Spatial distribution of logistics facilities and truck traffic

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Logistics sprawl

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"historical trend towards spatial deconcentration of logistics terminals in metropolitan areas"

Dablanc & Rakotonarivo (2010)

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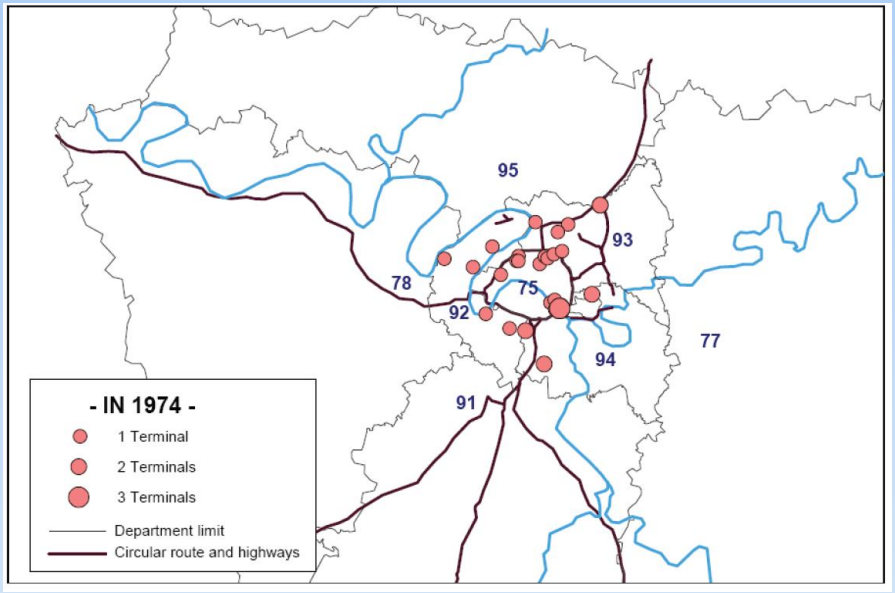
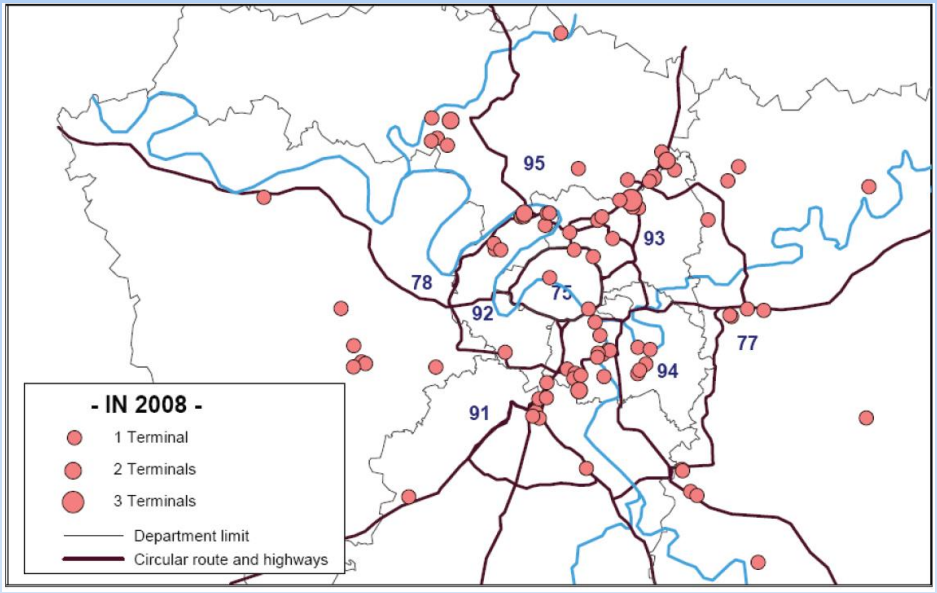
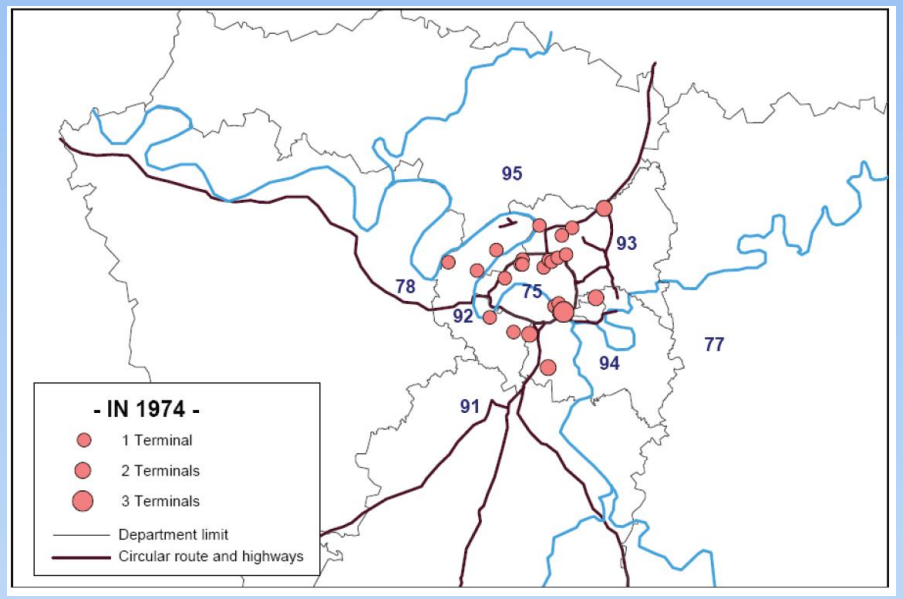
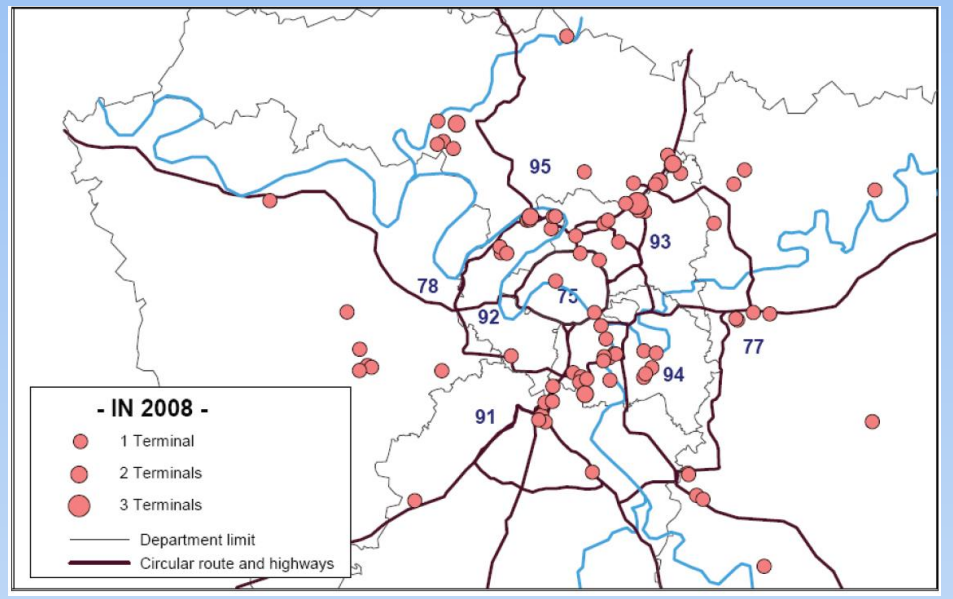




Locations of selected parcel delivery cross-docking facilities in the Paris region (1974-2008)

Traffic Impacts of Logistics sprawl





Mean distance of delivery cross–docking facilities to the Paris center increased from 6km to 16km

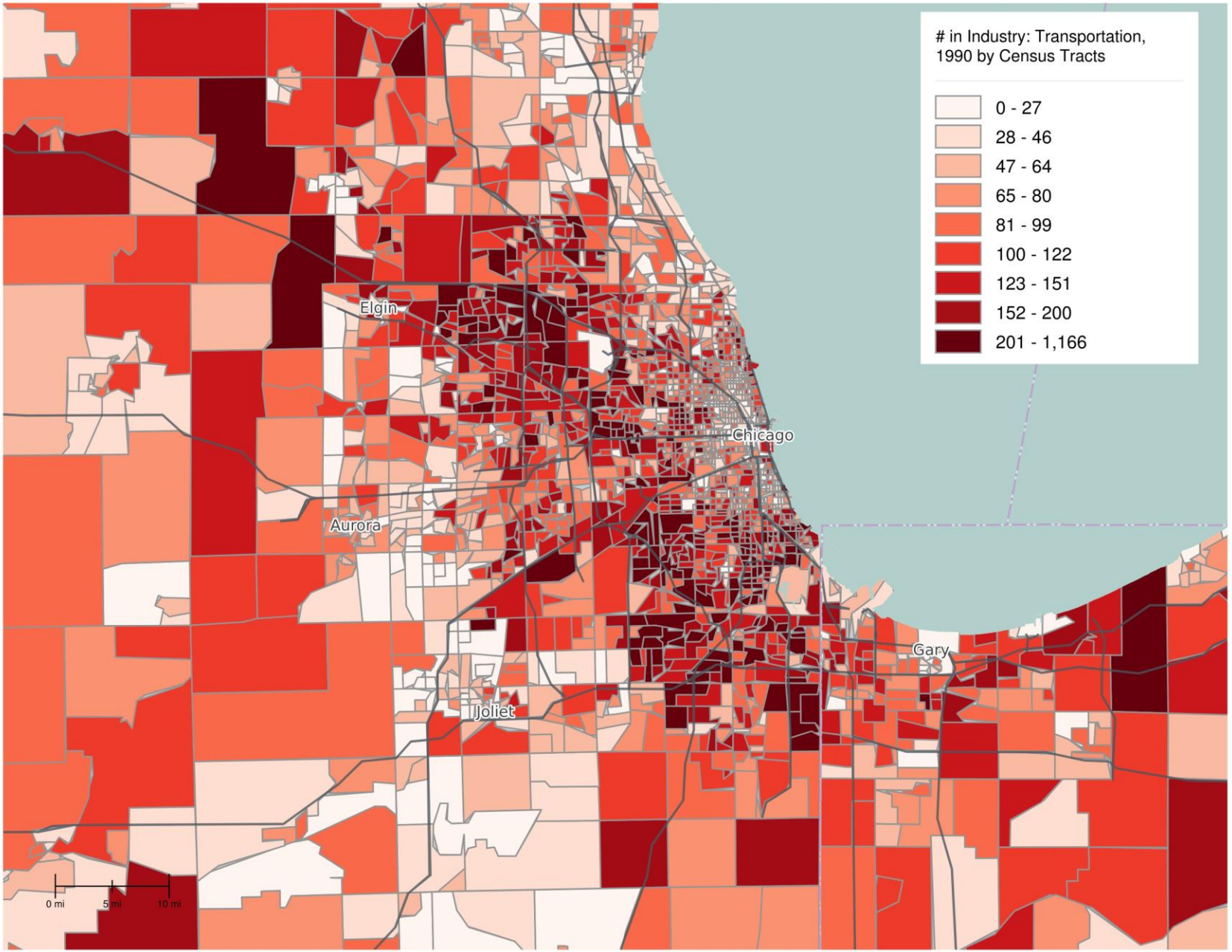
→10km increase in VMT for shipments to Paris core area

→Estimated increase in CO_2 = 15,ooo tons/yr (93 terminals)

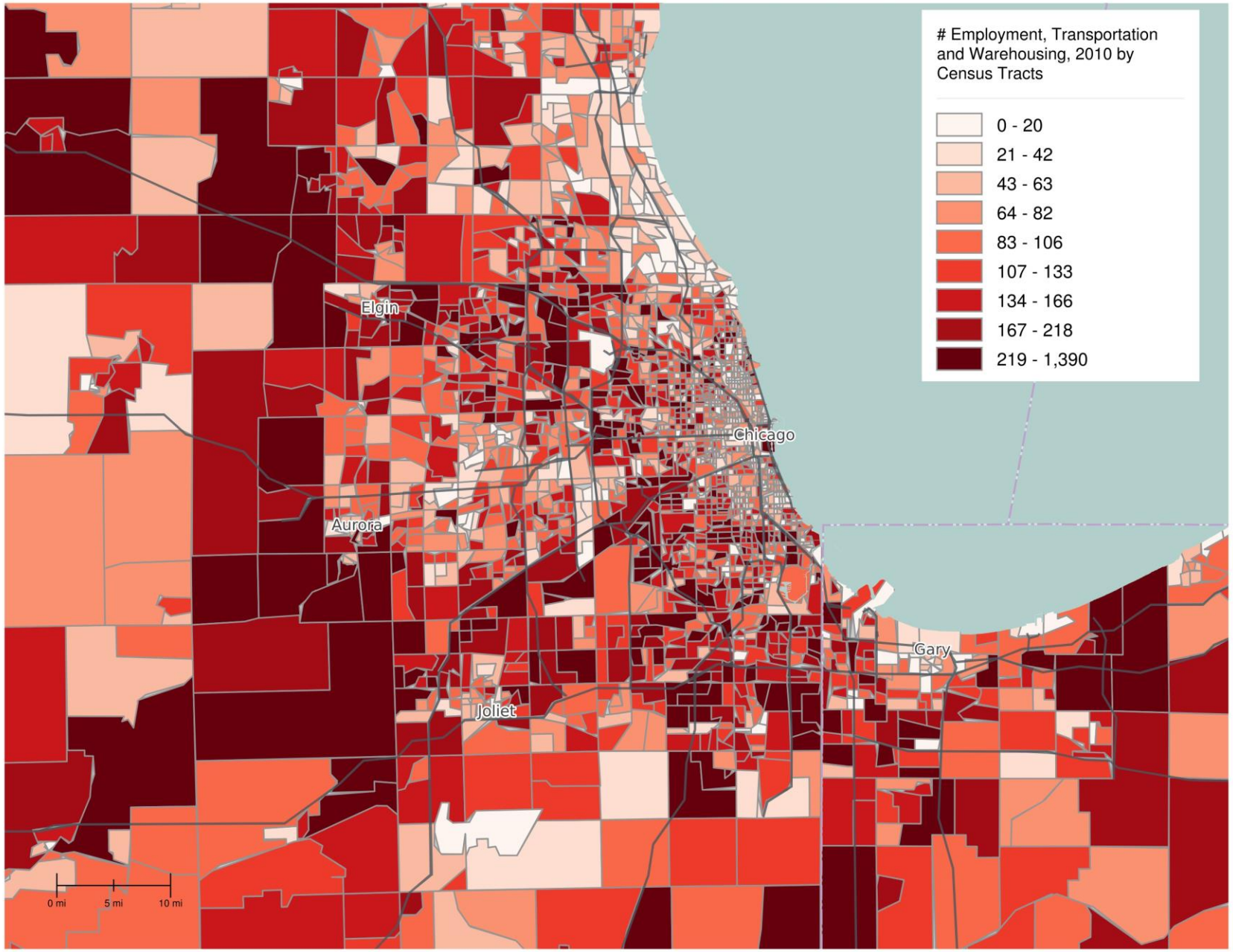
Subsequent studies identify wide-spread logistics sprawls in Europe and US

- Atlanta: Dablanc and Ross (2012)
- Paris: Heitz and Dablanc, (2015)
- Toronto: Woudsma et al., (2016)
- Zurich: Todesco et al., (2016)
- Los Angeles: Dablanc et al., (2014)
- Seattle: Dablanc et al., (2014)

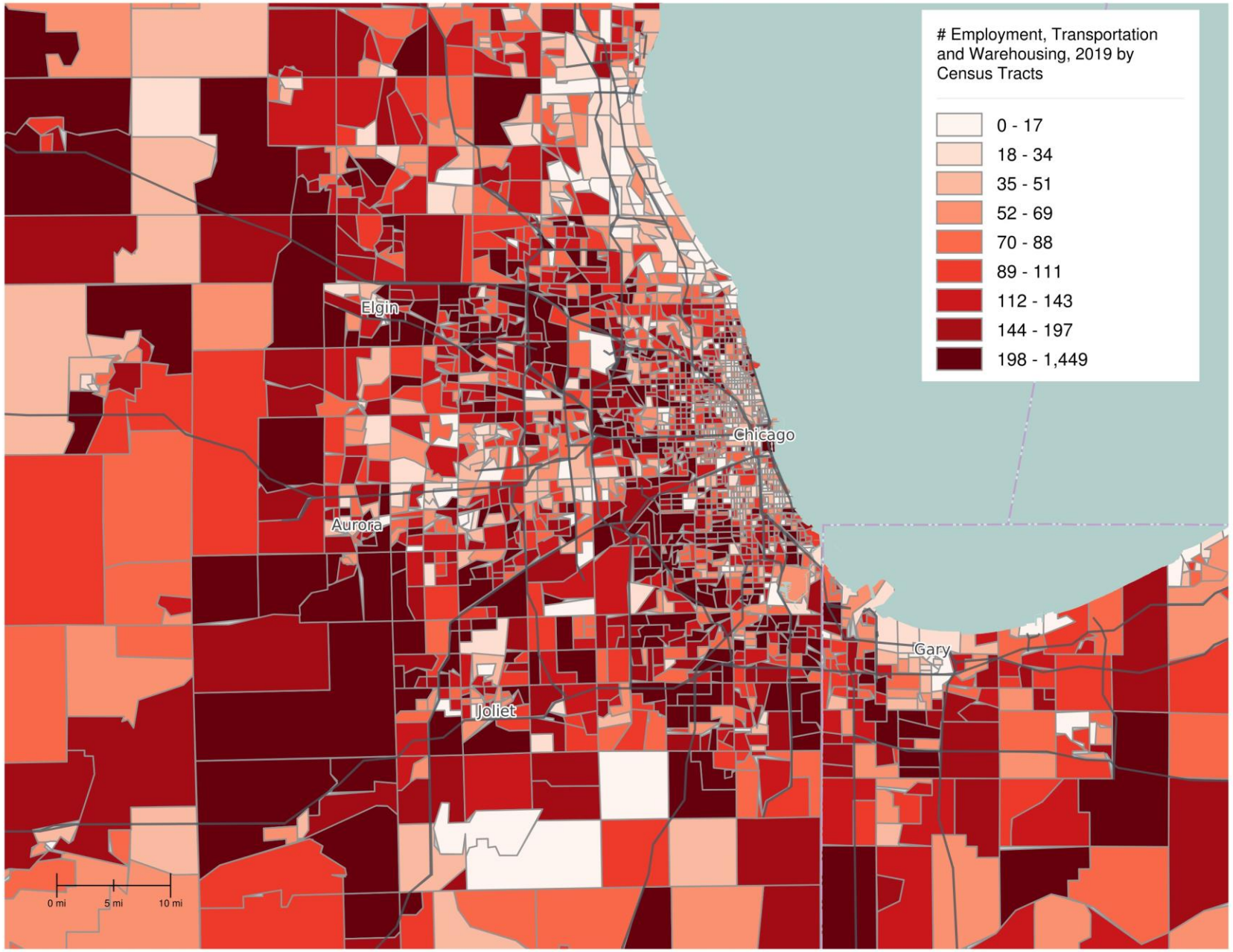
Transportation & warehousing employment 1990



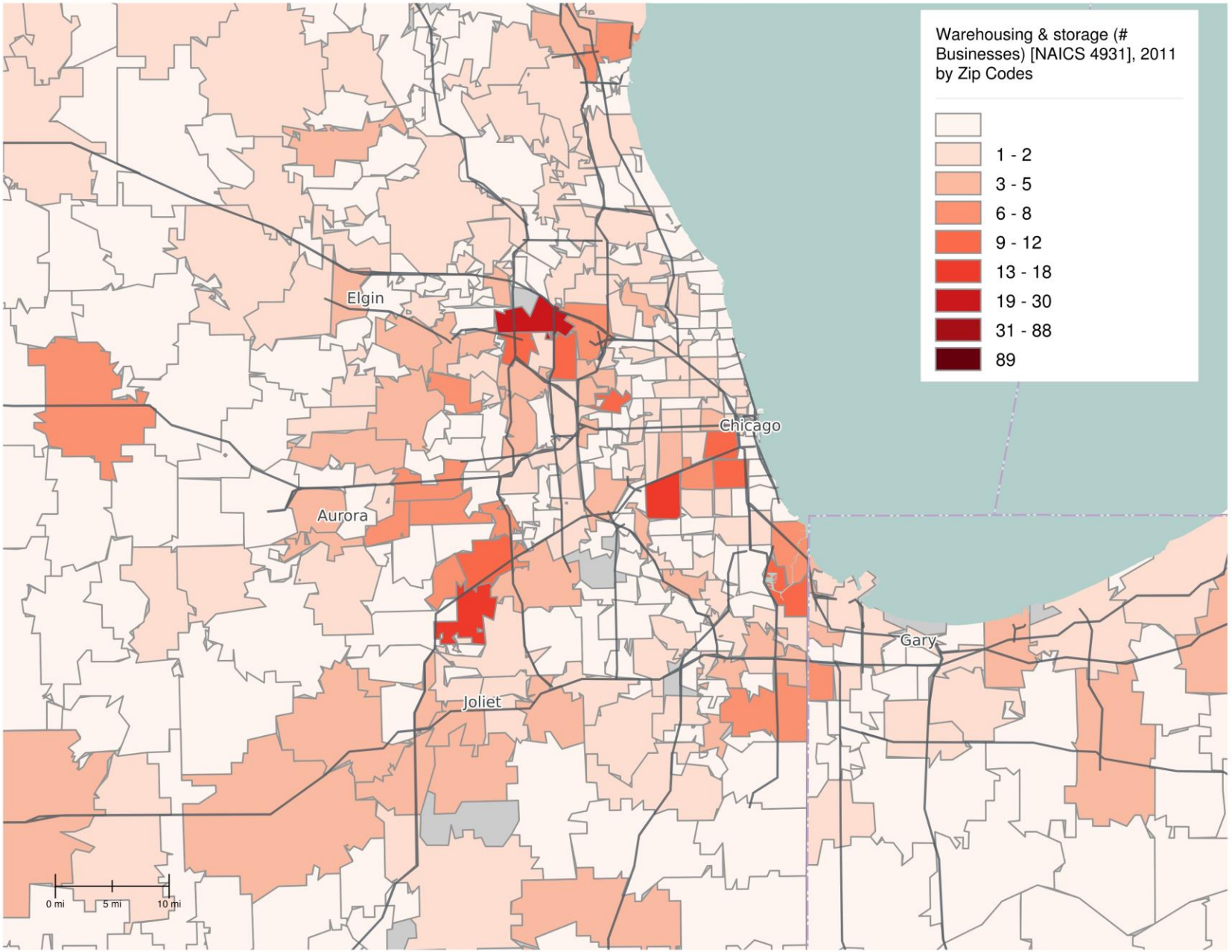
Transportation & warehousing employment 2010



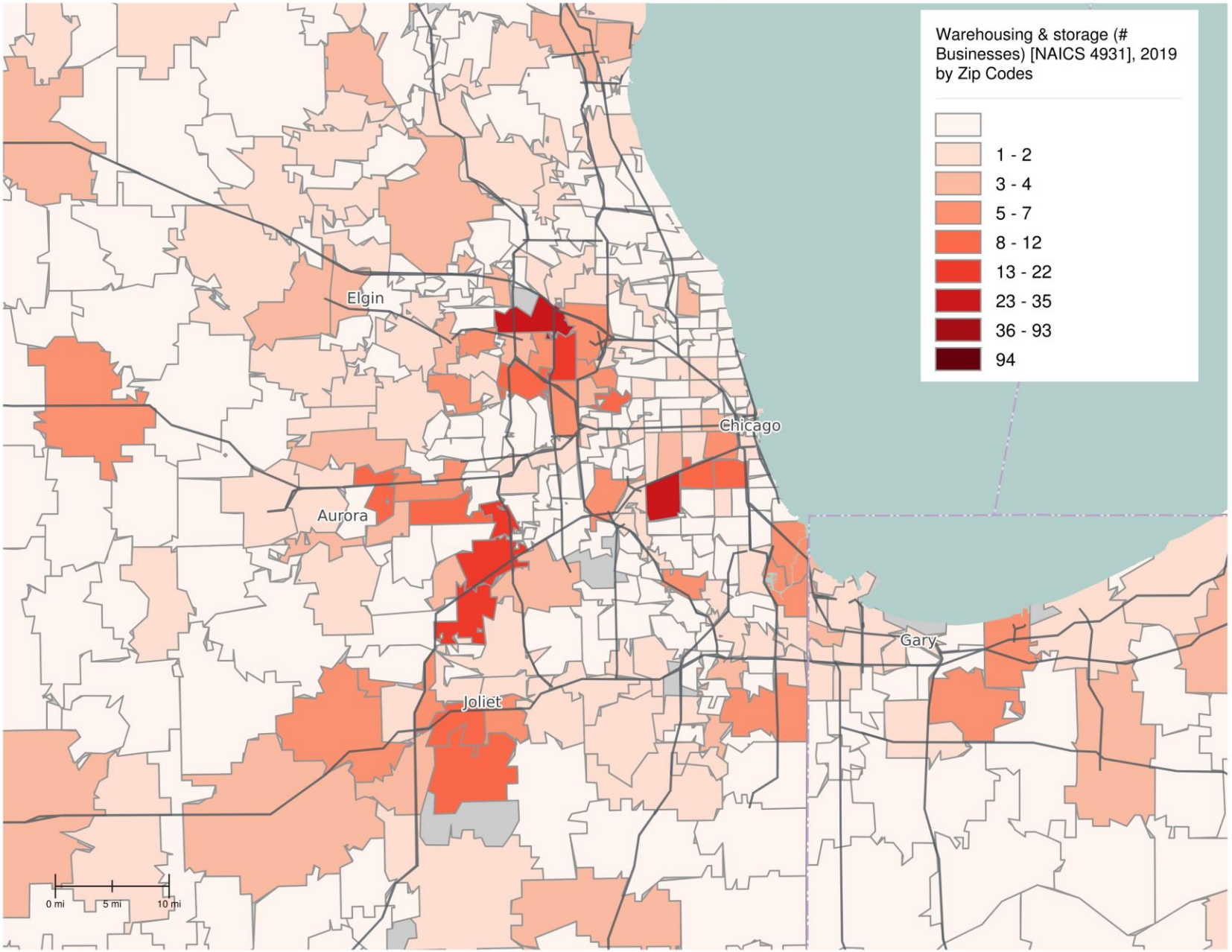
Transportation & warehousing employment 2019



Warehousing businesses 2011



Warehousing businesses 2019



Many transportation planners are concerned about the negative impacts of logistics sprawl

→ Increase in truck vehicle miles traveled (VMT)

- Congestion
- Carbon emission
- Air pollution

How can we bring logistics back into cities? The case of Paris metropolitan area

Logistics Sprawl Assessment Applied to Locational Planning: A Case Study in Palmas (Brazil)

Articles

Beyond 'logistics sprawl' and 'logistics anti-sprawl'. Case of the Katowice region, Poland

Robert Krzysztofik, Iwona Kantor-Pietraga, Tomasz Spórna, Weronika Dragan & Valentin Mihaylov

But, only one existing study looked at truck traffic impact of logistics sprawl

Paris crossdocking facility in 2010

Research questions

1. How does logistics sprawl affect truck VMT?
2. What is the appropriate land use policies to reduce truck VMT?

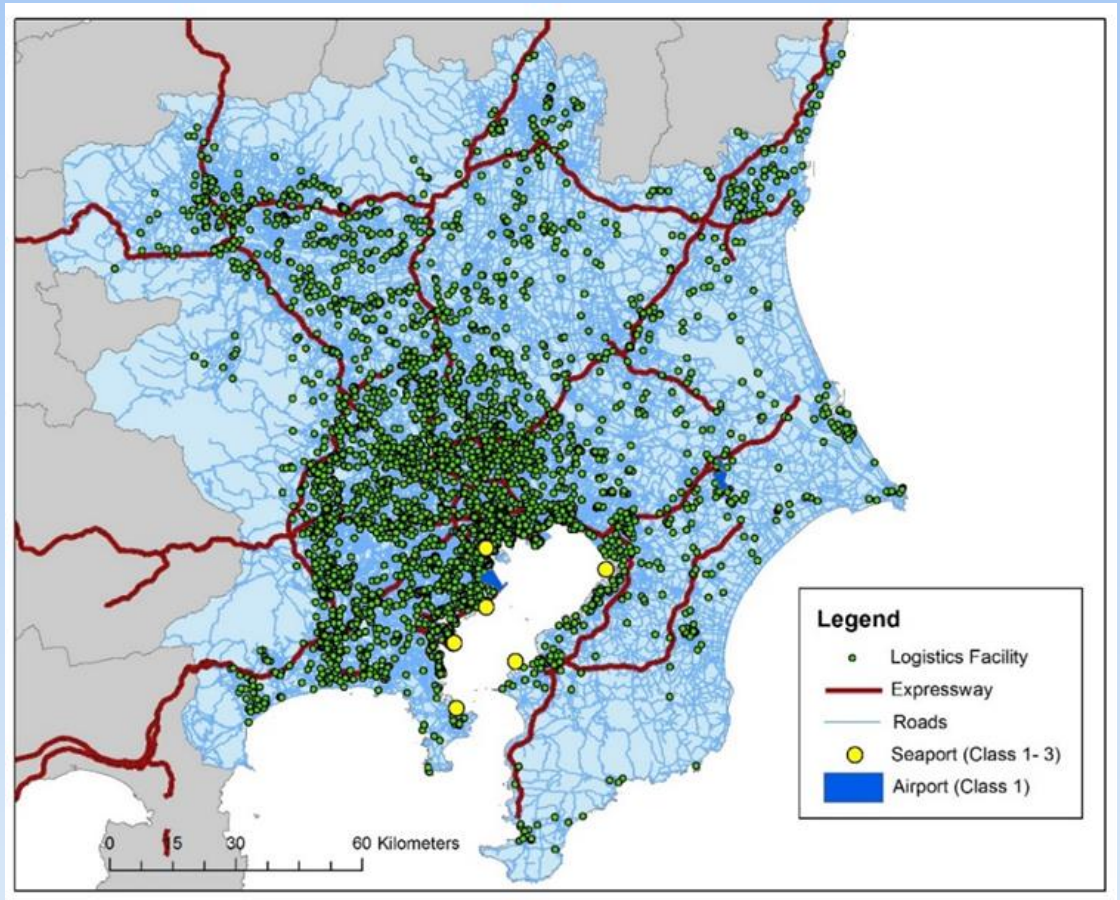
A series of papers 2015-2019

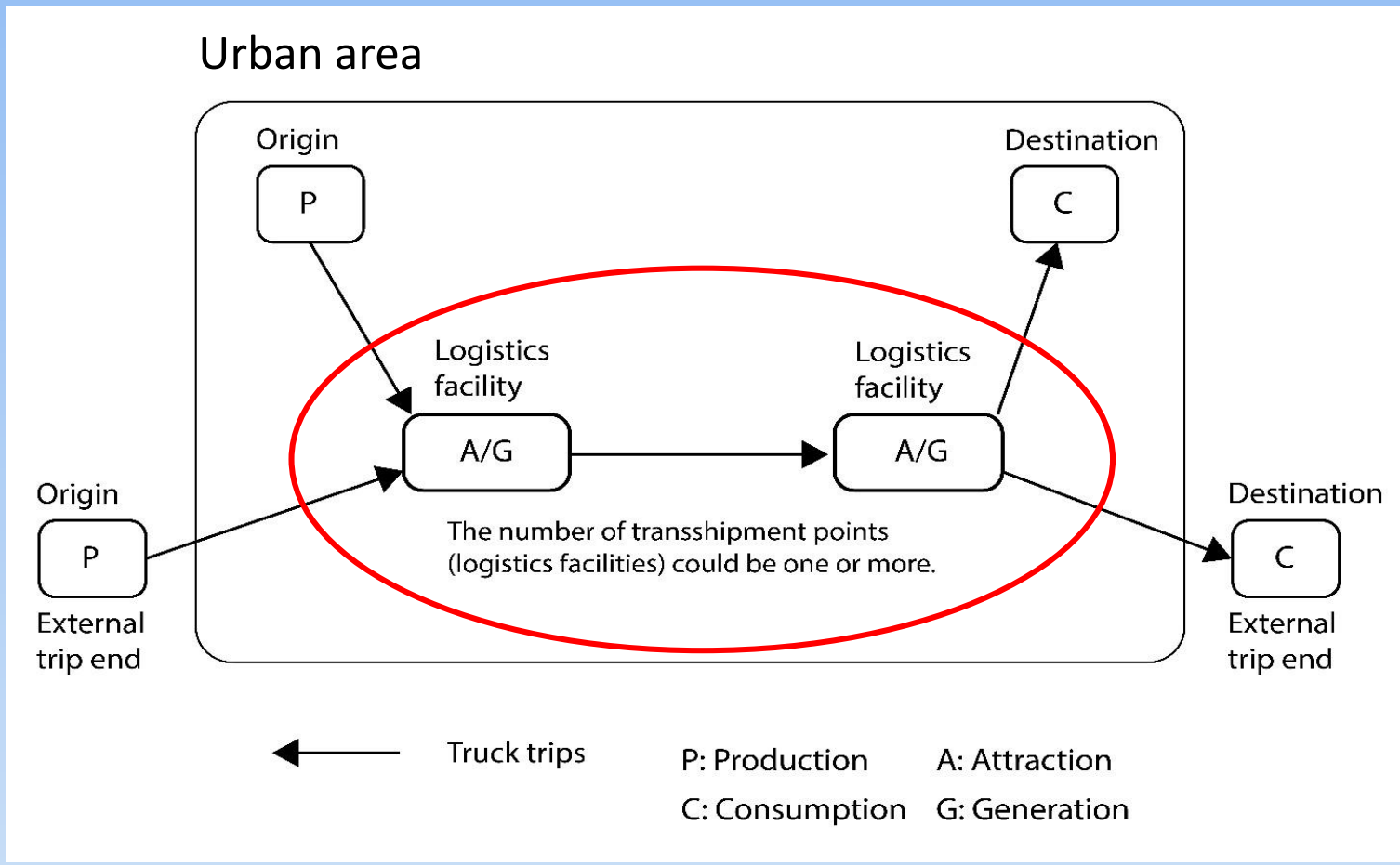
Data 2003 & 2013 Tokyo Metropolitan Freight Survey

2013: Targeted 136,632 total establishments and 43,131 responded (31.6 % resp. rate).

4,580 logistics facilities with 2,147 facilities (11% of all logistics facilities in the TMA) provided complete shipment records.

Expansion factors based on location, employment size, facility type.

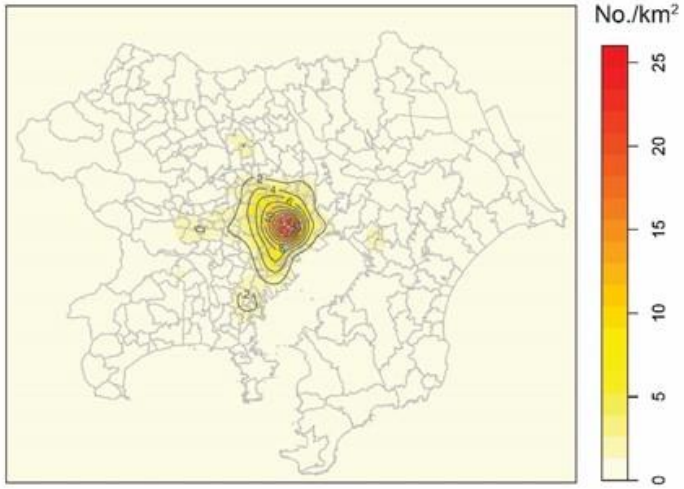




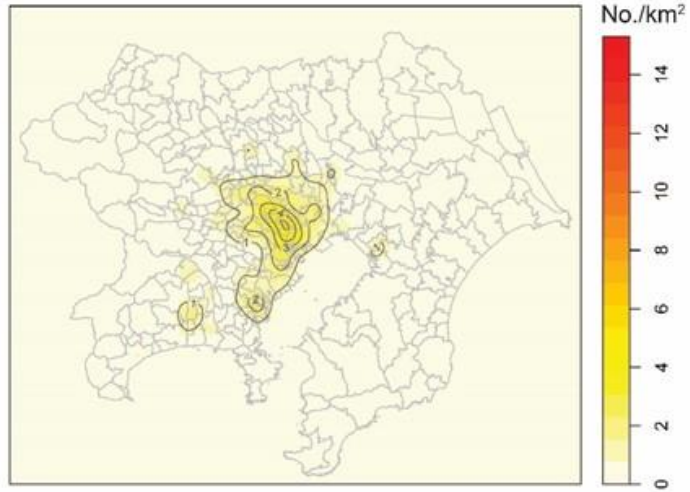
In our definition, logistics facilities (LF) include distribution centers, truck terminals, warehouses, intermodal facilities and oil terminals.

2003 2013

< 400m²

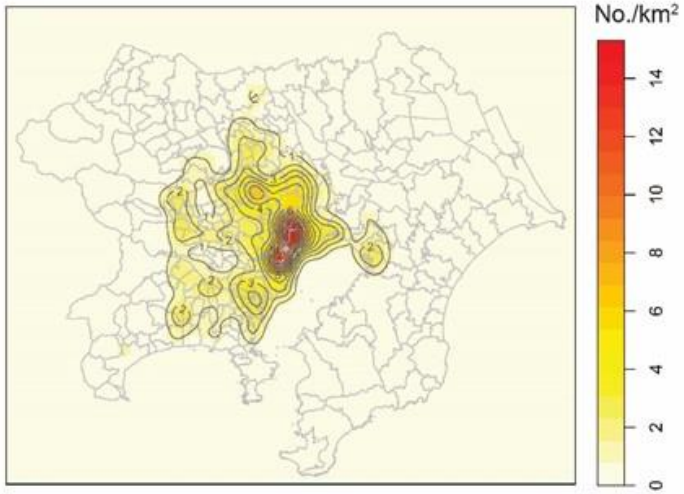


Logistics Facilities (400 m² or Smaller) in 2003

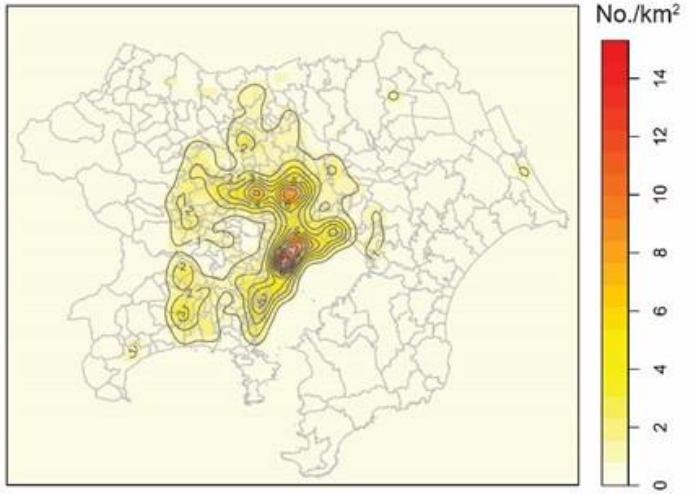


Logistics Facilities (400 m² or Smaller) in 2013

> 400m²



Logistics Facilities (Larger than 400 m²) in 2003



Logistics Facilities (Larger than 400 m²) in 2013

Avg. distance of logistics facilities from the urban center

2003: 25.7 km

2013: 32.3 km

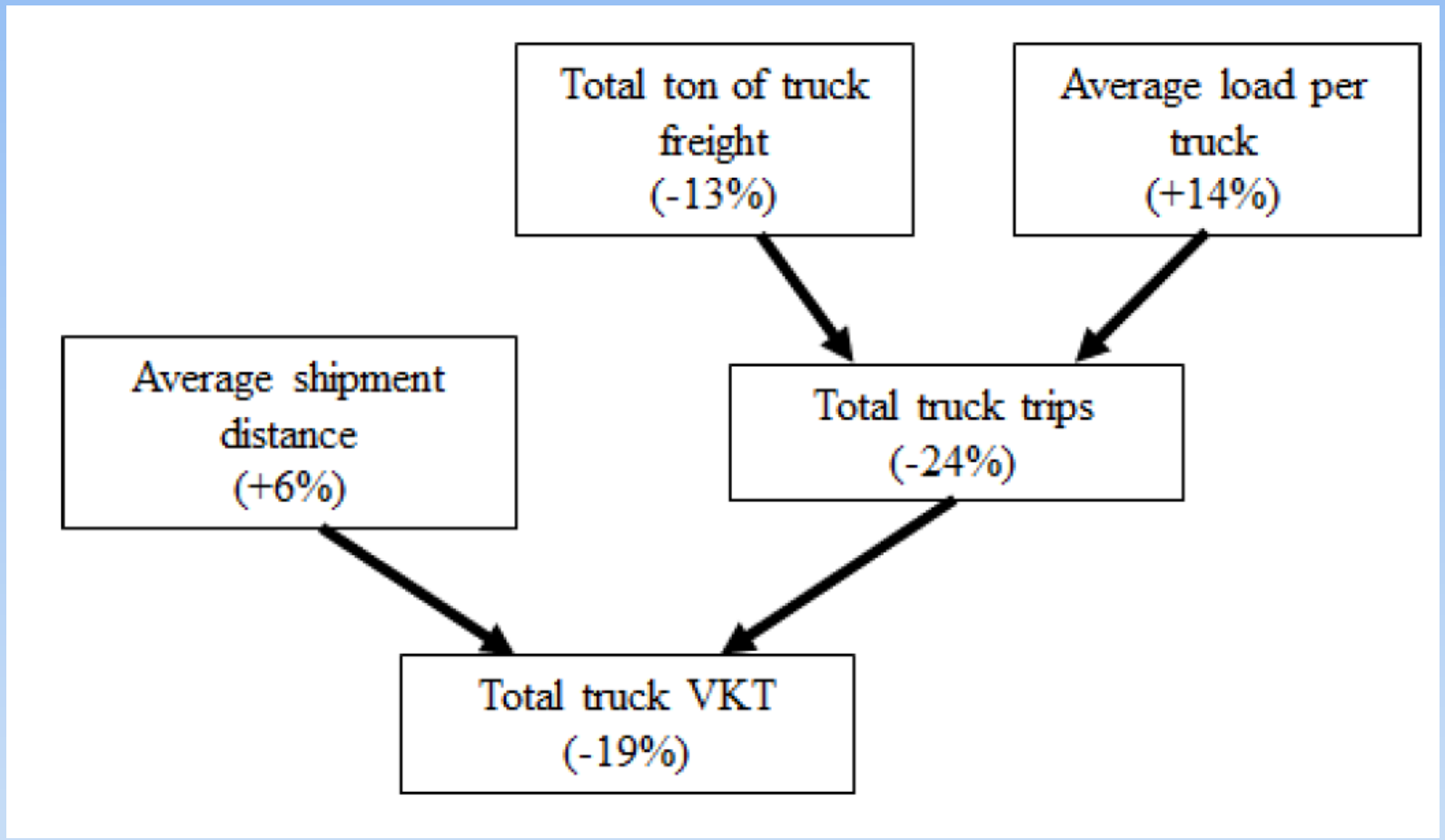
Quintiles (QUs) of the distance (km) from the urban center for urban structure indicators and logistics facilities

	2003				2013			
	QU1	QU2	QU3	QU4	QU1	QU2	QU3	QU4
Establishments	9.0	18.4	32.1	48.2	9.7 (+0.7)	19.3 (+0.9)	32.7 (+0.6)	48.0 (-0.2)
Population	15.4	25.6	36.4	49.2	15.1 (-0.3)	24.9 (-0.7)	35.6 (-0.8)	48.2 (-1.0)
Factories	12.0	20.4	35.4	50.6	14.6 (+2.6)	24.1 (+3.7)	40.2 (+4.8)	54.5 (+3.9)
Shipment demands	10.9	20.5	33.9	49.7	14.2 (+3.3)	25.8 (+5.3)	38.4 (+4.5)	51.7 (+2.0)
Logistics facilities	8.2	15.4	27.2	41.5	13.4 (+5.2)	23.2 (+7.8)	35.2 (+8.0)	48.2 (+6.7)

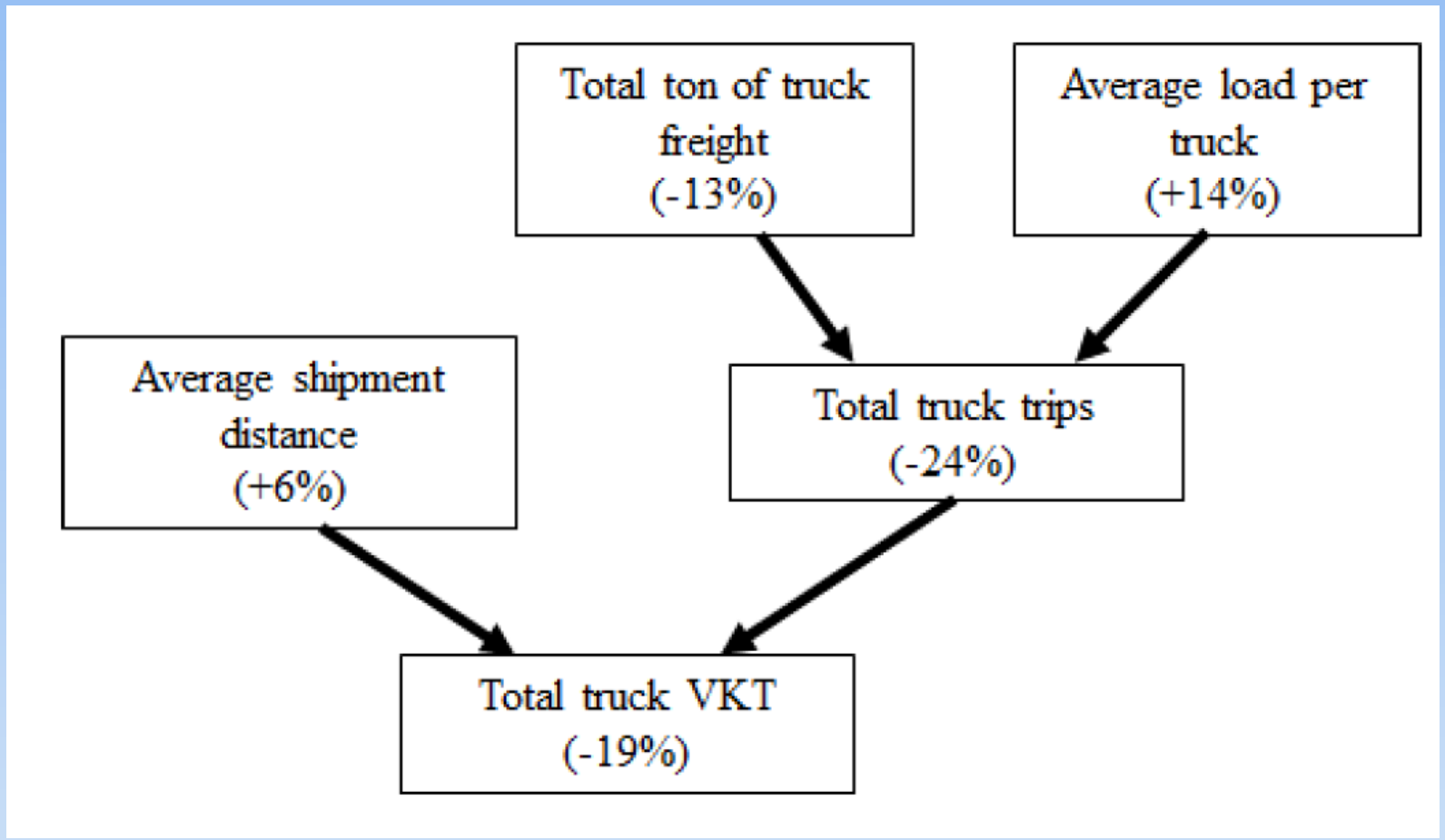
Decentralization of logistics facilities is on par with decentralization of factories and shipment demands

	Average shipment distance (km)	Total truck-km-traveled (mil.)	Truck-km-traveled per tons handled by LFs	Total truck trips (thou.)	Average load (ton/truck trip)
All LFs in the study area					
2003	34.9	23.7	20.5	680	2.72
2013	37.1	19.3	19.6	520	3.10
Change	+6%	-19%	-4%	-24%	+14%

While avg. shipment distance increased, truck VMT decreased (by 19%!)

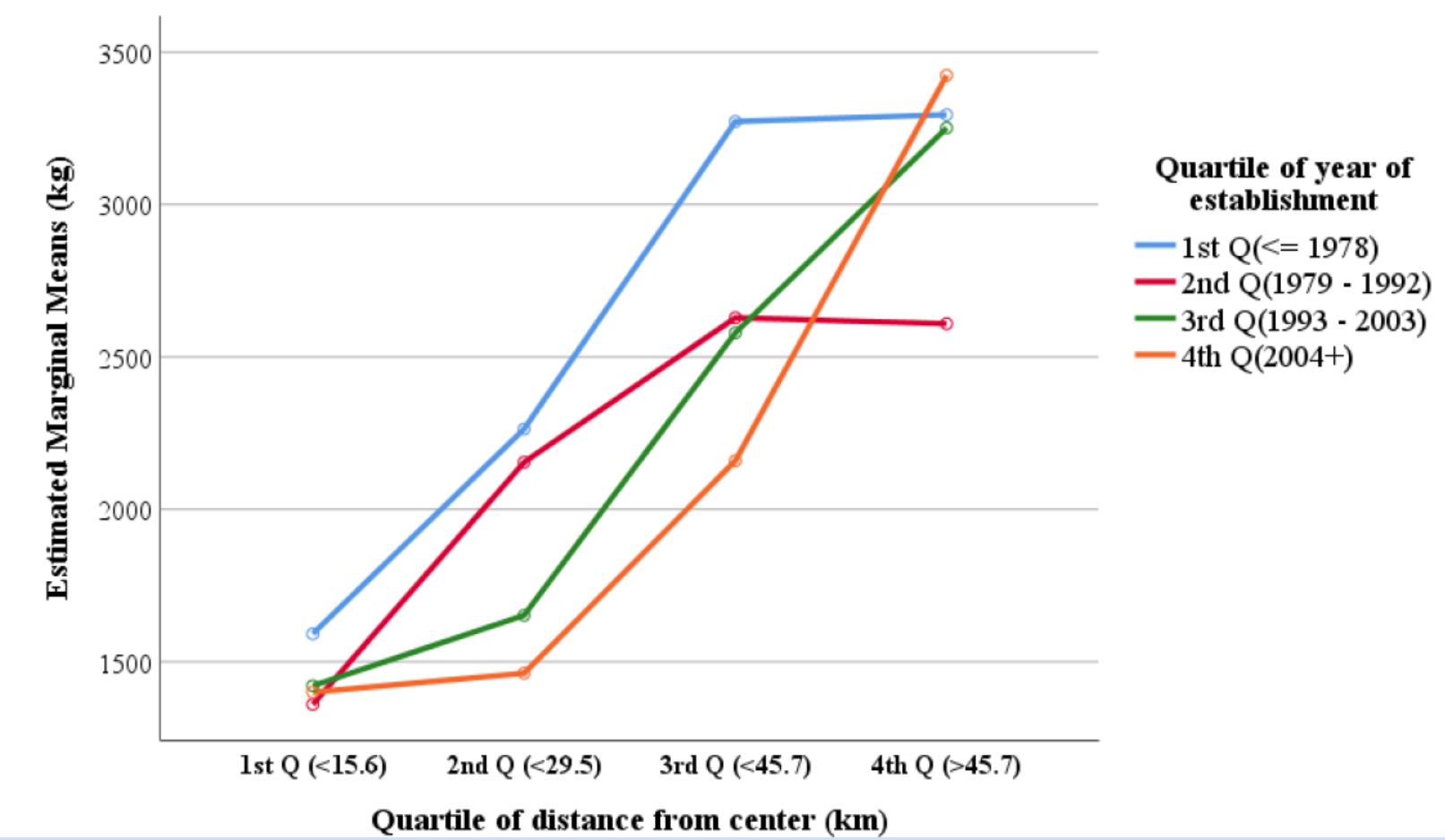


- Manufacturing left Tokyo → less freight overall
- Load size increased → less number of trips



Is larger average load enabled by logistics sprawl?

Distance to urban center vs. truck shipment load size



Association between load size and distance from the urban center is mostly consistent regardless of age of facility

Observations

- Logistics sprawl does not necessary increase truck VMT
- Relationship between truck VMT and location of logistics facilities is complex
- Factors: load size, shipment distance, shipment frequency, facility size, commodity type

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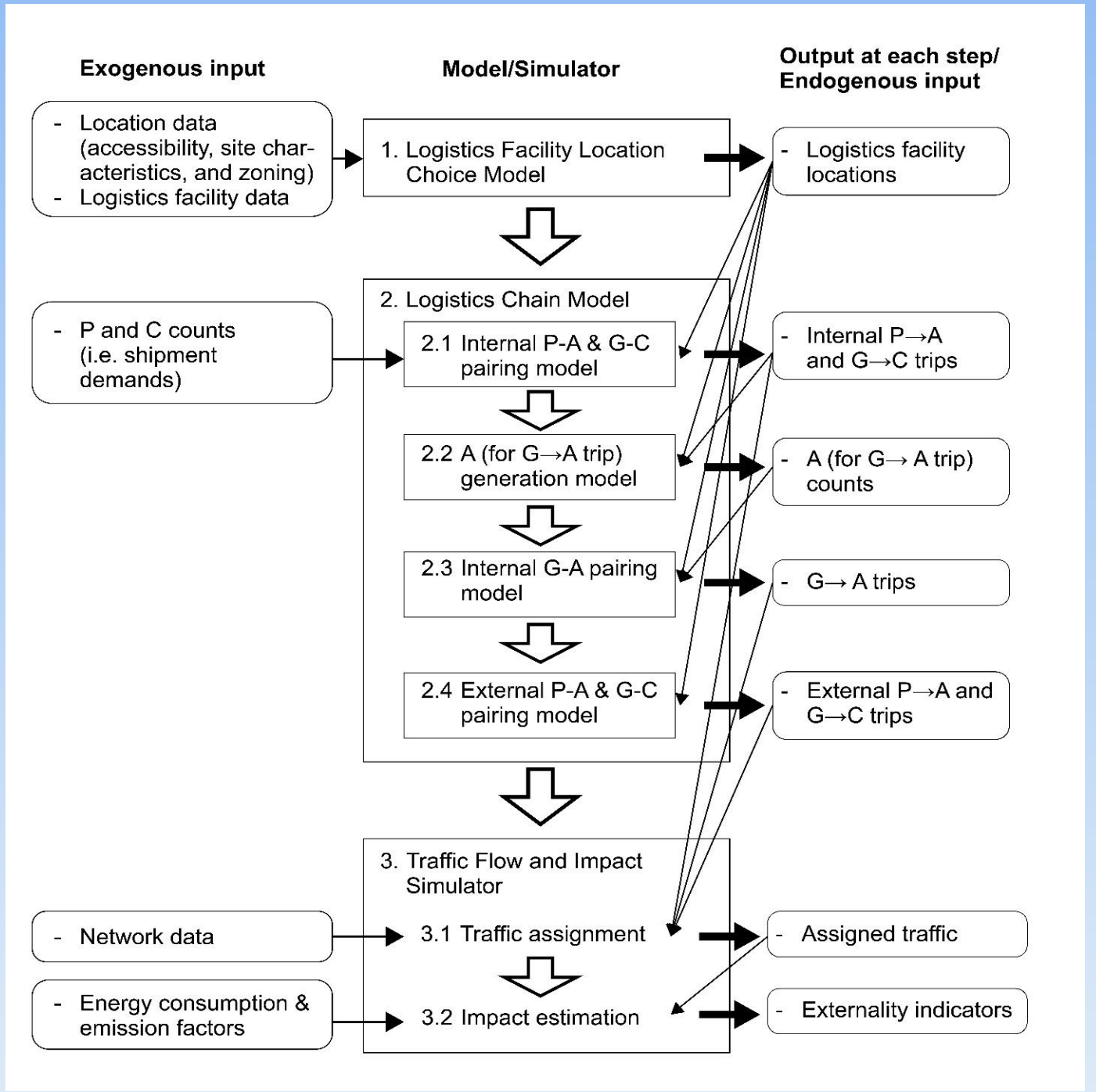
Is it possible to formulate effective land use policy for logistics facilities?

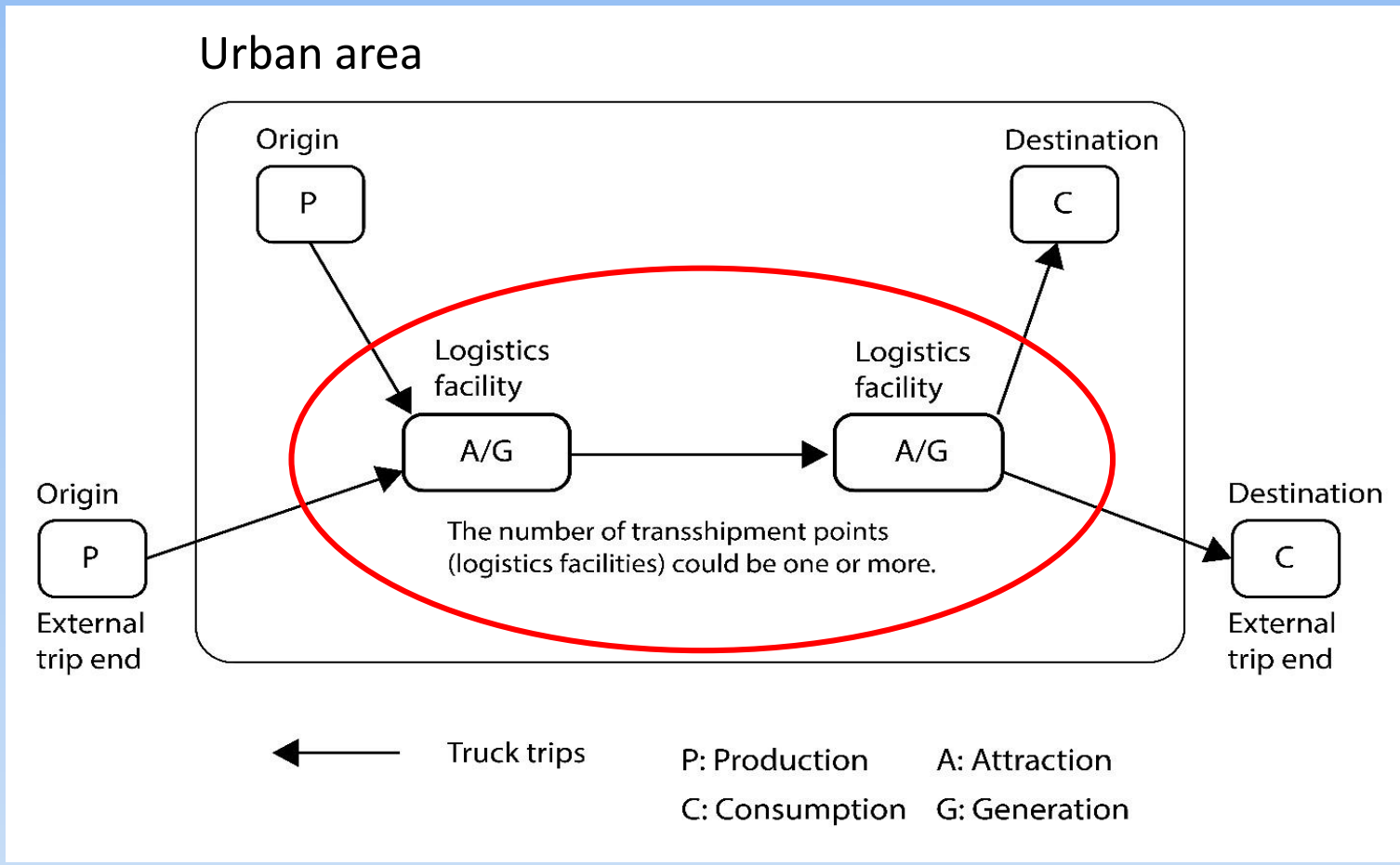
Land use policy analysis

- Used computer simulation to test various land use strategies

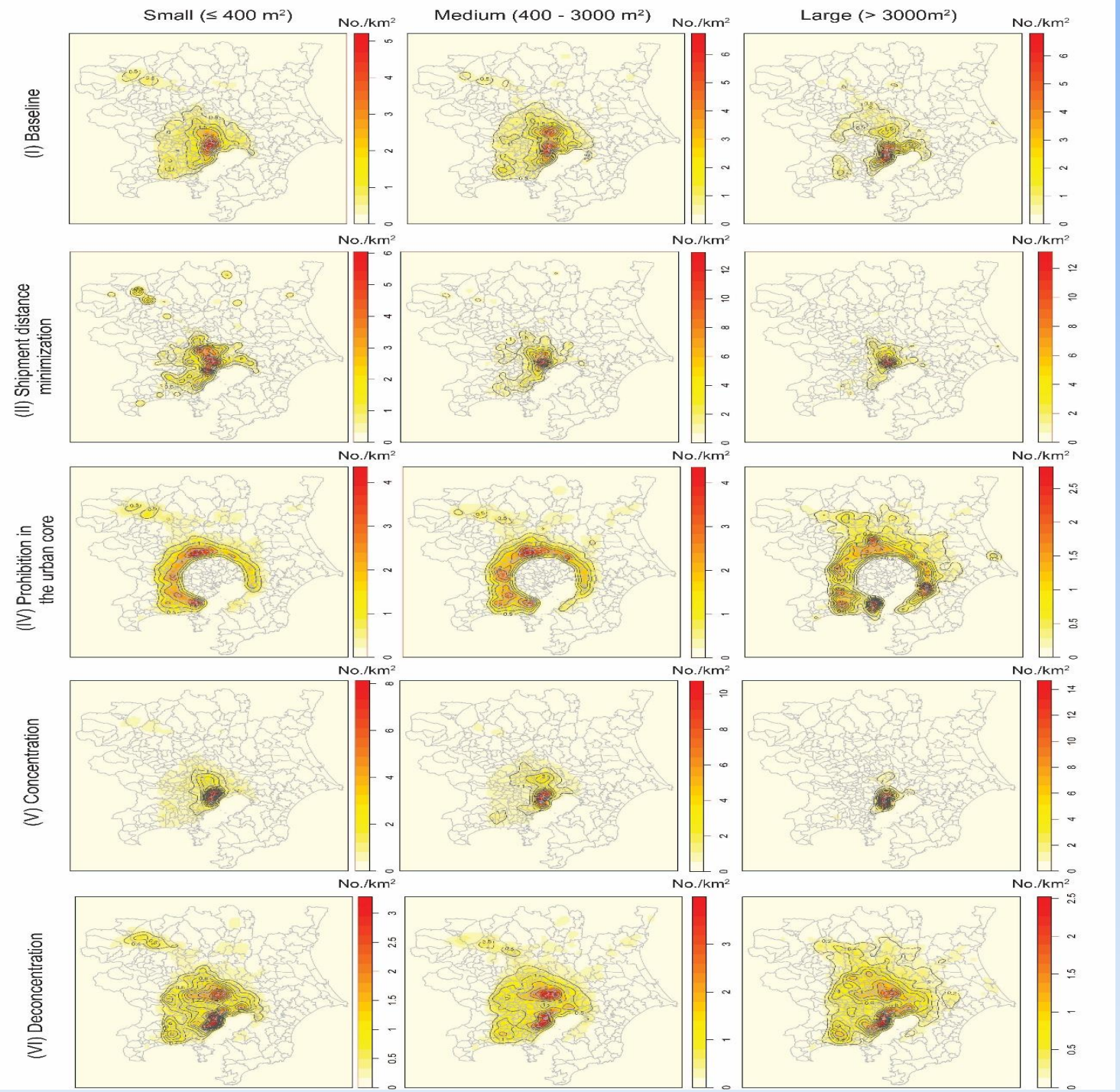
ULLTRA-SIM

2013 TMFS data set





Note: The simulation model does not include effect of location on shipment size.



Scenarios

(I) Baseline

(II) Shipment distance minimization

(IV Decentralization)

(V) Concentration

(VI) Deconcentration

Scenarios	Description	Mean of dist. to urban center (small, medium, large LFs)
(I) Baseline	No adjustment to model parameters or choice probabilities – best replication of 2013 Survey data	37.3 km 38.3 km 37.3 km
(II) Shipment distance minimization	All LFs are at the location that minimize sum of shipment distances (via feedback loop)	34.6 km 34.4 km 30.2 km
(III) Centralization	All LFs are at the urban center	0km, 0km, 0km
(IV Decentralization)	No LFs are allowed within 30 km from the urban center	48.6 km 49.0 km 50.8 km
(V) Concentration	Concentrates logistics facilities in the port area that has traditionally served as the major freight generator.	36.0 km 36.7 km 32.9 km
(VI) Deconcentration	Discourage LF to locate in Industrial zones and locations that are in the highest 0.5 % of employment accessibility and high population density.	40.4 km 40.7 km 42.6 km

Scenario analysis results

		Total VKT [mil. km]	Total VHT [thou. hr]	Total CO_2 [thou. ton]
(I) Baseline	Mean	26.9	560	16.3
	SD	0.05	1.0	0.03
(II) Distance minimization	Mean	23.8	494	14.4
	SD	0.01	0.2	0.01
	Diff. from (I)	-11.6%	-11.7%	-11.7%
(III) Centralization	Mean	27.8	568	17.0
	SD	-	-	-
	Diff. from (I)	+3.6%	1.3%	+4.1%
(IV) Decentralization	Mean	29.6	613	17.9
	SD	0.06	1.0	0.03
	Diff. from (I)	+10.2%	9.4%	+9.9%
(V) Concentration	Mean	26.6	554	16.2
	SD	0.05	1.1	0.03
	Diff. from (I)	-1.1%	-1.1%	-0.8%
(VI) Deconcentration	Mean	27.4	571	16.6
	SD	0.05	0.8	0.02
	Diff. from (I)	+2.0%	1.9%	+1.9%

What we found

- **Reality is complex**

Facility-specific and variable characteristics (e.g. demand locations, commodity handled) have strong effects on truck VMT

Extremely challenging, if not impossible, to reduce truck VMT through land use policies

Thank you

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