

Is More always Better in Alliances? The Role of Partner Similarity in Innovation Alliances

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Do Alliances Increase Innovation?

- Alliances and other cooperative agreements important in innovation processes (Chesbrough, 2006; Coombs *et al.*, 2003; Laursen *et al.*, 2006; Tether, 2002).
- The number of alliances is burgeoning, especially in highly dynamic high tech sectors (Hagedoorn, 2002; Hagedoorn *et al.*, 2006) to foster their innovation outputs (Powell *et al.*, 1996; Rothaermel and Boeker., 2008; Rothaermel *et al.*, 2004).
- However, not all alliances offer similar opportunities for innovation and not all firms equally benefit from alliances (Anand and Khanna, 2000; Kale *et al.*, 2002; Kale *et al.*, 2007; Zollo *et al.*, 2002a)

Why Heterogeneity in Alliance Returns?

- Learning and capabilities development:
 - Experiential learning, suggesting that alliance experience accumulation enhances firm returns from alliances (Anand and Khanna, 2000; Sampson, 2005; Gulati *et al.*, 2009).
 - Developing alliance capabilities and learning mechanisms to transfer and reuse alliance management and coordination knowledge learned from past alliances (Kale *et al.*, 2002; Kale *et al.*, 2007; Zollo *et al.*, 2002; Rothaermel and Deeds, 2006).

Inter- and Intra- Industry Partnership

- Typology of partnership:
 - Industries tend to cluster activities requiring same capabilities (Richardson, 1972).
 - Firms in same industry are likely to adopt similar frames, or worldviews, to perceive and interpret environment and actions of competitors.
 - Industries lead to a greater degree of correspondence and cohesion between types of knowledge applied within the same industry (Huff, 1982; Spender, 1987) (c.f., scientific (Kuhn, 1962) and technological (Dosi, 1982) paradigms).
 - Inter- and intra-industry collaborations provide opportunities for lower and higher knowledge variety respectively.
 - Similarity in partners' technological knowledge facilitates knowledge exchange in alliances (Mowery et al. 1996; Sampson, 2007)
 - Moderate levels of technological distance are found to be effective for partners innovation compared to high or low levels of technological knowledge similarity (Sampson, 2007).

Cognitive Distance

- Nooteboom et al. (2007) developed the construct of cognitive distance between alliance partners to explore the interplay between knowledge variation and partners' absorptive capacity at different levels of distance
 - Increasing CD enhances variation and novelty in the knowledge that partners access providing enhanced opportunities for partners' innovation. At the same time, CD diminishes partners' AC and their abilities to leverage the benefits of such variation. This interplay generates a concave relationship between cognitive distance and partners' innovation.
- Increasing complexity of alliance tasks and dissimilarities between partners increase transaction and cooperation costs in alliances and partners exposure to opportunistic behaviour (White and Lui, 2007)
- Distinction between scale and scope of search strategy and role of search for knowledge within a firm's own industry and search of knowledge (Katila, 2002; Katila and Ahuja, 2002) outside a firm's own industry.

Hypothesis 1: Intra-Industry Alliances

- Higher number of alliances with partners within the same industry leads to diminishing returns to firm innovation, as the creative and novel potential of combining a larger pool of similar knowledge diminishes, and the returns to innovation from increasing application and use of existing knowledge eventually reach saturation – competency trap. The opportunities from supplementing knowledge will exhaust as the scale of such alliances increases.
- Firms are likely to exploit the most obvious and less costly knowledge combinations first; as they expand the number of alliances, costs of search for novel combinations progressively increase, the probability of highly original combinations diminishes (Deeds and Hill, 1996; Katila and Ajuja, 2002) while facing high coordination costs without simultaneously enhancing their odds for innovation

Hypothesis 1: There is an inverted U-shaped relationship between intra-industry alliances and firm innovation output

Hypothesis 2: Inter-Industry Alliances

- Inter-industry alliances bring together firms with greater diversity in their lines of business, production processes and operating practices (Mowery *et al.*, 1996; Mowery, Oxley, and Silverman, 1998)
- Inter-industry alliances expose partners to knowledge which is distant, of wider and broader scope, provide access to knowledge of higher variation, increasing the possibility of generating new knowledge combinations and novel solutions (Kogut and Zander, 1992).
- However, the higher level of knowledge incongruence increases risks and uncertainties in cross-partner knowledge sharing and joint project coordination.
- It requires greater efforts and resources in combining and absorbing knowledge from their partners, increasing managerial and coordination challenges.
- Increased managerial complexity poses high demands on cognitive and coordination abilities (Simon, 1955) and augments coordination and management costs, reducing the initial boost to innovation offered by low levels of such alliances.

Hypothesis 2: Inter-Industry Alliances

- Managerial attention is diluted due to increased number of varied collaborative tasks that need to be attended (Ocasio, 1997) and increasingly less attention is paid to fully develop each one of these possibilities (Koput, 1997).
- It is expected that firm innovation will start declining as the number of inter-industry alliances increases.
- Need to develop tighter forms of control and governance structures in order to mitigate the increased coordination and transaction costs in such alliances (Gulati and Singh, 1998).
- As the number of these projects increase, management becomes more aware of failures, and intensifies monitoring inter-industry partnerships. It attracts higher managerial attention, management dedicates more resources and becomes more meticulous in attending the coordination of inter-industry alliances.

Hypothesis 2: There is a U-shaped relationship between inter-industry alliances and firm innovation output

Sample and Data Sources

- Focus on the UK bio-pharmaceutical sector
- 110 publicly listed UK bio-pharmaceutical firms between 1991 and 2001
 - Whole population of firms in this sector for which data is publicly available
 - Sector-specific directories (Coombs and Alston, 2000; Coombs and Alston, 2002)
- Alliances ReCap.com and BioScan (Arora and Gambardella, 1990; Pisano, 1990; Deeds and Hill, 1996; George *et al.*, 2002): 2,284 alliances
 - Intra-Industry alliances: number of alliances formed within each year with partners at same 4 digit SIC (193 alliances)
 - Inter-Industry alliances: number of alliances formed within each year with partners at same 1&2 digit SIC (Sampson, 2005) (1,776 alliances)
- Innovation: Patents (UKPTO)
- Controls:
 - Alliance experience: 1-year lags (Sampson, 2005)
 - Firm size, Investments in R&D (FAME, Thomson's Analytics, R&D Scoreboard)
 - Dummy for firms in pharmaceuticals

Statistical Method

- Count dependent variable models for panel data
 - Fixed-effects (FE) specification of the Poisson model for panel data
 - The Poisson model assumes that the mean and variance of the dependent variable are equal - a strong assumption when there is overdispersion in the data .
 - For overdispersed data the Negative Binomial model is normally preferred, but it does not capture heterogeneity caused by unobserved firm- and year- specific effects.
 - We use a version of the Poisson model FE model developed by Wooldridge (1995) which corrects standard errors for the potential bias and allows for overdispersion (e.g. Czarnitzki *et al.*, RP 2009)

Descriptive Stats and Correlations

	N	Mean	Median	S.D	1	2	3	4	5	6	7
1. N of Patents	1210	0.328	0	1.624	1						
2. Inter-Industry Alliances	455	3.903	2	4.248	-0.018	1					
3. <i>Squared</i> Inter-Industry Alliances	455	33.244	4	76.584	-0.016	0.923*	1				
4. Intra-Industry Alliances	455	0.424	0	1.372	-0.037	0.254*	0.209*	1			
5. <i>Squared</i> Intra-Industry Alliances	455	2.059	0	11.358	-0.027	0.183*	0.136*	0.905*	1		
6. Cum. Alliances (Ln 1-year lagged)	673	1.599	1.386	1.384	0.076	0.602*	0.493*	0.284*	0.203*	1	
7. Number of Employees (Ln)	701	4.789	4.419	2.158	0.392*	0.381*	0.318*	0.322*	0.292*	0.300*	1
8. Investments in R&D (Ln)	386	15.426	15.562	2.506	0.349*	0.320*	0.245*	0.318*	0.285*	0.410*	0.763*

Poisson Conditional FE Panel Data

DV: Number of Patents	Model 1	Model 2	Model 3
	Conditional FE (robust st.er.)	Conditional FE (robust st.er.)	Conditional FE (robust st.er.)
Intra-Industry Alliances	0.6769† (0.5049)		0.4552 (0.5192)
Intra-Industry Alliances <i>Squared</i>	-0.1324** (0.0641)		-0.1052* (0.0598)
Inter-Industry Alliances		-0.2242*** (0.0740)	-0.2035*** (0.0755)
Inter-Industry Alliances <i>Squared</i>		0.0070** (0.0030)	0.0051* (0.0031)
Ln Cum N. of Alliances (Lag 1)	0.0913 (0.1909)	-0.0856 (0.1854)	0.1035 (0.2003)
Ln Employees	0.5092 (0.5077)	0.3766 (0.5291)	0.5888 (0.5191)
Ln R&D	-0.0029 (0.5203)	0.3970 (0.5181)	-0.0931 (0.5219)
Observations	94	94	94
Wald Chi ²	17.14	11.57	22.49
Prob > Chi ²	0.0042	0.0411	0.0021
Log Likelihood	-128.95858	-127.71027	-122.51135 ¹²

Discussion of Results

- Our results provide weak support for an inverted U-shaped relationship between intra-industry alliances and innovation outputs (H1)
- The point of curvature is 3.8 alliances
 - Based on the average figures in our sample, firms form 0.4 exploitation alliances, therefore, they are not exceeding the “optimal” size of 3.8 alliances for intra industry alliance portfolios
 - Shire Pharmaceuticals and SmithKline Beecham (which merged with Glaxo Wellcome in 2000 to become GlaxoSmithKline - GSK) have persistently exceeded, although sometimes only marginally, the number of 3 intra industry alliances per year between 1991 and 2001.

Discussion of Results

- Support for U-shaped relationship between inter-industry alliances and firm innovation outputs (H2), where the point of minimum in our sample is 17 alliances
- On average, the firms in our sample hold 4 inter-industry alliances and are far below the “low point” of the U-shaped curve of 17 alliances
- A further expansion of inter-industry alliances would be beneficial to firm innovations
 - Accumulation of alliance experience would allow firms overcoming inefficiencies and coordination problems and therefore benefiting from developing innovations through partnerships with heterogeneous partners
 - Two companies in our sample hold inter industry alliances with more than 17 alliances, Novartis UK Ltd and Genzyme Limited. Both of these firms have formed these many alliances in 4 out of the 11 years period considered in the present study

Discussion and Conclusions

- In general, our results indicate that overexpansion of intra-industry alliances may be detrimental to firm innovation, while expanding inter-industry alliances can benefit firm innovation, possibly because firms put resources in place to attend, i.e., coordinate and manage, fairly large portfolios of alliances with heterogeneous partners.
- Specific to inter-industry alliances, our results indicate that there are two strategies for managing such alliance holdings, with both being beneficial to firm innovation – high and low numbers:
 - The choice between these two strategies may depend on firm corporate strategy and the level of change in the underlying technical knowledge in a sector that may demand for high or low levels of inter industry alliances to ensure long-term survival.

Limitations and Further Research

- Investigate interdependencies between intra- and inter-industry alliance holdings; it relates to recent literature on organisational ambidexterity (Rothaermel and Deeds, 2004; Zollo and Winter, 2002; Raisch and Birkinshaw, 2008; Raisch, Birkinshaw, Probst, and Tushman, 2009)
- Test similar hypotheses in other sectors, countries and time periods
- Explore other measures of innovation, that could include more information on its content (radical vs. incremental)
- The types of innovation returns from intra and inter industry alliances are likely to determine firm's desire to invest in such alliances in subsequent points in time, all things being equal. These relationships are not explored in the extant literature.

	RE	Cond. FE	RE	Cond. FE	RE	Cond. FE
Inter-industry	-0.320***	-0.224*			-0.311***	-0.226*
	(0.100)	(0.126)			(0.095)	(0.123)
Inter-industry Square	0.009**	0.006			0.008**	0.005
	(0.004)	(0.005)			(0.004)	(0.005)
Intra--industry			0.490	0.692†	0.441	0.788†
			(0.473)	(0.525)	(0.430)	(0.511)
Intra--industry Square			-0.081†	-0.091†	-0.078†	-0.101*
			(0.062)	(0.067)	(0.053)	(0.060)
All Experience(L1)	0.014**	0.010†	0.006	0.004	0.011**	0.009†
	(0.006)	(0.007)	(0.006)	(0.006)	(0.005)	(0.006)
Size	0.152	-0.156	-0.075	-0.316†	0.225	-0.117
	(0.189)	(0.223)	(0.185)	(0.217)	(0.189)	(0.250)
R&D	0.144	0.129	0.132	0.168	0.144	0.149
	(0.159)	(0.211)	(0.162)	(0.213)	(0.164)	(0.218)
Pharma Dummy	0.373	-0.378	-0.058	-0.690	0.505	-0.251
	(0.535)	(0.708)	(0.549)	(0.755)	(0.540)	(0.700)
Constant	-0.033	0.457	-0.550	0.142	-0.038	0.327
	(0.499)	(0.624)	(0.498)	(0.659)	(0.493)	(0.616)
Observations	242	95	242	95	242	95
Wald Chi2	19.31	10.29	4.28	6.77	26.23	12.95
Prob > Chi2	0.0037	0.1131	0.6391	0.343	0.001	0.1137
Log Likelihood	-195.2892	-101.80	-199.049	-102.38	-192.485	-99.658