Co-evolution of networks and spatial clustering

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Cluster emergence and network evolution: a longitudinal analysis of the inventor network in Sophia-Antipolis

Introduction
By looking at the successful business park of Sophia-Antipolis this study investigates whether and how networks of collective learning among inventors emerged throughout the emergence of a cluster. We expect local collective learning has only emerged in IT, where growth has been more extensive and more locally-based, and not in Life Sciences.

Methodology
On the basis of EPO and USPTO patent data we reconstructed co-inventorship networks for the two main industries of Sophia-Antipolis from 1978 till 2002. The emergence of a local collective learning is indicated by:
- increasing local orientation
- increasing connectivity
- decreasing average path length
- increasing clustering coefficient

Results: emergence of collective learning

Evolution of connectivity

Evolution of small world properties of the main component

Evolution of geographical orientation (number of links per geographical scale)

Conclusion
- The growth process of firms in a cluster strongly affects the evolution of local knowledge networks.
- The emergence of a local collective learning milieu is a very incremental and long-lasting process, for which geographical proximity per se is not a sufficient condition.

What is SIENA?
- A software program that analyses the dynamics of networks over time;
- Detecting the forces that have driven the evolution of a network from one state into another;
- Estimating parameters for selected drivers of network evolution;
- By simulating repetitively with which micro-steps the network evolution might have taken place.

Longitudinal network analysis: using SIENA

A hypothetical example

Network at time t

Network at time t+1

<table>
<thead>
<tr>
<th>NETWORK STRUCTURE</th>
<th>t</th>
<th>t+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nodes</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Number of links</td>
<td>88</td>
<td>107</td>
</tr>
<tr>
<td>Density</td>
<td>0.0072</td>
<td>0.0087</td>
</tr>
<tr>
<td>Average degree</td>
<td>3.592</td>
<td>3.657</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NETWORK CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of links created</td>
</tr>
<tr>
<td>Number of links dissolved</td>
</tr>
<tr>
<td>Number of links retained</td>
</tr>
<tr>
<td>Distance (total change)</td>
</tr>
</tbody>
</table>

Descriptive statistics of network at two observation moments

Three drivers of network evolution

- Preferential attachment
- Similarity / Proximity
- Closure / Transitivity

Geosciences