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Collaborative and Legal Dynamics of International R&D- Evolving Patterns in East Asia

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ABSTRACT

International R&D collaboration is perceived as important R&D strategy to obtain complementary resources, to learn from the partner as well as to share risks and costs. Previous studies suggested that international R&D collaboration has positive impacts but the impacts investigated in literature are either not clearly defined or largely focused on business or technology. This study attempts to investigate collaborative influence and legal value of international R&D by analyzing East Asian collaborative patents with multiple assignee countries from the perspectives of social network theory and cross-country patent infringement probability. It is found that international R&D is positively related to both collaborative influence and legal value. The evolving pattern shows that China and Taiwan are the most prolific and fastest-growing patenting countries. Also, Taiwan is the most important partner country in East Asia's internationalization of R&D. Two important contributions of this study can be summarized as follows: 1) this study defines collaborative influence and legal value based on which the dynamics of East Asia's international R&D collaboration can be obtained, 2) the legal value defined in this study can be used to evaluate patent value and the quality of R&D partnership in East Asia.

1. Introduction

Strategic collaboration facilitates pooling of complementary skills, learning from the partner as well as sharing risks and costs. There have been a large number of literature examining impacts of strategic alliance on firm level innovation (Ahuja, 2000a; Brown and Eisenhardt, 1995; Dodgson, 1992; Duysters and Hagedoorn, 1998; George et al., 2002; McGill and Santoro, 2009; Smith et al., 1991). It is suggested in literature that strategic collaboration allows firms to access strategic assets (Baum et al., 2000; Teece, 1992), complementary technology (Duysters and Hagedoorn, 1998; Mohnen and Hoareau, 2003) and opportunity of learning from collaborators and suppliers (Fritsch, 2002; Simonin, 1999a,b).

The multinational enterprises and its vehicle, foreign direct investment, are key forces in globalized economy (Brakman and Garretsen, 2008). Foreign direct investment which has grown more rapidly since 1990 is the critical driver of international R&D collaboration. The international collaboration is enhanced by reduced air travel cost, international communication cost and seeking for greater efficiency as growing competition in domestic and international markets forces firms to become efficient and competitive. International flow of information, technology, capital, goods, services, people have deepened global supply chain and global interdependence through which world economic growth and living standard can be advanced (Bohnstedt et al., 2012; Ernst and Kim, 2002; Hsu et al., 2015).

International R&D collaboration is investigated in literature to examine absorptive capacity and technology learning (Kim and Inkpen, 2005), opportunities and limitations (Narula, 2004), home and host innovation systems (Criscuolo et al., 2002), collaborative research in developed countries (Georghiou, 1998; Van Beers et al., 2008), collaboration between developed and developing countries (Srivastava et al., 2013), collaboration in developing countries (Li, 2010). International R&D collaboration is one of common form of international business activities which include foreign direct investment, joint ventures and strategic alliances (Moore and Lewis, 1999). Although international R&D collaboration is perceived as an important R&D strategy (Hsu et al., 2015), the significance of international R&D collaboration varies by regions. For example, East Asia is one of the most successful regional economies (Abbott, 2003) with extensive R&D collaboration among Taiwan, Japan, Korea, and China (Tsukada and Nagaoka, 2011).

Previous studies provide evidence to prove the positive impacts of collaborative R&D. However, the impacts investigated in literature are either not clearly defined or largely focus on business or technology. Studies have scarcely analyzed collaborative influence, nor has attention been paid to the legal value of international R&D collaboration.

Theoretical and empirical studies fail to take account of collaborative influence and legal value that can also shape the relation between International R&D collaboration and collaboration performance. Two issues related to collaborative influence and legal value need to be considered. First, it is accepted in literature that international R&D has positive influence on collaboration because collaboration relies on resource exchange and social interaction. More intensive international R&D leads to higher

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collaborative influence but how collaborative influence of international R&D can be measured? Second, legal value has been scarcely investigated for international R&D. One important question needs to be answered is whether or not international R&D has positive influence on legal value.

Therefore, this study aims to analyze the evolving pattern of dynamic R&D collaboration in East Asia as well as fill these gaps by answering the following research questions:1) How to measure the collaborative influence of international R&D, 2) Does international R&D have positive influence on legal value.

This study examines how collaborative influence and legal value can be analyzed for understanding the performance of international R&D. Specifically, this study argues that collaborative influence and legal value of international R&D collaboration can both be measured and international R&D has positive effect on both collaborative influence and legal value. Research questions are answered by analyzing the patent output of international R&D in the context of East Asian Countries. It contributes to literature in three aspects: First, this study empirically shows that international R&D has positive effect on both collaborative influence and legal value. Second, it measures legal value quantitatively for East Asian countries. Third, this study provides evidence on the evolving pattern of international R&D in East Asia.

The remainder of the paper is organized as follows: Theoretical Background is reviewed, Data and Method are explained, Results are discussed, and finally, Conclusion with Management Implication, Limitation and Future Study is provided.

2. Theoretical Background

2.1. International R&D Collaboration

Knowledge flow in the same countries are more intense than cross countries (Keller, 2002). Geography is believed a constraint of flow of knowledge (Jaffe et al., 1993; Thompson, 2006). Literature investigating International knowledge flow have focused on trade (Grossman and Helpman, 1991), Foreign Direct Investment (Branstetter, 2006; Lee, 2006) and firm innovation (Kotabe et al., 2007).

International R&D collaboration generates output that can be more applicable to wider variety of preferences and be beneficial to multiple countries. Some prior studies suggested that international R&D collaboration generates better output because diverse knowledge and competences can be integrated from different countries (Levinthal and March, 1993; March, 1991). However, other studies suggested that high coordination cost and communication difficulties, e.g. culture and language, and therefore independent R&D without international collaboration is more efficient and valuable (Furman et al., 2005; Singh, 2008). Although there is no consensus on the influence of international R&D collaboration on the quality of R&D, a number of literature suggest international R&D collaboration generates positive impact on quality of patent. For example, Alnuaimi et al. (2012) found international collaboration bring positive influence on patent value measured by patent citation (Alnuaimi et al., 2012). Branstetter Li and Veloso investigated China and India's patents and found that patent with foreign inventor is of higher value measured by patent citation (Branstetter et al., 2014).

In summary, there has little attention paid to the influence of International R&D in literature. Also, the influence has scarcely been characterized. International R&D collaboration gives rise to two fundamental issues. First, international R&D requires collaborative interaction to exchange resource, share experience and communicate between at least two teams in different countries. Second, international R&D may generate inventions involving in patent infringement lawsuit which is becoming a routinized business strategy in modern knowledge-based economy. Prior studies in literature leave open the questions of how to understand the collaborative influence and legal value of international R&D collaboration.

2.2. Social Network Theory for Understanding Collaborative Influence

Firms collaborate with each other in order to access strategic assets (Baum et al., 2000) or complementary technology (Duysters and Hagedoorn, 1998; Mohnen and Hoareau, 2003). Firms collaborate through various forms of interaction in order to exchange resource and finally develop services or products that can generate higher economic benefit. The existence of a certain number of collaborations allows all these firms to form a network-like structure based on which social network theory was developed. The use of social network theory allows understanding the social relations among these collaborating firms.

Social network theory originally studied by sociologist has gradually used in other research fields and become an interdisciplinary concept. Granovetter (1973) proposed the theory of weak tie after his social network research, and argued social network is a proxy of understanding interconnection between microscopic analysis and macroscopic analysis (Granovetter, 1973). In the late 1990s, collaboration between researchers from different fields by the use of social network analysis had been initialized so social network analysis become more interdisciplinary. Watts (2004) published a book entitled "Six Degrees: The Science of A Connected Age" (Watts, 2004), together with other interdisciplinary works contribute to expansion of small world concept from conventional neuro-science and bio-information system to any natural or human system that can be modeled by network.

A social network formed on the basis of resource exchange among firms can be used for understanding how resources are exchanged in this collaboration network, how firms are positioned to influence resource exchange, and which resource exchange is important (Wasserman and Galaskiewicz, 1994; Wellman and Berkowitz, 1988). Each resource exchange can be depicted as a linkage or a tie between a pair of firms. The strength of a network linkage is proportional to how much resources are exchanged or the frequency of resource exchange between two paired firms (Marsden and Campbell, 1984).

Social network theory has been used in literature to investigate network of innovators, formal and informal knowledge networks in R&D (Allen et al., 2007), international R&D centers (De Prato and Nepelski, 2012), knowledge network and collaboration network by patent analysis (Guan and Liu, 2016; Jaffe et al., 1993). The constructed collaboration network can be analyzed to obtain network properties through which the collaboration structure can be quantitatively calculated and the collaborative influence of each network actor can therefore be analyzed. Network actor has to be properly selected to meet the required level of studies. Compare to person and firm, country seems to be a more acceptable and proper network actor when it comes to a country-level study on international R&D collaboration.

2.3. Patent Infringement Probability as a Proxy of Legal Value

Economic literature recognize that patent is an important R&D output for protection of R&D results, for creating a better bargaining power and building image of a firm or an organization. Prior studies investigated how to estimate value which is usually classified into three types of values: 1) legal value (Agliardi and Agliardi, 2011; Allison et al., 2003; Lanjouw, 1998; Lanjouw and Schankerman, 1997; Marco, 2007; Reitzig et al., 2007), 2) technology value (Lee, 2009; Suzuki, 2011; von Wartburg et al., 2005) and 3) economic value (Gallini, 1992; Gambardella et al., 2008; Gilbert and Shapiro, 1990; Klemperer, 1990; Scotchmer, 1996; Scotchmer et al., 1990). For the legal perspective, patent can be used for protecting proprietary process or product technology, and creating retaliatory power against competitors in a knowledge economy (Alikhan and Mashelkar, 2004). Therefore, it can be observed that the number of patent infringement has been increasingly remarkably over the past two decades (Moore, 2000; Su et al., 2012) and patent infringement has been a popular topic (Somaya, 2003). Patent as a type of R&D output has been used to protect