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External R&D Resource Strategy and Firm Performance

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R&D Alliances and Firm Performance: Implications from Taiwan's ICT Firms

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INTRODUCTION

The capability of a firm's technology innovation can be accumulated either from the firm's endogenous technology resources or from the external collaborative R&D resources. Firms without sufficient internal research resources may obtain innovative capability via the technological collaboration externally. R&D alliances have been regarded as a critical source of a high-technology firm's competitive advantage in previous management studies. Previous studies regarding R&D alliances mainly focus on issues of the process of technological collaboration or the performance evaluation of a single type of R&D alliances. Little effort has been conducted to explore the impact of different R&D alliances on a firm's performance. Thus, the primary objective of this paper attempts to examine the impact of R&D alliances on a firm's performance.

Based on previous studies, a number of hypotheses were examined in the context of the Taiwanese information and communication technology (ICT) firms. Firms with collaborative R&D projects with universities, research institutions, other firms, as well as received subsidies or technology transfers from the government, are expected to have better performance than those who do not have such collaborative projects, subsidies, or transfers. By examining empirical data, this paper attempts to compare the performance between firms having external R&D alliances and firms without such the external R&D alliances. To meet the research objectives, a questionnaire survey of 165 firms within Taiwan's ICT industry has been conducted. Moreover, a range of secondary data has also been collected from various databases.

The results of this paper suggest that Taiwanese ICT firms tend to improve their technological performance via collaborative R&D projects with universities, research institutions, and other firms, while market performance and financial performance can be improved by receiving technology transfers and subsidies from the government. The results of this research not only can give some insights to Taiwanese ICT firms regarding choosing external R&D alliances, but also can provide the government the direction of resource allocation for future science and technology policies and subsidy policies. The contribution of this study can enrich the existing theories and empirical studies as well as to provide suggestions to both the industry and the government in China and Taiwan regarding the relationship between external R&D alliances and firm performance.

THEORETICAL BACKGROUND

The importance of the technology innovation as a source of the core competence of the firm has been discussed by an increasing number of scholars and researchers (Schumpeter, 1934; Porter, 1985; Barney, 1991; Kogut and Zander, 1992; Hamel and Prahalad, 1994; Dedrick and Kraemer, 1998). The capability of a firm's technology innovation can be accumulated either from the firm's endogenous technology resource or from the external technology transfer. Firms with abundant

research resources are possible to accumulate the capability of technology innovation internally while firms without sufficient internal research resources may obtain innovative capability via the technology collaboration externally.

"Technology transfer is any process by which basic understanding, information, and innovations move from a university, an institute, or a government laboratory to individuals or firms in the private and quasi-private sectors" (Parker and Zilberman, 1993). A number of studies have focused on the technology transfer between universities and entrepreneurial companies (Steffensen et al., 2000; Liu and Jiang, 2001; Shane, 2002). In addition to the university-industry collaboration, external R&D resources can be also conducted via collaboration with public-supported research institutions (Kassicieh et al., 2002; Sakabibara and Dodgson, 2003) and even via spin-offs from competitors (Yeheskel et al., 2001).

From the results of previous empirical research, a number of studies suggest that firms with collaborative research projects with universities outperform firms without such projects in terms of patent number (Zucker et al., 2002; Lockett et al., 2003; Power, 2003). Other studies assert that firms with collaborative research projects with universities have better financial performance than firms without such projects (Lockett et al., 2003; Niosi and Banik, 2005). Moreover, a firm's investment on collaborative R&D projects with universities can enhance a firm's growth (Lindelöf and Löfsten, 2004; Niosi and Banik, 2005). Based on the above discussion, the hypothesis can be derived as following:

Hypothesis 1: Firms with collaborative R&D projects with universities are expected to have better technological, market, and financial performance than those firms who do not have such collaborative projects.

Moreover, a firm's collaborative R&D projects with external research centers or institutions can also improve its performance. A number of empirical studies suggest that firms conducting collaborative R&D projects with external research institutions improve their technological performance (Kennedy and Holmfeld, 1989; Herbert, 1995; Blau, 1999). However, very few studies attempts to examine whether collaborative R&D projects with external research centers or institutions can improve a firm's market of financial performance not. In this research, I like to examine whether collaborative R&D projects with external research centers or institutions have an impact on market and financial performance. Thus, the hypothesis is derived as following:

Hypothesis 2: Firms with collaborative R&D projects with research institutions or centers are expected to have better technological, market, and financial performance than those firms who do not have such collaborative projects.

Inter-firm collaborative R&D projects may also influence a firm's performance. There are fruitful empirical studies examining how firms apply inter-firm collaborative R&D projects to improve

their performance. A number of studies suggest that firms with collaborative R&D projects with other firms in the industry can have better technological performance (Koichi et al., 1990; Walker, 1995; Peters and Becker, 1998; Harding, 2001; Hemmert, 2003). Moreover, other studies also find that inter-firm collaborative R&D projects can improve a firm's financial performance (Walker, 1995; Yeheskel et al., 2001; Hemmert, 2003; Branzei, 2005) as well as market performance (Branzei, 2005). Thus, based on the above discussions, the third hypothesis for this research is listed as following:

Hypothesis 3: Firms with inter-firm collaborative R&D projects are expected to have better technological, market, and financial performance than those firms who do not have such collaborative projects.

In addition to collaborative R&D projects with universities, research institutions or centers, and other firms, external R&D resources can be also obtained from the governmental sectors, such as subsidies. A number of empirical studies suggest that governmental subsidies can help to improve a firm's financial performance (Poznanski, 1994; Grupp, 1997; Yi and Shin, 2000; Liu and Shieh, 2005). Several studies also advise that firms receiving subsidies have better market performance than firms without such subsidies (Grupp, 1997; Lerner, 1999; Lackman, 2005). Moreover, Lackman (2005) suggests that firms receiving subsidies have better technological performance than firms without such subsidies. Therefore, the hypothesis can be concluded as following:

Hypothesis 4: Firms receiving financial subsidies from the government are expected to have better technological, market, and financial performance than those firms who do not have such subsidies.

Technology transfer from the government is another type of external R&D resources. Firms with collaborative R&D projects with the government, including technology transfer, may have better technological performance (Cohen et al., 2002; Jang and Huang, 2005) or financial performance (Mowery, 1998) than firms without such projects. Therefore, the final hypothesis of this research can be draw as following:

Hypothesis 5: Firms receiving technology transfers from the government are expected to better technological, market, and financial performance than those firms who do not have such transfers.

RESEARCH METHOD

There have been a number of studies on the technology development in Asia Pacific countries, such as Japan, Korea, China, or Taiwan (Hobday, 1995; Dedrick and Kraemer, 1998). These studies provide the insight of the trajectory of technology development in these countries. The Taiwanese ICT industry can be also traced back to the 1970s. With extensive government support, Taiwan has been the world's largest manufacturer of personal computers and peripherals since the 1990s and rapidly caught up in the semiconductor and liquid crystal display (LCD) sectors in the

late 1990s (Tung, 2001). Since a majority of Taiwanese ICT firms are latecomers, it is vital to explore how Taiwanese firms improve their performance via various external R&D resources. Therefore, this paper attempts to explore whether different R&D alliances can influence a Taiwanese ICT firm's technological, market, and financial performance.

Sample firms of this research were Taiwanese ICT manufacturing listed firms. In 2002, a total number of 165 firms returned the questionnaire, making 40% of response rate for this study. The questionnaire asked respondents whether firms had adopt the following R&D alliances: collaborative R&D projects with universities, research institutions or centers, other firms, as well as whether receiving subsidies and technology transfer from the government. Performance measurement was divided into three main categories: technological performance, market performance, and financial performance. Technological performance was measured by number of patents. Market performance was measured by market share in terms of production value. Financial performance was measured by returns on assets, returns on equities, operating profit rate, and gross profit rate[1]. Data of all performance measurement were the secondary data collected via the governmental agent database. An analysis of variance (ANOVA) was employed to examine whether firms with external R&D alliances or activities have better performance than firms without such alliances or activities.

RESULTS AND FINDINGS

Table 1. Descriptive Summary of Types of R&D Alliances

Origin of R&D Alliances	Number of Firms Having Alliances	Number of Firms Having No Alliance	Total Number
Universities	118	47	165
Research Institutions	104	61	165
Inter-Firm	106	59	165
Government Subsidies	62	103	165
Governmental Tech. Transfer	43	122	165

Table 1 shows a summary of different types of R&D alliances in this research. As can be seen in Table 1, a majority of Taiwanese ICT firms have collaborative R&D projects with universities, research institutions, and other firms in the industry. In contrast, fewer firms in this research received subsidies or technology transfers from the governmental agents. This implies that collaborative R&D projects with universities, research institutions, and other firms are main choices of external R&D resources for Taiwanese ICT firms.

[1] Market share was measured in 2002. All financial performance measurements were employed by 3-year (2000-2002) and 7-year (1996-2002) averaged ratios.

Table 2. Summary of ANOVA Results

F Value	**Universities**	**Research Institutions**	**Inter-Firm**	**Government Subsidies**	**Government Technology Transfer**
Tech. Performance	8.139*	3.023†	5.161*	0.668	1.987
Market Performance	0.394	0.333	1.553	0.504	4.174*
3-Year ROA	0.086	0.612	0.163	0.309	0.578
7-Year ROA	0.596	2.594	0.742	2.827†	0.188
3-Year ROE	0.032	0.654	0.261	0.092	0.549
7-Year ROE	0.021	2.694	0.151	2.967†	0.951
3-Year Operational Profit	0.890	0.000	0.136	0.402	0.384
7-Year Operational Profit	0.504	0.837	0.709	0.386	0.415
3-Year Gross Profit	0.693	1.166	1.446	2.144	0.025
7-Year Gross Profit	1.717	2.056	0.419	3.034†	0.542

** $p<0.001$; * $p<0.05$; † <0.1.

Table 2 summarizes the results of ANOVA. A number of significant findings are observed and concluded as following:

Finding 1: Firms with collaborative R&D projects with universities have better technological performance (measured by patents) than firms without such collaborative R&D projects.

Finding 2: Firms with collaborative R&D projects with research institutions have better technological performance (measured by patents) than firms without such collaborative R&D projects.

Finding 3: Firms with collaborative R&D projects with other firms have better technological performance (measured by patents) than firms without such collaborative R&D projects.

Finding 4: Firms receiving technologies transferred from the government have better market performance (measured by market share) than firms without such technology transfers.

Finding 5: Firms receiving R&D subsidies from the government have better financial performance (measured by 7-year averaged ROE, ROA, and gross profit rate) than firms without such subsidies.

CONCLUSION

The results suggest that firms with collaborative R&D projects with universities, research institutions, and other firms, have better technological performance measured by patent number than firms without such collaborative projects. However, market performance and financial performance cannot be improved through these collaborative R&D projects with universities,

research institutions, and other firms. As shown in the results, market performance only can be improved via technology transfers from the government while financial performance, including 7-year ROA, ROE, and gross profit rate, can only be improved by the governmental subsidies. Some implications from the above results can be drawn in this paper. If a firm would like to improve its number of patents and then to accumulate its technological competence, it is better for this firm to conduct collaborative R&D projects with universities, research institutions, and other firms. If a firm is inclined to improve its revenues, then it is better to receive technology transfers from the government directly. Finally, if a firm would like to improve its financial performance, such as ROA, ROE, or gross profit rate, then it is better for this firm to receive subsidies from the governmental agents. Our results are mainly consistent with previous research.

For business practices, the results of this paper suggest that Taiwanese ICT firms tend to improve their technological performance via collaborative R&D projects with universities, research institutions, and other firms. Taiwanese ICT firms can improve their market performance by receiving technology transfers from the government while improve their financial performance by receiving subsidies from the government. For the policy makers, our results suggest that R&D subsidy policies or technology transfers from the government can not improve a firm's technology competency, which is measured by patents, but can improve a firm's market performance or financial performance. Thus, this provides an insight for both Chinese and Taiwanese governments that the government should encourage firms to conduct collaborative R&D projects with universities, research institutions, and other firms instead of relying on the subsides or technology transfer from the governmental sectors. Moreover, another insight for Chinese or Taiwanese firms is that a firm can employ an appropriate R&D alliance strategy in order to achieve its various strategic intentions.

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