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The determinants of government-sponsored R&D alliances☆

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ABSTRACT

This study aims to explore the main motive of enterprises for participating in government-sponsored R&D alliances, as well as their performance after joining an R&D alliance. The data comprises 491 projects of R&D alliances with 1688 firms. The study applies multiple regression analysis and fsQCA to test the relationship among the factors determining the formation of R&D alliances and their performance. According to the empirical findings, R&D capacity and government grants are the motive factors of enterprises to participate in R&D alliances, influencing corporate operational performance. In other words, after participating in R&D alliances, enterprises enhance their operational performance.

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1. Introduction

Innovation is a valuable resource for competitiveness performance, but investing in innovation requires a lot of R&D resources. Unlike larger companies, SMEs (Small and Medium Enterprises) have to seek external resources to promote R&D activities, thus developing alliances with other enterprises. Alliances are beneficial in terms of resource leveraging and cost reduction (Narula & Duysters, 2004). In addition, external strategic partners can increase the enterprise's understanding of customer needs, and further create competitive products. For this reason, alliances are core elements in the growth strategies of firms from a wide range of industries. When they work, alliances allow firms to create values that no single firm could have created (Lichtenthaler & Lichtenthaler, 2004; Sampson, 2005). The advent of radical innovations poses a significant challenge for the companies: They must find a way to adapt and master the new technology to ensure that their products and processes fully exploit the change. R&D alliances offer increasingly popular means for meeting the challenges, increasing the likelihood of innovation success, helping a firm to access a new technology, and expanding the R&D scale.

Millions of SMEs have become the key driving force of the economic development in Taiwan, where, especially in the 1970s and early 1980s, SMEs enjoyed a strong position in the country's production outputs, numbers of enterprises, numbers of employees, and export value. Compared to other newly industrializing countries (NICs) including South Korea, Singapore, and Hong Kong, Taiwan's SMEs excelled in providing

employment opportunities. SMEs account for 97% of all enterprises and for 78% of the employed population in Taiwan. In the late 1980s, Taiwan faced a series of challenges including the appreciation of NT dollars, the increase of land and labor costs, the decrease of export competitiveness, and the movement of SMEs to foreign production bases (Lin, 2010). The changing environment brought up the changes in the SMEs' competitive mode. The ability to carry out R&D is critical in maintaining the technical competitiveness of SMEs (Drilhon & Estime, 1993). To assist the development of SMEs, the Taiwanese government set up the Small and Medium Enterprise Administration depending from the Ministry of Economic Affairs. This administration assists the SMEs in improving their operational environment and structural transformation, and in increasing their access to financing, especially for production technology innovation.

Innovation competences are central competence areas in the knowledge-based economy, and thus, the government uses incentive industry policies to encourage firms to invest on R&D activities. These government-sponsored projects encourage R&D activities and represent an easy way for firms to access external resources for reducing risk of R&D. The Taiwanese government has launched government-sponsored technology-development programs since the 1970s, such as the Industrial Technology Development Program (ITDP), and the Small Business Innovation Program (SBIR), among others (Lin & Lin, 2012). Facing the rising of China, firms are eager to upgrade technology and relocate competitive advantage (Lin, 2010). Sole proprietorship accounts for 60% of all SMEs in Taiwan, but these government-sponsored programs assist SMEs to access additional resources, and encourage formation of R&D alliances. The government-sponsored R&D alliance is a critical external learning alternative to upgrade technology capabilities of SMEs.

The aim of this research is to analyze the factors affecting Taiwanese SMEs' decision to engage the government-sponsored R&D alliance. The

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study uses fsQCA to examine the relationship between the determinants of engaging R&D alliances and the performance of R&D alliances. The survey data is from six major government-sponsored projects that cover most of R&D alliances in Taiwan.

This article has five sections: **Section 2** examines the existing literature to develop a model that captures the effects of the motivation underlying R&D alliance in Taiwan; **Section 3** describes the data and fsQCA; **Section 4** presents the empirical results, and **Section 5** draws implications from the findings.

2. Conceptual background

By reviewing this strand of the literature (Anand & Khanna, 2000; Branstetter & Sakakibara, 2002; Fukugawa, 2006; Hagedoorn, 1996; Kennedy & Keeney, 2009; Lin & Lin, 2012; Mathews, 2002; Mitchell & Singh, 1992; Sakakibara, 2002; Spence, 1984), the study outlines 7 motivating factors for SMEs to form government-sponsored R&D alliances, and 2 variables for performance measure.

2.1. The determinants of R&D alliance

2.1.1. Firm size

SMEs can use external resources by cooperating with other firms, reducing the risk of innovation by sharing costs among members. Kleinknecht and Reijnen (1992) indicate that R&D alliance does not typically occur between big, high-tech firms. A statistical survey of Japanese data shows that SMEs cooperate in R&D more than large firms do (Okamuro, 2007). In the case of Spanish firms, however, Bayona, Garcia-Marco, and Huerta (2001) find that large firms and firms with certain internal R&D capabilities are more prone to cooperation. Bayona et al. (2001) also conclude that the smaller the size of the firm, the greater the market considerations. This study includes the size of the firm as a variable affecting the decision of forming R&D alliances.

2.1.2. R&D capacity

Firms with advantageous R&D capacity do not need to cooperate with others to access the necessary knowledge and abilities. Miotti and Sachwald (2003) indicate that the quantity and quality of R&D resources affect the propensity to cooperate with specific partners. In other words, a firm that currently has not sufficient R&D capabilities is more prone to form R&D alliances than R&D capable firms (Sakakibara, 2002). The learning benefit of R&D alliances depends on the possibility to access the technological resources of alliance partners, thus high quality partners with better R&D capabilities are attractive to other firms that want to acquire advanced technology expertise (Baum, Calabrese, & Silverman, 2000).

2.1.3. Network linkage

Network resources are specific resources that firms can use to design and implement their strategies (Barney, 1991). The network approach views cooperation as an attempt to access external resources to compensate for the weaknesses of a firm (Gomes-Casseres, 1997; Gulati, 1999; Lin, 2010). Okamuro (2007) demonstrates that the most popular aim of cooperation is to obtain technical advice from partners. Network linkage allows a firm to access external capabilities of a specialized

Table 1
Industry classifications and the number of firms in the sample data.

Industry classification	Number of firms
Electronics, information, communications, and optoelectronics	101
Machinery and transportation	75
Biotechnology and pharmaceutical,	53
Material and chemical	81
Design and advertisement	4
Others	123
Total	436

Table 2
The number of employees in the sample data.

Number of employees	Number of firms	Percentage
Under 10	45	10.32
11–50	148	33.94
51–100	74	16.97
101–200	52	11.93
201–500	54	12.39
Above 500	63	14.45
Total	436	100.00

market network. Firms can benefit from informational advantages through their participation in interfirm networks. Firms need to know potential partners, and be aware of their needs and requirements to build alliances that effectively address their needs and have acceptable risks. Firms also need information about the reliability of those partners, and vice versa (Gulati, 1999). Therefore, a firm with a large network linkage has advantageous information about the cooperative partners, and builds alliances easily.

2.1.4. Government grants

Government grants SMEs help to conduct innovative R&D projects and to stimulate industry re-investment in R&D (Lin & Lin, 2012). Sakakibara (1997) and Miotti and Sachwald (2003) find that government policies have a positive effect on forming R&D alliances. In the case of Taiwan, the government plays a critical role in making SMEs to actively involve in R&D for innovative applications and services. These government-sponsored projects help SMEs to reduce the costs and the level of risk when they engage in innovation or R&D activities. These projects also aim to boost overall R&D spending, and to speed up industrial upgrading.

2.1.5. Technological complexity

Singh (1997) reports that alliances moderate the failure risk in businesses with high-complexity technologies; therefore, firms need to access new technological knowledge and complementary technologies. However, SMEs cannot obtain the required level of complexity and knowledge by themselves (Bayona et al., 2001). Many scholars also find that alliances help developing complex technologies (Hagedoorn, 1993; Hladik, 1985; Link & Bauer, 1989; Wang, 1994). These complex technologies are costly and difficult to internalize; thus, the more complex the technology is, the greater the opportunity to form alliances.

2.1.6. Competition

R&D alliance allows firms to access new knowledge and complementary technology to upgrade their capability and enhance strategic position (Sakakibara, 2002). In other words, firms in a competitive industry are more prone to participating in R&D alliances to moderate the competition in the market. Environmental resources become increasingly scarce in the competitive industry. Hence, as competition increases, firms will probably seek to link external institutions to mobilize resources and social support (Baum & Oliver, 1991). Sakakibara (2002) also points that firms in a highly concentrated industry can easily access the information of their rivals, and seek to build alliances.

Table 3
The amount of government grants in the sample data.

Government grants	Number of firms	Percentage
Under NT\$1 million	102	23.39
1–3 million	126	28.90
3–5 million	56	12.84
5–10 million	72	16.52
Above 10 million	80	18.35
Total	436	100.00

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