Evaluating and Forecasting Commodity Flows, Ontario

WSP | Parsons Brinckerhoff

MTO

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Team and Context

Just like it takes a <u>village</u> to raise a child — it took a **Team** to build these models

MTO

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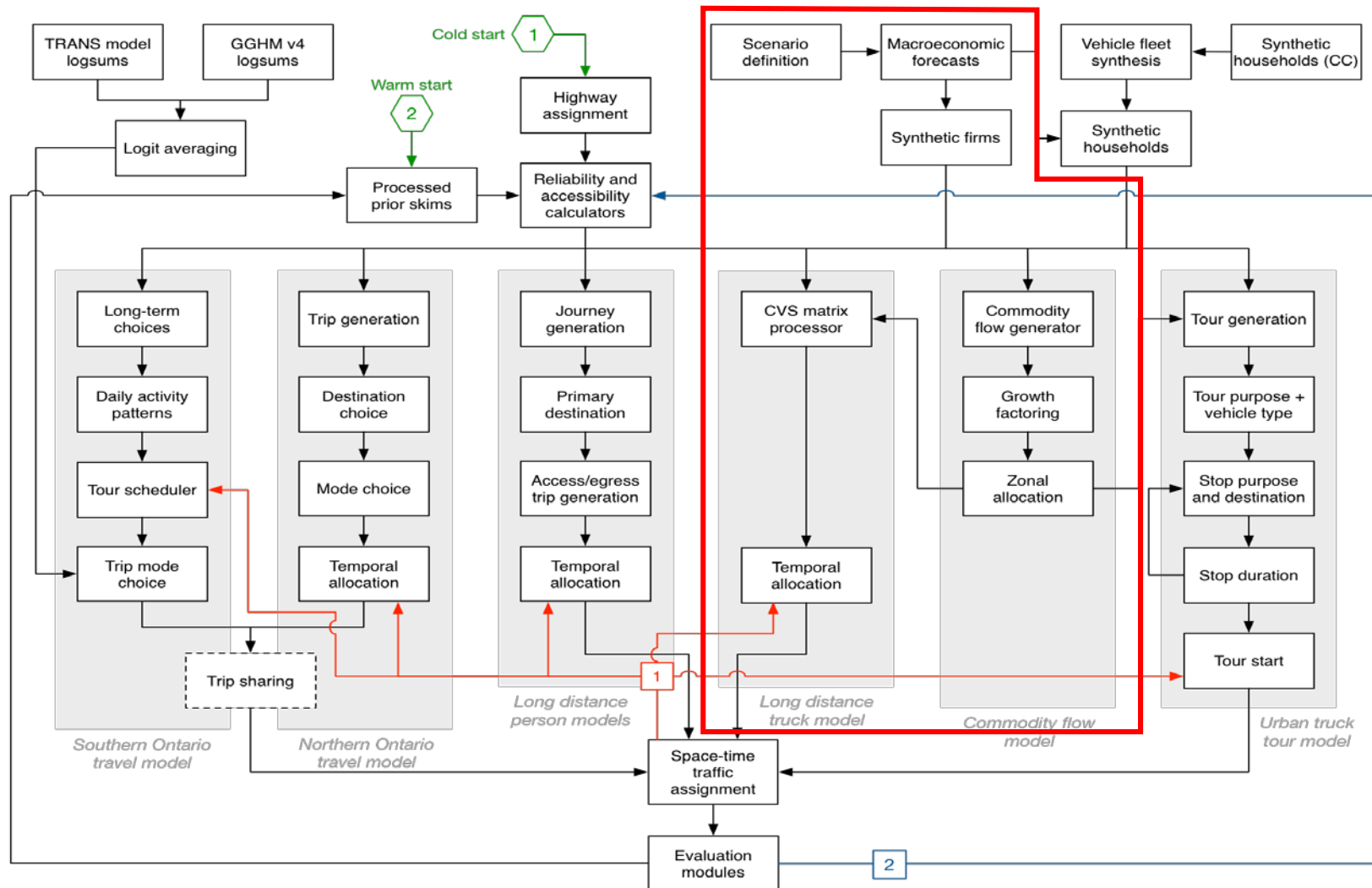Sundar Damodaran

Michael Casey

WSP|PB

Rick Donnelly

Bryce Sharman

Mausam Duggal

# Context – **TRESO : Tr**ansportation and **E**conomic **S**imulator of **O**ntario

- First generation and first-of-its kind provincial model to forecast passenger, freight, and commodity flows to and from Ontario and the rest of the world.

- Focus on maximizing the use of available data while maintaining behavioral linkages.

- Explicitly models commodity flows, long-distance and short distance truck flows, drayage, empty trucks, commodity mode choice.

Demand and Supply Data

Demand Data…and lots of it
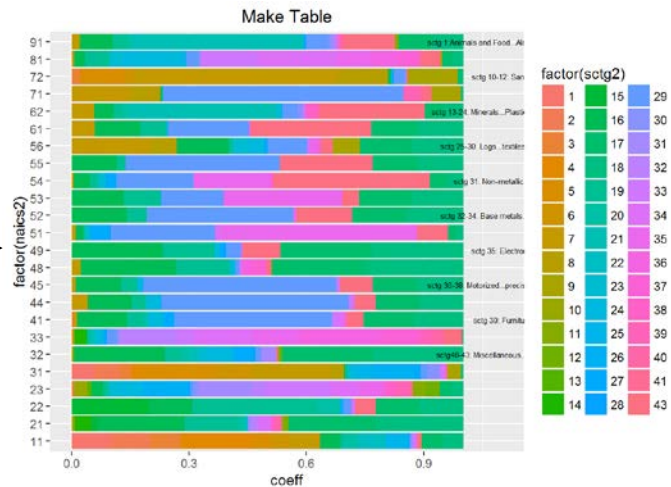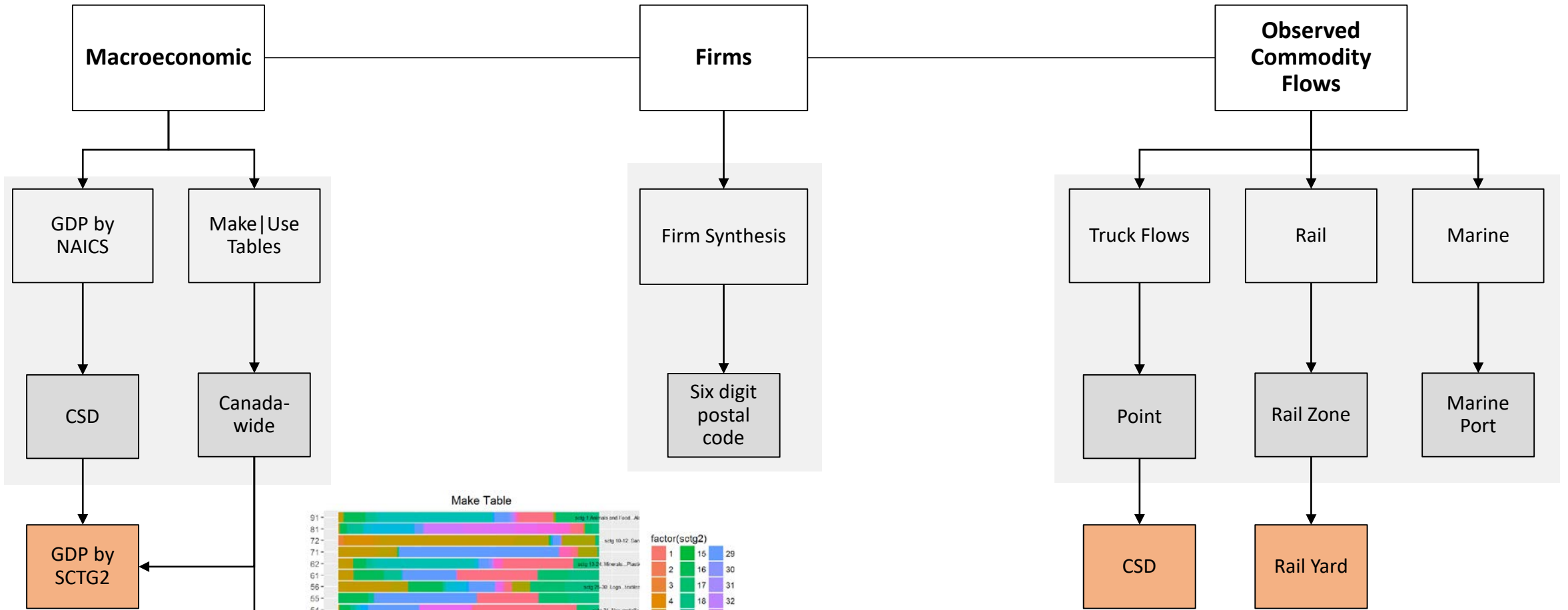
Supply Data

Road network that covers all of North America with varying level of detail – **120,000 links**

- Greatest detail within CMAs (Ontario only) and the GGH area (all road classes except for local roads)

- Outside Ontario but within Canada – Arterial and above
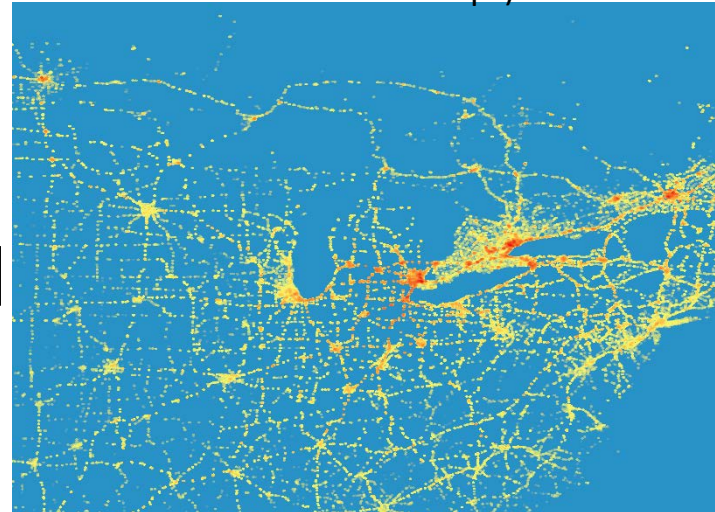
- In the USA – state highways and above

Zone system produced on the "fly"

- Initial attempt – gradual rasterization algorithm (GR) or Quad Tree (**6800 zones**)

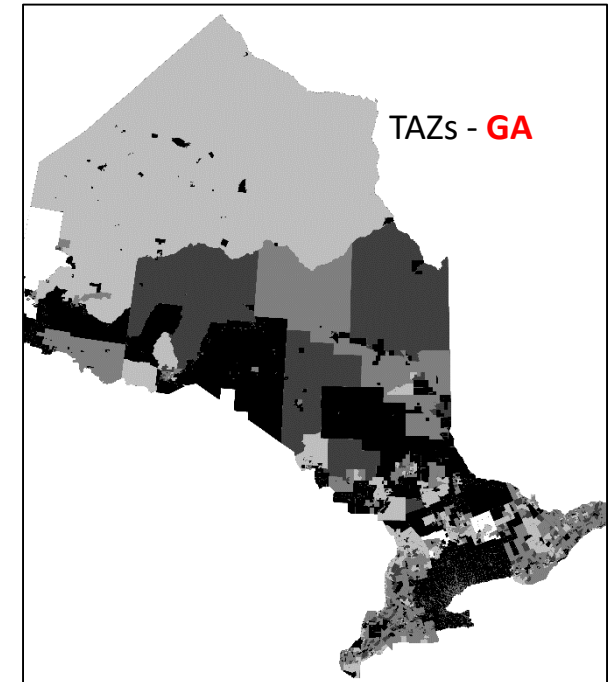- Final attempt – gradual aggregation (GA) of DA generation algorithm (**5400 zones**)

Quad Tree - **GR**
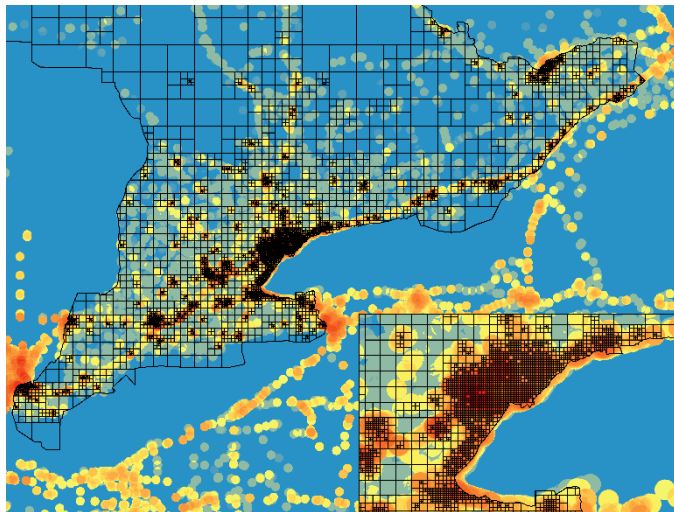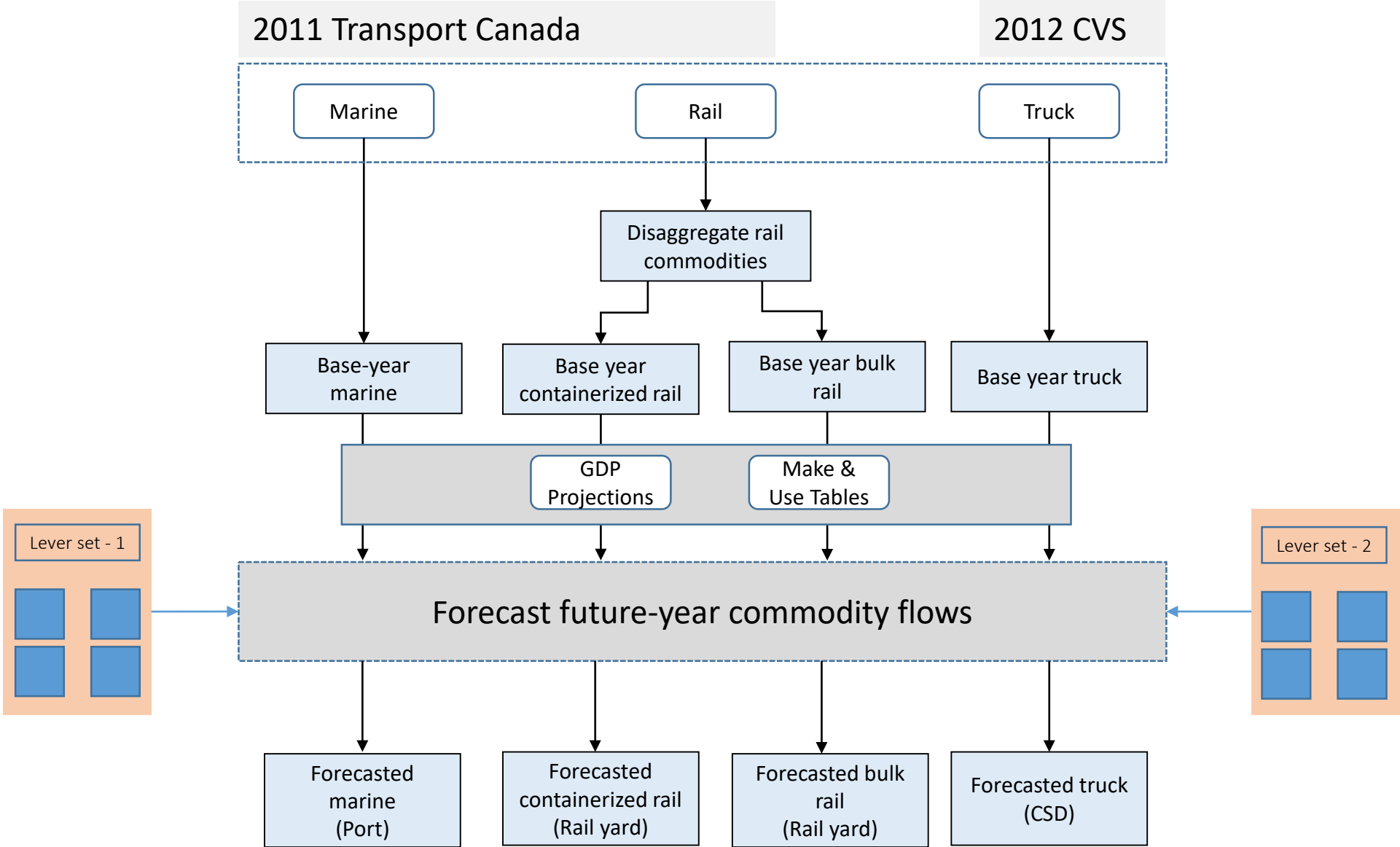

Activity definition (dwelling units + truck stops)

TAZs - **GA**

Commodity Flow Model
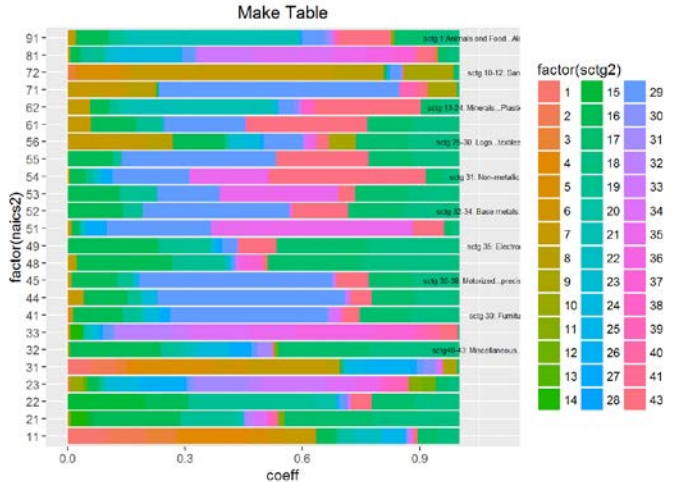
Commodity model flow chart

Commodity model highlights

- Designed to be a **plug-and-play tool** i.e. multiple scenario evaluation capability

- **Eight degrees of freedom** or levers for scenario analysis

  - GDP by industry (from macro-economic model)

  - Make and use tables

  - Rail/Marine containerization flag (0/1)

  - Rail/Marine bulk flag (0/1)

  - Drayage flag (0/1)

  - Rail yard proportion of commodities within rail zone (0 - 1)

  - Commodity containerization ratio (0 – 1 for each SCTG2 commodity)

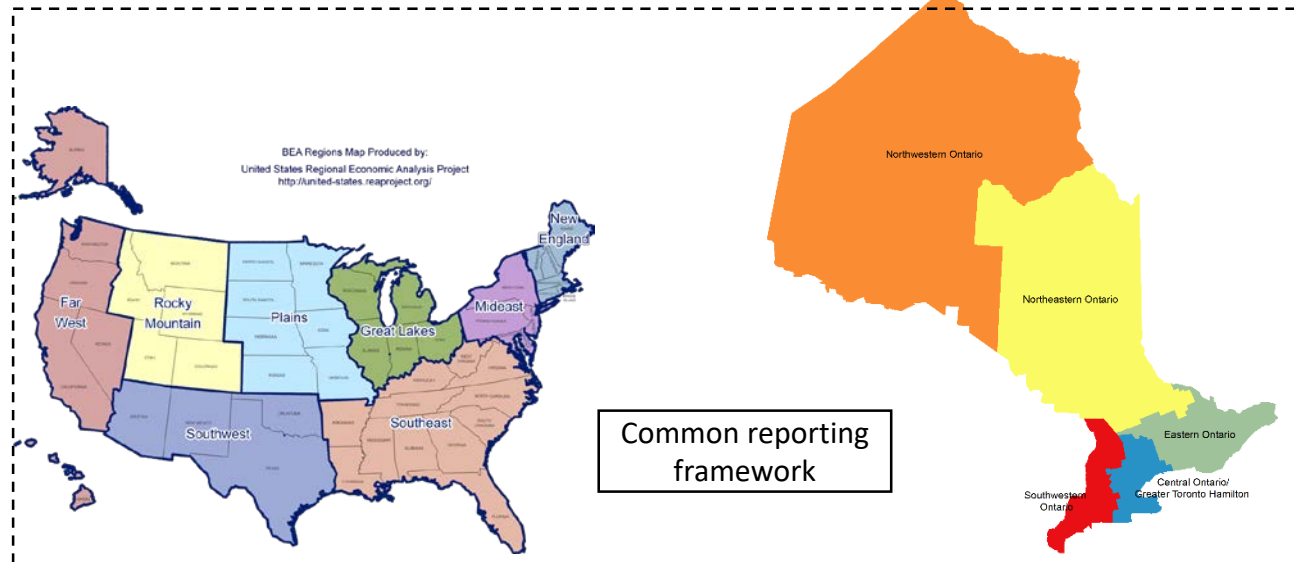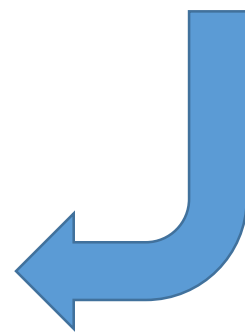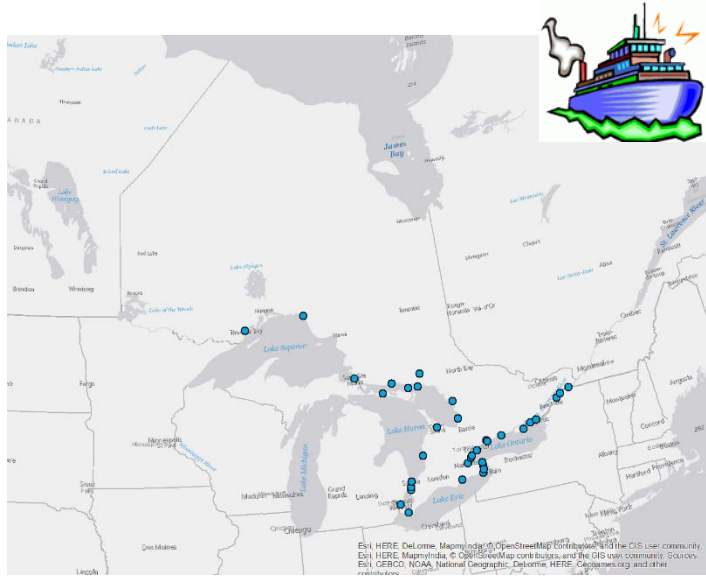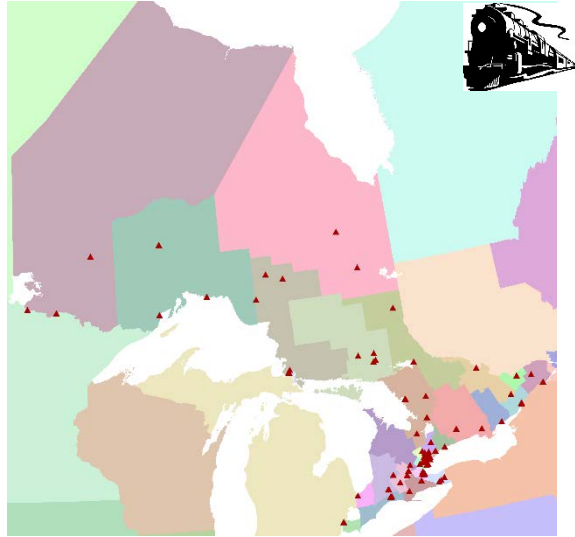 - Relative value-to-weight ratio, by year

Real GDP (millions)
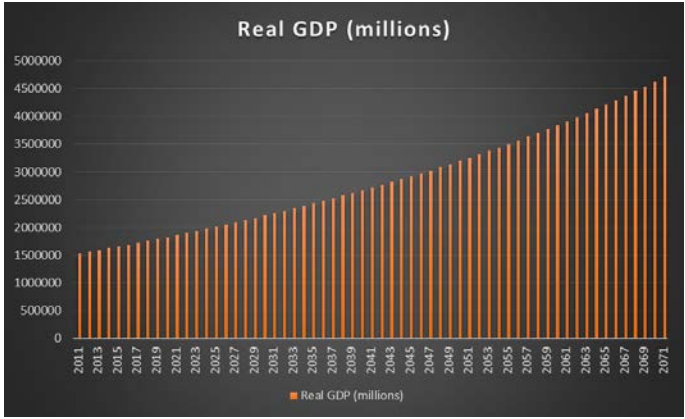
SCTG2	Containerization ratio
1	0
2	0
3	0.23
4	0
5	1
6	0.193
7	0.327
8	0.262
9	1
10	0.292
…	…

year	1	2	3	4	5	6	7	8	9	10	…	34	35	36	37	38	39	40	41	42	43
2011	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.0	1.0	1.000000
2012	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.015000	1.040000	1.015000	1.015000	1.040000	1.015000	1.015000	1.0	1.0	1.015000
2013	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.030225	1.081600	1.030225	1.030225	1.081600	1.030225	1.030225	1.0	1.0	1.030225
2014	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.045678	1.124864	1.045678	1.045678	1.124864	1.045678	1.045678	1.0	1.0	1.045678
2015	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.061364	1.169859	1.061364	1.061364	1.169859	1.061364	1.061364	1.0	1.0	1.061364
2016	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.077284	1.216653	1.077284	1.077284	1.216653	1.077284	1.077284	1.0	1.0	1.077284
2017	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.093443	1.265319	1.093443	1.093443	1.265319	1.093443	1.093443	1.0	1.0	1.093443
2018	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.109845	1.315932	1.109845	1.109845	1.315932	1.109845	1.109845	1.0	1.0	1.109845
2019	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	…	1.126493	1.368569	1.126493	1.126493	1.368569	1.126493	1.126493	1.0	1.0	1.126493

Make Table
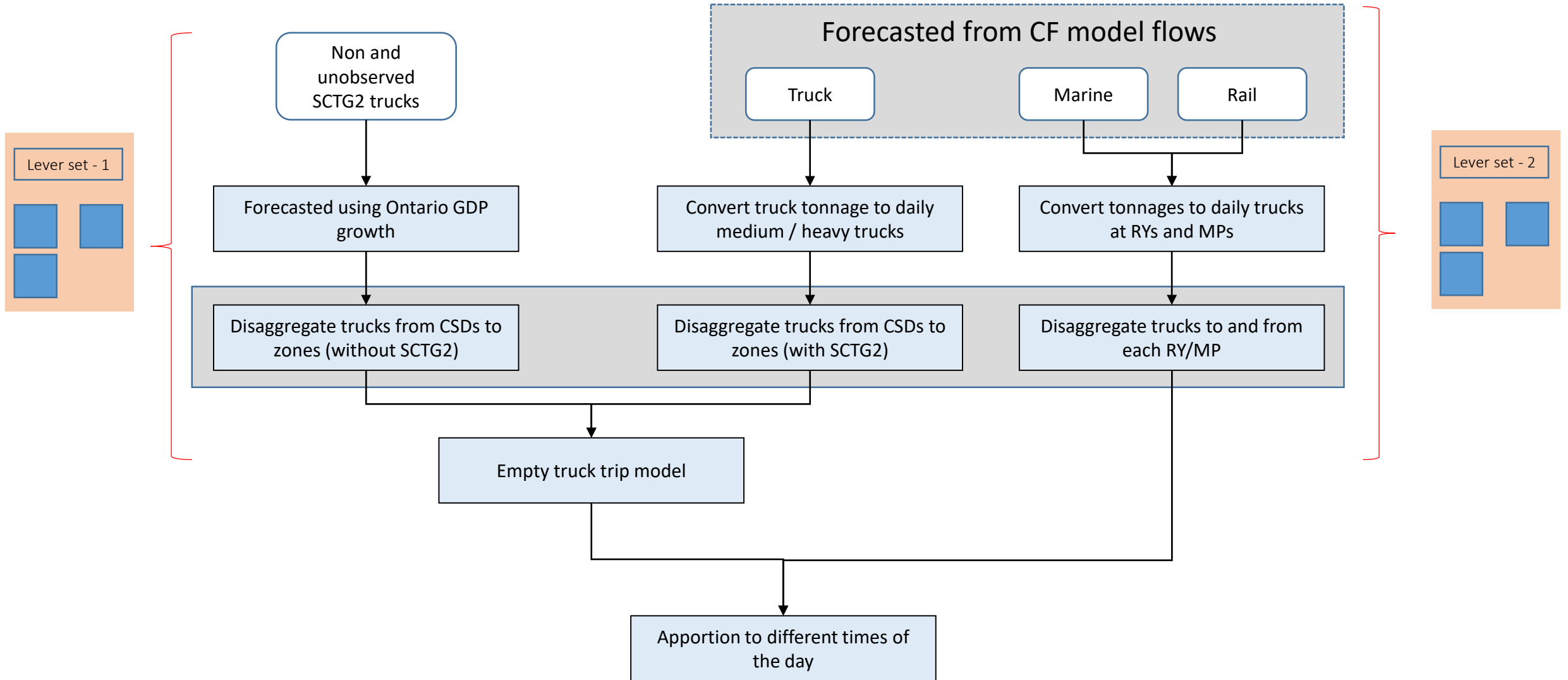
2011 Commodity Flows visualized
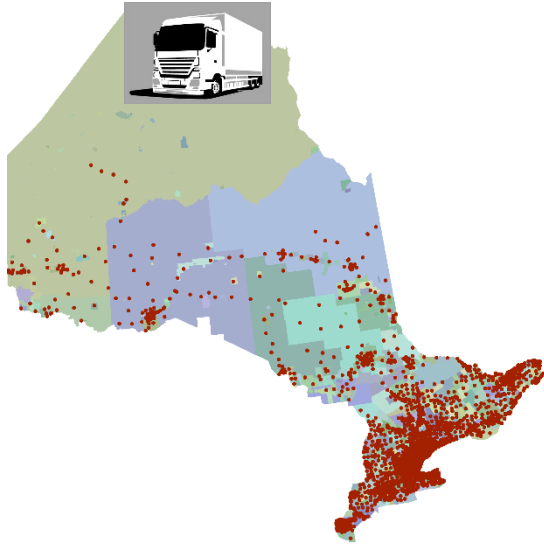
Common reporting framework

2011 Commodity Flows visualized - Sankeys

- Truck flows from ROW to Ontario

- Rail bulk flows from Ontario to ROW

Long Distance Model
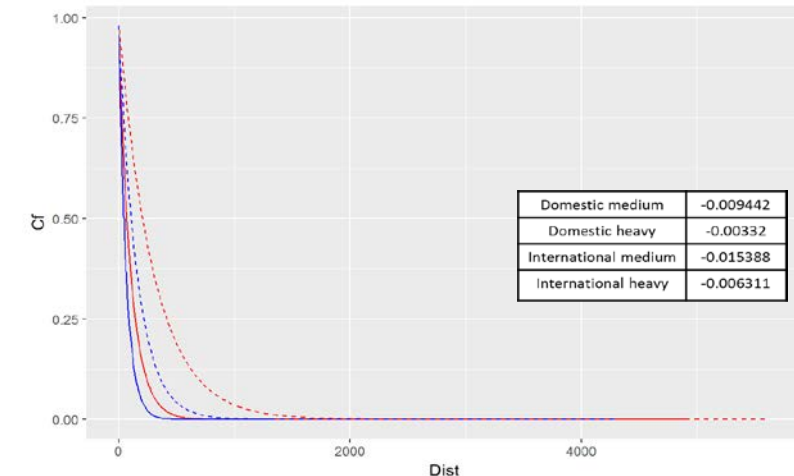
Long-distance truck model

Long Distance Truck model highlights

- **Agent-based** (firms) framework

- Designed to be a **plug-and-play tool** i.e. multiple scenario evaluation capability

- **Six degrees of freedom** or levers for scenario analysis

  - GDP ratios

  - Proportion of medium trucks

  - Conversion from source units to days

  - Synthetic firms

  - Empty truck model function decay parameters
    - Breakdown by med/heavy trucks, and domestic/international

  - Time of day profiles by distance via GPS processing

GDP Ratio to 2011

Curve-fit for commodity 39
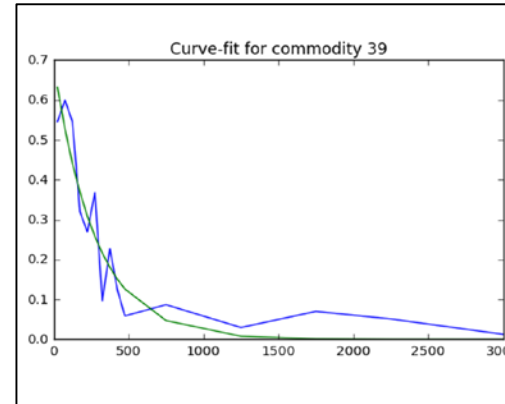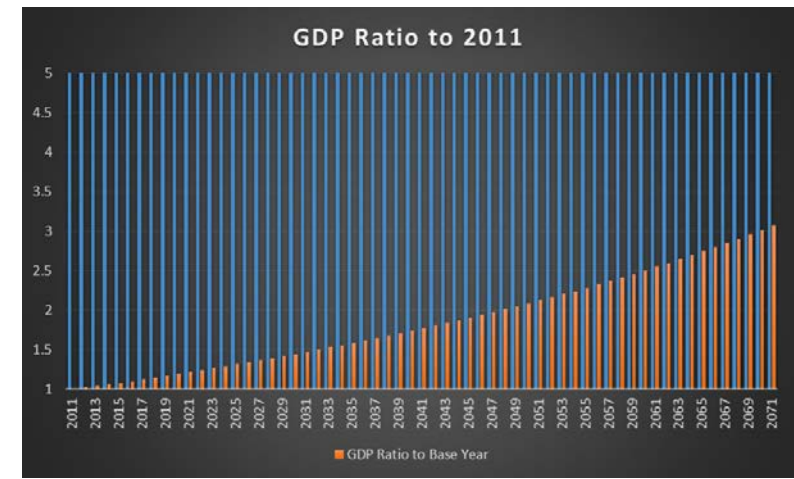
Distance\SCTG2	1	2	3	4	...	42	43
0	0.459	0.000	0.641	0.484	...	0.907	0.357
25	0.435	0.000	0.599	0.438	...	0.766	0.317
75	0.390	0.000	0.523	0.359	...	0.545	0.250
125	0.349	0.000	0.457	0.294	...	0.388	0.197
175	0.313	0.000	0.399	0.241	...	0.276	0.155
225	0.280	0.000	0.348	0.197	...	0.196	0.122
275	0.251	0.000	0.304	0.161	...	0.140	0.096
325	0.225	0.000	0.265	0.132	...	0.100	0.076
375	0.202	0.000	0.232	0.108	...	0.071	0.060
425	0.181	0.000	0.202	0.089	...	0.050	0.047
475	0.162	0.000	0.177	0.073	...	0.036	0.037
750	0.089	0.000	0.084	0.024	...	0.000	0.000
1250	0.030	0.000	0.022	0.000	...	0.000	0.000
1750	0.000	0.000	0.000	0.000	...	0.000	0.000
2250	0.000	0.000	0.000	0.000	...	0.000	0.000
2750	0.000	0.000	0.000	0.000	...	0.000	0.000
3250	0.000	0.000	0.000	0.000	...	0.000	0.000

Domestic medium	-0.009442
Domestic heavy	-0.00332
International medium	-0.015388
International heavy	-0.006311

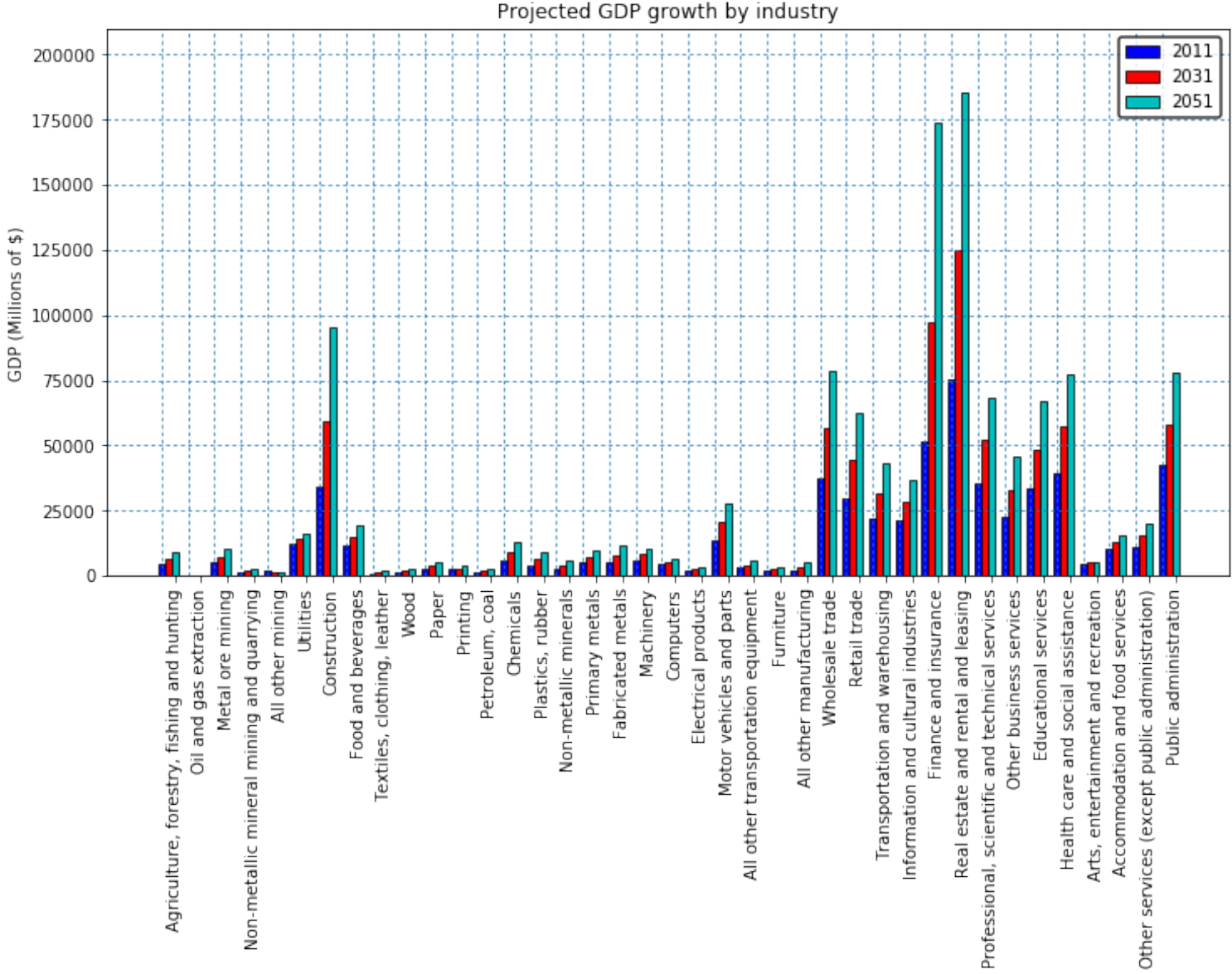# 2011 Long Distance truck flows visualized

Forecast Commodity Flows…sneak peek

GDP by NAICS projections

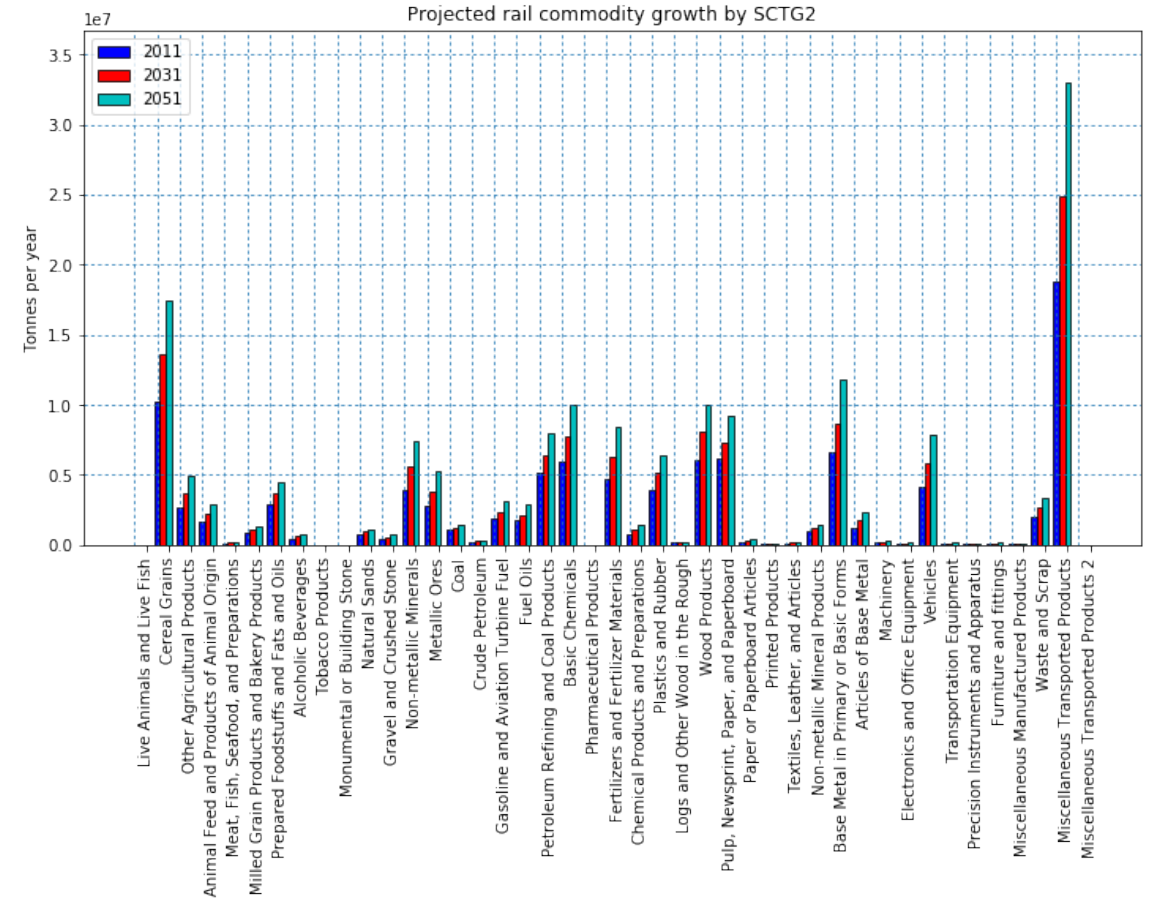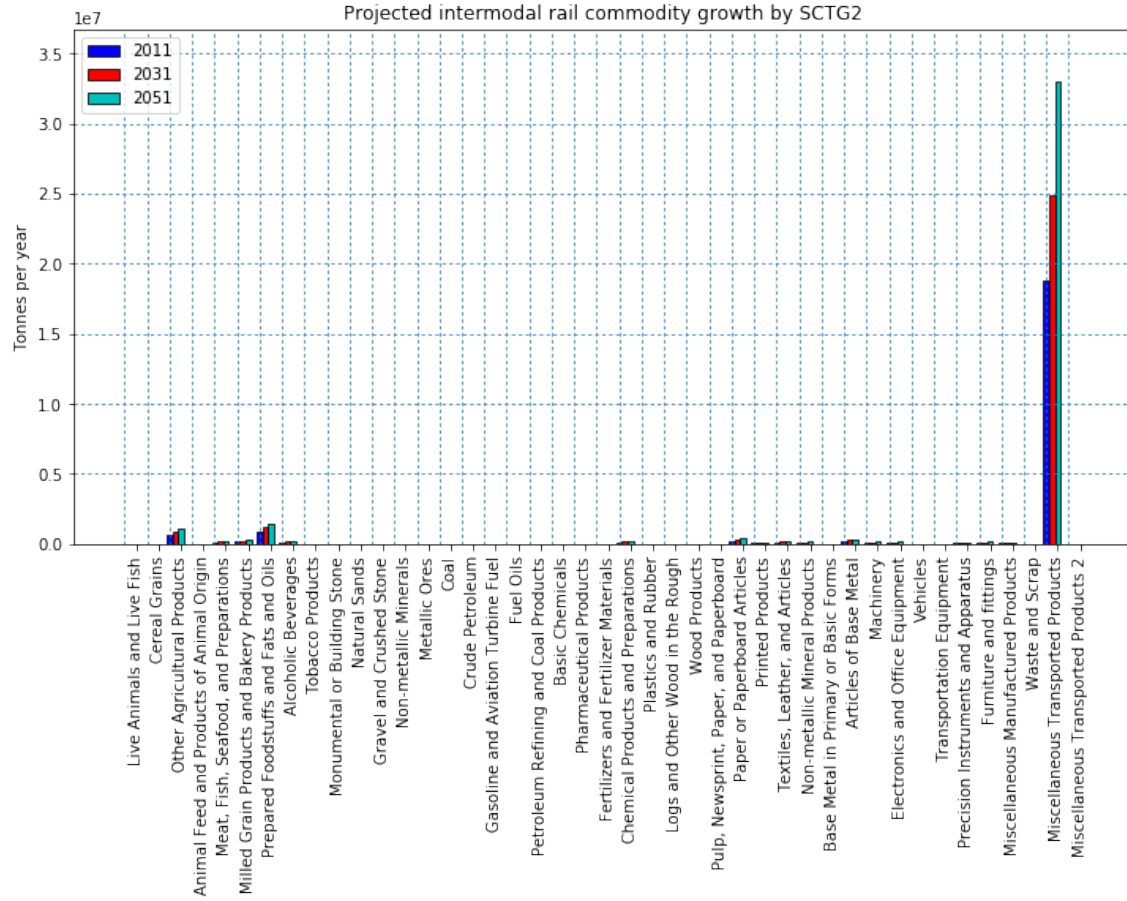Projected GDP growth by industry

Commodity Growth Projections
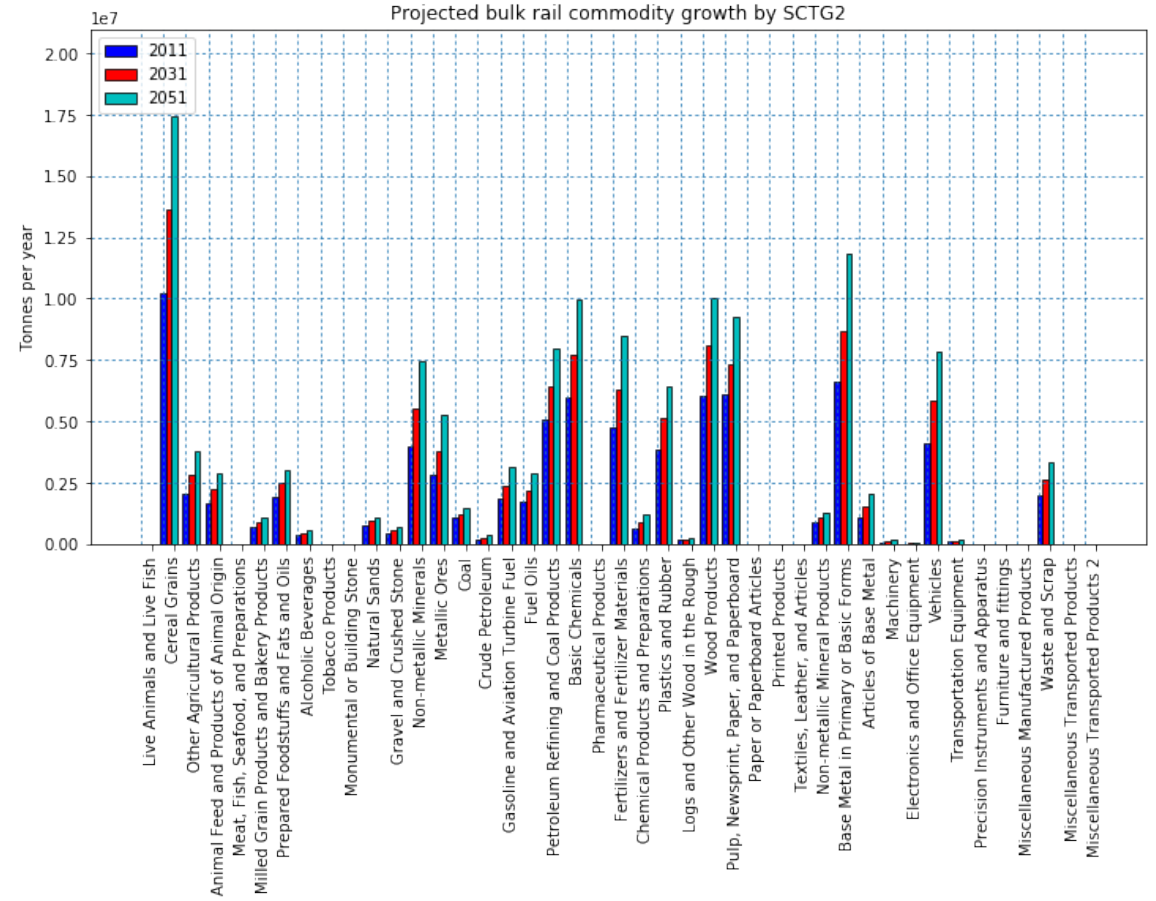

Marine
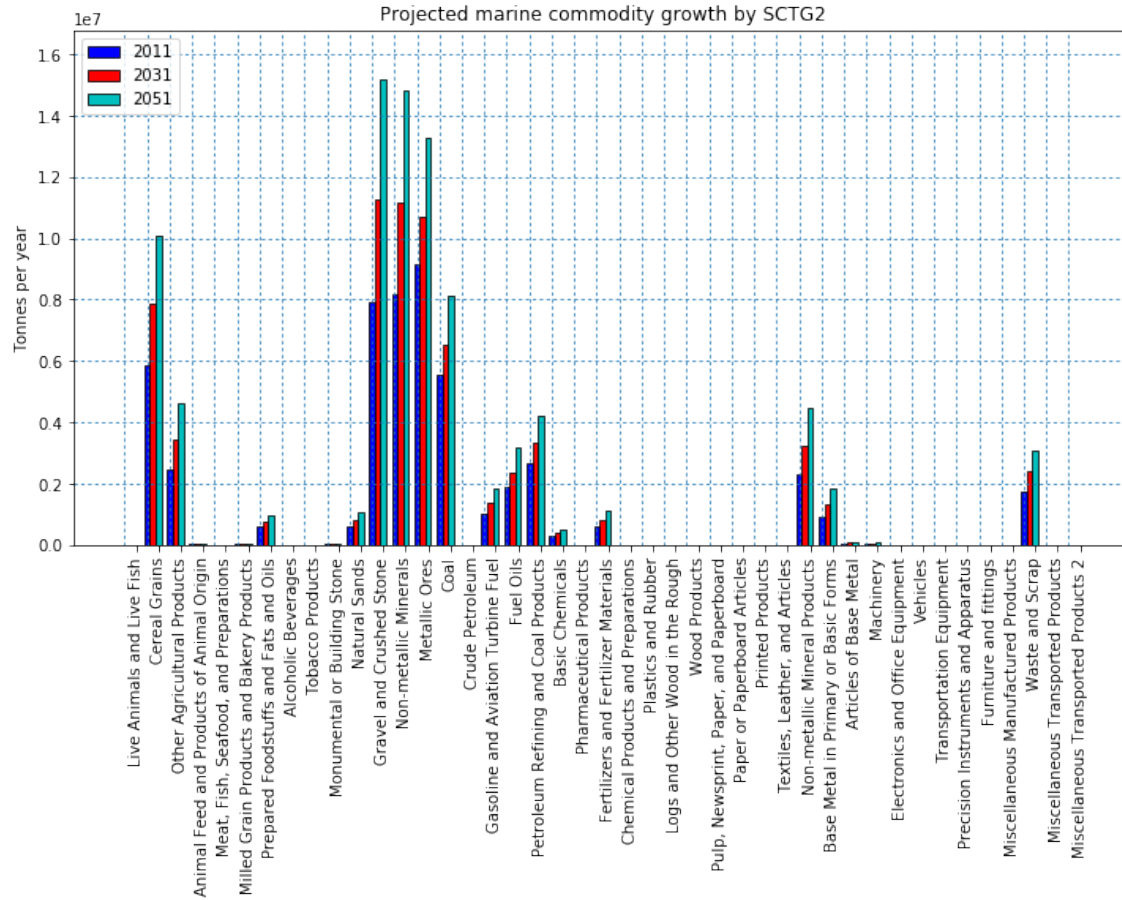
Rail

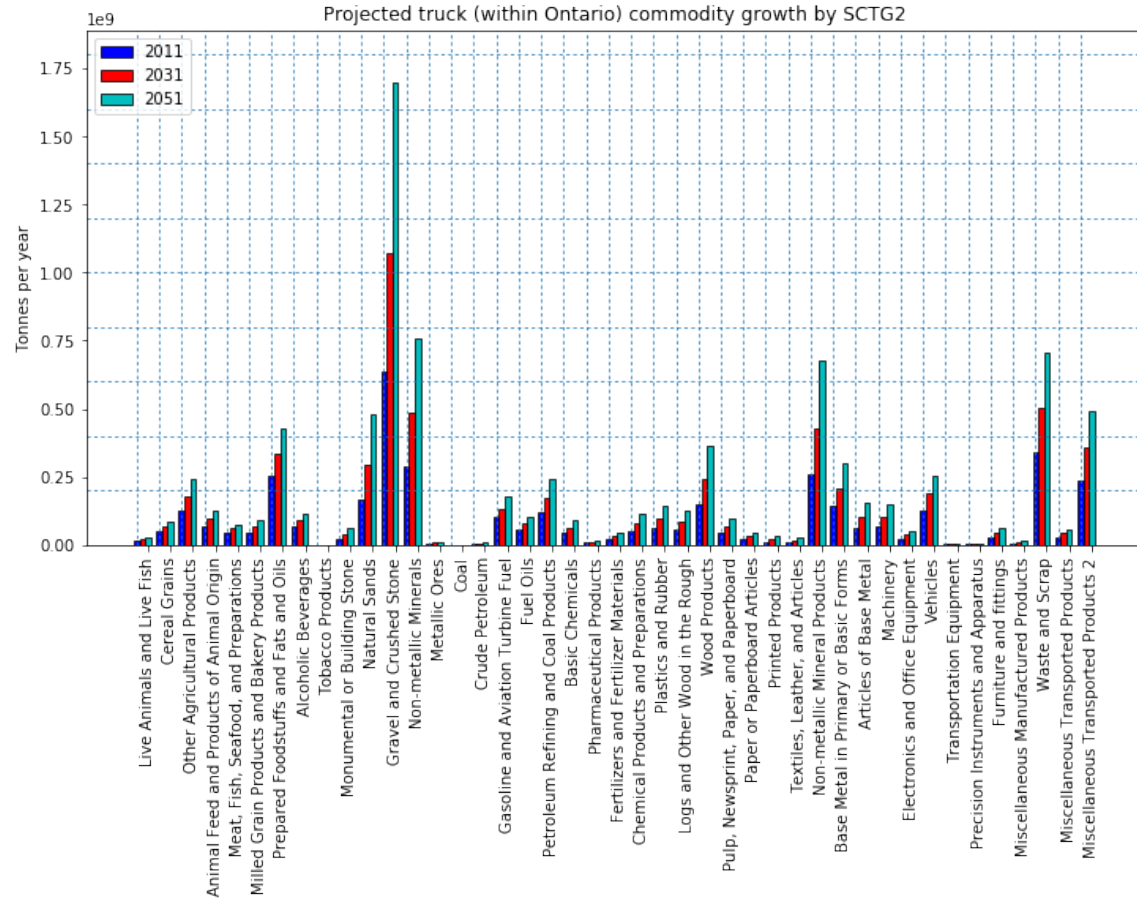# Commodity Growth Projections
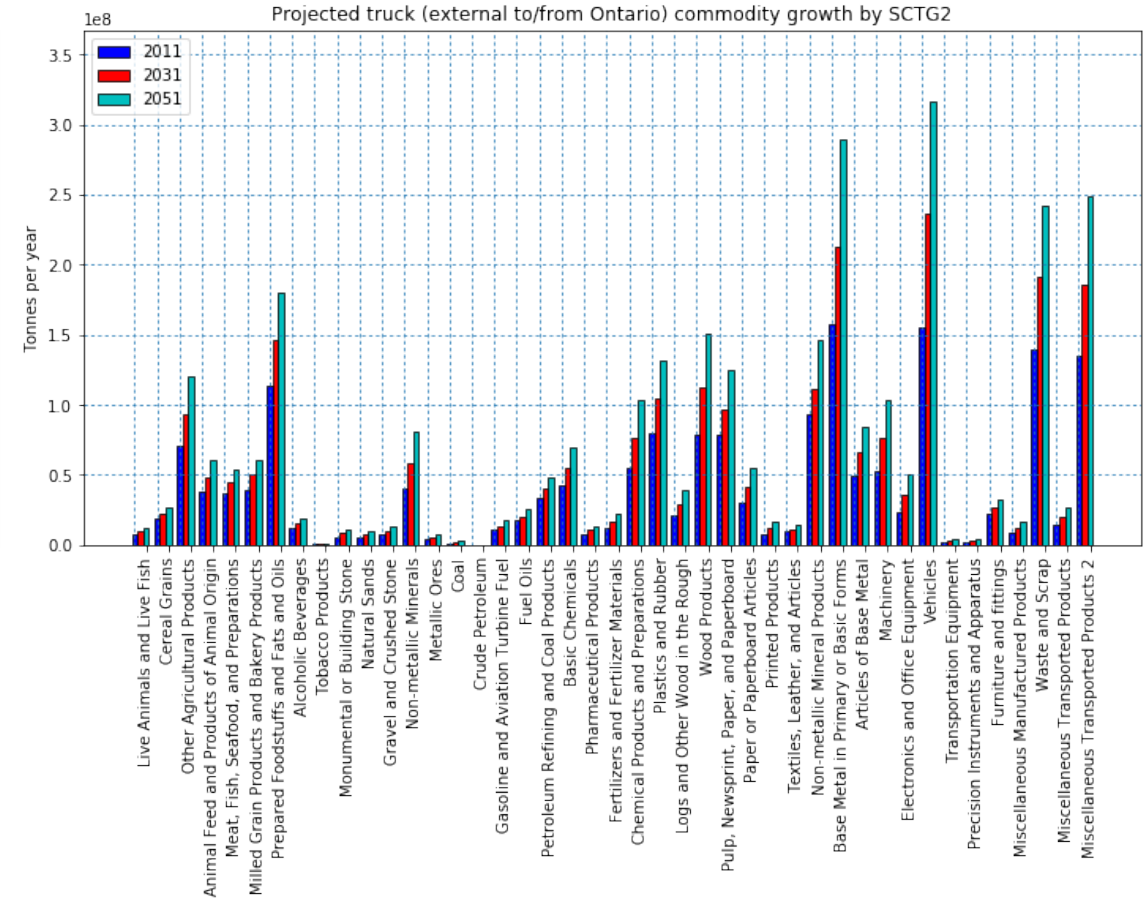

Intermodal Rail

Bulk Rail

Commodity Growth Projections

Intra-Ontario

Inter-Ontario

Lessons learnt

We are really excited about...

- Increasing the **leverage** of the GPS truck processing by tying it to firms|commodities

- Continuing to **expand** the CVS – amazing dataset

- Continuing to move towards an **agent based framework** – MATSIM is the ultimate goal...TRESO has already made the first forays.

MATSIM - every truck represented as an individual point on the network with **ALL** information

Questions?