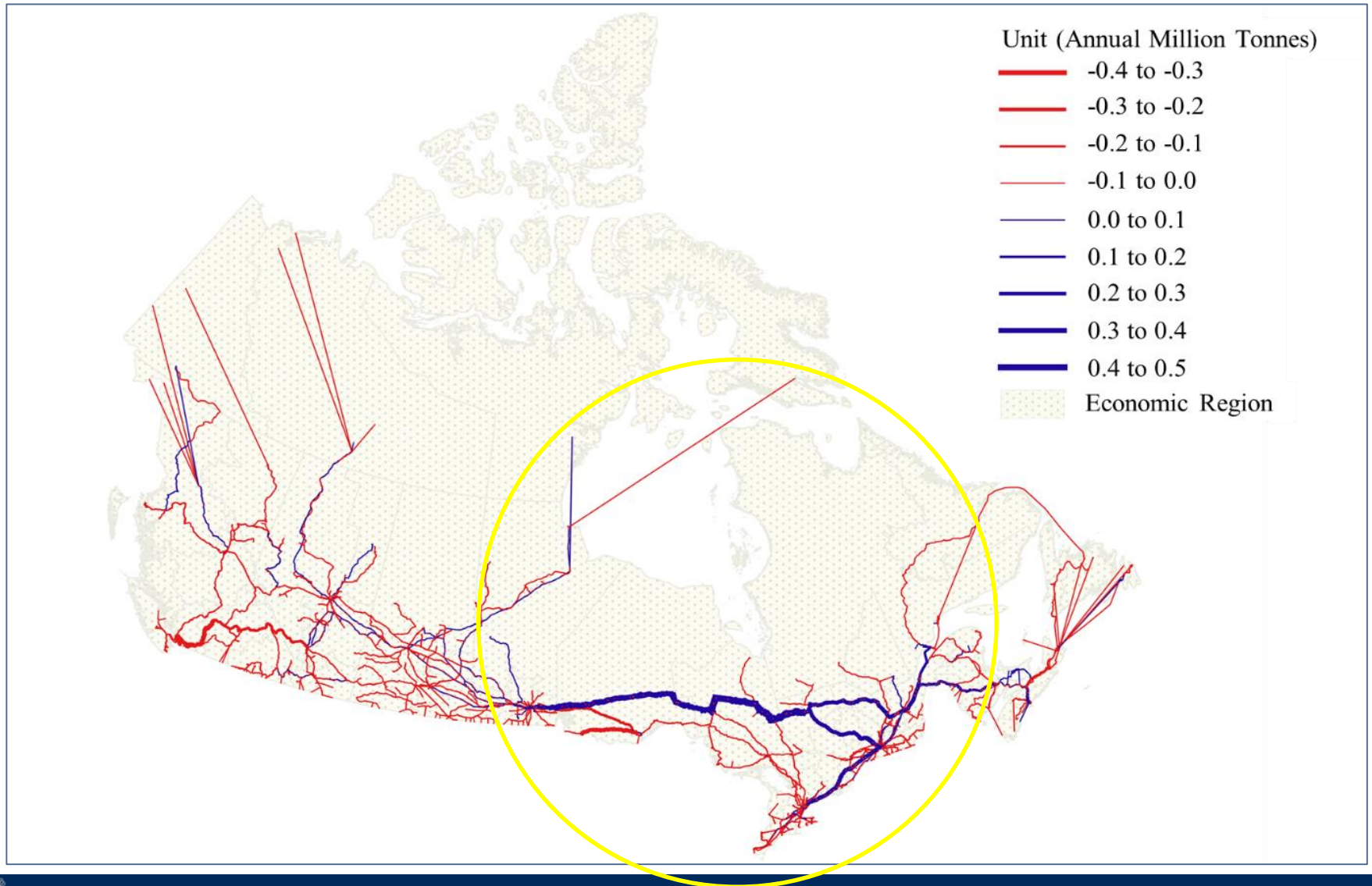
	Before CETA Tonne-Km (In millions)		After CETA Tonne-Km (In millions)		Change Tonne-Km (In millions)		Difference (%)	
	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck
<b>Export</b>	137840	291774	137344	291132	-496	-641	-0.4%	-0.2%
<b>Import</b>	100510	249777	101616	251557	1105	1780	1.1%	0.7%
<b>Total</b>	238351	541551	238960	542690	609	1139	<b>0.3%</b>	<b>0.2%</b>

Tonne_Km	Difference (%)	
	Rail	Truck
Export	 -0.4%	 -0.2%
Import	 1.1%	 0.7%

# Route Assignment (Road Network)



# Route Assignment (Rail Network)





# Validation

(Rail Mode)

Measure	FAF Database	Model Results	Difference
Rail Exports to US (Tonne)	67,968,187	70,755,436	-4%
Rail Imports from US (Tonne)	27,095,121	18,831,251	30%

- Port clearance not listed in CBSA
- International freight shipped via US gateways are omitted

# Validation

## (Rail Mode)

CANSIM Table 404-0016

Model Result		Validation Data		Difference
Measure	Magnitude	Measure	Magnitude	
Tonne-Km Total Rail Freight Flow (Million Tonne-Km)	416378	Revenue Rail Freight (Million Tonne-Km)	411623	-1%
		Revenue & Non- Revenue Rail Freight (Million Tonne-Km)	415006	0%

Revenue Freight (Tonne-Km)= Weight of Paid Freight (in Tonne) \* Distance (Km)

# Validation

(Road Mode)

1. 18 road segments selected from Highway 401 selected
2. To convert international freights to Total Freight:

$$\frac{\text{International Freight}}{\text{Total Freight}} = 57\%$$

3. Payload factor from FHWA:

$$15.8 \frac{\text{Ton}}{\text{Truck}} = 14.3 \frac{\text{Tonne}}{\text{Truck}}$$

4. For 365 Days



# Near Port of clearance Validation (Hwy 401)

Description	Mode Outcomes	AADTT 2008	Difference
401 at Pearson	12324	13318	7%
401 at Pine Point Park	6487	16930	62%
401 at Yorkdale	8644	13908	38%
401 at Pickering Nuclear Station	9048	10042	10%
401 at Port Hope	12792	10574	-21%
401 at Belleville	12991	9218	-41%
401 at Brockville	12381	9374	-32%
401 at Quebec-Ontario boundry	8670	7572	-14%
401 at Kingston	12093	8758	-38%
401 at Cobourg Conservation Area	12792	9942	-29%
401 at Toronto Premium Outlets	12464	21750	43%
401 at Kelso Conservation Area	14315	19956	28%
401 at Puslinch Lake	13473	21284	37%
401 at Grand River	16494	21238	22%
401 at Alexander Graham bell Pkwy	9400	22850	59%
401 at London	9404	18560	49%
401 at Chatham Kent	9420	10170	7%
401 at Baptiste Creek	9846	10834	9%
<b>Total</b>	<b>203038</b>	<b>256278</b>	<b>21%</b>

# Key Findings

(Model Results)

## □ Higher demand for both rail and road

- Higher demand on Atlantic Gateways
- Higher demand across the Eastern provinces
- Higher demand along the Quebec City-Windsor Corridor
- Greatest increase expected for port of Montréal

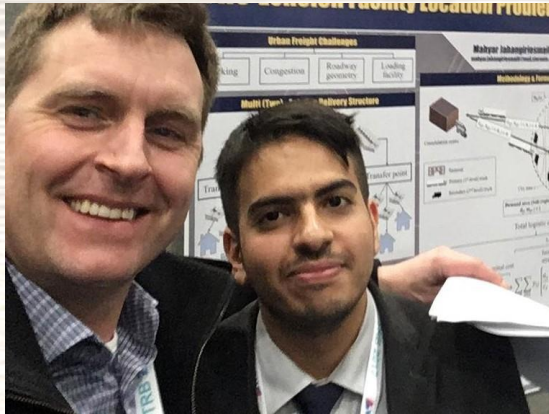
## □ Reduction in exports for both rail and road

- Diversion of trade flows toward EU
- More investment on high-value and low-volume goods
- Lower commodity movement near US-Canada borders
- Lower demand on the west coast ports
- Largest decrease estimated for port of Vancouver

# Future Research

- Utilize a Canadian freight demand (modal) dataset**
  
- Have information about conditions of major roadways**
  - Passenger and heavy-vehicle traffic flows
  - Larger set of intermodal facilities
  
- Develop a location choice model to identify the preferred intermodal facility**
  - Transportation cost (e.g. distance)
  - Commodity features (e.g. bulk/container, perishable, etc.)
  
- Use of Canadian payload factor**
  
- Developing a well-integrated four-step model**

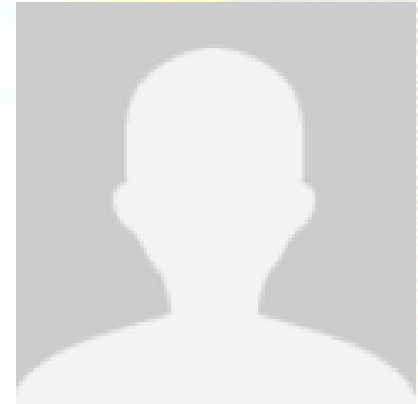
# Thank You Questions



Professor Matthew Roorda



Professor Chris Bachmann



Rupert Allen

- Project Funded by Innovation, Science and Economic Development Canada, formerly industry Canada
- Transportation network provided by MTO