Technology Space and Strategic Alliance In a Converging Sector

Anindya Ghosh & Johannes M. Pennings

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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*
  - *Heterogeneity in IP activity confers penalties and social isolation (Zuckerman, 1999; Rao,et al, 2002, Hsu and Hannan, 2005)*

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 classsified 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

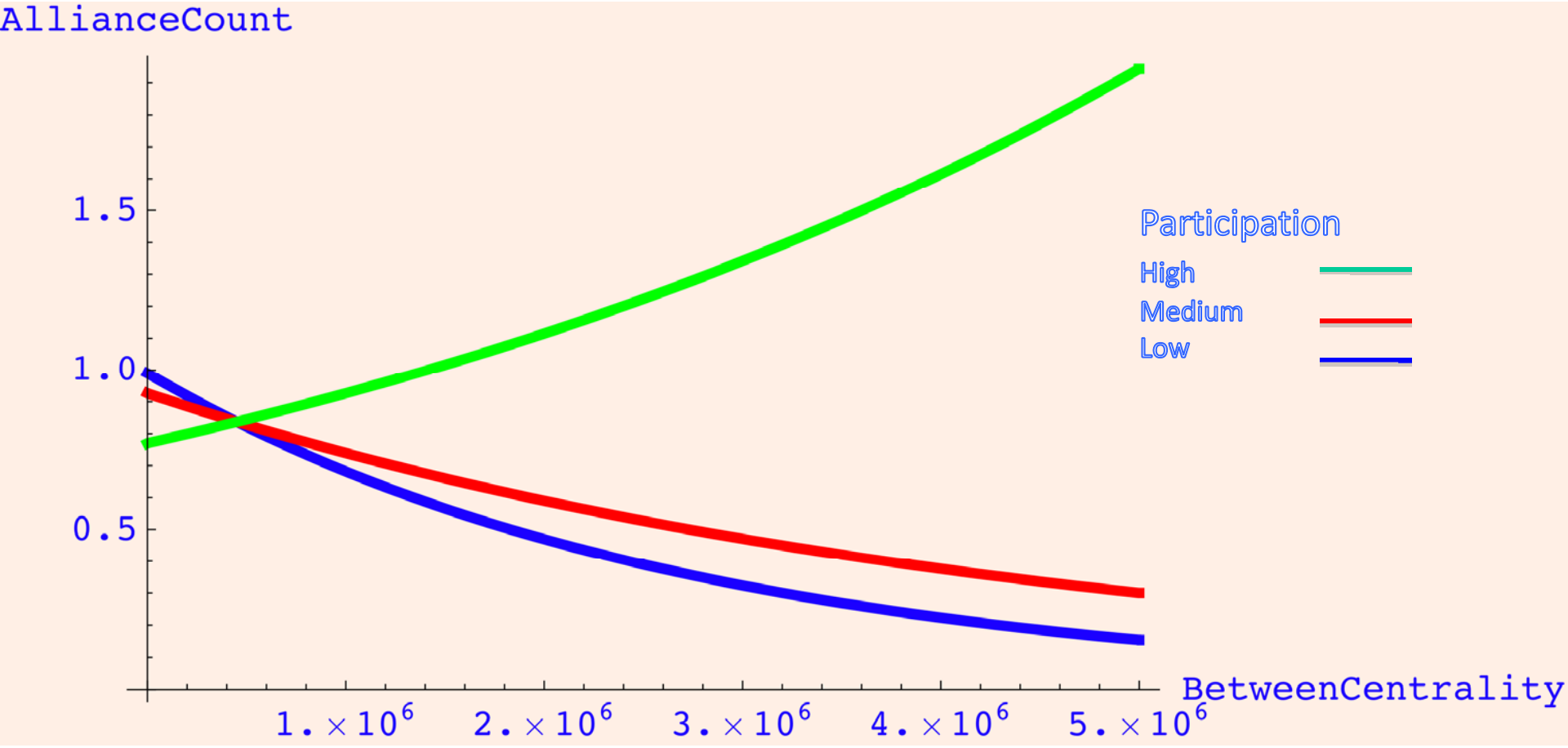
Alliance Count from 1989-1998		
Specification	Fixed Effect Negative Binomial	
Model	(1)	(2)
Dep Var: AllianceCount		
BetweenCentrality	-1.79e-07***	-3.96e-07***
	(5.25e-08)	(9.88e-08)
Legacy		
Chem IP	0.00440**	0.000372
	(0.00202)	(0.00262)
C&C IP	0.000570	-7.05e-05
	(0.00187)	(0.00181)
IP Specialization	-0.298**	-0.282**
	(0.122)	(0.122)
Participation	-0.365	-0.349
	(0.263)	(0.263)
BetweenCentralityXParticipation		7.75e-07***
		(2.82e-07)
Constant	0.447***	0.431**
	(0.171)	(0.171)
Observations	1385	1385
Log Likelihood	-2362.0874	-2358.1972
Wald Ch-square	580.46***	592.57***
Number of cid	167	167
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

- *Status* inferred from betweeness 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

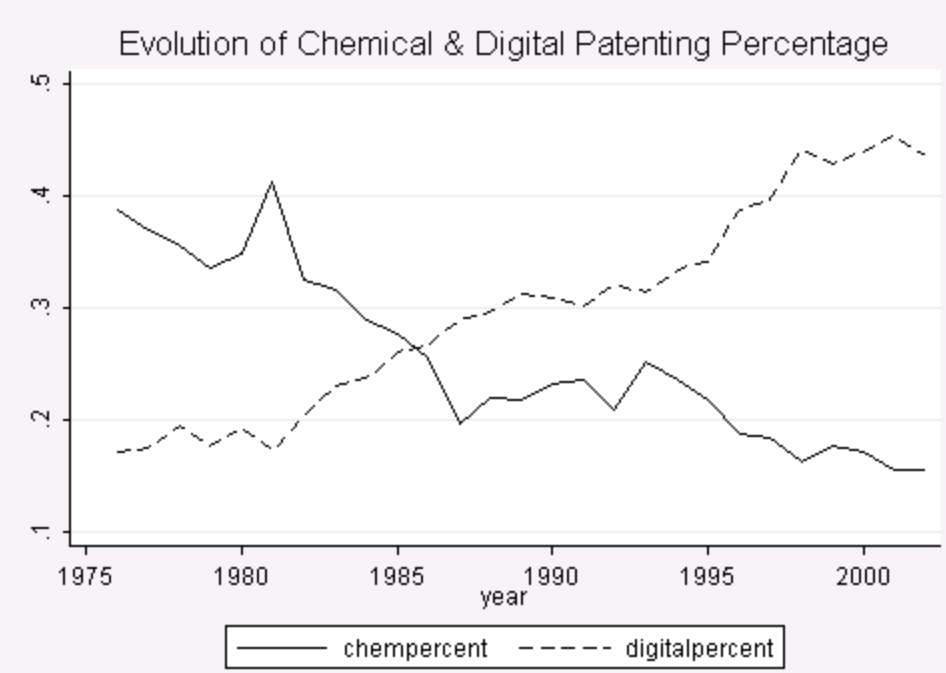
Conclusions

- 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



Convergence



Full Regression Results

	Alliance Count from 1989-1998		
Specification	Fixed Effect Negative Binomial		
Model	(1)	(2)	(3)
Dep Var: AllianceCount			
BetweenCentrality	-1.79e-07***	-3.96e-07***	-3.36e-07***
	(5.25e-08)	(9.88e-08)	(1.04e-07)
Legacy			
Chem IP	0.00440**	0.000372	0.00152
	(0.00202)	(0.00262)	(0.00274)
C&C IP	0.000570	-7.05e-05	0.00135
	(0.00187)	(0.00181)	(0.00198)
Mech IP	0.00395	-0.000344	-0.00357
	(0.00583)	(0.00605)	(0.00637)
Drugs IP	0.0140	0.0121	0.0106
	(0.0104)	(0.0104)	(0.0105)
EEE IP	-0.00275	-0.00294	-0.00350
	(0.00318)	(0.00313)	(0.00314)
Other IP	0.00114	0.0148	0.00638
	(0.0131)	(0.0138)	(0.0145)
IP Specialization	-0.298**	-0.282**	-0.260**
	(0.122)	(0.122)	(0.122)
Participation	-0.365	-0.349	-0.301
	(0.263)	(0.263)	(0.262)
BetweenCentralityXParticipation		7.75e-07***	1.58e-06***
		(2.82e-07)	(5.32e-07)
BetweenXParticipXTechDiverity			-2.68e-06*
			(1.46e-06)
Entry	-0.721***	-0.716***	-0.730***
	(0.260)	(0.260)	(0.260)
IP Flow	0.000317	0.000553**	0.000506**
	(0.000227)	(0.000235)	(0.000235)
PriorAlliances	0.00178***	0.00226***	0.00225***
	(0.000506)	(0.000525)	(0.000528)
yr90	0.198	0.204	0.201
	(0.151)	(0.151)	(0.151)
yr91	1.363***	1.367***	1.362***
	(0.127)	(0.127)	(0.127)
yr92	1.711***	1.711***	1.707***
	(0.124)	(0.124)	(0.124)
yr93	1.694***	1.693***	1.690***
	(0.124)	(0.124)	(0.124)
yr94	1.632***	1.624***	1.621***
	(0.126)	(0.126)	(0.126)
yr95	1.792***	1.769***	1.772***
	(0.127)	(0.128)	(0.127)
yr96	1.544***	1.514***	1.515***
	(0.131)	(0.132)	(0.131)
yr97	1.141***	1.111***	1.107***
	(0.138)	(0.138)	(0.138)
yr98	1.224***	1.180***	1.175***
	(0.135)	(0.137)	(0.137)
Constant	0.447***	0.431**	0.427**
	(0.171)	(0.171)	(0.171)
Observations	1385	1385	1385
Log Likelihood	-2362.0874	-2358.1972	-2356.5013
Wald Ch-square	580.46***	592.57***	598.48***
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