Lessons from Network Science for Helping Entrepreneurs to Connect

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Supply Chains or food systems and subsectors are in fact networks

The science of networks

Real world applications

Concluding thoughts
Networks and Supply Chains
Consider a food system (not a new idea)

Tart Cherry Marketing Channels (or Sub Sector)

A Food System or supply chain is in fact a network of entrepreneurs

Tart Cherry Marketing Channels (or Sub Sector)

Figure 3-9. Organization and Coordination of Broiler and Egg Subsectors
Other examples

Source: Cook et al. 1978.

Figure 3-2. Marketing Channels for Grade A Milk

* 86% of U.S. supply is from producers directly.
+ Four largest processors of packaged fluid milk had 60% of fluid milk shipments in 1977. Fifteen through eighth had 12%.
* Largely private label.
+ Convenience stores, dairy stores, vending machines, etc.

- Surplus-to-manufacturing plants, coop. (59%)
- Other processes, regular.
- Retail chain processors.
- Retail stores—corporate chains.
- Retail stores—voluntary chains & coop. buying groups.
- Retail stores—other.
- House to house deliveries.
- Institutions and restaurants.
- Schools and government installations.
Figure 3–15. Channels Making Up the Potato Subsector
What is New

- Understanding value or supply chains as networks
- Networks—both social and economic
- Provides a new set of tools for analyzing & enhancing entrepreneurial efforts
- Examine entrepreneurs’ roles and possibilities within a network, instead of being an “isolate”
What can we learn from network and complex systems science to help entrepreneurs understand where they should spend their time developing relationships?
The Science of Networks

Nodes

Links
Alternative Potential Structures of Networks (Value Chains)

Each node represents a person; each line represents a potential channel for interpersonal communication. The most central node in each network is colored black (darkest).

Network Analysis: “Kite Diagram”

Measures:
1. Degrees – number of direct connections
2. Betweenness – quality of direct connections
3. Closeness – degrees of separation (lengths of communication paths)

Source: After Krackhardt (2008)
**Actor degree centrality**

\[
C_D(n_i) = d(n_i) = x_{i+} = \sum_j x_{ij} = \sum_j x_{ji}
\]

Standardization measures are independent of \( g \) and can be compared across networks of different sizes:

\[
C_D'(n_i) = \frac{d(n_i)}{g - 1}
\]

Group degree centralization:

\[
C_D = \frac{\sum_{i=1}^g [C_D(n^*) - C_D(n_i)]}{\max \sum_{i=1}^g [C_D(n^*) - C_D(n_i)]}
\]

**Actor betweenness centrality**

\[ C_B(n_i) = \sum_{j<k} g_{jk}(n_i) / g_{jk} \]

**Group betweenness centralization**

\[ C_B = \frac{2 \sum_{i=1}^{g} [C_B(n_i) - C_B(n_i)]}{[(g-1)^2(g-2)]} \]

**Actor closeness centrality**

\[ C_C(n_i) = \left[ \sum_{j=1}^{g} d(n_i, n_j) \right]^{-1} \]

The sum of distances from actor \( i \) to all the other actors (\( d \) is a distance function). Index of group closeness:

\[ C_C = \frac{\sum_{i=1}^{g} [C'_C(n_i) - C'_C(n_i)]}{[(g-2)(g-1)/(2g-3)]} \]

\( g_{jk} = \) number of geodesics linking two actors
Network Analysis: Measures of Centrality

Source: After Krackhardt (2008)
A Network of Connectors Linked by Weak Ties

Network types, and why they matter
Examples of A) random and B) scale-free 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.
Topological phase transitions of networks

After Csermely (2009)
Real-World Applications
2009 Northeast Local Foods Conference (LFC): Pre-Conference Network (N~100)

Total number of ties: 629

"Isolates", made new connections at the event

The total number of ties increased from 629 to 1,429

LFC: Post-Conference Network: Homophily

Suppose there are at least two distinct subgroups or “affinity” networks.

If these two groups can learn from one another, how can they be linked?

Local Foods Conference:

*A few have many connections, many have few*

The number of other participants with whom the respondent had worked or “connected” prior to the conference.

Prior connections and new connections made at the conference.

Source: K Brasier and S Goetz, *LFC Technical Report, 2010*
Another example of the potential to use networks...
versus...

Beyond cooperatives (clusters): Information sharing/learning Compete AND cooperate Regional branding Influence legislation

Photo courtesy of: ces.ca.uky.edu/Lee/AgNaturalResources
Distribution Networks of Five Northeast Supply Chains

Basic data: Clancy and Ruhf, 2010

Map prepared by David Fleming, The Northeast Regional Center for Rural Development; http://nercrd.psu.edu
Northeastern Food Supply Chains (more examples of networks)

Map prepared by Pamela K. Hileman, The Northeast Regional Center for Rural Development; http://nercrd.psu.edu

AD-Angello’s Dist.
AMH-American Mussel Harvesters
BB-Borealis Breads
BH-Basis Holdings LLC
CADE-Center for Agriculture Development and Entrepreneurship, Inc.
CB-Chenango Bounty
CF-Chesapeake Fields
CJH-Cellars at Jasper Hill
COM-Crown O’Maine
CROPP-Organic Valley Coop. East
DR-Deep Root Organic Truck Farmers
EB-Earth Brokers, LTD
EFC-Evans Farmhouse Creamery and Maple Sugar House
FC-The Farmers Cow Cooperative
Fchef-Farm to Chef
FF-Farm Fresh Connection LLC
FPC-Fresh Point Connection
FL-Finger Lakes Organic Grower Coop.
HVA-Hawthorne Valley Association
HVT-Hardwick VT Cluster
IF-Isadore Foods LLC
OD-Oakhurst Dairy
PFNM-Pineland Farms Natural Meats
PVMM-Pioneer Valley Milk Marketing
RAI-Regional Access, Inc.
RFMC-Rhody Fresh Milk Cooperative
RH-Red Hen Baking Company
RT-Red Tomato, Inc.
RP-Real Pickles
RVF-CT River Valley Foods
SMC-Silvery Moon Creamery
SRM-South River Miso, Inc.
TOG-Tuscarora Organic Growers
WF-Whole Foods, Inc.
TOG Business Network Map

Vegetables, herbs, flowers sold to: Restaurants, Retail, Schools; Wegmans
Farmers sell to one another, supporting roadside stands

Bus tours, Field days

Processing, loading, sorting, scheduling, marketing, etc.

Tuscarora Organic Growers Incorporated 1993
Local. Quality. Integrity.
7 Board Members** (list)

James Crawford, Founder

David Robb* – General manager
Lee Armstrong – Grower coordinator
Tony Ricci – Account manager/marketing
Shawn Rogers – Accounts payable
Teresa Showalter – Operations manager
Reina Dudley – Sales
*replaced Chris Fullerton in 2007

Parallel Sales (10-20%)

Crop Improvement Meetings

Keystone Development Agency ($)
McCormick & Schmick’s Seafood Restaurant - Washington, DC

McCormick & Schmick’s Seafood Restaurant brings the freshest seafood dining to Washington, D.C. at its K Street location, right next to Farragut Square and just two blocks from the White House.

Open for lunch and dinner, McCormick & Schmick’s Seafood Restaurant offers our guests a selection of seafood favorites at the peak of their seasons, including Alaskan Halibut, Northwest Salmon, Hawaiian Mahi Mahi, Oregon Petrale Sole and many other specialties, including aged steaks, pastas and antipasto salads.

Named by Washingtonian Magazine’s readers as “Best Seafood Restaurant” and “Best Happy Hour,” this classic downtown DC restaurant is the “too and be seen” restaurant in the heart of the city.

Plan your next corporate event or social gathering in one of our private or semi-private dining rooms. We will work with you to choose the right seafood, poultry, beef and pasta selections to provide a custom menu that is sure to please your guests.

When you are ready to experience the best seafood dining in Washington DC, book a reservation online or call us to reserve a table.

This Location is Now Hiring!

* A couple of decades ago it was impressive enough a seafood restaurant used fresh rather than frozen ingredients, but McCormick & Schmick’s promises more: "worth a visit"—Phyllis Richman, Washington Post
Chesapeake Fields Business Network Map

Parallel Sales (80-90% of production)

Soy saucers, Bread (artisan), Popcorn

Natto Beans (Japan)

Foreign Visitors, farm visits

Montigue Farms, VA

Department of Ag., Tourism, DBED, other

North Dakota

Dr. Neil Doty

Pennsylvania

Univ. of MD, DE; Wash. College

Chesapeake Fields Farmers Cooperative (CFF)
Preservation through Profitability
F. Evans, President

John Hall, Leader

Chesapeake Fields Institute (CFI)
J. Hall, Executive Director

Winter meetings w/ farmers

IP protocols

Quality standards, farmer commitments

Ed Fry

Bill Susan

Bill Cooper

Chris Hagameyer

Roy Crowe

33 Farmers

Farm sizes range from 100-500 acres

Farm, consumer, & resident education

Spillover benefits to other farmers

Farmer comm

Corn, wheat, soybeans

55 Investors (including non-farmers)

Chesapeake Fields
LLC
Joe Bower, President

D. Tompkins – VP
Lansing Williams – CFO
Joseph Goetz – Director of Sales
New business a/c mgr.
Other

Inputs: Seed (wheat, soybeans, corn); Sillinger Seed

Bill Susan

Spillover benefits to other farmers

Farmer, consumer, & resident education

D. Tompkins – VP
Lansing Williams – CFO
Joseph Goetz – Director of Sales
New business a/c mgr.
Other

Inputs: Seed (wheat, soybeans, corn); Sillinger Seed
What about the underlying networks?
Network Graphs

Pennsylvania Women’s Agricultural Network

Chesapeake Fields

TOG

Source: Goetz, Brasier, Raboanarielina and Rangarajan (forthcoming)
Using Network Analysis

• Time = perhaps the single most important resource for the entrepreneur
• How does an entrepreneur decide whether or not to invest the time required to enter into a business transaction with another person?
• Question of benefit vs. cost: How can these be assessed given limited information?
• Understanding networks gives new meaning to “market” intelligence
How to collect the data?

• From whom to you source inputs?
• To whom do you deliver outputs?
• Who do you go to for market information?
  - Individual A
  - Individual B
  - Individual C
  - Individual D
  - Individual E
  - Individual F
  - __________
  - __________

• Use software such as UCINet

Leave empty (to be filled in)
Concluding Thoughts (1) within the Ag. Value Added/Econ. Dev. context

- Making connections within food supply chains and discovering new markets is a challenge, but potential payoffs are high.

- Requires entrepreneurs who understand the local landscape, plus distant markets and networking (connecting) people.

- Mapping and understanding networks of key individuals (hubs) is a starting point.
Networks do not emerge and grow spontaneously

- Much that we do not know about their formation
- Entrepreneurship: reconciling opportunities vs. transactions (information) costs and barriers to entry
- Networking helps!
Network science can provide new insights...

• Importance of weak ties
• Importance of individual nodes (hubs)
• Law of preferential attachment (rich get richer)
• Fit get fitter, and richer (more connections)
• Focus on individual’s position within network(s) rather than only his or her individual characteristics