Unraveling decentralization of warehousing and distribution centers
A case study of four metropolitan areas in California

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Research Objective

Warehousing location change and its implications

Question 1: Why should we care about warehousing location change?

Question 2: How can we systematically measure warehousing location change?

Question 3: Are there consistent trends across metropolitan areas?
Question 1
Why should we care about warehousing location change?
Warehousing Location Change Implication

‘To the urban periphery’
Suggests
More freight movements

More Truck travel in metro areas
More potential negative externalities on communities

Why should we be concerned?
Supply Chain Expansion & Restructuring

Factors driving Restructuring
- Economies of Scale
- Advanced info-com-tech
- Advanced transport-tech
- Access to supply chain
- Customer-driven goods production systems
- E-commerce
- Increasing share of high value/low weight goods

Geographically Extensive Supply Chains
- Suppliers-Producers-Distributors-Consumers

System-wide integration
Geographical separation
Search for low costs
From 1970s

Logistics Industry Restructuring Goals
- Scale
- Velocity
- Reliability
To the urban periphery

Trade-offs suggest decentralization.
Question 2

How can we systematically measure warehousing location change?
A (very simplified) metro area

CBD

High density urban core

Low density suburban area
A simple supply chain

CBD

WH: warehouse

High density urban core

Low density suburban area

PORT
Decentralizing warehouses? (Before)

High density urban core

Low density suburban area
Decentralizing warehouses? (After)

- CBD
- High density urban core
- Low density suburban area
- WH
- PORT
- Decentralized warehouses in low density suburban area
Clustering warehouses?

High density urban core

Low density suburban area

Land availability & Zoning suitable for warehousing

Cargo service airport

Port
What if?

Changes in the location of the market?
<table>
<thead>
<tr>
<th>Spatial Structure</th>
<th>Of warehousing establishments</th>
<th>With respect to Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Of warehousing employment</td>
<td>Of warehousing employment</td>
<td>With respect to Population</td>
</tr>
</tbody>
</table>

**Measure 1.**
Decentralization

*Average distance from CBD from geographic center*

**Measure 2.**
Relative decentralization

*Average distance to all employment to all population*

**Measure 3.**
Concentration

*Gini coefficient for warehouses*

**Measure 4.**
Relative concentration

*Gini coefficient difference, between warehousing employment and all employment*
Data

• **ZIP code Business Patterns (ZBP) 2003-2013**
  - Subset of County Business Patterns (CBP)
  - Developed/maintained by Census
  - N of establishment available; Employment imputation (quadratic programming)
  - Centroids at the locations with the highest concentration of activities
  - ZIP code size varies by development density

• **Warehouses?**
  - NAICS “493-Warehousing and storage”
  - Facilities that store goods, and/or provide logistics services

• **Case study areas**
  - Four metro areas in California
    - *Los Angeles CSA, San Francisco CSA, Sacramento CSA, San Diego MSA*
  - Vary in size, industry mix and role in global economy
### Case study areas: Population, Employment & Area

<table>
<thead>
<tr>
<th>Metro area</th>
<th>Los Angeles CSA</th>
<th>San Francisco CSA</th>
<th>Sacramento CSA</th>
<th>San Diego MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>18 M</td>
<td>7 M</td>
<td>3 M</td>
<td>2.5 M</td>
</tr>
<tr>
<td>Employment</td>
<td>7 M</td>
<td>3 M</td>
<td>1 M</td>
<td>1 M</td>
</tr>
<tr>
<td>Notes</td>
<td>The largest international trade node in the U.S.</td>
<td>A major International trade center in higher value goods</td>
<td>A trade node for the central valley</td>
<td>A hub for cross-border trade and industry</td>
</tr>
</tbody>
</table>

*CSA: Combined Statistical Area
*MSA: Metropolitan Statistical Area
## Case study areas: Warehousing Industry

<table>
<thead>
<tr>
<th>Metro area</th>
<th>Los Angeles CSA</th>
<th>San Francisco CSA</th>
<th>Sacramento CSA</th>
<th>San Diego MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warehouses</td>
<td>Warehousing employment</td>
<td>Warehouses</td>
<td>Warehousing employment</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>775</td>
<td>34,333</td>
<td>257</td>
<td>9,603</td>
</tr>
<tr>
<td>2013</td>
<td>1,001</td>
<td>49,266</td>
<td>311</td>
<td>11,476</td>
</tr>
<tr>
<td>%Δ</td>
<td>29%</td>
<td>43%</td>
<td>21%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Los Angeles 2003

N of warehousing employment by ZIP code in 2003

Legend
N of Emp. by ZIP code
- 1 - 100
- 101 - 300
- 301 - 600
- 601 - 1200
- 1201 - 3000
- over 3000

Intermodal facilities
Cargo service airports
Seaports
Apple’s new distribution center in Elk Grove added 1,000+ jobs in 2012-2013.
Question 3
Are there consistent trends across metropolitan areas?
### Results: M1 Decentralization

<table>
<thead>
<tr>
<th>Metro area</th>
<th>Measure 1-1 Average distance from CBD</th>
<th>Measure 1-2 Average distance from Geo-Center of Warehouses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warehouses</td>
<td>Warehousing Employment</td>
</tr>
<tr>
<td><strong>Changes 2003-2013</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Los Angeles</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>San Francisco</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Sacramento</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>San Diego</strong></td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

* Welch’s t-test for statistical significance (unpaired, unequal variance)
## Results: M2 Relative Decentralization

<table>
<thead>
<tr>
<th>Metro area</th>
<th>Measure 2-1 Average distance to</th>
<th>Measure 2-2 Average distance to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Employment</td>
<td>All Population</td>
</tr>
<tr>
<td></td>
<td>Warehouses</td>
<td>Warehousing Employment</td>
</tr>
<tr>
<td>Changes 2003-2013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>San Francisco</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sacramento</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>San Diego</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
## Results: M3 & M4 Concentration

<table>
<thead>
<tr>
<th>Metro area</th>
<th>Measure 3</th>
<th></th>
<th>Measure 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gini Coefficient</td>
<td>Relative Gini Coefficient Difference</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warehouses</td>
<td>Warehousing Employment</td>
<td>Warehouses</td>
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</tr>
<tr>
<td><strong>Changes 2003-2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles</td>
<td>+</td>
<td>+</td>
<td>n/a</td>
<td>+</td>
</tr>
<tr>
<td>San Francisco</td>
<td>+</td>
<td>-</td>
<td>n/a</td>
<td>+</td>
</tr>
<tr>
<td>Sacramento</td>
<td>-</td>
<td>+</td>
<td>n/a</td>
<td>+</td>
</tr>
<tr>
<td>San Diego</td>
<td>+</td>
<td>+</td>
<td>n/a</td>
<td>+</td>
</tr>
</tbody>
</table>

*Gini: Jackknife standard error for statistical significance*
1. Little evidence of consistent warehousing decentralization across four metropolitan areas.
   - Los Angeles: decentralization + concentration true for all measures
   - San Francisco: weak decentralization
   - Sacramento: dispersed centralization
   - San Diego: clustered centralization

2. How you measure matters.

3. Multiple measures provide more information on the nature of the spatial change.

4. Warehousing employment seems more flexible with respect to spatial change than warehouses due to land use regulation.
5. Factors that might drive warehousing decentralization

- Land rent & availability
- Role in international trade
- Local market size – population, industry size and composition
- Costs of congestion and delay
- Land use regulation and tax policy
- Local labor pool
Question?

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