What is a cluster (PoE)?
Structure and dynamics of industrial agglomerations

Mario A. Maggioni
DISEIS
(Dept. of International Economics, Institutions and Development)

CSCC
(Cognitive Science and Communication research Centre)
If so, then Sevilla is the right place to held such a meeting since Luis Buñuel set the action of the movie in this city.

why Clusters are so appealing?

1. Escape from globalization traps: internalization of regional production systems as gradual global extension of local inter-firm relationships at local and interregional level

2. Fits perfectly in the NEG paradigm: space does (positively) matter in economic decisions and theories

3. It has an impressive political “plasticity”: Left (critics of Anglo-Saxon MoC); Right (against big government); Decentralisation/regionalism; “Small is beautiful”; 3rd way
Thousand of different definitions
Rosenfeld (1997, p. 4) “A cluster is very simply used to represent concentrations of firms that are able to produce synergy because of their geographical proximity and interdependence, even though their scale of employment may not be pronounced or prominent.”

Porter (1998, p. 199) “A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities”.

Feser (1998, p. 26) “Economic clusters are not just related and supporting industries and institutions, but rather related and supporting institutions that are more competitive by virtue of their relationships.”

Swann and Prevezeer (1998, p. 1) “A cluster means a large group of firms in related industries at a particular location”.

Simmie and Sennett (1999a, p. 51) “We define an innovative cluster as a large number of interconnected industrial and/or service companies having a high degree of collaboration, typically through a supply chain, and operating under the same market conditions.”

Roelandt and den Hertag (1999, p.9) “Clusters can be characterised as networks of producers of strongly interdependent firms (including specialised suppliers) linked each other in a value-adding production chain.”

Bresnahan et al. (2001, p. 836) “a spatial and sectoral concentrations of firms”

Maggioni and Riggi (2008) “From an empirical perspective, the best way to identify a cluster – and an innovative cluster in particular – is to analyse the complex nexus of interdependences among producers, sub-suppliers along a territorially identified value chain through an in depth case study. However, when statistical and econometric analyses of the macro-behaviour of all innovative clusters in a country have to be performed, one should resolve in using an “aggregate” and standard definition of cluster based on the presence in a given area of a significant number of firms (level of employment) belonging (relative) to a certain industry”
A series of temptative taxonomies
<table>
<thead>
<tr>
<th>Cluster Type Growth</th>
<th>Characteristics of Member Firms</th>
<th>Intra-cluster Interdependencies</th>
<th>Prospects for Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshallian</td>
<td>Small and medium-sized locally owned firms</td>
<td>Substantial interfirn trade and collaboration, strong institutional support</td>
<td>Dependent on synergies and economies provided by cluster</td>
</tr>
<tr>
<td>Hub and Spoke</td>
<td>One or several large firms with numerous smaller suppliers and service firms</td>
<td>Cooperation between large firms and smaller suppliers on terms of the large firms (hub) firms</td>
<td>Dependent on growth prospects of large firms</td>
</tr>
<tr>
<td>Satellite Platforms</td>
<td>Medium- and large-sized branch plants</td>
<td>Minimum interfirn trade and networking</td>
<td>Dependent on ability to recruit and retain branch plants</td>
</tr>
<tr>
<td>State-anchored</td>
<td>Large public or non-profit entity and related supplying and service firms</td>
<td>Restricted to purchase-sale relationships between public entity and suppliers</td>
<td>Dependent on region’s ability to expand political support for public facility.</td>
</tr>
</tbody>
</table>

Source: Markusen (1996)
Table 1. Industrial clusters

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pure agglomeration</th>
<th>Industrial complex</th>
<th>Social network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm size</td>
<td>Atomistic</td>
<td>Some firms are large</td>
<td>Variable</td>
</tr>
<tr>
<td>Characteristics of relations</td>
<td>Non-identifiable</td>
<td>Identifiable</td>
<td>Trust</td>
</tr>
<tr>
<td></td>
<td>Fragmented</td>
<td>Stable and frequent trading</td>
<td>Loyalty</td>
</tr>
<tr>
<td></td>
<td>Unstable</td>
<td></td>
<td>Joint lobbying</td>
</tr>
<tr>
<td></td>
<td>Frequent trading</td>
<td></td>
<td>Joint ventures</td>
</tr>
<tr>
<td>Membership</td>
<td>Open</td>
<td>Closed</td>
<td>Non-opportunistic</td>
</tr>
<tr>
<td>Access to cluster</td>
<td>Rental payments</td>
<td>Internal investment</td>
<td>History</td>
</tr>
<tr>
<td></td>
<td>Location necessary</td>
<td>Location necessary</td>
<td>Experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Location necessary but not</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sufficient</td>
</tr>
<tr>
<td>Space outcomes</td>
<td>Rent appreciation</td>
<td>No effect on rents</td>
<td>Partial rental capitalization</td>
</tr>
<tr>
<td>Example of cluster</td>
<td>Competitive urban economy</td>
<td>Steel or chemicals production complex</td>
<td>New industrial areas</td>
</tr>
<tr>
<td>Analytical approaches</td>
<td>Models of pure agglomeration</td>
<td>Location-production theory</td>
<td>Social network theory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Input–output analysis</td>
<td>(Granovetter)</td>
</tr>
<tr>
<td>Notion of space</td>
<td>Urban</td>
<td>Local or regional but not urban</td>
<td>Local or regional but not urban</td>
</tr>
</tbody>
</table>

An explosive growth of the literature

Figure 1: Number of Articles on clusters

Source: Maggioni et al. (2009)
The “basic” theory ...

Marshall’s Triad of External Economies of Industrial Localisation
(Based on Marshall, 1890, Book Four, Ch. X)

- Local Pool of Specialised Labour
  - Accumulated skills
  - Local Market for special workers

- ‘Local Industrial Atmosphere’
  - Localised knowledge accumulation
  - Creation of new ideas and business methods

- Local Supporting and Ancillary Trades
  - Supply of inputs
  - Organisation of trade

- Local Inter-firm Division of Labour
  - Specialisation in different branches of production
  - Use of specialised machinery

... and the harsh reality

Table 1. London business perceptions of advantages and disadvantages of proximity to related activities, by sector (percentages)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Advantages from</th>
<th></th>
<th>Net advantage from</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shared</td>
<td>Interaction</td>
<td>Customer</td>
<td>Competition</td>
</tr>
<tr>
<td></td>
<td>intelligence</td>
<td>potential(^a)</td>
<td>attraction(^b)</td>
<td>Competition(^c)</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>7</td>
<td>3</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>5</td>
<td>3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Construction</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>—10</td>
</tr>
<tr>
<td>Wholesale distribution</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>—7</td>
</tr>
<tr>
<td>Retailing</td>
<td>4</td>
<td>5</td>
<td>12</td>
<td>—6</td>
</tr>
<tr>
<td>Hotels and catering</td>
<td>2</td>
<td>6</td>
<td>37</td>
<td>—1</td>
</tr>
<tr>
<td>Non-air transport</td>
<td>9</td>
<td>4</td>
<td>1</td>
<td>—10</td>
</tr>
<tr>
<td>Air transport</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Financial services, City and fringe</td>
<td>37</td>
<td>10</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Financial services, rest of London</td>
<td>18</td>
<td>12</td>
<td>—</td>
<td>—9</td>
</tr>
<tr>
<td>Professions</td>
<td>26</td>
<td>4</td>
<td>—</td>
<td>—4</td>
</tr>
<tr>
<td>IT and computing</td>
<td>3</td>
<td>3</td>
<td>—</td>
<td>—3</td>
</tr>
<tr>
<td>Other business services</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>—5</td>
</tr>
<tr>
<td>Education</td>
<td>6</td>
<td>—</td>
<td>3</td>
<td>—9</td>
</tr>
<tr>
<td>Health</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>—10</td>
</tr>
<tr>
<td>Representative organisations.</td>
<td>20</td>
<td>7</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Culture and entertainment</td>
<td>6</td>
<td>13</td>
<td>10</td>
<td>—9</td>
</tr>
<tr>
<td>All private sector</td>
<td>11</td>
<td>5</td>
<td>4</td>
<td>—4</td>
</tr>
</tbody>
</table>

\(^a\)includes perceived advantages from co-operation, sub-contracting, potential contacts and convenience for meetings.

\(^b\)includes bringing more business in and providing a greater choice for consumers.

\(^c\)represents the difference between numbers citing greater competition as an advantage and as a disadvantage of proximity.

\(^d\)numbers perceiving disadvantages in terms of poaching have been subtracted from those perceiving advantages from proximity to a larger pool of labour.

Source: Gordon and McCann (2000)
A static micro economic perspective: Costs and benefits

Locational BENEFITS are a concave non monotonic function of the number of firms. As the number of firms located in a cluster increases, BENEFITS firstly increase because of agglomeration economies (productive specialisation, scientific/technical spillovers, increases in the quality of labour force and efficiency of local credit markets) then decrease when congestion sets in.

Locational COSTS are a convex non monotonic function of the number of firms. As the number of firms located in a cluster increases, COSTS initially decrease until some “optimal” number of users for a given set of urban, industrial, and environmental resources is reached; then increase due to the competition between a larger number of firms for a limited pool of local inputs (K, L, land, business services and infrastructures) which raises their prices.
A static micro perspective: optimal dimensions of cluster

Source: Maggioni (2002a)
The development of a cluster (logistic models)

Source: Maggioni (2002b)
Computers and office equipment in California (1956-2000)

Source: Maggioni (2005)
Stock–flows (flows depends on stock) models of industrial clusters’ development

- Spin-off and imitation
- Signaling (I and II)
- Information diffusion
- Anchor tenant
- Leader–suppliers relationship
- Social legitimacy
- Agglomeration economies and diseconomies

Source: Maggioni (2008)
• **Spin–off and imitation:** new firms within a cluster are often started by former employees or originated through imitation (contagion) processes. Both phenomena are proportional to the incumbent mass;

• **Signalling:** in an uncertain environment with information asymmetries between insiders and outsiders, 1) the number of firms (of the same industry) already located in the cluster signals the profitability of the location (quality of workforce, availability of intermediate inputs, etc.) to potential entrant; 2) by locating into an established cluster a firm signals his quality to potential customers by showing it’s ability to survive to harm’s length competition in inputs markets (i.e. skilled labour, venture capital/bank funding, etc.)

• **Information diffusion:** information (news or rumours) about a new profitable location for a given type of firm may be diffused in a given population of potential entrants and entrepreneurs through an epidemic model

• **Anchor tenant:** the existence of a large established industrial firm creates positive externalities Thus the number of new start-up firms (and their internal growth) is therefore positively related to the number of anchor tenants in the cluster (due to knowledge spillovers, specialised inputs procurements and user innovation networks).
• **Leader-suppliers:** this explanation focuses on the composite (both synergetic and competitive) relationship existing between a small number of large leading and innovative firms – acting as organizers and coordinators of the activity of the clusters – and a large number of imitative small firms which act mainly, but not exclusively, as sub-contractors.

• **Social legitimacy:** density affects founding rates of “organisational population” (for our purposes: a given type of firm) through institutional processes. Once a sufficient number of instances of the form exist, the need for justification (and thus the cost of organizing) declines. Other things being equal, legitimation of a form increases the founding rate of population using that form.

• **Agglomeration economies and diseconomies:** each new entrant increases the locational benefits to incumbents (labour market pool, intermediate inputs pool, technological externalities and knowledge spillovers) only up to a point, then it decreases them when congestion and competition prevail.
The population ecology approach

However the actual relations between the firms and between firms and mobile factors are neither identifiable nor static. Firms and other actors will change suppliers, customers, products and inputs in response to current advantages and to their very specific requirements. The system is without any particular observable organisation or interagent loyalty and simply functions as an ecology of activity benefiting from proximity, and developing emergent form of specialisation, possibly including distinct forms of economic culture.


Ecology is the study of patterns in nature, of how these patterns came to be, how they change in space and time, why some are more fragile than others. Population ecology is concerned with how populations interact with the environment and how these interactions give rise to the larger patterns of communities and ecosystems. The environment is more than just sun, air, earth and water: it includes other organisms which may help or hinder the survival of a species. Population ecology is also the study of how these organisms interact (...) in competition and in co-operation.

Endogenous exogenous and relational determinants of cluster (region $r,s$; industry $i,j$) dynamics

- **Geographical benefits**
- **Cluster size $X_{ir}$**
- **Net new entries**
- **Net incumbents Growth**
- **World Demand**
- **Inter-industry Interactions $X_{jr}$**
- **Intra-industry Interactions $X_{is}$**

Source: Maggioni (2008)
The development of a cluster (logistic models)

One population in isolation

\[
\frac{dn_q}{dt} = r_q \cdot n_q(t) \left(1 - \frac{n_q(t)}{K_q}\right)
\]

Two interacting populations

\[
\begin{align*}
\frac{dn_1}{dt} &= r_1n_1(t) \left[1 - \frac{n_1(t) + c_{12}n_2(t)}{K_1}\right] \\
\frac{dn_2}{dt} &= r_2n_2(t) \left[1 - \frac{n_2(t) + c_{21}n_1(t)}{K_2}\right]
\end{align*}
\]

The classical formulation

A more convenient formulation

Source: Maggioni (2005)
Florida: Aircrafts and Instruments (1948-2000)

Source: Maggioni (2005)
Searching or planning?
Searching (what and how to search)

• What
  – Concentration (Herfindhal, Entropy, etc.)
  – Specialization (LQ, absolute measures)
  – Co-location (pearson, Lisa, Gi*)
  – Interdependences “potential” (I-O)
  – Interdependences “actual” (SNA, RRA)

• How
  – Cluster analysis
  – Discriminant analysis
  – Factor Analysis
## Types of approaches to regional industry cluster analysis

<table>
<thead>
<tr>
<th>Benchmark Analysis</th>
<th>Intraregional Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comprehensive</strong></td>
<td><strong>Intraregional Analysis</strong></td>
</tr>
<tr>
<td>• Study applies industry groupings derived for a <strong>relevant reference area</strong> (e.g., nation or world) to regional data to identify potential regional clusters or to document regional specializations within broader national or global industries</td>
<td>• Study examines trends and linkages among firms and industries <strong>within the study region</strong> to identify local clusters (groups of related companies located in proximity)</td>
</tr>
<tr>
<td>• Groupings are developed from an analysis of interdependence among <strong>all or most industries</strong>, necessitating heavy reliance on secondary data sources (e.g., national input-output and other published economic series)</td>
<td>• <strong>All or most industries</strong> are included in the analysis, necessitating heavy reliance on secondary data sources (e.g., regional input-output and other published economic series)</td>
</tr>
<tr>
<td><strong>Focused</strong></td>
<td><strong>Intraregional Analysis</strong></td>
</tr>
<tr>
<td>• Study applies industry groupings derived for a <strong>relevant reference area</strong> (e.g., nation or world) to regional data to identify potential clusters or to document regional specializations within national or global industries</td>
<td>• Study examines trends and linkages among firms and industries <strong>within the study region</strong> to identify local clusters (groups of related companies located in proximity)</td>
</tr>
<tr>
<td>• Groupings are identified for only <strong>selected industries</strong>, often those perceived as particularly important to the region, permitting use of labor-intensive qualitative methods and primary data collection</td>
<td>• <strong>Only selected industries</strong> are investigated, permitting use of labor-intensive qualitative methods and primary data collection techniques</td>
</tr>
</tbody>
</table>

Source: Feser et al. (2008)
How to identify **Potential Cluster Region**: specialization/co-location

<table>
<thead>
<tr>
<th>Gi*</th>
<th>Location Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High (&gt; 1)</td>
</tr>
<tr>
<td>High</td>
<td>PCR</td>
</tr>
<tr>
<td>Low</td>
<td>Specialized Region</td>
</tr>
</tbody>
</table>

Source: Carrol et al. (2008)
How to identify relevant linkages and relationships?

SNA roster recall approach
How does a network based empirical research work?

1. Thanks to the questionnaire we can...

2. ...gather data on relationships...

3. ...from relations among actors of the database...

4. ...we turn on matrix...

5. ...we develop network graphics ....

6. ...and finally we produce measurements....
   – About nodes (centrality, clustering)
   – About networks (density; centralization)
   – About subset (cliques, plexes)

In order to perform:
   – Comparisons with other districts
Networks of firms: the research framework

**Production Network**
- **Productive Cooperation Network**
  - **Knowledge Network 1:** Adopting Ordinary Technology
  - **Knowledge Network 2:** Developing New Technology
  - **Knowledge Network 3:** Market Information
  - **Knowledge Network 4:** Customers and suppliers

**Labour Market Network**

**(Formal and informal) Ownership Network**

**Financial Network 1:** Bank payments
- **Financial Network 2:** Short term financing
- **Financial Network 3:** Medium-long term financing
- **Financial Network 4:** Extraordinary Finance Operations
- **Financial Network 5:** Trade Financing
Almost every question is asked in a two-sided way

D3 In the last three years, during demand peaks exceeding your production capacity, **which of the following firms have you contacted to help you?**

Please list and in case add firms not included in the list.

D4 In the last three years, **which of the following firms have contacted you asking for help** during high demand peaks exceeding their production capacity?

Please list and in case add firms not included in the list.

D13 In the last three years, have you **enrolled staff previously working in the following firms/institutions?**

Please list and in case add firms not included in the list.

D14 In the last three years, have members of you **staff moved in the following firms/institutions?**

Please list and in case add firms not included in the list.
Cooperation networks (D3 + D4)

Planning I
(it’s a risky business)

• Myopic markets vs. Blind governments
  – Blind giants, narrow windows, and angry orphans
  – Selecting within the existent or looking for sprouts
  – European scale or national quotas

• Starting/developing a cluster as an enterprise
  – Higher failure rate in the first years
  – Going the Venture Capital way? (2/10 pays all?)
Planning II
(how to measure success?)

• What sort of indicators
  – Employment level / growth rate
  – Wage level / growth rate
  – Productivity level / growth rate
  – Per capita income level / growth rate

• What to contrast:
  – cluster against rest of the region?
  – Cluster regions against non-cluster regions?
Useful references


Useful references


McCann and Sheppard S. (2003) The Rise, Fall and Rise Again of Industrial L  ti Th ’ R i l St di  37 649 663
THANK YOU!

Mario A. Maggioni
mario.maggioni@unicatt.it