Factors Affecting the Efficiency of Truck Usage and implications for logistics sprawl: A Disaggregate Analysis

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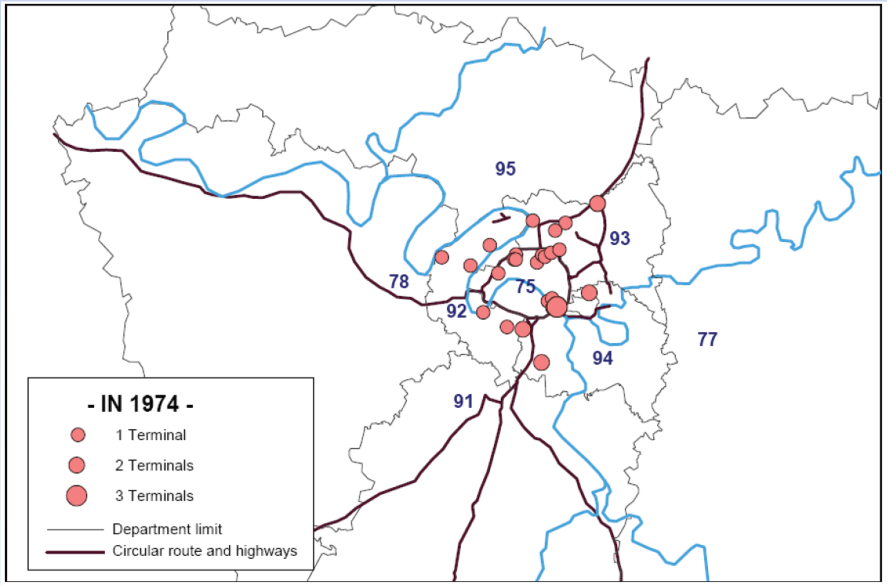
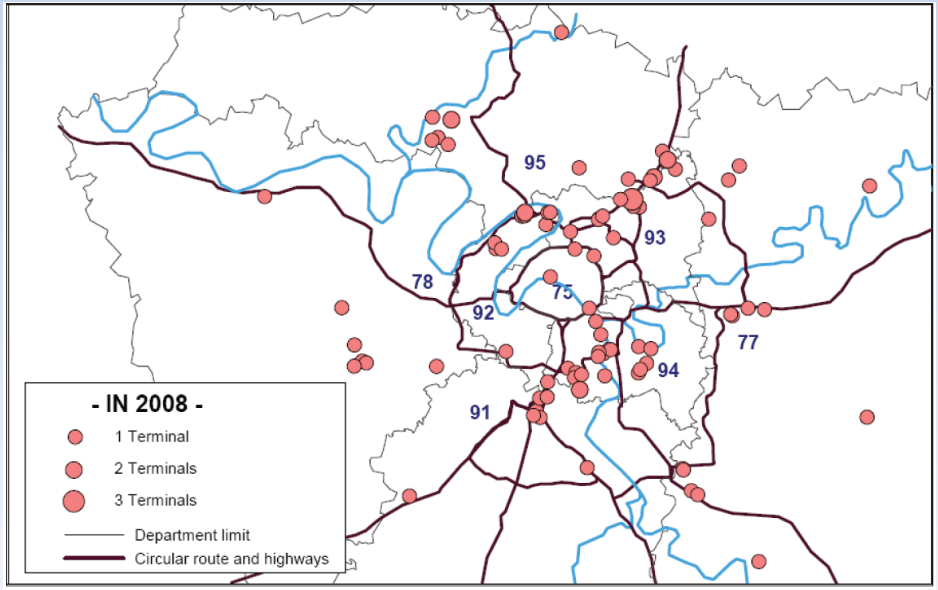
Logistics sprawl

“historical trend towards spatial deconcentration of logistics terminals in metropolitan areas”

Dablanc & Rakotonarivo (2010)





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

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

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

Factors: change in logistics and supply chain operations, need for high throughput facilities, land price, etc.

Studies of relationship between logistics facility locations and truck travel

Wagner (2009)

Traffic impact analysis using truck trip generation rates and survey O-D data in Hamburg

Co-locating logistics facilities would reduce truck traffic.

Davydenko, Tavasszy, and Quak. (2013)

Scenario analysis for the Netherlands using commodity flow and logistics chain models

Centralized shipment pattern reduces truck VKT by only 0.2%

Increasing transport cost per km by 10% reduces truck VKT by 3.1%

Sakai, Kawamura, and Hyodo (2017)

Freight surveys from 2003 and 2013

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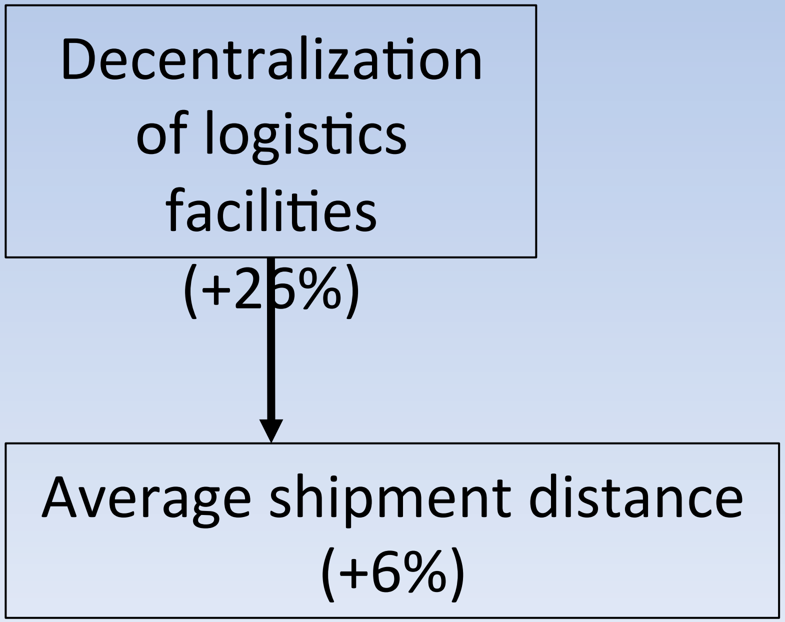
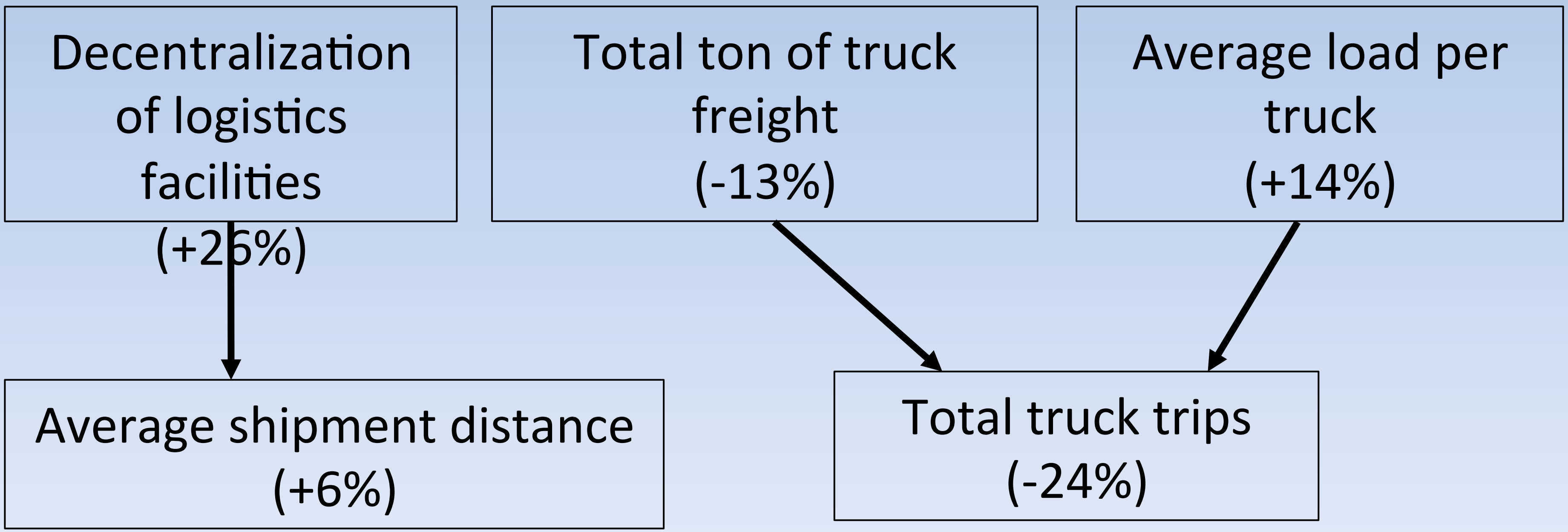


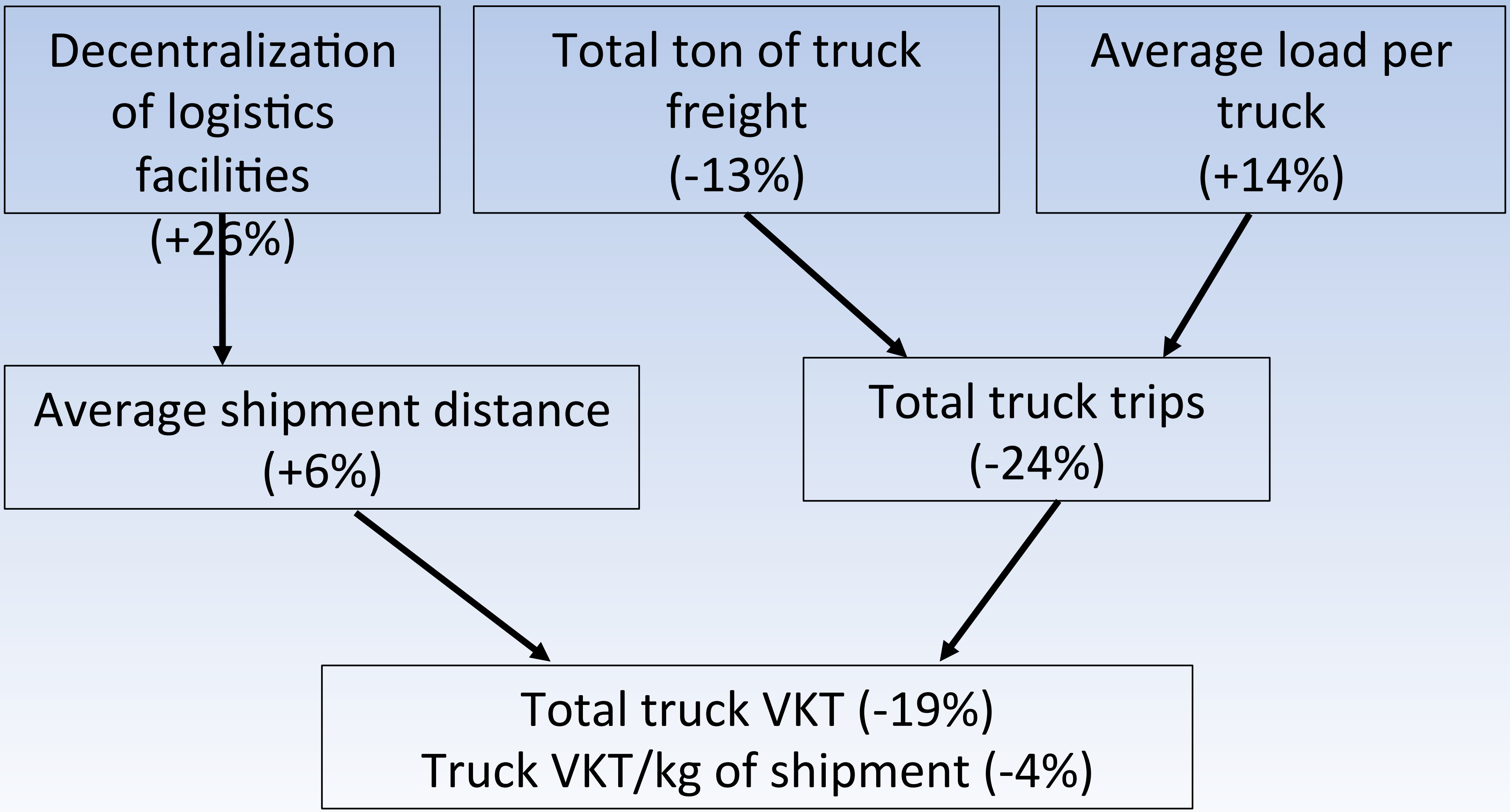
Sakai, Kawamura, and Hyodo (2017)

Freight surveys from 2003 and 2013



Sakai, Kawamura, and Hyodo (2017)

Freight surveys from 2003 and 2013



Research questions

- What factors contribute to increase in avg. load size?
- What factors contribute to truck km per ton (efficiency)?

2 hypothesis:

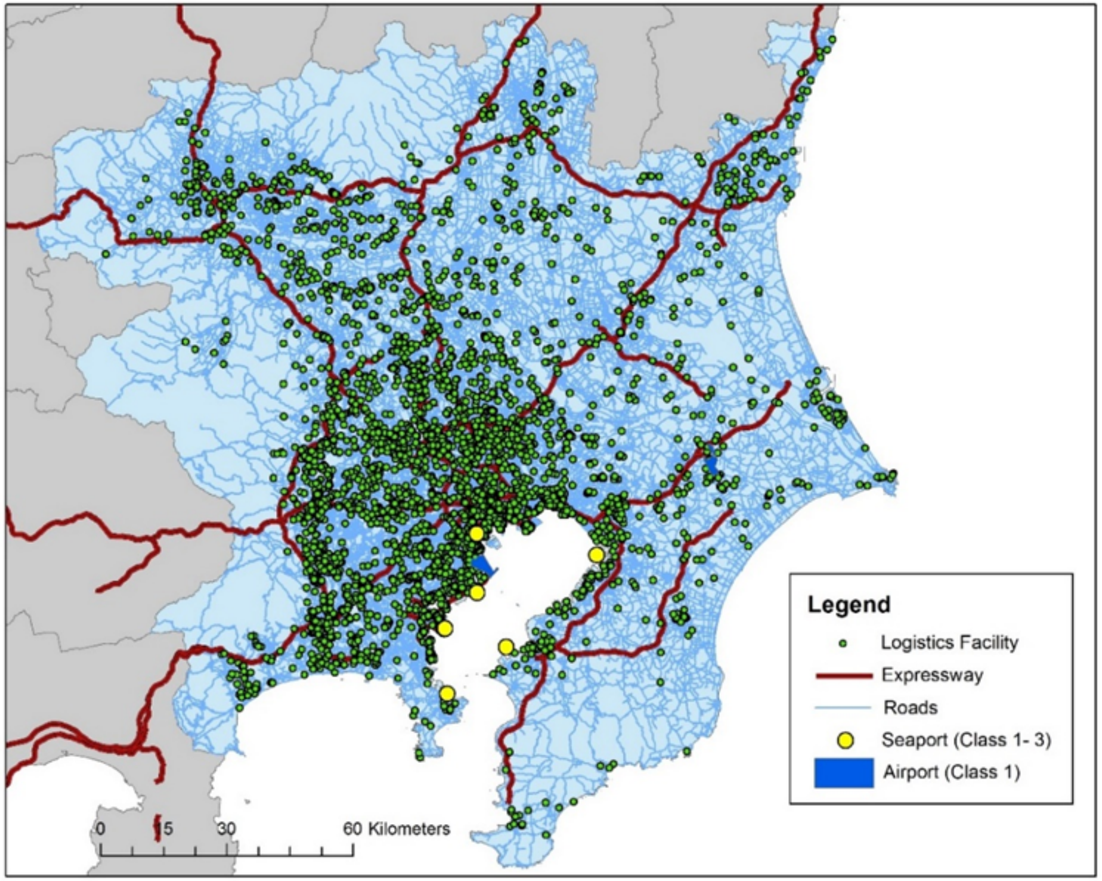
  - change in logistics operations
  - change in physical characteristics of LFs (size, land use, & location)

Data 2013 Tokyo Metropolitan Freight Survey

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.

logistics facilities (LF) include distribution centers, truck terminals, warehouses, intermodal facilities and oil terminals



Explanatory variables

	Exp. Variable	Description
Size	Ln(floor area)	Floor area of the facility in m^2
	Ln(employee size)	Number of employees at the facility.
Location & land use characteristics	Ln(distance from center)	Ad aerial distance from the center of Tokyo Metropolitan Area, which is assumed to be at the Tokyo Station.
	Ln(population density)	Population density in thousand per km^2.
	Share of industrial zone	Share of land that is zoned for industrial activities within the 1km-by-1km polygon where the facility is located.
	Land price	Average land price in million yen per m^2.
	Port Area (dummy)	1 if in port areas along Tokyo Bay, 0 otherwise.
Logistics operation	Newer facility	1 if 2004 or later
	Ln(avg. shipping distance)	Average shipping distance per truck trip in kilometers, which is calculated using shortest-path analysis over the road network in the Tokyo Metropolitan Area.

Regression results:
Response var: Ln(average load per truck trip)

Dependent Variable: Ln(avg. load)		Adj R Square = 0.226, N (expanded) = 7,468	
	Coefficients	SE	P-value
(Constant)	3.758	0.758	0.000
Ln(floor area)	0.539	0.014	0.000
Ln(avg. shipping distance)	-0.113	0.025	0.000
Ln(employee size)	-0.364	0.151	0.016
Ln(distance from center)	0.299	0.037	0.000
Ln(population density)	-0.032	0.01	0.001
Share of industrial zone	0.574	0.147	0.000
Land price	0.364	0.06	0.000
Dummy for port area	0.39	0.066	0.000
Dummy 2004 or newer	-0.079	0.051	0.120

Interpretation (shipment size)

- Larger facilities located away from urban center in industrial areas with low population density tend to generate lager shipments per truck

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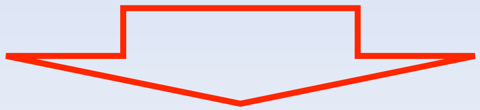
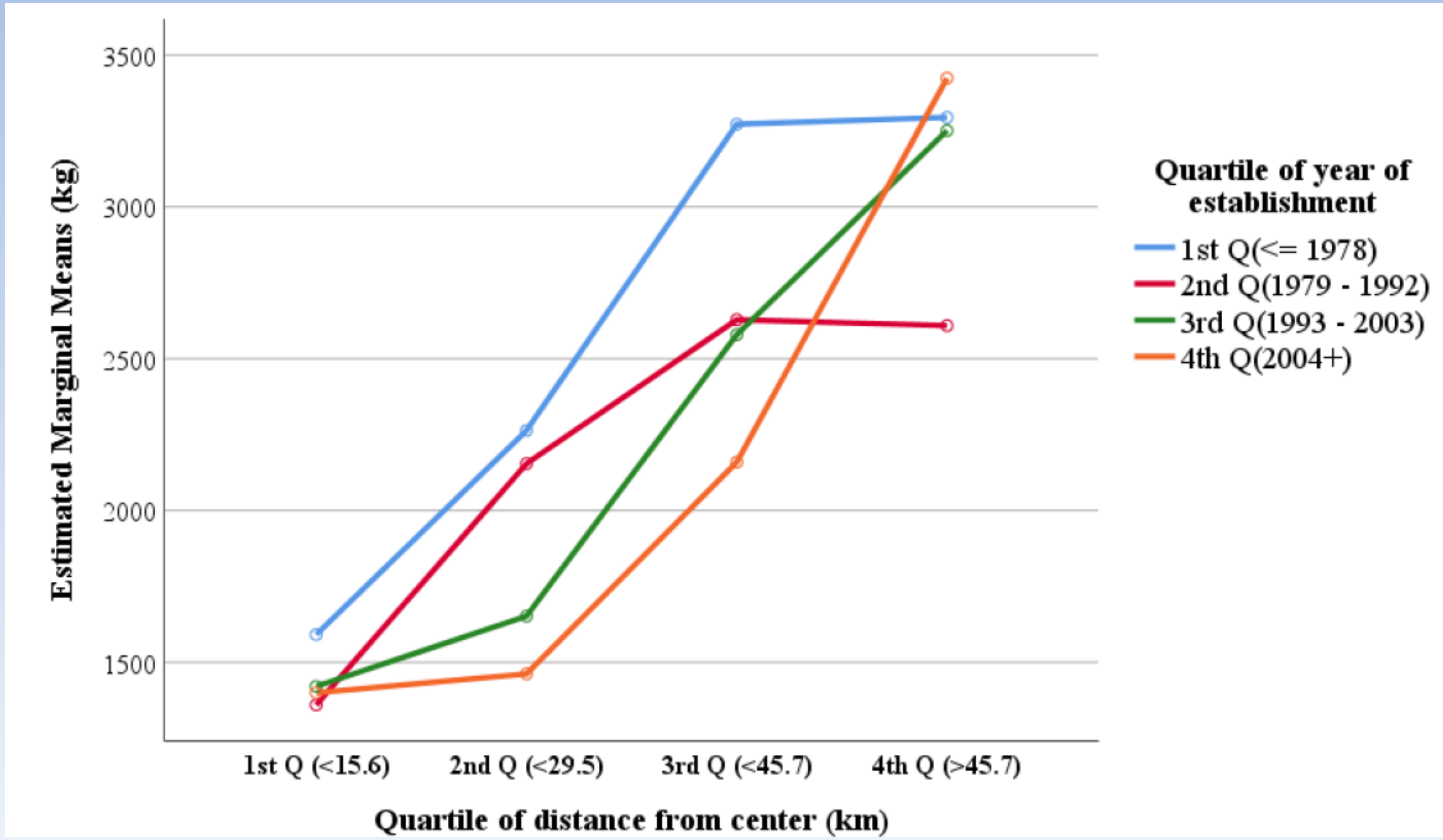
- Age of facility is not a significant factor



Change in logistics strategies may not be a factor

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

Regression results:
Response var: Ln(shipping distance per kg of shipment)

Dependent Variable: Ln(shipping distance per kg of shipment)		**Adj R Square = 0.120, N (expanded) = 7,468**	
	Coefficients	SE	P-value
(Constant)	3.782	.830	.000
Ln(floor area)	-.419	.016	.000
Ln(employee size)	-.817	.167	.000
Ln(distance from center)	-.051	.041	.217
Ln(population density)	.039	.011	.000
Share of industrial zone	-.322	.165	.052
Land price	-.228	.068	.001
Dummy for port area	-.264	.074	.000
Dummy 2004 or newer	.077	.057	.178

Interpretation

- Size (floor area, employees) improves efficiency (in terms of VKT generation)
- LFs in port and industrial areas improves efficiency
- Price premium for "efficient" locations?
- But, distance from the urban center is insignificant
- Again, age of facility is not significant

Summary

Shipment size is critical in understanding effects of logistics sprawl on truck VKT

Large LFs in low density, industrial areas (e.g. port area near CBD) tend to be efficient in terms of truck VKT generation

Unknowns:

- Causality
- Relative location w.r.t. shipment demands (i.e. shipment distance vs. shipment size trade-off)
- Effects of commodity types (e.g. parcel delivery)

Thank you