Spatial dynamics of the logistics industry in California metropolitan areas

Urban Goods Movement Lecture Series
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Overview

- What is “logistics sprawl”?
- Why should we care?
- Why should location patterns change?
- What do we know?
- Our approach
- Results
- Discussion
Urban sprawl in the literature

“The uncontrolled spreading of urban development into areas adjoining the edge of a city”*

- An enduring urban planning problem
  - 1950s suburbanization
  - 1974 *The Costs of Sprawl*
  - Critiques of suburban development
    - Newman and Kenworthy
    - Cervero, Ewing, others
    - New urbanism

*www.thefreedictionary.com
Main critiques

- Public and private capital and operating costs
- Transportation and travel
- Land, natural habitat
- Quality of life
- Social segmentation
What is logistics sprawl?

“Logistics sprawl is the phenomenon of relocation and concentration of logistics facilities (warehouses, cross-dock centres, freight terminal, etc.) towards suburban areas outside city centre boundaries” (Dablanc and Rakotonarivo, 2010)

• A shift of location from central areas to suburban or exurban areas
• Spatial concentration of activities in logistics clusters
Why should we care?

- Warehouse and distribution sector is growing faster than US economy
  - From 2003-2013, 33% increase in W&D employment, 4% increase in total employment
- W&D activity generates negative externalities
  - Truck trip generation hot spots
  - Air pollution, GHG emissions, noise, quality of life, possibly environmental justice impacts

If W&Ds are moving further from markets, truck travel and impacts increase
Why should location patterns change?

- **Economic restructuring**
  - Global, geographically dispersed supply chains
  - Reduced transport costs
  - Access to regional, national, global markets
    - Access to highways, rail nodes, intermodal
  - From “push” to “pull” logistics
    - Velocity and reliability, minimized dwell time

- **Scale economies**
  - Ever larger facilities
  - Automation

- **Land availability and prices**
  - Larger parcels, favorable zoning
What do we know?

- **Decentralization**
  - Los Angeles and Atlanta, 2000s, increase in geographic spread
  - Seattle, 2000s, decrease in geographic spread
  - UK and Japan, 2000s, suburbanization

- **Concentration**
  - One case study, Netherlands, increased concentration

*Little evidence so far of consistent location trends across metro areas*
Research approach and methods
Some considerations

- Changing location with respect to what?
  - If population and employment are decentralizing, then W&D may be following the market
  - If markets are national or global, does metropolitan location matter?

- Many possibilities for spatial shifts
  - Centralization vs decentralization
  - Concentration (clustering) vs dispersion
  - Implications for truck travel vary
Our approach

- Measures to capture
  - Absolute and relative change
  - Centrality and concentration

- Many possibilities
  - Use several measures and compare results

- Unit of analysis
  - Establishments, employment
## Spatial measures

<table>
<thead>
<tr>
<th>Spatial structure</th>
<th>Absolute</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrality</td>
<td>Measure 1 Decentralization</td>
<td>Measure 2 Relative decent.</td>
</tr>
<tr>
<td></td>
<td>1-1 Ave distance to CBD</td>
<td>2-1 Ave distance to all employment</td>
</tr>
<tr>
<td></td>
<td>1-2 Ave distance to freight nodes</td>
<td>2-2 Ave distance to all population</td>
</tr>
<tr>
<td></td>
<td>1-3 Ave distance to W&amp;D geographic center</td>
<td></td>
</tr>
<tr>
<td>Concentration</td>
<td>Measure 3 Concentration</td>
<td>Measure 4 Relative conc.</td>
</tr>
<tr>
<td></td>
<td>3-1 W&amp;D Gini coefficient</td>
<td>4-1 WD distribution relative to total emp density distribution</td>
</tr>
</tbody>
</table>
Measures 1-1 and 1-2
Measure 2

\[ D = \frac{\sum_{j=1}^{N} \left( \frac{\sum_{i=1}^{n} D_{ij} \times X_i}{X} \right) \times E_j}{E} \]

Where,

- \( D_{ij} \) = distance to ZIP Code (i) from each W&D (j) or distance to census tract (i) from each W&D (j) (i = 1, 2, \ldots, n; j = 1, 2, \ldots, N)
- \( X_i \) = total employment in ZIP Code (i)
- \( X = \text{sum of } X_i \)
- \( E_i \) = the number of W/D establishments or employment in ZIP Code (j)
- \( E = \text{sum of } E_i \)
Test our measures with four largest metro areas in California

- Los Angeles (CSA)
  - Largest US international trade center
  - Second largest US metro area

- San Francisco (CSA)
  - Largest US high tech center

- Sacramento (CSA)
  - State capitol
  - Agricultural trade center

- San Diego (MSA)
  - Border city
Employment and establishment data

- Zip Code business patterns (ZBP), 2003 – 2013
  - Annual data
  - 6-digit industry code
  - Establishments and employment

Advantages
- Reliable and consistent
- Covers entire US

Disadvantages
- Location limited to zip code centroids
- Zip codes vary in size, not consistent with political boundaries
- Data suppression for small numbers
## Population and employment trends

<table>
<thead>
<tr>
<th>City</th>
<th>Population (millions)</th>
<th>Employment (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2010</td>
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<tr>
<td>Los Angeles</td>
<td>16.4</td>
<td>17.9</td>
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<tr>
<td>San Francisco</td>
<td>7.6</td>
<td>8.2</td>
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<td>Sacramento</td>
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</tr>
<tr>
<td>San Diego</td>
<td>2.8</td>
<td>3.1</td>
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</tbody>
</table>

Source: US Census, ZBP
## Trends in W&D activity

<table>
<thead>
<tr>
<th>Year</th>
<th>Los Angeles</th>
<th>San Francisco</th>
<th>Sacramento</th>
<th>San Diego</th>
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<tbody>
<tr>
<td>2003</td>
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<td>34,333</td>
<td>257</td>
<td>9,603</td>
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<td>49,266</td>
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<td>29%</td>
<td>43%</td>
<td>21%</td>
<td>20%</td>
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*W&D = NAICS 493, facilities that store goods and/or provide logistics services*
### Trends in employment/establishment

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<thead>
<tr>
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<td>37.4</td>
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Spatial trends, establishments
Los Angeles

N of warehousing establishments by ZIP code in 2003-2013

Legend

N of Est. by ZIP code

- 1 - 3
- 4 - 8
- 9 - 18
- 19 - 31
- over 32

Data Year

- Data in 2013
- Data in 2003

METRANS
Transportation Center
San Francisco

Map showing the number of warehousing establishments by ZIP code in 2003-2013. The map includes various cities such as San Francisco, Oakland, San Mateo, and others, with different symbols indicating the number of establishments.
## Average distance to CBD (miles)

<table>
<thead>
<tr>
<th></th>
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<th>San Diego</th>
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<td><strong>Establishments</strong></td>
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<td>2003</td>
<td>25.1</td>
<td>33.8</td>
<td>14.3</td>
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<td>2013</td>
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</table>
### Average distance to geographic center (miles)

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<tr>
<td><strong>Establishments</strong></td>
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<td>20.7</td>
<td>28.8</td>
<td>14.7</td>
<td>12.9</td>
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<tr>
<td>2013</td>
<td>22.7</td>
<td>29.5</td>
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<tr>
<td><strong>Employment</strong></td>
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<td>2003</td>
<td>19.3</td>
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<td>8.8</td>
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<tr>
<td>2013</td>
<td>23.0</td>
<td>26.3</td>
<td>13.7</td>
<td>9.8</td>
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</tbody>
</table>
### Results: M1 Decentralization; change 2003-2013

<table>
<thead>
<tr>
<th>Metro area</th>
<th>1-1 Ave distance CBD</th>
<th>1-2a airports</th>
<th>1-2c seaports</th>
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<tbody>
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</tbody>
</table>
### M1-3 Ave distance to WD geo-center, 2003-2013

<table>
<thead>
<tr>
<th>Metro area</th>
<th>1-3 Ave distance WD geo-center</th>
<th>Decentralization with respect to employment, but not establishments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Est</td>
<td>Emp</td>
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<tr>
<td>LA</td>
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<td>SD</td>
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</tr>
<tr>
<td>Metro area</td>
<td>2-1 Ave distance all employment</td>
<td>2-2 Ave distance all population</td>
</tr>
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</tbody>
</table>
## M3 Gini coefficient, change 2003-2013

<table>
<thead>
<tr>
<th>Metro area</th>
<th>3 Gini coeff</th>
<th></th>
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<tbody>
<tr>
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<td>Est</td>
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<tr>
<td>SD</td>
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<td>+</td>
</tr>
</tbody>
</table>

More concentration, but spatial configuration unknown
Share WD establishments in total emp density quartiles

- **LA-2003**
  - 1st Quartile: 39%
  - 2nd Quartile: 12%
  - 3rd Quartile: 46%
  - 4th Quartile: 3%

- **LA-2013**
  - 1st Quartile: 31%
  - 2nd Quartile: 17%
  - 3rd Quartile: 44%
  - 4th Quartile: 7%

- **SF-2003**
  - 1st Quartile: 32%
  - 2nd Quartile: 16%
  - 3rd Quartile: 31%
  - 4th Quartile: 20%

- **SF-2013**
  - 1st Quartile: 28%
  - 2nd Quartile: 22%
  - 3rd Quartile: 23%
  - 4th Quartile: 20%

- **SC-2003**
  - 1st Quartile: 46%
  - 2nd Quartile: 6%
  - 3rd Quartile: 48%
  - 4th Quartile: 17%

- **SC-2013**
  - 1st Quartile: 56%
  - 2nd Quartile: 7%
  - 3rd Quartile: 36%
  - 4th Quartile: 29%

- **SD-2003**
  - 1st Quartile: 50%
  - 2nd Quartile: 17%
  - 3rd Quartile: 32%
  - 4th Quartile: 20%

- **SD-2013**
  - 1st Quartile: 51%
  - 2nd Quartile: 17%
  - 3rd Quartile: 29%
  - 4th Quartile: 29%
Share WD emp in total emp density quartiles

LA-2003
LA-2013
SF-2003
SF-2013
SC-2003
SC-2013
SD-2003
SD-2013

1st Quartile
2nd Quartile
3rd Quartile
4th Quartile
Results summary 1

- **Decentralization**
  - Establishments: consistent evidence of decentralization for LA only
  - Employment: consistent evidence of decentralization for all

- **Land availability and price**
  - Large facilities locating in places where land is more available and cheaper
  - Airports in LA, SF, SD are in/near core
    - Price, demand as push factors
Results summary 2

- Importance of base conditions
  - LA decentralized most, but SF is most decentralized
    - Physical geography likely plays a role
  - Sacramento and SD much smaller, have much lower average densities, and far less decentralized by all measures
    - Labor force access as centralizer

- W&Ds are relatively concentrated
  - Concentration increasing, but spatial patterns differ
Explaining results 1

- Metropolitan size
  - Size correlated with density
  - Density a proxy for demand, land price
  - More land intensive activities are priced out of central locations
  - Zoning may contribute
    - Redevelopment of industrial zones
  - Demand pressures evident in LA, SF, not in Sac, SD
Economic structure

- Largest metro areas are trade centers
- W&Ds oriented to external markets have different location priorities
  - Access to national, international transport system
- LA and SF have more foreign trade than Sac and SD
- LA and SF have larger shares of employment in manufacturing, wholesale/retail trade, transportation
## Commodity flows, 1,000 tons, 2007

<table>
<thead>
<tr>
<th></th>
<th>Internal</th>
<th>Domestic</th>
<th>Foreign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles</td>
<td>434,377</td>
<td>252,711</td>
<td>172,300</td>
</tr>
<tr>
<td>San Francisco</td>
<td>230,374</td>
<td>154,570</td>
<td>62,253</td>
</tr>
<tr>
<td>Sacramento</td>
<td>55,293</td>
<td>73,048</td>
<td>7,242</td>
</tr>
<tr>
<td>San Diego</td>
<td>46,349</td>
<td>37,721</td>
<td>14,003</td>
</tr>
</tbody>
</table>

Internal = origin and destination within zone  
Domestic = origin or destination outside zone, in US  
Foreign = origin or destination outside US  

Source: Freight Analysis Framework, 2007
Physical geography

- LA a vast (5400 mi$^2$) metro area with decentralized population and employment
- SF has bay in center; land availability and access more constrained
- Main foreign trade source in SD is border, a physical constraint to location shifts
- Sacramento is located in flat plain with capacity to expand in all directions, but still plenty of land availability near core
Next steps

- Expand to 100 largest US metro areas
- Develop and estimate models to test factors associated with decentralization, concentration
- Consider methods to estimate impacts of spatial change
QUESTIONS

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