The Scale and Diversity of the Northeast Food Distribution System

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1. Marketing Channels as an Organizing Framework

(aka Supply Chains)

Producers

Processors

Food Manufacturers

Food Service Firms

Consumers

Export

Grocery Retail – Wholesalers
Following the Food Dollar (Canning, 2011)

2008 industry group value-added

"Other" comprises advertising (2.0¢) and legal and accounting (1.8¢).
Key socio-demographic features of the Northeast US
The Northeast: Densely settled and wealthy...

Figure 7.
Population Density by County: 2010
(For information on confidentiality protection, nonsampling error, and definitions, see www.census.gov/prod/cen2010/doc/pl94-171.pdf)

Note: Population density expressed as average number of people per square mile of land area. Source: U.S. Census Bureau, 2010 Census.
Northeast is part of rapid minority population gains

Figure 5.
**Percentage Change in Minority Population by County: 2000 to 2010**
(Counties with a minority population of at least 1,000 are included in the map. Minority refers to people who reported their ethnicity and race as something other than non-Hispanic White alone in the decennial census. For information on confidentiality protection, nonsampling error, and definitions, see www.census.gov/prod/cen2010/doc/p94-171.pdf)
A few stylized facts about the food system
Farmers are shortening the supply chain...
...and not all are served: Example of New York City
2. Supply Chain Establishment Statistics

- Data available from County Business Patterns (U.S. Department of Commerce)
## About the scale and diversity of a food system

### Supply Chains (nested)

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Field/plot, Farm; Firm</th>
<th>County</th>
<th>State</th>
<th>NE-Region</th>
<th>Nation/Globe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer/ Farmer</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Processor/ Manufact.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Wholesale- Retail</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Consumer</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

- **Scale**: Local → Regional → National/global
- **Level**: Field/plot, Farm; Firm → County → State → NE-Region → Nation/Globe
The U.S. Supply Chain for Meat Products, 2009

Map prepared by Hamideh Etemadnia
The U.S. Supply Chain for Meat Products, 2009

Map prepared by Hamideh Etemadnia
The U.S. Supply Chain for Meat Products, 2009

Map prepared by Hamideh Etemadnia
**Gini-Simpson Index (1 - \( \lambda \)) of Meat Products Supply Chain Diversity**

**The US**

**The US without NE**

**Northeast only**

Based on the share of different types of establishments in the supply chain relative to the total number of establishments in county \( i \). Prepared by Hamideh Etemadnia, The Northeast Regional Center for Rural Development.
3. Insights from Network Science

- Supply chains as *networks* of firms
- *Scale* and *diversity* have specific meanings
- Random vs. scale-free networks
- Diversity: small vs. large supply chains
  - Sysco and WalMart
  - Small producer niche networks
For a given network, $P(k)$ is the fraction of nodes that have $k$ links. $P(k)$ is a connectivity distribution or probability that a randomly chosen node in a network has $k$ links.
For a given network, \( P(k) \) is the fraction of nodes that have \( k \) links. \( P(k) \) is a connectivity distribution or probability that a randomly chosen node in a network has \( k \) links.
Wal-Mart has perfected the hub-and-spoke system or scale-free network structure

- “Warehouse-on-wheels”
- 35 food distribution centers (hubs) serve 3,090 Supercenters at the end of the spoke (links)
- Goal: Stores within one day’s drive of a DC (hub)
Perils of a scale-free network: *Tomato Plant Blight*, Summer 2009

- Large retailers buy starter plants from industrial breeding operations in the South and distribute them in the Northeast.
- Example of “tightly coupled” incident: failures in one part of the system quickly multiply.
- With consolidated food chain (only a few big meat producers): E. coli can quickly and widely spread.
Sysco is the global leader in selling, marketing and distributing food products to restaurants, healthcare and educational facilities, lodging establishments and other customers who prepare meals away from home.

Distribution Centers

http://www.sysco.com/investor/OnlineAnnual2011/at-a-glance.html
Simulating how optimal hub scale and diversity change with...

- changes in processing technology
- changes in distance requirements
- changes in fuel prices
Optimal Hub Location Simulations (Meat Products)

Hub capacity fixed at 40 tons
Unlimited shipping distance

Hub capacity expanded to 150 tons

Optimal Hub Location Simulations (Meat Products)

Max. shipping dist. = 200 miles (fixed hub capacity)

Max. dist. = 100 miles

Examples of *self-organizing networks*: Small scale/niche food operations in the Northeast

Birds flocking, an example of self-organization in biology (*Source: Wiki*)
Northeastern Food Supply Chains (examples of networks)

Principle of Self-Organizing

Distribution Networks of Four NE Supply Chains

Map prepared by David Fleming, The Northeast Regional Center for Rural Development; http://nercrd.psu.edu
Topological phase transitions of networks

- Random graph
- Scale-free network
- Star network
- Subgraphs

After Csermely (2009)
Network Graphs

Pennsylvania Women’s Agricultural Network

Chesapeake Fields

TOG

Source: Goetz et al. (forthcoming)
Summary: NE Food Distribution System

- A diverse system:
  - Large and small scale (parallel to production ag)
  - Highly efficient, but does not reach all consumers and is potentially vulnerable
- Pronounced trend towards Supercenter and Big-box formats
- Small niche operators/supply chain are thriving
Thank you

Questions?

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