Technology Space and Strategic Alliance
In a Converging Sector

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Motivation and Research Questions

• The architecture ("rules of the games") of Industries or Sectors is shaped to a large extent by firm activities in technology and corporate development.

• We try to map the Converging Imaging Sector as a "Technology Space" as well as an "Arena for Strategic Cooperation" and answer the following:

  **Sector Level**

  – How do we describe the *technology space* in a given Sector?
    • *Status system*
      – Network constructed through deference relations (Stuart, 1998) in Intellectual Property (IP)
      – Complementarities in IP and relative participation in the space

  **Firm Level**

  – How do legacy capabilities of firms affect alliance activities in a converging sector?
  – Does the status of the firm in the technology space produce a propensity for alliance formation?
  – What is the effect of technology specialization of the firm on alliance formation?
  – Is the degree of membership of the firm in the sector important to predict alliance?
Theory & Hypotheses (I)

– Legacy capabilities are the basis of firm status and many firms endowed with those capabilities face obsolescence in a converging sector
  • Even if facing obsolescence, firms endowed with important complementary assets might survive the onslaught of discontinuous technologies (Teece, 1986; Tripsas, 1997). And they might have more incentives to partner with other firms to increase the life of intangible assets that might decline economically as the sector experiences convergence.

  **H1**  The higher the firm’s patenting in a technology category threatened by obsolescence, the higher its rate of alliance formation.

– Centrality of firms in the sector specific technology space and status
  • More central firms enjoy higher status (Podolny & Stuart, 1995) and are prone to loss aversion (Thaler, 1984) and status leakage (Podolny, 2001) when facing lower status partners in uncertain environment

  **H2a**  The higher a firm’s status (betweenness centrality) the lower its rate of alliance formation
Theory & Hypotheses (II)

– Diversity of IP within the sector specific technology space

  **H2b** The more diffuse a firm’s status *(higher the diversity)* the lower its rate of alliance formation

– Degree of participation in sector specific technology space relative to overall participation of the firm in technology development activities
  • *High levels of participation imply greater status saliency and attendant conformity* (Homans, 1951; Fleming, 2005, Hagedoorn et al., 2003)

  **H2c** The more marginal a firm’s presence *(participation)* in the sector, the lower its rate of alliance formation
Data

• Patent Data
  – Focal patents provided by Eastman Kodak
    • 35,473 patents with 3660 assignees and 3039 firms from 1976 to 2002
    • 17,224 patents classified as digital
    • 18,091 patents classified as chemical
  – USPTO & NBER
    • We collect two generation of patents that are cited by the focal patents and that cite them
    • 178,796 patents from 1976 to 2002
    • 16,475 firms in the assignees

• Alliance Data
  – SDC Platinum
  – 249 firms from population of 3039 with alliance data from 1989-1998

• Financial Data
  – Compustat, Worldscope
**Variables**

- **Dependent Variable**
  - *AllianceCount*: A count of the number of alliances made by firm i at time t+1

- **Independent Variables**
  - *BetweenCentrality*: Betweenness Centrality of firm i in the network of firms formed by backward patent citations in five years prior to and including time t
  - *Legacy*
    - *Chem IP*: A count of the number of patents in the technology category of Chemical as defined by Jaffe, Trajtenberg & Hall (JHT) by firm i at time t
    - *C&C IP*: A count of the number of patents in the technology category of Computers & Communication as defined by JHT by firm i at time t (proxy for Digital)
  - *IP Specialization*: Diversity (Herfindahl) measure of firm i’s patenting using the JHT categories of technology
  - *Participation*: Percentage of patents of firm i at time t in the sector’s Technology Space
Main Results

- **Status** inferred from betweenness centrality has negative effect on Alliance Propensity

- **Diversity** or technological diversification (specialization) has positive (negative) effect on Alliance Propensity

- Participation or Degree of Membership in Imaging Sector is not signification but if it is combined with **Status** there is strong propensity to ally as shown in [this figure](#)
Conclusions

- Industry evolution in a converging sector is mapped using three firm IP variables: *Status, Technology Diversity and Degree of Participation*

- IP activity informs about corporate development activities (IP vs. Alliance behavior)
  - High status (central) firms have lower propensity to collaborate perhaps because of loss aversion and status leakage

- IP specialization within Imaging sector discourages Strategic Collaboration
  - Generalists shun partnering with specialists maybe because of
    - *Status leakage or loss aversion*
    - *Collaborations require absorptive capacity that specialist might lack given the breadth of technological expertise required given the uncertainties in a converging sector*

- If firm status is high and firms have reasonably high participation in sector they have strong motivation to monetize their capabilities through alliance activities
2-way Interaction Effects

Alliance Count

Participation
- High
- Medium
- Low

Between Centrality

1.0 \times 10^6 \quad 2.0 \times 10^6 \quad 3.0 \times 10^6 \quad 4.0 \times 10^6 \quad 5.0 \times 10^6
Convergence

Evolution of Chemical & Digital Patenting Percentage

- chempercent
- digitalpercent
## Full Regression Results

<table>
<thead>
<tr>
<th>Specifcation</th>
<th>Alliance Count from 1989-1998</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td>Fixed Effect Negative Binomial</td>
</tr>
<tr>
<td><strong>Dep Var:</strong> AllianceCount</td>
<td></td>
</tr>
<tr>
<td><strong>BetweenCentrality</strong></td>
<td>-1.79e-07*** (5.25e-08)</td>
</tr>
<tr>
<td><strong>Legacy</strong></td>
<td>-3.96e-07*** (9.88e-08)</td>
</tr>
<tr>
<td><strong>Chem IP</strong></td>
<td>-3.36e-07*** (1.04e-07)</td>
</tr>
<tr>
<td><strong>C&amp;C IP</strong></td>
<td>0.000440** (0.00202)</td>
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<tr>
<td><strong>Mech IP</strong></td>
<td>0.000372 (0.00262)</td>
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<tr>
<td><strong>Drugs IP</strong></td>
<td>0.00152 (0.00274)</td>
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<tr>
<td><strong>EEG IP</strong></td>
<td>-7.05e-08 (0.00135)</td>
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<tr>
<td><strong>Other IP</strong></td>
<td>0.000877 (0.00187)</td>
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<tr>
<td><strong>IP Specialization</strong></td>
<td>-0.00344 (0.00086)</td>
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<tr>
<td><strong>Participation</strong></td>
<td>-0.00357 (0.00038)</td>
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<tr>
<td><strong>BetweenCentralityXParticipation</strong></td>
<td>-0.262** (0.262)</td>
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<tr>
<td><strong>Entry</strong></td>
<td>-0.260** (0.260)</td>
</tr>
<tr>
<td><strong>IP Flow</strong></td>
<td>0.000325 (0.000313)</td>
</tr>
<tr>
<td><strong>PriorAlliances</strong></td>
<td>7.79e-07*** (2.82e-07)</td>
</tr>
<tr>
<td><strong>yr90</strong></td>
<td>0.00127*** (0.00257)</td>
</tr>
<tr>
<td><strong>yr91</strong></td>
<td>0.127*** (0.127)</td>
</tr>
<tr>
<td><strong>yr92</strong></td>
<td>1.711*** (0.124)</td>
</tr>
<tr>
<td><strong>yr93</strong></td>
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<tr>
<td><strong>yr94</strong></td>
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<td><strong>yr95</strong></td>
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<td><strong>yr97</strong></td>
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<td><strong>yr98</strong></td>
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<tr>
<td><strong>Constant</strong></td>
<td>-2.686-06** (1.46e-06)</td>
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<td><strong>Observations</strong></td>
<td>1385</td>
</tr>
<tr>
<td><strong>Log Likelihood</strong></td>
<td>-2362.0874</td>
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<tr>
<td><strong>Wald Ch-square</strong></td>
<td>580.46***</td>
</tr>
<tr>
<td><strong>Number of cid</strong></td>
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Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1