

Using proxies to describe the metropolitan freight landscape

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- Introduction and conceptual framework
- Freight landscape
- Data, models and case study
- Discussion

- A lot yet to be learned about urban freight
- Limited data
 - Comprehensive, consistent data on freight flows within metropolitan areas
- Limited (but growing) understanding of how freight moves within metro areas
- No “theory of urban freight”
 - How do we explain....
 - Spatial shifts in warehousing/distribution facilities
 - Severe passenger freight conflicts in city cores
 - And much more.....

A possible conceptual framework

- Are there systematic relationships that explain urban freight dynamics?
- As in standard urban economics model, is density a useful proxy?
 - Land value
 - Transport supply and demand
 - Shipper and receiver behavior

What we observe

- Freight problems more intense in city cores
 - Truck access most difficult
 - Parking and loading more limited
- External costs higher, because more people affected
- Freight shipments are different in city cores

*Suggests a general relationship
between development density and
urban freight problems*

Standard model

- Explains basic structure of cities
 - Land value
 - Population and employment distributions
 - Commuting patterns
- Greatest population density and highest land values at center
 - Unit cost of housing decreases with distance from center, because transport costs increase with distance from center
- A *declining* land rent curve (constantly decreasing slope)

How might land rent affect freight dynamics?

Land value affects transport supply

- **Road supply relative to demand declines**
 - Land is more valuable in other uses
 - Above ground or below ground far more costly
 - Therefore congestion must increase
- **Passenger transport**
 - From cars and roads to public transport, non-motorized modes
 - Utilize existing capacity (space) more efficiently
- **Freight transport**
 - No obvious economies in response to density
 - With more demand, bigger trucks more efficient, but road capacity constraints

Land value affects space consumption

- **Land supply relative to demand decreases**
 - Taller buildings more costly
 - Smaller apartments, stores, offices
 - Intensity of space utilization (indoor congestion?) must increase
- **Residential**
 - Less storage space, so purchases in smaller batches
 - Substitution of dwelling space with out of home space
 - Parks, coffee shops, restaurants
 - Demographics – fewer kids

More on space consumption

- **Office/commercial**
 - More intense use of space
 - Less parking, loading, delivery facilities
 - Less space for storage (inventory)
- **Retail**
 - Smaller shops with more sales per space unit
 - Less space for storage, more turnover per unit
- **Warehousing/distribution**
 - Mostly priced out

Density and markets

- Density means more potential market per space unit
- Specialized products, services
 - Greater diversity of products, greater capacity to serve niche markets, so more suppliers, distributors

Putting it all together.....

The Freight Landscape

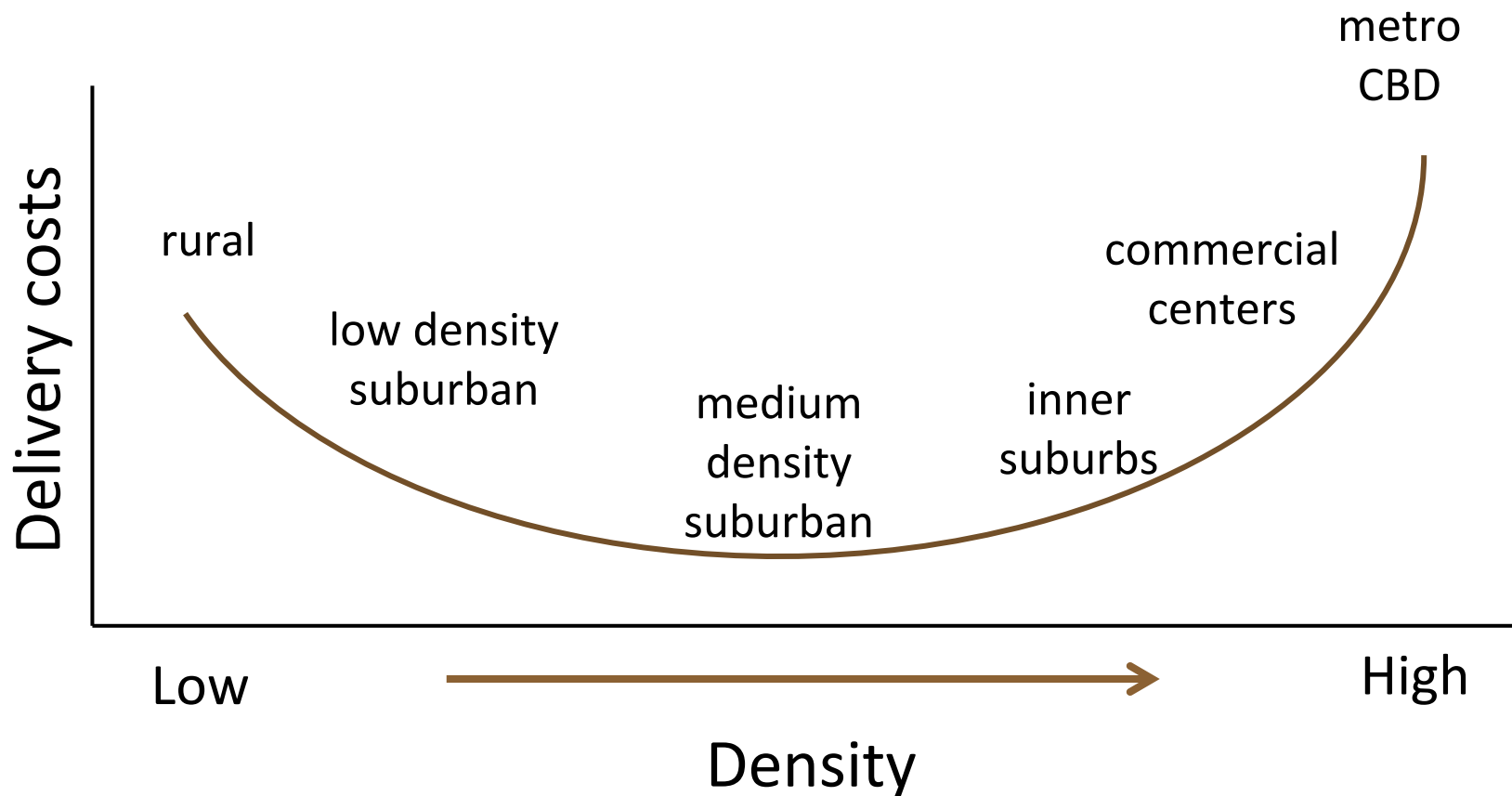
A Conceptual Framework

The freight landscape premise

- Land value has many effects on behaviors that generate freight flows;
- Density is a proxy for land values;
- Therefore we should be able to use density to proxy these effects on freight flows

Delivery costs and density

Example: retail deliveries



Density and delivery characteristics

Density	Low	Medium	High
Demand	Sparse	Moderate	Concentrated
Loads	Small, LTL	Full truck loads	Small
Trucks	Small	Large	Small
Inventory space	Ample	Ample	Limited
Frequency	Low	Medium	High
Loading and parking	Ample	Ample	limited
Delivery distance	Long	Shorter	Long/shortest

Back to density as proxy

- Use population and employment density as proxy for freight demand
- Test relationship between density and freight flow volumes
 - Big problem: lack of metro level freight data
- If this relationship is confirmed, we can use population and employment patterns as indicators of freight demand and flows

Data and models

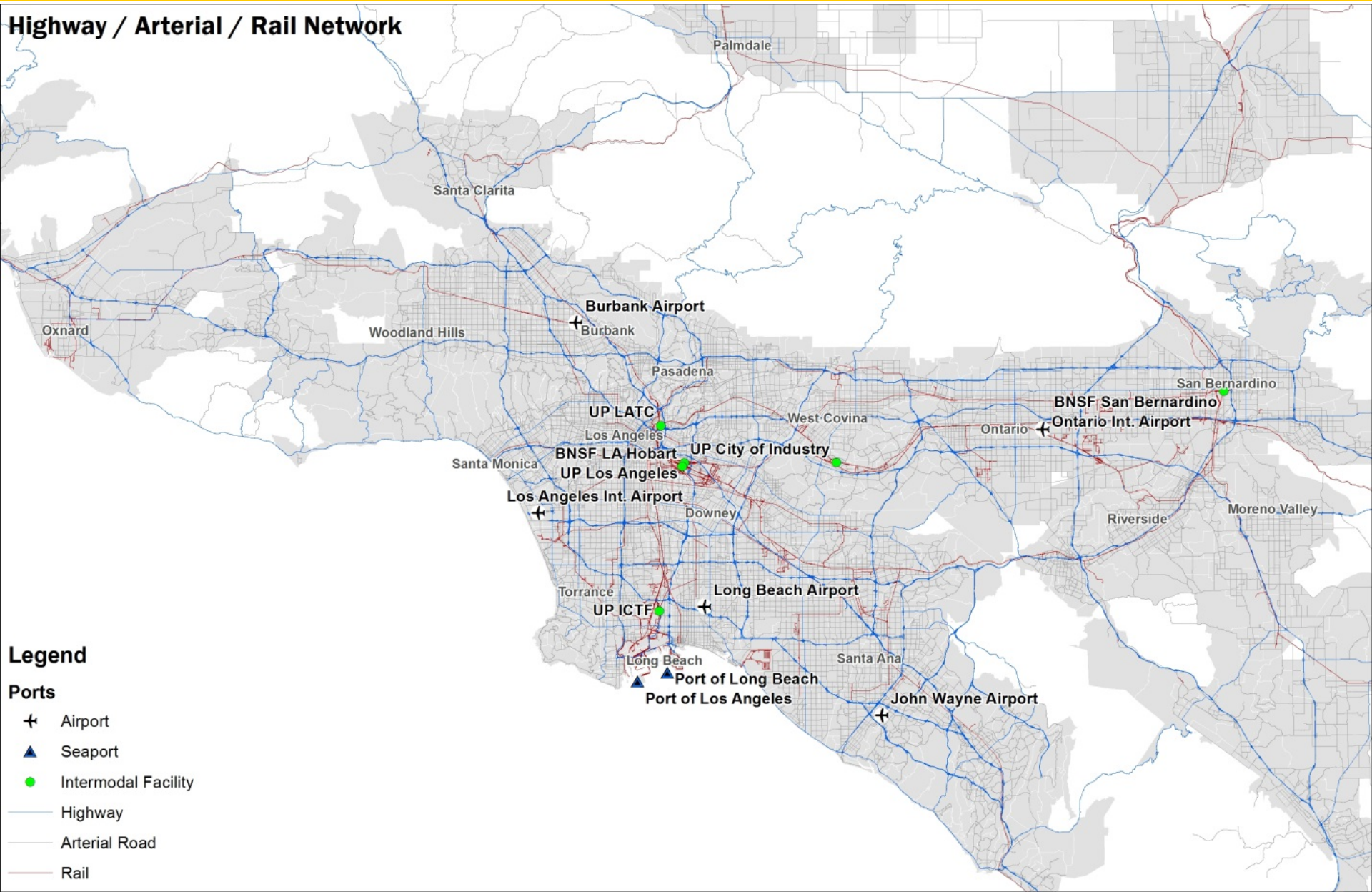
Los Angeles Region case study

Background: The Los Angeles Region

- **17.6 Million Population 2010**
- **7.0 Million Employment 2010**
- **The Los Angeles/Long Beach port complex:**
 - \$382 Billion in 2011, the largest in the US
- **Los Angeles International Airport**
 - 5th largest air freight center

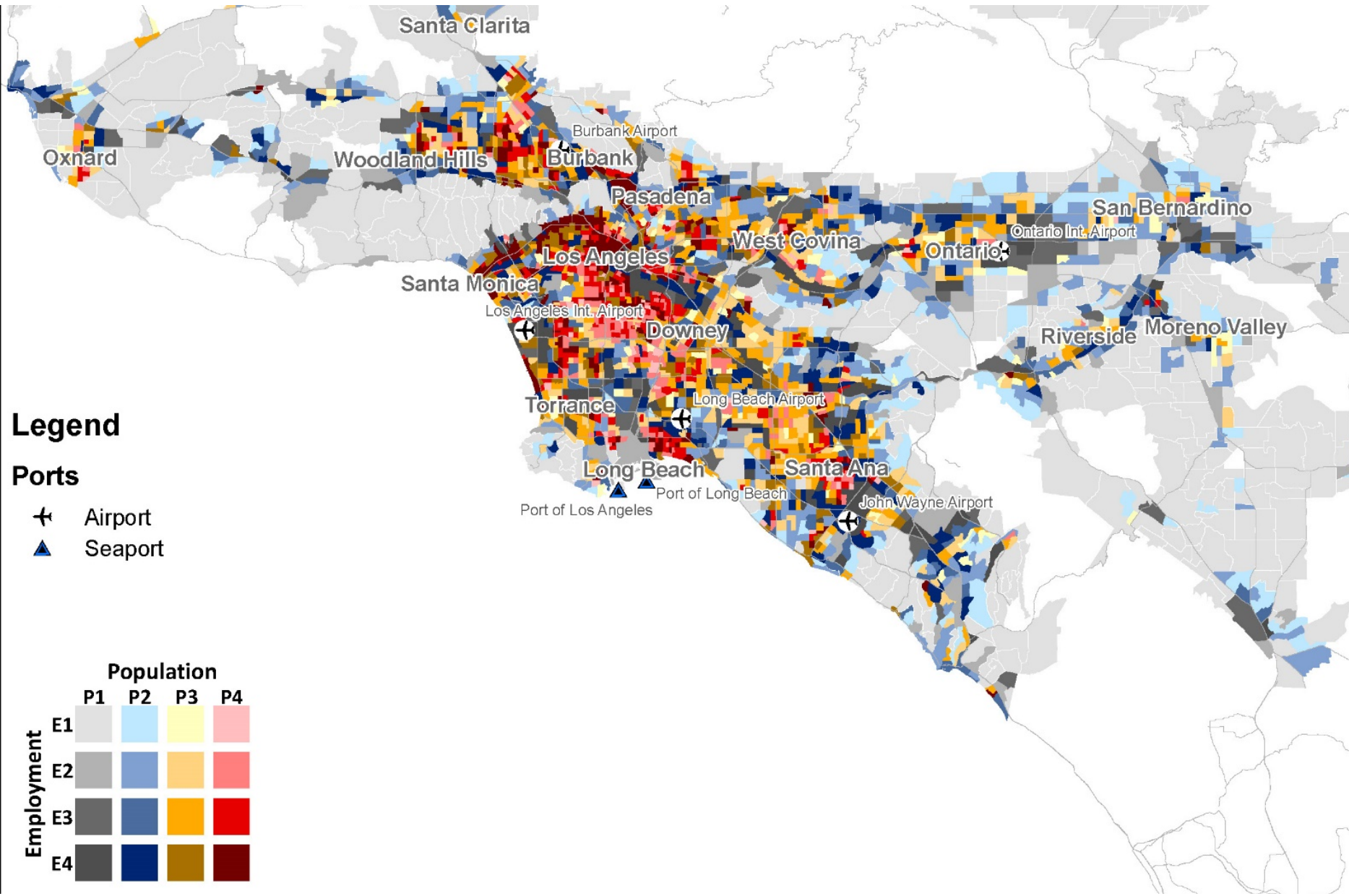
The Los Angeles region

Highway / Arterial / Rail Network



- **Small area (census tracts) population characteristics**
 - Demographics, socio-economics
 - US Census
- **Small area (census tracts) employment characteristic**
 - Detailed industry sector, establishments, jobs
 - LEHD (Longitudinal employer-household dynamics)
- **Detailed (link level) highway, rail networks**
- **Model produced link level traffic flow by vehicle type**
- **Spatial unit: Transportation analysis zones (TAZs)**

Population and employment density



Share of P/E combinations

	P Q1	P Q2	P Q3	P Q4
E Q1	14.7	5.6	2.8	1.4
E Q2	3.3	8.1	8.0	5.4
E Q3	2.6	5.6	8.6	8.3
E Q4	4.5	6.0	5.8	9.3

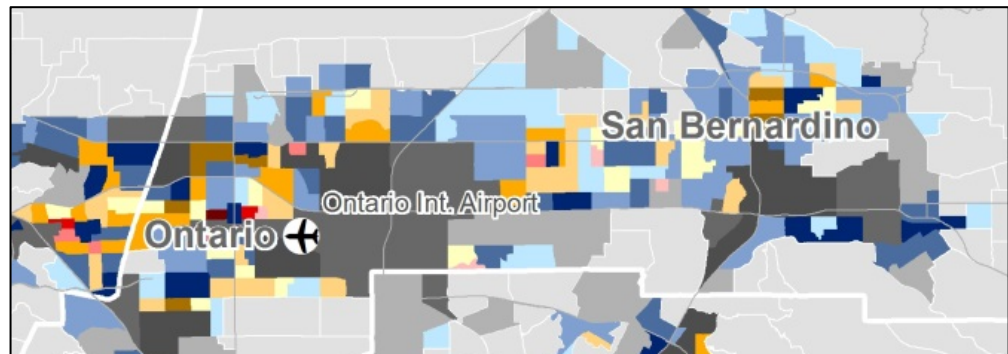
Freight landscape examples

LA Downtown



Old industrial
zone

Ontario airport industrial zone



Two models

Naïve Model

Regress traffic volume
density on

Combinations of
population and
employment density,

Supply factors

Enhanced Model

Regress traffic volume
density on

Population, employment
characteristics,
Supply factors

*Use spatial lag model to account for
spatial autocorrelation*

General forms

Model 1:

$$Y_i = f(S_i, D_i)$$

Where:

Y = truck flow density in zone i ,

S = vector of transport supply and relative location measures

D = vector of transport demand measures (population and employment density) for zone i

Model 2:

$$Y_i = f(S_i, P_i, E_i)$$

Where:

P = vector of population characteristics

E = vector of employment industry sectors

Variables

Dependent	Truck volume per lane-km Total vehicle volume per lane-km
Independent	
Supply	Lane-km density Highway access Freight generator access
Demand	Pop/emp density category dummies Pop density, emp density Industry mix, industry concentration

N = 3,658 Traffic Analysis Zones (TAZ)

Observations from model 1

- Transport supply variable coefficients have expected sign
- Reasonable level of explanatory power
- General relationship of density seems to hold
- Simple population/employment combinations perform surprisingly well
- Can we do better with more nuanced description of population and employment characteristics?

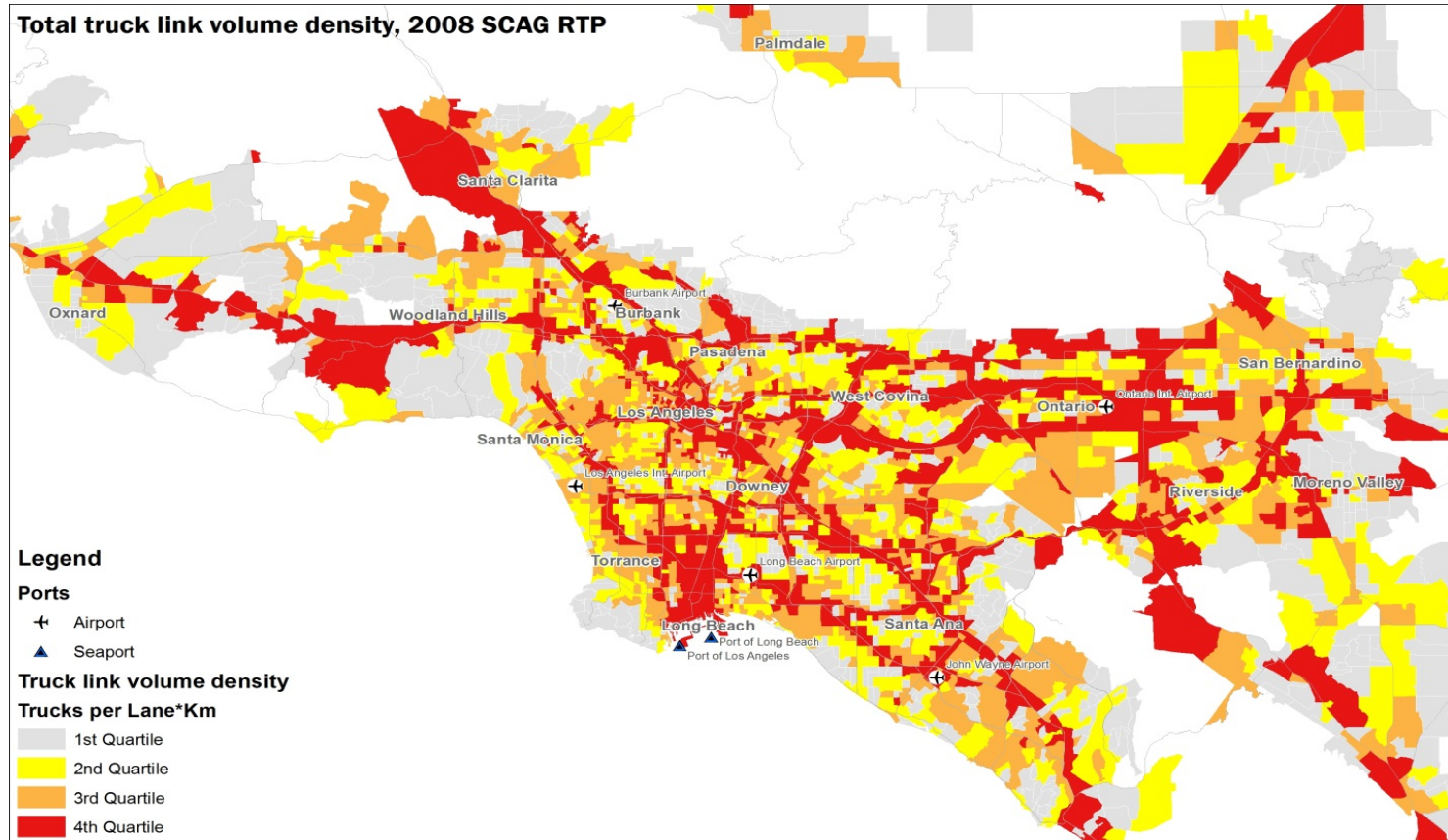
Summary of model 2 results

- **Similar to model 1**
 - Population and employment characteristics generally significant and with expected signs
 - Differences between total vehicles and trucks as expected
- **Models measure different things**
 - Model 1: effects of spatial concentrations of population/employment combinations
 - Model 2: population, employment characteristics

On the relationship of density and freight

- The general concept makes sense
- Both models provide preliminary support
 - Results remarkably similar across model forms
 - No counter-intuitive results
- A first step in thinking more systematically about urban freight
- BUT....
 - LA is one case study; needs to be replicated
 - Better test is actual flow data

Thank you



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