Who cultivates the inter-firm networks in regional cluster?
-Innovation and Social Networks-

Ichiro Sakata

Innovation Policy Research Center (IPR-CTR)
Graduate School of Engineering
University of Tokyo
Japan
Outline

1. Background
2. Aim & Scope
3. Data & Methods
4. Results
5. Discussions
6. Conclusion
1. Background

Regional cluster as a recipe for industrial innovation in region

<table>
<thead>
<tr>
<th>Country</th>
<th>Program</th>
<th>Time Span</th>
<th>Regions</th>
<th>Major contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A.</td>
<td>Clusters of Innovation</td>
<td>2001</td>
<td>All regions</td>
<td>Benchmark of regions</td>
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<td>Germany</td>
<td>BioRegio</td>
<td>1995~</td>
<td>3 regions</td>
<td>Selective funding to the regions</td>
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<tr>
<td></td>
<td>InnoRegio</td>
<td>1999~</td>
<td>23 regions</td>
<td>Selective funding to the regions</td>
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<td>Finland</td>
<td>Science Park</td>
<td>1982~</td>
<td>14 regions</td>
<td>Industry–Academy relationships Incubation</td>
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<td>Japan</td>
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<td>2001~</td>
<td>18 regions</td>
<td>Industry–Academy relationships Incubation</td>
</tr>
<tr>
<td></td>
<td>Intelligent cluster</td>
<td>2002~</td>
<td>12 regions</td>
<td>Collaboration among organizations intellectual property</td>
</tr>
</tbody>
</table>
Clusters are geographic concentrations of interconnected companies and institutions in a particular field.
(M.E. Porter, HBR, 1998)

Definition of regional clusters

agglomeration
cluster

weakly bounded
tightly interconnected
Previous works 1

Network as a locus of innovation

1. Information and knowledge dissemination and sharing (ex. Podolny and Page, 1998; Dyer and Nobeoka, SMJ 2000).
3. Cooperation (Nishiguchi and Beaudet, SMR 1998)
4. Robustness (Albert and Barabási, 2002)
Previous works 2

Accumulating evidence on the relationships between network and performance

• Centrality and firm growth

• Centrality and innovativeness
  Tsai (AMJ 2001)       Bell (SMJ 2005)
Limitations of previous works

- Small data set (case study approach) (~500 nodes)
- Lack of details in network structure (macroscopic)
- Lack of the networking mechanism

Our focuses in this study

- Comparative study with a large data set (~50,000 nodes in total)
- From micro-, meso-, to macro-structures of networks
- Elucidation of networking mechanism
2. Research Purpose

1. System development to monitor the development of regional clusters and analyze deeper structures of them from macro-, meso-, to micro-levels.

2. Evaluation of regional clusters in Japan from a network perspective.

3. Elucidation of networking mechanisms by a comparative study.
3. Data & Methods

**Scope**

**Inter-firm networks**

*(supplier-customer relationships)*

Network = Nodes + Links

Organizational network

Node = Organization *(Firms, University, Public research institute)*

Link = Relationships *(Customer-Supplier, Alliance, Managerial Board, etc.)*
Why supplier-customer relationships?

→ the best information channel for Japanese firms.

<table>
<thead>
<tr>
<th>Information channels</th>
<th>Firm A</th>
<th>Firm B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact with customers and outsourcing contractors</td>
<td>71.9</td>
<td>63.4</td>
</tr>
<tr>
<td>Inter-industry exchange</td>
<td>23.0</td>
<td>36.6</td>
</tr>
<tr>
<td>Meetings of chambers of commerce and industry and other industry associations</td>
<td>23.4</td>
<td>32.0</td>
</tr>
<tr>
<td>Meetings of associations and other trade bodies</td>
<td>29.1</td>
<td>31.4</td>
</tr>
<tr>
<td>Exchanges with friendly enterprises at the personal level, etc.</td>
<td>23.7</td>
<td>29.4</td>
</tr>
<tr>
<td>Exchanges with financial institutions</td>
<td>16.2</td>
<td>25.5</td>
</tr>
<tr>
<td>Meetings of entrepreneurs in the same region</td>
<td>22.3</td>
<td>22.9</td>
</tr>
<tr>
<td>Lectures and other events</td>
<td>16.5</td>
<td>19.6</td>
</tr>
<tr>
<td>Exchange with universities and public research facilities</td>
<td>8.6</td>
<td>17.6</td>
</tr>
<tr>
<td>Technology workshops</td>
<td>10.4</td>
<td>13.1</td>
</tr>
</tbody>
</table>

A: not entering a new field. B: entering a new field.

Source: Small and Medium Enterprise Agency (2006)
### 18 clusters

<table>
<thead>
<tr>
<th>#</th>
<th>Region</th>
<th>Main industrial category</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Osaka</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>B</td>
<td>Chukyo</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>C</td>
<td>Kinki</td>
<td>Pharmaceutical &amp; Medical</td>
</tr>
<tr>
<td>D</td>
<td>Hiroshima-Okayama</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>E</td>
<td>North-Kyushu</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>F</td>
<td>Hukuoka</td>
<td>Environment</td>
</tr>
<tr>
<td>G</td>
<td>Hokkaido</td>
<td>Pharmaceutical &amp; Agriculture</td>
</tr>
<tr>
<td>H</td>
<td>Nagano</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>I</td>
<td>Niigata</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>J</td>
<td>Sapporo</td>
<td>Pharmaceutical &amp; Agriculture</td>
</tr>
<tr>
<td>K</td>
<td>Kyoto</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>L</td>
<td>Toyama</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>M</td>
<td>Sapporo</td>
<td>Information Technology</td>
</tr>
<tr>
<td>N</td>
<td>Hamamatsu</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>O</td>
<td>Hukuoka</td>
<td>Medical Device</td>
</tr>
<tr>
<td>P</td>
<td>Aomori</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Q</td>
<td>Yamagata</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>R</td>
<td>Okinawa</td>
<td>Food</td>
</tr>
</tbody>
</table>
3. Data & Methods

Data (from NTT & Teikoku DB)

I Network construction
(extraction of the maximum connected component)

II Visualization of Networks

IV Clustering the network
(extraction of modules)

III Network Analysis

IIIa Density
IIIb Path length
IIIc Clustering coefficient

VI Module Analysis

VIa Inter-module coordination
VIb Connector-Hub analysis

V Visualization of modules
3. Data & Methods

Measures of network structure

• Density (DEN)  Closure of regional economy
  
  Def DEN = number of links per node

• Path length ratio (PLR)  Efficiency of resource allocation
  
  Def PLR = average path length (random network)/
  average path length (real network)

• Clustering coefficient ratio (CCR)  Robustness of regional economy
  
  Def CCR = clustering coefficient (real network)/
  average coefficient (random network)

• Inter-module coordination (IMC)  Density of the connections among modules
  
  Def IMC = 1/modularity
### 4. Results

#: Cluster ID, \( n \): number of nodes, \( K \): number of links

<table>
<thead>
<tr>
<th>#</th>
<th>Region</th>
<th>Main industrial category</th>
<th>( n )</th>
<th>( K )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Osaka</td>
<td>Manufacturing</td>
<td>8,834</td>
<td>43,092</td>
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<td>B</td>
<td>Chukyo</td>
<td>Manufacturing</td>
<td>7,914</td>
<td>34,162</td>
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<td>C</td>
<td>Kinki</td>
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<td>5,437</td>
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<td>D</td>
<td>Hiroshima-Okayama</td>
<td>Manufacturing</td>
<td>3,553</td>
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<td>North-Kyushu</td>
<td>Manufacturing</td>
<td>3,275</td>
<td>13,420</td>
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<td>Hukuoka</td>
<td>Environment</td>
<td>3,272</td>
<td>14,226</td>
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<tr>
<td>G</td>
<td>Hokkaido</td>
<td>Pharmaceutical &amp; Agriculture</td>
<td>2,038</td>
<td>7,740</td>
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<tr>
<td>H</td>
<td>Nagano</td>
<td>Manufacturing</td>
<td>1,933</td>
<td>10,018</td>
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<td>I</td>
<td>Niigata</td>
<td>Manufacturing</td>
<td>1,898</td>
<td>8,426</td>
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<td>J</td>
<td>Sapporo</td>
<td>Pharmaceutical &amp; Agriculture</td>
<td>1,871</td>
<td>6,086</td>
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<tr>
<td>K</td>
<td>Kyoto</td>
<td>Manufacturing</td>
<td>1,798</td>
<td>7,362</td>
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<td>L</td>
<td>Toyama</td>
<td>Pharmaceutical</td>
<td>1,397</td>
<td>5,364</td>
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<tr>
<td>M</td>
<td>Sapporo</td>
<td>Information Technology</td>
<td>1,113</td>
<td>3,820</td>
</tr>
<tr>
<td>N</td>
<td>Hamamatsu</td>
<td>Manufacturing</td>
<td>1,049</td>
<td>4,080</td>
</tr>
<tr>
<td>O</td>
<td>Hukuoka</td>
<td>Medical Device</td>
<td>931</td>
<td>2,702</td>
</tr>
<tr>
<td>P</td>
<td>Aomori</td>
<td>Agriculture</td>
<td>673</td>
<td>2,164</td>
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<tr>
<td>Q</td>
<td>Yamagata</td>
<td>Manufacturing</td>
<td>625</td>
<td>2,078</td>
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<tr>
<td>R</td>
<td>Okinawa</td>
<td>Food</td>
<td>527</td>
<td>2,594</td>
</tr>
</tbody>
</table>
4. Results

DEN: Density, IMC: Inter-module coordination
PRL: Path length ratio, CCR: Clustering coefficient ratio

---

DEN vs. #node

---

IMC vs. #node

---

PRL vs. #node

---

CCR vs. #node
Summary on the size effect of regional network

- As cluster sizes increases, PRL and CCR strongly increases.
- Efficiency of resource allocation
- Robustness of regional economy
- DEN and IMC slightly increases.
- Closure of regional economy
- Connection among modules

- In small clusters, A large variance in network structures.
- There is a room improving regional networking by political support.
5. Discussions

What determines the variance in small clusters?

Well structured and not-well structured networks

- Well-structured: Nagano, Hamamatsu, Okinawa
- Not-structured: Hiroshima-Okayama, Sapporo, Hukuoka
Connector-Hub analysis

Hub (Leader in the module)

Nagano

Hamamatsu

Okinawa

Hiroshima-
Okayama

Sapporo

Hukuoka

Connector (linking modules)
Connector-Hub analysis

Nagano

Hamamatsu

Okinawa

Provincial Hub

Connector Hub

Hub (Leader in the module)

Connector (linking modules)
Comparison of modular structures

Ex. Nagano
1,930 firms

○ Number of firms in each module
— Strength of ties between modules

Fujitsu, Toshiba, NEC

Techno-Excel

Kitz

Nihon-Densan-Sankyo, Tamagawa-Seiki

Nihon-Densan-Kopal

Nihon-Dennetsu

Mitsubishi-electronics

Yuasa-Shoji

Chinon-Tech

Shinko-Denki, Nisse-Jushi

Seiko-Epson
Comparison of modular structures

Ex. Hamamatsu
1,049 firms

Number of firms in each module
Strength of ties between modules
Comparison of modular structures

Ex. Okinawa
527 firms

○ Number of firms in each module
— Strength of ties between modules

- Zima, Nanto-Syuhan, Orion-beer
- Nettai-Shigen-Syokubutsu-Kenkyujo San-Bio
- Kinki-Nihon-Tourist
- Okinawa-Mitsukoshi
- Coca-Cola-Bottling
- Nokogiri
- Mitsui-Bussan
- Okinawaken-Bussan-Kousya
- Daimon-Shouji
- Mitsubishi-Shoji, Itouyu
- Kanehide-Bio
- Okinawa-Nougyou-Kyoudou-Kumiai
- Ryukyu-Jasco
- Okinawa-Kyoudou-Seika
Comparison of modular structures

Ex. Hiroshima-Okayama
3,553 firms

- Number of firms in each module
- Strength of ties between modules
Comparison of modular structures

Ex. Sapporo
1,871 firms

○ Number of firms in each module
— Strength of ties between modules

- Mitsui-Bussan
- NEC
- Fujitsu
- Toppan
- Suzuken
- Higashi-Nihon-House
- Kawasaki-Docon
- Tanbaya
- Air-Water
- Kaneshime-Takahashi-Suisan
- Oryx
- Higashi-Nihon-House
- Tanbaya
- Visual-Systems
- Houkensyo
- Hokuren
- Higashi-Nihon-House
- Tesk
- Kuwazawa-Kougyou

Number of firms in each module
1,871 firms
Ex. Sapporo
Comparison of modular structures

Ex. Hukuoka
931 firms

Kyudenko

Itou-Tyouonpa

Organo

Suzuken

Mitsui-Bussan

Sanix

Hitachi

Toshiba-Medical

Nakagawa-Kenzai

Toshiba

Cannon

Sumitomo-Shouji

Nishitele-Information-Service

Nihon-Arcon

Nihon-Kayaku

Syoukou

Nihon

Arcon

○ Number of firms in each module
— Strength of ties between modules
Propositions

Regional networking can be improved by the existence of;

1. Connector-hub firms

2. Headquarters of them in the region.
<table>
<thead>
<tr>
<th>Rank</th>
<th>Prefecture</th>
<th>#</th>
<th>Rank</th>
<th>Prefecture</th>
<th>#</th>
<th>Rank</th>
<th>Prefecture</th>
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<td>Tokyo</td>
<td>1964</td>
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<td>Gunma</td>
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<td>16</td>
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<td>64</td>
<td>25</td>
<td>Ibaraki</td>
<td>15</td>
<td>41</td>
<td>Miyazaki</td>
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<td>10</td>
<td>Hokkaido</td>
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<td>26</td>
<td>Yamaguchi</td>
<td>14</td>
<td>42</td>
<td>Nara</td>
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<td>Chiba</td>
<td>56</td>
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<td>Shiga</td>
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<td>32</td>
<td>Iwate</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Normalized number of headquarters of public firms

# of headquarters / # of worker population

# of worker population

Tokyo

Kyoto

Hokuoka

Hyogo

Osaka

Shizuoka

Aichi

Kanagawa

Saitama

Chiba

Hokkaido
6. Conclusion

1. System development: Our tool includes indices (density, clustering coefficient, path length, Inter-module coordination, connector-hub), and visualization (network & module).

2. Evaluation of network structures of 18 regional clusters in Japan.

3. Elucidation of networking mechanism: network structures are dependent of cluster size (# of firms), especially in the nascent stage of development, and they are determined by the existence of connector-hub firms not but provincial hub firms, and headquarters of hub firms in the region.

4. Implication: Policy for networking is effective for small clusters. To develop dense networks, rearing regional firm or attracting headquarters from the other regions especially Tokyo is necessary.
Limitations and future works

Limited Scope: Supplier-Customer relationships among firms

→ Extended network analysis

Multiple layer structures of network consisting of various types and scopes of nodes and links

Visible layer
- Organization
- Contract (Transaction, Joint research, etc.)

Invisible layer
- Human
- Technology

Other regions
- Other countries

Extended network analysis

Other layers and regions are not shown in the diagram for simplicity.
Thank you for your listening!

Any questions, comments, suggestions, and proposals are welcome!

Innovation Policy Research Center (IPR-CTR)
University of Tokyo, Japan