

Governance and Alliance Performance in R&D Alliance: The Intermediary Role of Inter-organization Knowledge Exchange

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Abstract. R&D alliance has become the dominant organization mode for developing technology, and its smooth operation depends heavily on effective governance. The purpose of this paper is to explore how governance affects alliance performance in R&D alliance. Drawing on transaction cost economics, organization theory, social capital theory and knowledge theory, this paper constructed a conceptual model. Then, an empirical testing was conducted. The results show in R&D alliance governance has significant positive effect on alliance performance and inter-organization knowledge exchange. Other results show inter-organization knowledge exchange is positive associated with alliance performance, and the influence of relational governance is stronger than that of contractual governance. The findings highlight the intermediary role of inter-organization knowledge exchange in relationship between governance and alliance performance.

Keywords: R&D alliance; governance; performance; inter-organizational knowledge exchange.

1. Introduction

R&D alliance is a strategic tool for firms to enhance competitive advantage, as well as a necessary complement of in-house technology development. R&D alliance not only acts as a mechanism of sharing cost and risk among partners, but also has potential to generate synergy effect via integrating heterogeneous knowledge. Meanwhile, R&D alliance is also a high-risk strategy. The operation of alliance is accompanied with great amount of opportunistic risks, conflicts and coordination problems. Therefore, to ensure effectiveness of cooperation in R&D alliance, two goals must be accomplished: eliminating opportunistic behavior risks; and coordinating cooperation activities according to the established targets (Hoetker and Mellewigt, 2009; Stenicke et al, 2012). Governance in R&D alliance is the way to realize these two goals. Governance provides required control and coordination, and thus lower transaction costs, coordination costs; maintain stability of R&D alliance. Most scholars employ such transaction cost economics (TCE) perspective or organization perspective in explaining how governance affects cooperation performance (Poppo and Zenger, 2002; Huang et al., 2012; Wang and You, 2015). However, is that all? While TCE and organization theory focus on anti-opportunism and coordination aspects of governance, they neglect the influence of governance on knowledge interaction between organizations. Extant researches have suggested that there is close relationship between governance and inter-organization knowledge exchange (Li and Poppo, 2010; Capaldo, 2014). Meanwhile, tacit and explicit knowledge exchange between partners is the requisition for the success of R&D alliances (Dooley and Sullivan, 2007; Li et al., 2018). Thus, inter-organization knowledge exchange must be taken into consideration in explaining how governance affects alliance performance.

Based on TCE, organization theory, social capital theory and knowledge theory, this paper tries to explore the relationships among governance, inter-organization knowledge exchange and alliance performance. The remainder of this paper contains four sections. First, a conceptual model is developed. Then, research methodology is introduced. Next, empirical testing is conducted and the results are analyzed. Finally, this paper discusses conclusions, managerial implications.

2. Theory and Hypothesis

2.1 Theory

2.1.1 Governance in R&D Alliance

Governance in R&D alliance is a process of constructing, maintaining and terminating cooperative R&D relationships. According to Poppo and Zenger (2002), governance includes contractual and relational governance. Contract is a mechanism to ensure exchange of productions, service and knowledge between organizations (Argyres and Mayer, 2007). Contracts coordinate and control partners' activities by specifying each partner's roles, obligations and penalties for defaults. In addition, as uncertainties and requisition for coordination increase, contractual relationships can embed some formal organizational mechanisms to enhance control and coordination, which include command structures and authority systems, incentive systems, standard operating procedures, nonmarket pricing and dispute resolution procedures (Stinchcombe, 1985).

Different from TCE and organization theory, social control theory and relational contract theory highlight the effect of relational mechanisms on economic activities. Relational governance refers to managing cooperation with trust and relational rules or norms (Heide and John, 1992; Luo, 2007; Heide et al., 2010). Trust is widely acknowledged as an important social control mechanism to foster and sustain cooperative relationships. Rousseau et al. (1998) defined trust as a psychological state comprising the intention to accept vulnerability based upon positive expectations of intentions or behavior of another. Trust can lessen the risk, thus supporting inter-organization cooperation (Das and Teng, 2003). Relational norms are behavior expectation to solve problems and accomplish performance targets (Meryem, 2011), consisting of behavior norms such as flexibility, solidarity and or so. As a blueprint, relational norms guide and regulate appropriate and acceptable behaviors.

R&D alliance is based on relational contracts, which means contractual governance and relational governance is complementary in supporting alliance's operation. The bounded rationality of individuals and the complexity of R&D make contract cannot deal with every possible situation. Relational governance is more flexible and adaptive, and it can be applied to varied situation and conditions. However, the building of trust and relational norms is time consuming. Therefore, both contractual and relational governance are needed in the process of regulating partners' behaviors.

2.1.2 Inter-organization Knowledge Exchange

Inter-organization knowledge exchange represents all kinds of knowledge interaction between organizations, including knowledge sharing, transfer and spillover (Kotabe et al., 2003; Arikan, 2009). Tödtling and Lehner (2008) classified the mode of knowledge exchange as market transactions, knowledge spillover, informal networks, and collaboration/formal networks. Additionally, inter-organization knowledge exchange can be classified as explicit and tacit knowledge exchange. Explicit knowledge is codified and articulated and thus can be transmitted via language or images. In contrast, tacit knowledge is uncoded and unarticulated, which is relevant to feelings, moving skills, intuition. Tacit knowledge can be transferred only through intensive interactions and feedbacks (Nonaka and Takeuchi, 1995).

2.2 Hypothesis

2.2.1 Governance and Alliance Performance in R&D Alliance

According to TCE, it may induce opportunistic behaviors such as hold up, shrinking and knowledge appropriation (Poppo and Zenger, 2002; Wang and Chen, 2017). Contracts can minimize transaction costs and performance loss caused by opportunistic hazards with restriction and monitor (Hoetker and Mellewigt, 2009). Additionally, collaborative R&D between organizations is highly interdependent and thus requires great amount of coordination. Contracts can institutionalize interactions among partners, simplify the communication and decision-making, and enhance the information process capability (Galbraith, 1973).

Similarly, relational governance can facilitate cooperation and discourage opportunistic behaviors (Ryan et al., 2004), thus not only saving transaction costs but also enhancing value-creating ability.

Kendall and Brush's (2000) empirical research indicated that relational norms moderated the negative effects of asset specificity and environment uncertainty on transaction costs and enhanced adaptive capability of relationships. Additionally, trust can enhance coordination and decrease coordination costs. For alliances involving considerable interdependence, trust is an extraordinary lubricant. Firms with prior linkages are likely to have a greater awareness of the rules and procedures each needs to follow (Gulati and Singh, 1998). Thus:

H_{1a}: Increased contractual governance will lead to improvements in alliance performance.

H_{1b}: Increased relational governance will lead to improvements in alliance performance.

2.2.2 Governance and inter-organization Knowledge Exchange in R&D Alliance

Partners arrange their relationships by crafting contracts, and this process creates opportunities for partners to access each other's knowledge base, leading to inter-organization knowledge exchange. Steinicke (2011) argued that partners could observe each other's work modes and procedures in analyzing and defining common processes. In addition, contractual governance is able to impose restrictions on opportunistic behaviors like hold-up and knowledge spillover, and enhance the willingness and confidence of knowledge sharing. For example, confidentiality clauses provide ground rules for knowledge exchange.

The generation and development of trust and relational norms are constant social interaction process between partners (Dekker, 2004; Huang and Herriott, 2013), which can facilitate inter-organization knowledge exchange, especially tacit knowledge. In addition, trust can enhance the relationship openness and moderate the negative effect of competitive overlap on relationship openness. Relationship openness refers to the willingness and capability that partners share information (Inkpen, 2000). Trust not only influences the scope of knowledge exchange, but also the efficiency of knowledge exchange (Lane et al., 2001). Lastly, with guidance of relational norms, partners will behave cooperatively beyond contracts, facilitating intensive knowledge sharing.

Although both contractual and relational governance can facilitate knowledge exchange, the influence of contractual governance on inter-organization knowledge exchange is usually confined to the type of knowledge. Any knowledge has its tacit dimension, the tacitness of knowledge make inter-organization knowledge exchange unable to be coordinated via market or authority, but rely more on voluntary knowledge sharing based on mutual trust, especially when tacitness is too high. So, contractual governance often fails to provide enough safeguards to support inter-organization knowledge exchange (Heide et al., 2010). Comparatively, the flexibility and adaptation keep relational governance off the influence of tacitness. Thus:

H_{2a}: Increased contractual governance is associated with higher levels of inter-organization knowledge exchange.

H_{2b}: Increased relational governance is associated with higher levels of inter-organization knowledge exchange.

H_{2c}: The influence of relational governance on inter-organization knowledge exchange will be stronger than that of contractual governance.

2.2.3 Inter-organization Knowledge Exchange and Network Performance

The sharing of partners' skills can enhance the efficiency of division of labor, and the sharing of knowledge for some special problem can speed the searching process of solutions (Kotabe et al., 2003). Knowledge transfer can speed the development of novel solutions, and realize efficient division of labor by selectively using alliance assets and competences, thus saving lots of time and costs in the process of NPD (Capaldo, 2014). Meanwhile, because innovation often derives from unexpected fusion of diverse knowledge and experience, inter-organization knowledge exchange can speed knowledge innovation. From the perspective of individual firms, knowledge exchange will improve partners' operations and strengthen competitive advantages. Thus:

H₃: Higher levels of inter-organization knowledge exchange are associated with improved alliance performance.

2.2.4 The Intermediary Role of Inter-organization Knowledge Exchange

Governance creates a good atmosphere for partners to share knowledge. Only when partners devote themselves to a truly cooperative relationship, can tacit and local know-how be exchanged, thus creating more opportunities (Uzzi, 1997). Relational capital constructed by governance can facilitate inter-organization knowledge exchange, leading to improvements in performance of R&D alliance (Xue et al., 2010). Meanwhile, governance can coordinate inter-organization knowledge interaction directly, facilitating knowledge mobility, and finally generating synergic effects. Toyota promoted knowledge sharing in its supplier network and enhanced network performance by introducing network-level knowledge-sharing routines (Dyer and Nobeoka, 2000). Thus:

H_{4a}: Inter-organization knowledge exchange mediates the relationship between contractual governance and alliance performance.

H_{4b}: Inter-organization knowledge exchange mediates the relationship between relational governance and alliance performance.

3. Methodology

3.1 Sample and Data Collection

The hypotheses were tested using data collected from firms in Wuhan, China, which have collaborative R&D experience recently. The respondents were either CEOs or members of board of directors, and we requested them to answer the questions with reference to relevant information of the collaborative R&D projects they engaged with questionnaires. We sent 250 surveys in total and finally received 190 surveys back. The final sample size was 169.

The sample firms' basic information is as followed. 28.4 percent of them are stated-owned, 56.8 percent of them are private firms, and 14.8 percent of them are foreign related firms. 6.5 percent of sample firms belong to low technology industry, 41.4 percent of them belong to low-medium technology industry, 37.9 percent of them belong to medium-high technology, and 14.2 percent of them belong to high technology. 27.8 percent of the respondent firms are below 5 years, 39.6 percent of them belong to 6-10 years, 23.1 percent of them belong to 11-15 years, and 7.1 percent of them are above 16 years. 11.2 percent of the sample firms are less than 50, 30.2 percent of them belong to 51-100, 21.9 percent of them belong to 201-500, and the rest of them are more than 500.

3.2 Measures

We measured contractual governance using the scale developed by Murray and Kotabe (2005), comprised of two items. We used six items to operationalize relational governance from extant literature (Poppo and Zenger, 2002; Fink et al., 2007). We measured inter-organization knowledge exchange with five items based on the scale developed by Kotabe et al. (2003). We measured alliance performance with five items adapted from (Saxton, 1997). All measures above are 7-point Likert scales, and each measures is obtained by computing the average score.

Some control varieties should be taken into consideration. Technological intensity belongs to categorical variable. "1" was allocated to low technology, "2" was allocated to low-medium technology, "3" was allocated to medium-high technology, and "4" was allocated to high technology. Alliance duration was measured with the number of years since alliances were formed (Krishnan, 2006). Investment size was measured by number of people engaged in collaborative R&D projects. We measured partner complementarity that assessed whether the combination of partners' abilities enabled the achievement of tasks beyond their individual reach (Schreiner et al., 2009), based on 7-point Likert scale. We measured physical distance with single item that assessed whether partners were very far from each other, based on 7-point Likert scale.

4. Analysis and Results

4.1 Reliability and Validity

All scales Cronbach's alpha is above 0.7, demonstrating superior reliability. The standardized loading of each item was between 0.7-0.9, demonstrating superior construct validity. Average variance extraction (AVE) of contractual governance is 0.681, and AVE of relational governance is 0.690, demonstrating superior convergent validity. The composite reliabilities (CR) are respectively 0.810 and 0.930. We further compared single factor model and double factor model of governance. The fit indices of double factor model are significantly better than the ones of single factor model. We employed EFA to test construct validity of inter-organization knowledge exchange and alliance performance. Both scales indicate superior construct validity, convergent validity and CR.

Table 1. Fit indices of hypothesized model and competitive model

Model	χ^2	df	χ^2/df	RMSEA	GFI	AGFI	NFI	CFI
Single factor	127.615	20	6.381	0.179	0.867	0.761	0.858	0.877
Double factor	33.687	19	1.773	0.068	0.952	0.910	0.963	0.983

4.2 Descriptive Statistics

As reported in table 2, there is significantly positive correlation between governance (contractual and relational) and alliance performance. Meanwhile, there is significantly positive correlation between governance (contractual and relational) and inter-organization knowledge exchange. Lastly, inter-organization knowledge exchange is significantly associated with alliance performance.

Table 2. Descriptive statistics and correlations

Construct	Mean	SD	1	2	3	4	5	6	7	8
1. Technological intensity	2.60	.812								
2. Network duration	1.74	1.22	.43							
3. Physical distance	4.28	1.34	.76	.14						
4. Investment size	93.11	48.22	.15	.11	.09					
5. Partner complementarity	4.05	1.32	.11	.11	.12	.14				
6. Contractual governance	4.01	1.28	.10	.11	.14 ^c	.13	.07			
7. Relational governance	4.25	1.13	.21 ^b	.19 ^c	.16 ^c	.13	.16 ^c	.28 ^a		
8. Inter-organization knowledge exchange	4.45	.92	.24 ^b	.22 ^b	.22 ^b	.15	.22 ^c	.33 ^b	.60 ^a	
9. Alliance performance	4.09	1.06	.22 ^b	.30 ^c	.25 ^a	.33 ^b	.25 ^b	.43 ^a	.55 ^a	.58 ^a

^a = Significant with $p < 0.001$; ^b = $p < 0.01$; ^c = $p < 0.05$; Two-tailed test.

4.3 Test of Hypothesis

The results of regression analysis are reported in table 3. Model 4 indicates that the positive relationship between governance (contractual and relational) and alliance performance is significant (0.001). Hypotheses 1a, 1b are supported. Model 2 demonstrates that both contractual and relational governance have positive influence on inter-organization knowledge exchange, hypotheses 2a and 2b are supported. Meanwhile, the effect of relational governance on inter-organization knowledge exchange is 0.492, larger than that of contractual ones (0.148), supporting hypothesis 2c. Model 5 shows the positive relationship between inter-organization knowledge exchange and alliance performance (0.001), supporting hypothesis 3. According to model 6, the indirect effect of contractual governance on alliance performance is significant. Meanwhile, according to model 2 and model 6, both indirect effect and direct effect of governance are positive. Hence, inter-organization knowledge exchange plays partly intermediary role between governance and alliance performance, supporting hypothesis 4a, and 4b.

Table 3. Results of regression analysis

Variables	Inter-organization knowledge exchange		Alliance performance			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Technological intensity	.192 ^b	.095	.139 ^c	.054	.049	.029
Network duration	.162 ^c	.079	.231 ^b	.156 ^b	.156 ^c	.135 ^c
Physical distance	.155 ^c	.086	.168 ^c	.099	.096	.076
Investment size	.068	.023	.248 ^a	.200 ^b	.216 ^a	.194 ^b
Partner complementarity	.158 ^c	.101	.155 ^c	.107	.081	.081
Contractual governance		.148 ^c		.256 ^a		.217 ^a
Relational governance		.492 ^a		.376 ^a		.247 ^a
Inter-organization knowledge exchange					.466 ^a	.263 ^a
R ²	.160	.429	.262	.493	.444	.533
Adjusted R ²	.134	.404	.239	.471	.424	.509
F-Statistic	6.206 ^a	17.296 ^a	11.566 ^a	22.386 ^a	21.582 ^a	22.790 ^a

^a= Significant with $p < 0.001$; ^b = $p < 0.01$; ^c= $p < 0.05$; Two-tailed test.

5. Conclusions and Discussion

To conclude, this paper takes a significant step toward exploring the relationships among governance, inter-organization knowledge exchange and alliance performance in R&D alliance. Specifically, the study argues that governance has positive influence on both alliance performance and inter-organization knowledge exchange. Meanwhile, the results indicate that beside the direct effect, governance influence alliance performance positively in an indirect manner via intermediary role of inter-organization knowledge exchange. Such knowledge-based perspective complements prior research on alliance governance. This paper also shows that the effect of relational governance is stronger than that of contractual ones.

This paper makes several contributions. First, we examine the relationship between governance and alliance performance in R&D alliance. Traditional governance literatures mainly address transaction relationships. However, in R&D alliance consisted of complex collaborative R&D relationships, governance plays more pivotal role in improving the overall performance. Our empirically findings confirm this theory. This paper finds that both contractual and relational governance have significantly positive effect on alliance performance. This result implies that more attention should be paid to governance. Second, TCE and organization theory tend to highlight control and coordination functions of governance. This paper extends this stream of research by empirically showing that both contractual and relational governance facilitate inter-organization knowledge exchange. This finding underscores the additional knowledge benefits of investing in governance. Moreover, this paper finds that the effect of relational governance is stronger than that of contractual ones. Hence, inter-organization knowledge exchange should be taken into account in the designing of governance structure. Managers of R&D alliances have better increase the proportion of relational governance in alliances that develop complex technologies. Third, this paper also finds that inter-organization knowledge exchange positively influences alliance performance. This result is similar to that observed in previous research. With intensive knowledge exchange among partners, knowledge can flow to the place where it is needed, accelerating the process of searching solutions and decreasing searching costs. In addition, knowledge interaction can facilitate diffusion of technologies and skills, thereby enhancing partners' competitive advantages. We suggest that manages establish knowledge linkages and knowledge-sharing routines in R&D alliance. Finally, in explaining how governance affects alliance performance, prior researchers have proposed that governance regulates partners' appropriate behaviors and strengthen task coordination. These studies

represent the logic of TCE. However, from knowledge-based view, any organization is essentially the locus of knowledge generation and application, and knowledge further determines the productivity. Therefore, governance cannot merely be seen as tools to control and coordinate exchange, but more a facilitator for learning and knowledge innovation. In general, it's necessary to explain the relationship between governance and alliance performance from the perspective of knowledge. Our findings address this gap by confirming that inter-organization knowledge exchange partly mediates relationship that governance has with alliance performance.

Our research suggests several promising opportunities in future research. First, our research indicates that the effect of relational governance on inter-organization knowledge exchange is stronger than that of contractual ones. Further research could examine how inter-organization knowledge exchange predicts governance structure of R&D alliance. Second, this paper examines the effects of contractual governance and relational governance in a relatively separate way. Further research could examine the interaction effect of contractual and relational governance.

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