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THE ROLE OF DISTANCE IN INTER-FIRM LEARNING FOR GLOBAL R&D ALLIANCES

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Abstract: *Although knowledge creation through global alliances has been popular, the extant literature has shown mixed findings on the relationship between partner knowledge gap and inter-firm learning. The relationship becomes more complicated in the global context because international collaboration poses different types of distance constraints on inter-firm learning. We examine the link between partner knowledge gap and inter-firm learning, as well as the moderating effects of three types of distances namely, global-connectedness, cultural, and geographic distance, based on the dataset collected from 236 global research and development (R&D) alliances formed between U.S. firms and their global partners in the bioscience and pharmaceutical industry. Our results indicate that partner knowledge gap induces inter-firm learning, such that the rivalry within an alliance is possibly reduced. The three types of distance differ in their moderating roles in the relationship between partner knowledge gap and inter-firm learning. Our study identifies multi-faceted effects of distance and highlights the contextual setting in international management in consideration of the distance effects.*

Keywords: *global R&D alliance, inter-firm learning, partner knowledge gap, distance, bioscience and pharmaceutical industry*

1. INTRODUCTION

Knowledge creation through inter-firm collaboration has become common in recent decades as technologies have evolved to become increasingly sophisticated. Firms concentrate on their cores in an attempt to access complementary knowledge through the formation of research and development (R&D) alliances (Reuer and Rahiri, 2013; Diestre and Rajagopalan, 2012). The increase in the number of R&D alliances in global business has consequently given rise to two questions that are important both in theory and practice. The first question is whether it would be more conducive for a firm to find a partner with a similar learning capacity to facilitate learning from the alliance (Feller *et al.*, 2013; Schildt *et al.*, 2012). Although the literature on organization learning or transaction-cost economics has discussed

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this issue for a long time, scholars still suggest inconsistent findings. One group argues that a small gap in partner learning capacity increases efficiency for knowledge creation (Lin *et al.,* 2012; Wen and Chuang, 2010), whereas others claim that it may cause internal conflict over knowledge sharing (Diestre and Rajagopalan, 2012; Letterie *et al.,* 2008).

The decision on whether to collaborate with capable partners over knowledge creation has been controversial, and the existence of distance makes the issue more complicated. Some scholars note the role of information and technology in closely linking firms and regard it as robust evidence for a weakened role in the presence of distance (Glaister and Buckley, 1996). Others are still convinced of the benefits of proximity, given that a smaller distance tends to encourage investment activities because of less significant uncertainties (Reuer and Rahiri, 2013; Alcacer and Chung, 2007).

The issue is complicated by distance that exists in different forms, which may cause variation in the results of global inter-firm collaboration. For example, greater cultural distance between alliance partners often results in miscommunication and cultural conflicts (Tihanyi, Gritffith, and Russell, 2005; Yeniyurt *et al.,* 2009). Countries are different in terms of intergovernmental network, thus providing alliance partners with different motivations in seeking markets and giving rise to the need to change products to conform to new regulative environments (Jandhyala and Phene, 2015). Therefore, distance generally seems to be contingent or contextual.

In this light, our research investigates how the link between partner knowledge gap and inter-firm learning is moderated by the different types of distance. Our contribution to the relevant literature on inter-firm learning across countries is distinct in two aspects. First, although most studies have measured inter-firm learning with patent data or survey-based data, the former may be inaccurate for inter-firm learning unless co-patenting is commonly used in the industry as a way to manage joint knowledge creation. Similarly, cognitive data obtained from surveys do not necessarily facilitate the actual creation of knowledge. Therefore, we select the bioscience and pharmaceutical industry, in which R&D alliances are common, and then take joint clinical trials as the measure of inter-firm learning because such trials are the essential and final task in the procedure for any R&D project in the industry. Second, we integrate the literature on organization learning and international business. Although both fields have elaborated on the identification of the determinants of inter-firm learning, efforts have not been substantially integrated. As inter-firm learning within global alliances has increasingly attracted scholarly attention in recent years, we hope that our efforts promote further understanding in the field.

The remainder of this paper is structured as follows: We first provide our theoretical perspective and propose hypotheses. We then discuss the research methodology, including data collection, measurements, and analytical approach. Subsequently, our statistical results are presented, and the paper concludes with a discussion.

2. LITERATURE REVIEW AND HYPOTHESES

2.1. Partner knowledge gap and inter-firm learning in the biopharmaceutical industry

In high-tech industries, international knowledge transfer is crucial for survival and growth. The bioscience and pharmaceutical industry is particularly characterized by high risk in terms of new product development because conducting R&D is costly, and ongoing R&D projects are often suspended as regulations change (Powell *et al.*, 1996). Even when a project succeeds, several years typically pass before a new product is finally approved by the relevant authorities (Mendes, 2008; Roberta and Enrico, 2013).

Given the characteristics of the industry, firms have collaborated with different partners to broaden their pipeline of new drug candidates. Two firms may share risks or access partner knowledge to complement their own knowledge through collaboration with others (Rosenkof and Almeida, 2003). Alternatively, one firm may conduct research while the other guides the product through its regulatory and clinical pathway (OECD, 2008). A hotly debated topic is whether inter-firm learning is facilitated or discouraged if alliance partners possess different levels of knowledge (learning capacity).

The results have hitherto been inconsistent. One group has suggested that knowledge gap strengthens the need for learning but replaces the internal R&D (Diestre and Rajagopalan, 2012). The logic underlying this belief is that knowledge gap motivates learning to acquire better skills and thereby stimulates the activities of search, assimilation, and utilization between two parties (Mowery, Oxley, and Silverman, 1996; Lai and Weng, 2013).

A partner with a relatively smaller learning capacity would have strong motivation to enlarge its capacity and to acquire complementary resources (Miler, Fern, and Cardinal, 2007). The firm thereby tends to have a wider range of innovative domains. Meanwhile, given its smaller knowledge stock, the firm may want to gain access to a platform that enables it to generate further knowledge; such a platform frequently appears with the usage right of certain essential patents owned by an alliance partner (Agrawal and Henderson, 2002). An alliance partner voluntarily offers technical advice and aids in problem-solving activities (Wen

and Chuang, 2010). Further, collaborations through alliances generate knowledge spillover between partners, thus providing complementary and valuable resources to the partner with the smaller knowledge stock (Mowery *et al.,* 1996).

Given that competing or teaching has been a permanent dilemma for alliance partners (Wen and Chuang, 2010), the literature has emphasized that what matters most for an alliance to create innovative knowledge jointly is the extent to which both parties possess similar learning capacities (Lin *et al.,* 2012; Schildt, 2012). A firm with larger knowledge stock may be able to encourage its partner to use its internal knowledge, thereby seeking an opportunity for licensing or further development based on own technology, as well as exploiting its resources and core competencies (Agrawal and Henderson, 2002; Phan and Peridis, 2000). In this light, a larger knowledge gap may reduce potential conflicts arising from internal competition, just as Wen and Chuang (2010) state, "in business practices, firms also choose alliances as an alternative to self-exploration, when both partners jointly explore a new knowledge domain (p. 701, 39–43).

However, the possibility exists that a greater knowledge gap between partners hampers inter-firm learning, such that partners engage in opportunistic behavior or free-riding (Gupta and Govindarayan, 2000; Schildt *et al.,* 2012). Several works have demonstrated that firms have more difficulty in absorbing knowledge if they have different levels of knowledge (Phelps, 2010; Gupta and Govindarayan, 2000). A greater difference in learning capacity constrains inter-firm learning, which eventually prevents firms from learning from each other (Mowery et al., 1996; Lai and Weng, 2014).

If a knowledge gap is too large, partners have to exert more effort in aligning two organizations into an integrative operation. This condition causes the resources and knowledge to be reserved for the output to be less or limited (Schulze and Brojerdi, 2012). A larger knowledge gap may cause one firm to increase the costs of absorbing knowledge from the other partner, whereas the other firm would reap no substantial gain in mutual learning. In this case, the alliance may end up with no outcome from the R&D collaboration. Hence, we suggest two alternative hypotheses.

H1a: As partner knowledge gap increases, the R&D alliance is more likely to facilitate inter-firm learning.

H1b: As partner knowledge gap increases, the R&D alliance is less likely to facilitate inter-firm learning.

2.2. Distance as a moderator

As a country increases its networking activities with the rest of the world, individuals and corporations in such country can have more opportunities for

information collection and diffusion (Oxley and Yeung, 2001). Global connectedness refers to the ability to interact with other parts of the world, obtain information, and diffuse own activities (Berry *et al.,* 2005). Country interactions have increased with the growth of varying types of transnational networks, such as inter-governmental organizations, free trade agreements, or memoranda of understanding, that include dyadic or multiple partnerships (Ingram, Robinson, and Busch, 2005). Other drivers of global connectedness are tourism and Internet use (Guillen and Suarez, 2005; Oxley and Yeung, 2001). Global connection facilitates knowledge exchange and sharing across countries (Ingram, Robinson, and Busch, 2005).

Countries have different levels of global-connectedness. Some are more connected and play a central role in their relationship with other countries, whereas others are more isolated and peripheral in the web of country networks. Global-connectedness would increase depending on the similarity of the institutional environment between countries (Berry *et al.,* 2005). Meanwhile, multi-contacts between countries may increase the possibility of conflicts related to the national interests (Ingram, Robinson, and Busch, 2005).

Trade and investment have been facilitated between highly globally connected countries. Given that membership in certain inter-governmental organizations offer substantial trade and investment benefits (Ingram, Robinson, and Busch, 2005), overlapping memberships may present similar institutional environments to the alliance. Greater differences in global-connectedness between countries, in other words, a high level of global-connectedness distance, indicate that the home countries of two alliance members have different institutional environments. In such a situation, alliance members would be more motivated for collaboration and learning because institutional unfamiliarity raises barriers to entry. Forming an alliance with a partner from a home country that has a different level of global connectedness would be helpful in exploring new markets for both parties and thus stimulate inter-firm learning. Therefore, different regulative and institutional environments would urge alliance members to pursue active inter-firm learning. Therefore, we propose the following hypothesis:

H2: Global-connectedness distance positively moderates the relationship between partner knowledge gap and inter-firm learning.

Cultural distance has been widely discussed in the field of international business strategies (Berry *et al.,* 2010; Ghemawat, 2001; Gupta and Govindarayan, 2000). In investigating the relationship between cultural distance and inter-firm learning, most studies have illustrated that greater cultural distance constrains the ability to collaborate between two firms (Hennart and Larimo, 1998) because such distance gives rise to operational difficulties derived from an incomplete

understanding of the local norms, values, or routines (Tihanyi, Griffith and Russell, 2005). Therefore, cultural distance is expected to increase complexity and uncertainty in managing an alliance (Tihanyi, Griffith and Russell, 2005) or managing the local subsidiary (Luo and Peng, 1999; Li and Guisinger, 1992).

Cultural differences increase the difficulties in transferring knowledge beyond a firm boundary (Van Wijk *et al.,* 2008). Such differences also impose difficulties on researchers in terms of adjusting to a new culture that is very different from their home-country cultures. This adjustment problem can further reduce the frequency or effectiveness of communication with colleagues in the partner firm. As a result, alliance participants with large cultural distance find it difficult to tap into the resources and opportunities embedded in the relationships with local researchers because the transfer of tacit knowledge requires extensive interaction and communication (Damanpour *et al.,* 2012). To facilitate inter-firm learning, a social relationship between alliance partners must be established to overcome many obstacles that originate from cultural distance.

Sometimes, cultural distance results in more than just communication difficulty. One important dimension of cultural distance is individualism, as suggested by Hofstede (1979). When conflicting interests exist between two firms, these firms tend to seek their own benefits prior to the mutual objective, and such opportunistic behavior has frequently caused alliance break-ups (Wen and Chuang, 2010). When one partner places its own interests ahead of the alliance goal, inter-firm learning cannot proceed effectively, such that the two firms are unlikely to attain the goal.

H3: Cultural distance negatively moderates the relationship between partner knowledge gap and inter-firm learning.

A third type of distance is geographic distance. A large volume of literature has demonstrated the positive relationship between geographic proximity and joint learning in an alliance (Gittleman, 2007; Fratianni and Oh, 2009). Geographic proximity enables interactions among participants in an R&D project. The close and frequent interactions, sometimes even face-to-face interactions, are specifically important for sharing or transferring critical knowledge. Von Hippel (1994) has illustrated that, while the advancement of information technology (IT) does not place significant importance on location for inter-firm learning, the most essential part of knowledge remains embedded in the owner firm. "Sticky" knowledge is difficult to transfer or share unless the transferring channel involves physical contact between the involved individuals.

With lesser geographic distance, a deep understanding between partners is possible at the alliance level, thus strengthening joint learning (Zaheer and George,

2004; Gittleman, 2007). This condition then expedites subsequent investments in partners (Almeida and Kogut, 1999; Rosenkopf and Almeida, 2003). Partners that are in close proximity can evaluate each other's resources and check progress more often than those that are distant. Bottleneck problems can therefore be more easily identified, and technical assistance for problem-solving can be efficiently facilitated, which increases the likelihood of facilitating inter-firm learning. Geographic proximity is highly important for alliance partners, even in the domestic setting, as the experience of the U.S. semiconductor industry illustrates (Reuer and Lahiri, 2013). Therefore, we hypothesize that:

H4: Geographic distance negatively moderates the relationship between partner knowledge gap and inter-firm learning.

3. RESEARCH METHOD

3.1. Data and sample

We select the biopharmaceutical industry as the research setting because R&D alliances are common in this industry, given the long duration of the process from product development to approval by an authorized institution. The leading actors in the U.S. biopharmaceutical industry consist of two groups (Diestre and Rajagopalan, 2012). One group comprises large multinational enterprises with their own distribution channels and sales networks. The firms in this group operate diversified R&D projects. The other group includes start-ups or small biopharmaceutical firms specializing in R&D for a few items.

We collect our data from Thomson Reuters Recap. This database has been used in the organization learning literature and provides a wide scope of information regarding alliance type, alliance initiation, termination date, and so on in the biotechnology and pharmaceutical industries. To avoid double data entry, we set the search parameters to American firms and their global R&D alliances during the period from 2000 to 2004. The period was chosen because R&D alliances increased particularly visibly during this time as bio-pharmaceutical start-ups began to emerge as an alternative to IT ventures. Other sources include LexisNexis, USPTO, Compustat, and World Bank.

Our finalized dataset contains 236 new (non-renewed) alliance projects formed between 109 American firms and their 167 non-American partner firms. Table 1 provides information (the number of firms per country and the corresponding percentages) about 236 firms broken down by nationality. In brief, the global R&D alliances were formed between firms in the U.S. and 28 non-U.S. countries. The highest percentage of alliance partners is found in the U.K.; however, alliance partners are globally diverse.

Table 1
Descriptive statistics for alliance partners

Partner Country	*No. of Companies*	*Percentage (%)*	*Aggregated Percentage (%)*
United Kingdom	38	16.10	16.10
Germany	36	15.25	31.35
Japan	31	13.14	44.49
Canada	27	11.44	55.93
Switzerland	17	7.20	63.13
Denmark	16	6.78	69.91
France	9	3.81	73.73
India	7	2.97	76.69
Ireland	6	2.54	79.24
Italy	6	2.54	81.78
Belgium	5	2.12	83.90
China	5	2.12	86.02
Netherlands	5	2.12	88.13
Singapore	4	1.69	89.83
Australia	3	1.27	91.10
Iceland	3	1.27	92.37
Argentina	3	1.27	93.64
Czech Republic	2	0.85	94.49
Spain	2	0.85	95.34
Israel	2	0.85	96.18
Sweden	2	0.85	97.03
Austria	1	0.42	97.46
Hungary	1	0.42	97.88
Kenya	1	0.42	98.30
South Korea	1	0.42	98.73
Norway	1	0.42	99.15
New Zealand	1	0.42	99.57
Zimbabwe	1	0.42	100.00
TOTAL	28	236	100.00
AVERAGE		9.04	3.57

3.2. Variables

- Dependent variable: Inter-firm learning is measured based on whether the R&D alliance conducted joint clinical trials. We use a binary format, coding 1 if the alliance conducted joint clinical trials and 0 otherwise. Joint clinical trials are specifically important as a proxy for inter-firm learning because patenting may

not be further pursued if the alliance motivation is global licensing. Joint clinical trials, instead, must be conducted regardless of the motivation and are, in fact, a more direct output of R&D collaboration.

- Independent variable: Partner knowledge gap, representing the relative size of learning capacity, is measured based on the absolute value of the differenced numbers of patents between a focal firm (a U.S. firm) and its alliance partners.
- Moderating variables: We also adopt three moderating variables related to country-level distance. Formulas and the definitions follow those proposed by Berry *et al.* (2010). Global-connectedness distance is measured based on Euclidean space using international tourism receipt and expenditure, each as a percentage of GDP, and Internet users per 1000 people. Cultural distance is estimated based on the differences between two countries in terms of attitude toward authority, trust, individuality, and importance of work and family, initially based on Hofstede (1980). Geographic distance is calculated based on the greatest circular distance between the geographic centers of countries, with the circle being denoted by the shortest distance between two points on the surface of a sphere, rather than a straight line through the sphere's interior.
- Control variables: Several control variables related to the focal firm's capability are included in the model. First, the size of the focal American firm is considered in the model by taking a natural logarithm on the total number of a firm's employees in year *t*. Second, the age of the focal firm needs to be controlled because older firms are more experienced in managing alliances. This variable is measured based on the number of operating years. Third, by including the focal R&D intensity in the model, we control the internal efforts for learning, which can prompt more joint clinical trials. This variable is measured based on the focal R&D expenses over the total assets in year *t*.

We also consider financial resources. We first control for the focal ROA because financial resources leverage internal efforts for learning. This variable is measured based on the firm's return over total assets in year *t*. Similarly, the amounts of capital expenditure and investing cash flow of the focal firm are included in the model because higher values of these variables are likely to lead to greater inter-firm learning. Each is calculated based on the logged values.

Variables concerning partner firms, including partner firm size (in terms of the logged value) and partner firm age, are also controlled because these two variables can either encourage or discourage inter-firm learning (represented by joint clinical trials) in the alliance.

Other variables include cross-patenting and focal centrality. Cross patenting at time *t*, a dummy variable, is also controlled to partial out the effect of past R&D

experiences on current inter-firm learning. We codify as 1 if a focal firm shares patent(s) before alliance formation; otherwise, we codify 0. Finally, we consider sum of centrality to exclude the possibility of a situation in which a few focal firms are approached for global partnership. We include the eigenvector centrality values for a focal American firm and the partner firm.

3.3. Statistical analysis

Our dependent variable, which is measured based on the existence of a joint clinical trial, is dichotomous. Thus, a logistic regression model is used to test the effects of the independent variables and the moderating effects of country-level distance on the relationship between partner knowledge gap and inter-firm learning. The usual ordinary least square (OLS) properties are assumed.

4. RESULTS

Table 2 provides a basic statistics and correlation matrix for all variables. Except for focal firm age and the focal firm size, other variables are moderately correlated. The reason for the high correlation between the focal firm age and the focal firm size can be attributed to the fact that a larger firm tends to have a longer business history. Nevertheless, the variation inflation factor (VIF) was estimated to be less than 10, which suggests that the correlation presents no serious problem in our research.

Next, we present the results of the logit regressions in Table 3. We gradually increase the value of the variable to examine whether the expected relationships are consistent across models. Model 1 includes control variables only. Model 2 shows the results from the main independent variable (partner knowledge gap) only. In Models 3, 4, and 5, moderators are added to examine the three types of country-level distance. Finally, in Model 6, the estimators having all variables are presented.

As shown in Table 3, the coefficient on partner knowledge gap is positive and consistent across all models. This finding indicates that as the knowledge gap between partners increases, inter-firm learning, which is measured based on joint clinical trials, is significantly facilitated. Although the decision to collaborate with a partner has been a long-standing issue in alliance management, our result implies that the knowledge gap may reduce rivalry between partners, thus helping both parties attain the mutual goal of inter-firm learning while satisfying individual interests. Thus, one firm can gain valuable access to the complementary resources that belong to the other firm. Meanwhile, the other firm can explore a new market and increase royalty revenue by licensing their patents to other firms. Thus, the R&D alliance is more likely to conduct joint clinical trials if two firms having

Table 2
Descriptive statistics and correlations

0	*Mean*	*S.D.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1. Inter-firm learning	0.458	0.499	1.000							
2. Focal firm size	-1.094	1.979	-0.027	1.000						
3. Focal firm age	20.686	22.082	0.041	0.669***	1.000					
4. Focal R&D intensity	34.324	293.736	-0.017	-0.101	-0.046	1.000				
5. Focal ROA	-0.304	0.513	0.080	0.456***	0.270***	-0.051	1.000			
6. Focal capital expenditure	6.688	0.072	-0.032	-0.440***	-0.333***	0.019	-0.204**	1.000		
7. Focal cash flow	6.665	0.128	-0.068	-0.251***	-0.373***	0.031	-0.203**	0.221***	1.000	
8. Cross-patenting dummy	0.072	0.259	0.007	0.037	0.003	-0.031	0.119†	-0.011	-0.047	1.000
9. Partner firm size	2.632	1.425	-0.005	0.029	0.080	-0.051	-0.012	0.092	0.034	0.064
10. Partner firm age	30.979	47.081	0.075	-0.049	0.063	-0.014	0.003	0.087	0.06	0.029
11. Sum of centrality	13.046	14.367	0.007	0.499***	0.307***	-0.086	0.203**	-0.150*	-0.097	0.076
12. Partner knowledge gap	69.39	105.144	0.162*	0.491***	0.540***	-0.049	0.165*	-0.195**	-0.329***	0.006
13. Global-connectedness distance	2.004	2.764	-0.068	-0.043	-0.03	-0.042	-0.147*	0.018	0.036	-0.080
14. Cultural distance	10.438	6.277	-0.210***	0.035	0.095	-0.081	-0.091	-0.056	-0.076	-0.067
15. Geographic distance	3.863	0.191	-0.066	0.057	0.074	-0.121†	-0.096	0.036	-0.046	0.001

0	*9*	*10*	*11*	*12*	*13*	*14*	*15*
9. Partner firm size	1.000						
10. Partner firm age	0.396***	1.000					
11. Sum of centrality	0.175**	-0.041	1.000				
12. Partner knowledge gap	0.254***	0.033	0.444***	1.000			
13. Global-connectedness distance	0.010	-0.034	0.028	-0.053	1.000		
14. Cultural distance	0.153*	0.181**	-0.072	-0.008	0.383***	1.000	
15. Geographic distance	0.264***	0.194**	0.036	0.084	0.320***	0.614***	1.000

† p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 3
Results of logit regression

0	*Model 1*		*Model 2*		*Model 3*		*Model 4*		*Model 5*		*Model 6 (full model)*	
Control Variable												
Focal firm size	-0.203†	(-0.115)	-0.263*	(-0.121)	-0.261*	(-0.123)	-0.255*	(-0.127)	-0.256*	(-0.124)	-0.298*	(-0.137)
Focal firm age	0.008	(-0.009)	0.000	(-0.010)	0.003	(-0.010)	-0.001	(-0.010)	0.001	(-0.010)	0.000	(-0.011)
Focal R&D intensity	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Focal ROA	0.511	(-0.352)	0.643	(-0.383)	0.599	(-0.392)	0.540	(-0.406)	0.670†	(-0.390)	0.742†	(-0.434)
Focal capital expenditure	-1.377	(-2.073)	-1.618	(-2.089)	-1.591	(-2.096)	-1.593	(-2.162)	-1.281	(-2.112)	-1.564	(-2.261)
Focal cash flow	-0.785	(-1.160)	0.010	(-1.197)	-0.008	(-1.202)	-0.270	(-1.299)	0.326	(-1.224)	0.362	(-1.434)
Cross-patenting dummy	-0.062	(-0.518)	-0.013	(-0.538)	-0.073	(-0.539)	-0.043	(-0.546)	0.331	(-0.560)	0.233	(-0.585)
Partner firm size	-0.061	(-0.105)	-0.152	(-0.112)	-0.139	(-0.114)	-0.048	(-0.117)	-0.185	(-0.120)	-0.080	(-0.136)
Partner firm age	0.004	(-0.003)	0.004	(-0.003)	0.005	(-0.003)	0.004	(-0.003)	0.005	(-0.003)	0.004	(-0.004)
Sum of centrality	0.007	(-0.011)	-0.002	(-0.012)	-0.001	(-0.012)	-0.002	(-0.012)	-0.005	(-0.012)	-0.003	(-0.013)
Explanatory Variable												
Partner knowledge gap (PKG)			0.006**	(-0.002)	0.006**	(-0.002)	0.005**	(-0.002)	0.007***	(-0.002)	0.009***	(-0.003)
Global-connectedness distance				0.083	(-0.089)					0.213†	(-0.117)	
Cultural distance							-0.051†	(-0.030)			-0.078†	(-0.044)
Geographic distance									-4.659**	(-1.769)	-3.728	(-2.278)
Moderator												
Global-connectedness distance * PKG					0.002†	(-0.001)					0.004†	(-0.002)
Cultural distance * PKG							0.001*	(0.000)			0.002***	(-0.001)
Geographic distance* PKG									-0.076**	(-0.029)	-0.131***	(-0.038)
Constant	13.997	(-15.146)	10.386	(-15.454)	10.625	(-15.556)	12.208	(-16.034)	6.616	(-15.843)	8.179	(-17.087)
Number of observations	236		236		236		236		236		236	
LR chi square	7.25		17.47		20.97		34.87		27.54		61.81	
Log likelihood	-159.110		-154.001		-152.251		-145.301		-148.963		-131.831	
Hit Ratio (%)	58.90		61.68		64.83		62.29		63.14		66.95	

Standard errors are in parentheses; † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

different levels of knowledge stocks form an alliance. Hence, Hypothesis 1a is supported.

Next, we test the effects of the country-level moderators on the relationship between partner knowledge gap and inter-firm learning. Model 3 shows a positive sign on global-connectedness distance as a moderator (β=0.002, $p<0.01$). The positive sign also appears in Model 6, which is the full model (β=0.004, $p<0.1$). This result demonstrates that, although statistically weak ($p<0.1$), the positive link between partner knowledge gap and inter-firm learning is strengthened if a high level of global-connectedness distance is present between partners (see Figure 2). The finding indicates that if a firm's home country is globally more networked than the partner's home country, a greater knowledge gap is more likely to facilitate inter-firm learning. A firm from a country with more global connections is expected to have larger and more diverse knowledge flows, which provide learning motivation for a firm from a country with a lesser knowledge stock. Meanwhile, the firms have a good reason to localize or adapt to the partner country setting. Global-connected distance thus necessitates considerable effort toward inter-firm learning. Hence, Hypothesis 2 is supported.

The coefficients on the interaction between cultural distance and the partner knowledge gap are positive both in Models 4 (β=0.001, $p<0.05$) and 6 (β=0.002, $p<0.05$). This finding suggests that cultural distance positively moderates the relationship between partner knowledge gap and inter-firm learning. However, given that the coefficient on cultural distance is negative, which means that greater

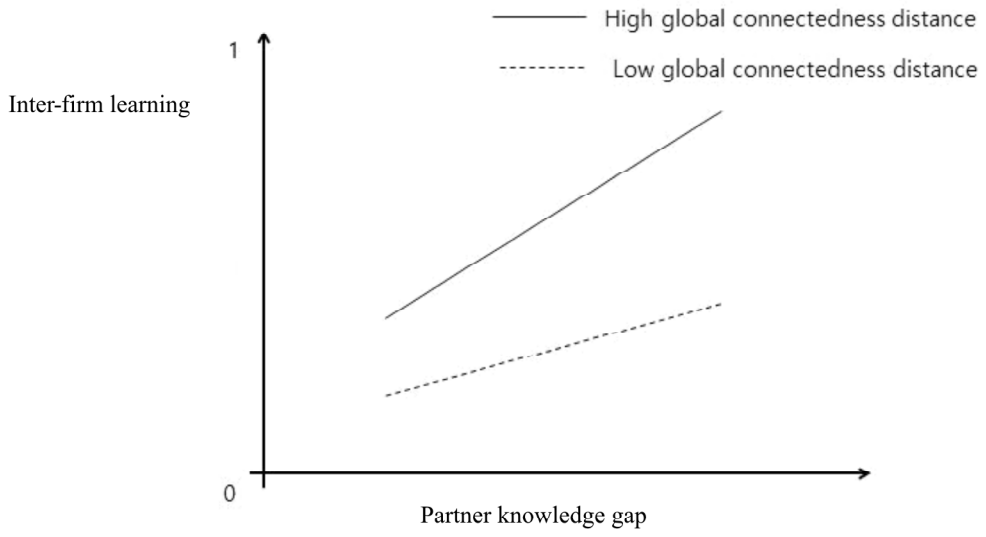

Figure 1: Interaction effect of global-connectedness distance

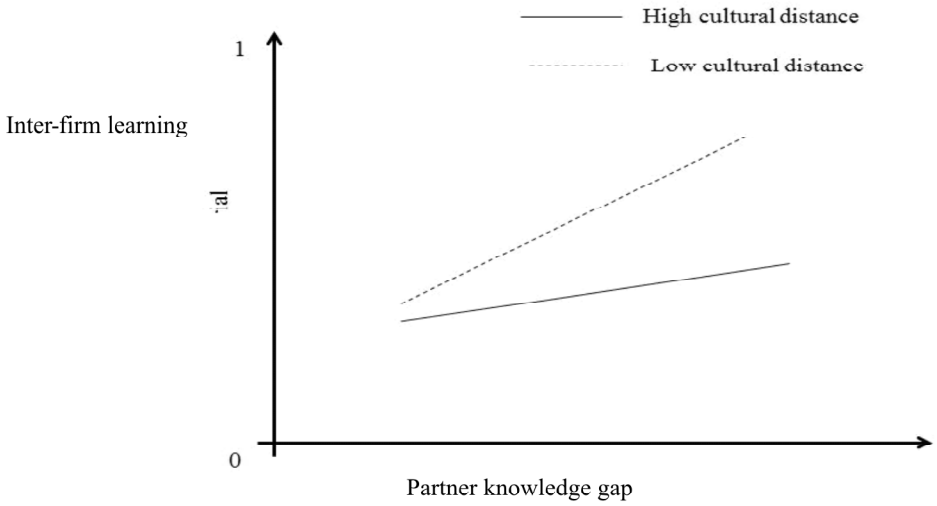

Figure 2: Interaction effect of cultural distance

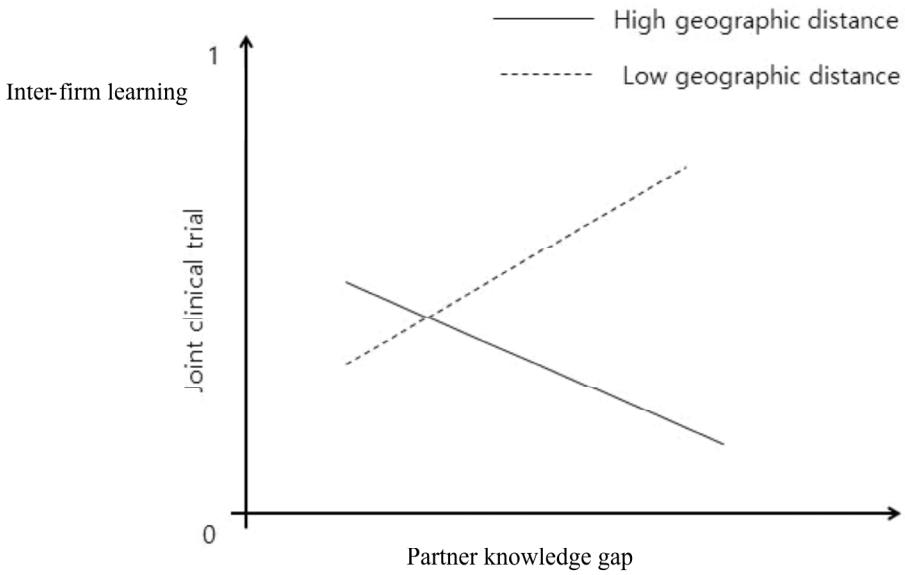

Figure 3: Interaction effect of geographic distance

cultural distance gives rise to more difficulties in inter-firm learning, a lower level of cultural distance strengthens the relationship between partner knowledge gap and inter-firm learning. Therefore, as Figure 3 illustrates, partner knowledge gap is more likely to facilitate inter-firm learning when the level of cultural distance between alliance partners is lower. Therefore, Hypothesis 3 is supported.

The moderator of geographic distance has a negative sign, which appears consistently in Models 4 and 6. This result indicates that, as geographic distance increases between partners, conducting close interactions becomes more difficult, which hampers knowledge transfer or problem-solving. Greater geographic distance fundamentally hinders both parties from obtaining valuable information or physical resources, or more frequently leads to miscommunication or misunderstanding-triggered distrust. However, when partners are geographically located adjacent to each other, the effect of partner knowledge gap on inter-firm learning is strengthened, thus supporting Hypothesis 4 (see Figure 4).

5. DISCUSSION AND CONCLUSION

Our study addressed one of the long-standing questions in firm management: to compete or to cooperate with an alliance partner. Our results suggest that greater relative knowledge stock would be more conducive to encouraging the creation of new knowledge between collaborators. The relationship can be explained by the current modus operandi in which a "small fish" swims with a "big shark," or firms collaborate on local adaption for a licensed product (Mendes, 2008).

The effect of partner knowledge gap on inter-firm learning, according to our research, is moderated by three types of country-level distance. First, global-connectedness distance represents a country's networking status with other countries. Our study suggests that, when alliance partners are from countries that are farther in their levels of networking with other countries, the positive link between partner knowledge gap and inter-firm learning would be stronger.

Cultural distance, our second moderator, measures the difference between two countries in terms of cultural values and attitudes. Our study confirms the positive moderating role of cultural distance on the relationship between partner knowledge gap and inter-firm learning. Therefore, in an environment in which sophisticated and advanced knowledge is required for collaborative outcomes, such as in the bioscience and pharmaceutical industry, communication efficiency, misunderstanding, or organizational unity would be highly important. Our study shows that similar cultural backgrounds may help alliances facilitate knowledge sharing and creation.

Finally, geographic distance, despite the advancement of IT technologies, still seems to be important. Larger geographic distance will impede face-to-face interaction for critical problem solving and thus reduce the effectiveness of inter-firm learning. Therefore, country-level geographic distance will also weaken the positive effect of firm-level knowledge gap.

Overall, our study addresses a key topic in strategic knowledge management: to compete or to collaborate with an alliance partner, particularly in the international context. Our findings contribute to the related literature by revealing that when space constraint is present relative to inter-firm learning, partner knowledge gap can motivate collaboration compared to a situation in which two competing partners work together. Different types of distance affect the link in a unique way, thus complicating global R&D management.

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