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## **Innovation Activities in Hong Kong Firms**

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### **Abstract**

This study explores the innovation activities and performance of Hong Kong companies. The results indicate significant relationships between different activities and innovation performance.

# **INNOVATION PATTERNS, R&D COOPERATION AND THEIR IMPACT ON TYPES OF INNOVATION: EVIDENCE FROM FIRMS IN HONG KONG AND GUANGDONG PROVINCE, CHINA**

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In a globalized and knowledge-based economy, companies must innovate continuously. Recent studies suggest that companies create multiple types of innovation and should expand the boundaries of their knowledge-production processes to cooperate with external organizations for innovation. Extant empirical studies of relationships between internal and external innovation activities, R&D cooperation, and types of innovation in developed countries have yielded mixed results. As a prominent Asian NIE, Hong Kong's innovation and technology management has rarely been studied. This study explores the innovation activities and performance of Hong Kong companies with operations in Guangdong. Using a survey—based on the CIS4—of 492 companies, we have found that intramural and extramural R&D, acquisition of machinery, and R&D cooperation are important for product, process, organizational, or marketing innovation. A notable result is that market-related efforts play a key role in most innovation undertaken by firms under study.

*Keywords:* Guangdong, Hong Kong, R&D cooperation, Types of innovation

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# **Innovation Patterns, R&D Cooperation and Their Impact on Types of Innovation: Evidence from Firms in Hong Kong and Guangdong Province, China**

## **1. Introduction**

Innovating and generating new technology are essential to long-term economic development (Verspagen, 2005; Kim and Nelson, 2000; Freeman and Soete, 1997; Grossman and Helpman, 1994), so much so that they play a critical role in predicting the long-term survival of organizations (Ancona and Caldwell, 1987), driving an organization's success (Higgins, 1995) and sustaining the competitive advantages of nations (Porter, 1990). The policy-related and scholarly literature have both linked the development of innovation with competitive and economic outcomes at the national (OECD, 2010; Schmoch et al., 2006; Lundvall, 1992), regional (Cooke et. al., 2001, 1997) and individual firm levels (Vega-Jurado et al., 2009; Amara and Landry, 2005).

Newly industrialized economies (NIEs) in Asia have also followed this path in creating policy frameworks to enhance innovation capabilities (Rowley and Warner, 2005; Kim and Nelson, 2000; Lall and Urata, 2003; Haque et al., 1995; Lall, 1992). Few economies have been more dynamic and successful in economic development in recent decades than the Asian NIEs (Brahmbhatt and Hu, 2009). Hong Kong, Singapore, Taiwan, and Korea were ranked, respectively, as the 2<sup>nd</sup>-, 1<sup>st</sup>-, 8<sup>th</sup>-, and 23<sup>rd</sup>-most competitive economies in the world by IMD in 2010 (IMD, 2010), and were positioned 11<sup>th</sup>, 3<sup>rd</sup>, 12<sup>th</sup>, and 19<sup>th</sup>, respectively, by the World Economic Forum in 2010 (WEF, 2010). Research has evaluated this strong economic performance as significantly related to innovation and technology development (Kim and Nelson, 2000), and innovation studies scholars are keen to understand how the NIEs have caught up with advanced industrialized economies (cf. Brahmbhatt and Hu, 2009; Hobday,

2007; Fagerberg and Godinho, 2005). The Asian NIEs have all spent around 2% of GDP on R&D during the last decade (Figure 1a)—with Hong Kong being the only exception. Some empirical studies were conducted on innovation patterns in NIEs in the early 1990s (Lall, 1992, Hobday, 1995), and, more recently, scholars have re-examined the relationship between innovation activities and performance in Korea, Singapore, and Taiwan (Bogliacino et al., 2009; Brahmhatt and Hu, 2009; Eom and Lee, 2010; Zhao et al., 2005). Studies of emerging innovation capabilities in Mainland China have also emerged (Guan et al., 2009; Fan, 2006), but conspicuous by their absence are similar empirical studies of Hong Kong.

Hong Kong has achieved consistently strong GDP growth and is considered the competitive equal of other Asian NIEs, although its technological base and innovation performance are considered weak (WEF, 2010). Hong Kong's R&D expenditures are consistently lower than those in the other NIEs (Figure 1a), but its overall productivity growth remains impressive and technology cooperation has been moderately strong over the past 10 years (Figure 1a & b). Given the strong performance of innovation-driven economies, it is worth exploring how Hong Kong firms have managed to stay globally competitive despite the low technological content of its goods and services. Enright et al. (2000) argued that Hong Kong has been de-industrialized and transformed into a service economy, providing logistics and financial and professional services to neighboring regions such as the Pearl River Delta (PRD). Empirical research indicates, however, that these linkages with the PRD have taken place without significant impact on technology advancement in the region (Huang and Sharif, 2009).

To explain Hong Kong's success, some argue that firms there efficiently provide producer services like quality control, project management, production engineering, and supply chain management to the region (Enright et al., 2005). This is important in developing countries

where company-level technological know-how must evolve continuously (Lall, 2000). Hong Kong is thus positioned as a management resource centre facilitating Chinese manufacturing firms' entry into world markets; its role in the globalization of manufacturing in China cannot be ignored (Meyer, 2008). Furthermore, Hong Kong has been identified as the most competitive city in China (Ni and Kresl, 2010), and therefore the managerial practices of Hong Kong companies should contribute significantly to Chinese competitiveness (Sharif and Tseng, forthcoming).

In spite of these assets, however, with so little relevant empirical evidence we have much to learn about Hong Kong's innovation performance. To what extent are Hong Kong firms innovating and in what ways are they doing so? We take a step towards answering these questions here by examining the innovation practices of Hong Kong companies, focusing on their innovation activities, types of innovation, and R&D cooperation. We thereby contribute to innovation scholarship in two ways.

First, we provide an empirical study of innovation activities undertaken by Hong Kong firms with operations in Guangdong province. In particular, we analyze data on external and internal innovation activities, R&D cooperation, types of innovation, and sources of innovation. We thereby provide for the first time a comprehensive assessment of innovation in Hong Kong companies. Second, the paper identifies specific innovation activities that have, when applied to specific types of innovation, proven particularly effective for Hong Kong companies.

Although the relationship between innovation capabilities and performance in advanced industrialized countries has been tested (Freeman, 2002), few studies have tested this relationship with data from newly industrializing economies such as Hong Kong, and likewise few studies have tested the full range of innovation activities. As one of the most competitive

economies in Asia, Hong Kong should be able to provide important innovation-related cases for academic analysis (Baark and Sharif, 2006; Yu, 2005; Hobday, 1995), the results of which should apply to similarly sized, outward-oriented economies such as Singapore, Taiwan, Malaysia, Finland, Norway, and Denmark. We therefore extend the focus on product and process innovation in the existing literature (Li et al., 2010), playing off an updated definition of innovation from the OECD (2005), to consider the full range of product, process, marketing, and organizational innovation.

The remainder of the paper consists of a review of the relevant literature that yields our research questions in section 2, a description of our methodology and statistical approach in section 3, presentation and discussion of the results in section 4, and concluding remarks with caveats about the study's limitations in section 5.

## **2. Literature Review and Research Questions**

### *2.1 Hong Kong's Innovation System: Growing Interdependence with Guangdong*

Hong Kong companies are closely integrated with the Pearl River Delta (PRD)—among the most highly efficient regions for technology adoption in China (Guan and Chen, 2010). In the 1980s and 1990s, many Hong Kong firms transformed themselves into service providers, transitioning from manufacturing to trading, thereby maintaining the former British colony's global competitive advantage. Many entrepreneurs in Hong Kong operate as traders in Hong Kong and as proprietors of or partners in plant facilities in the Mainland. The import/export firms operated by these entrepreneurs import goods from their factories in China, especially Guangdong, and subsequently re-export them to the rest of the world. Following this business model, Hong Kong entrepreneurs have successfully reduced their manufacturing costs and achieved high rates of growth by leveraging their access to the abundant, and relatively cheaper,

labor and land resources in Guangdong (Nelson and Pack, 1999).

The Hong Kong Census and Statistics Department (2007) recorded 12,535 manufacturing firms registered in Hong Kong in 2007, but 15,798 import/export firms there engaged in manufacturing-related activities using subcontractors in the Mainland. According to the Federation of Hong Kong Industries (2003), the number of companies in China owned and controlled by Hong Kong businesses was estimated at between 50,000 and 60,000 in 2002, employing approximately 447,000 and 11 million workers in Hong Kong and China, respectively. According to Tsang (2008), the National Bureau of Statistics of China recorded in 2007 some 70,000 export-processing plants in Guangdong, of which 57,500—employing 9.6 million workers—were Hong Kong-owned.

As shown in Figure 2, Hong Kong has recently been a major source of FDI for Guangdong and even other parts of China. In 2008, 44.41% of China FDI (US\$ 41 billion) was sourced from Hong Kong, of which 46.71% went to Guangdong. This investment constituted 55% of total FDI in Guangdong. By accounting for the close relationship between Guangdong and Hong Kong—we offer an empirical study of Hong Kong-owned companies with manufacturing operations in Guangdong—we avoid confusion that can arise in studies of Hong Kong companies that ignore their manufacturing operations in Guangdong and the PRD (Sit, 2005, 2006).

[Insert Figure 1 Here]

[Insert Figure 2 Here]

Since the opening of China, Hong Kong-owned manufacturing firms have demonstrated

strong marketing capabilities and managerial skills, and have made good use of these capabilities in collaboration with export-oriented sectors in China. Hong Kong companies have practiced adaptive entrepreneurship, competing with firms from developed economies by producing similar or incrementally improved products at lower cost (Yu, 2005; Sit, 1998). Concentrating on skillful exploitation of available technology, they rarely perform R&D aimed at creating proprietary technology or upgrade their technology (Davies, 1999). Hong Kong companies have worked well with other companies externally to gain cost and efficiency advantages, but they have depended on their intermediary firms to maintain a considerable share of business in the global market (Meyer, 2000). As shown in Figure 1, Hong Kong ranks very low in R&D expenditures as a percentage of GDP.

## *2.2 Key Concepts: Innovation Activities, Sources of Innovation, and R&D Cooperation*

### *2.2.1 Innovation activities*

Innovation occurs across a range of activities that can affect firm-level innovation performance. There is considerable empirical evidence that intramural and extramural R&D indicate a firm's level of innovativeness and boost innovation activity (Dosi, 1988; Freeman and Soete, 1997; Baldwin and Hanel, 2003; Strokey, 1995; Griliches, 1995; Hall, 1996; Hall and van Reenen, 2000; Frenkel et al., 2001). Notwithstanding the growth in recent years of R&D outsourcing and R&D-focused strategic alliances, intramural R&D has been shown to be positively correlated with product innovation, defined as “the market introduction of a new good or service or a significantly improved good or service with respect to its capabilities” (Romijn and Albaladejo, 2002; Vega-Jordon et al., 2008). The acquisition of machinery, equipment, and software also contributes to developing new processes for innovation. Process innovation involves incremental improvements through suppliers of new machinery and equipment (Vega-Jordon et al., 2009; Pavitt, 1984). Firms often prefer to invest in new equipment and

machinery offered by other companies, instead of developing process innovations themselves. Marketing strategies such as advertising (Koeller, 1995, 1996) and managing pairs of products/markets (Baldwin and Johnson, 1996) have also been shown to benefit innovation. In general, a good marketing strategy contributes to commercial success and to the exporting of new products/processes, thereby encouraging firms to innovate (Baldwin and Johnson, 1996).

Innovating firms need highly educated, technically qualified, and experienced personnel with diverse backgrounds (Freel, 2005; Guangzhou Hu, 2003; Koeller, 1996; Koschatzky et al., 2001; Romijn and Albaladejo, 2002; Shefer and Frenkel, 1998; Souitaris, 2002); in some studies training has been positively correlated with innovation (Baldwin and Johnson, 1996; Kam et al., 2003; Koschatzky et al., 2001; Souitaris, 2002). The qualifications and cumulative experience of managers are likewise important keys (Baldwin and Johnson, 1996; Romijn and Albaladejo, 2002; Souitaris, 2002).

### *2.2.2 Sources of innovation*

Innovation depends not only on factors internal to firms, but also on interactive processes involving relationships between firms and other external actors (Tidd, 2006; Kline and Rosenberg, 1986). To stimulate innovation, firms may seek information from customers, suppliers, universities, research institutions, government/public authorities, consultants, the press, or trade fairs (e.g. OECD, 2010, 2008a, 2008b; Santamaria et al., 2009, von Hippel, 1988).

External sources of innovation thus complement an organization's in-house knowledge-creation capabilities (Grant, 1996) through formal or informal networks that facilitate learning processes, including learning-by-using, learning-by-doing, and

learning-by-sharing (Lengrand and Chartrie, 1999; Foray, 2000). Interactions with external sources of innovation often provide missing external inputs into the learning process that many firms cannot provide for themselves (Romijn and Albaladejo, 2002), which then improve innovation performance (Caloghirou et. al., 2004). Hence, technological innovation can be conceptualized as a learning and evolutionary process (Cohen and Levinthal, 1989; Dodgson, 1993).

According to learning theory, a firm's innovation performance is also an outcome expanding its knowledge base (Henderson and Cockburn, 1996). Firms can acquire knowledge by tapping into external knowledge bases (Cohen and Levinthal, 1989; Huber, 1991). They can reinforce their technological capabilities by importing technologies, and then diffusing, assimilating, communicating, and absorbing new knowledge from a variety of innovation sources (Prahalad and Hamel, 1990). A firm's ability to acquire, utilize, and develop valuable resources and capabilities often depends on acquiring and absorbing external knowledge (Teece et al., 1997).

### *2.2.3 R&D cooperation*

Several innovation studies researchers, particularly those who apply the innovation systems approach, argue that firms do not operate or innovate in isolation, but through enduring inter-relations with other firms and institutions (Håkansson, 1987, 1989; von Hippel, 1988; Lundvall 1988; Freeman, 1991; Harland, 1996; Gulati et al., 2000; Coombs et al., 2003). As Teece (1986: 293) observed over 20 years ago, it requires a wide range of assets and competencies to develop even modestly complex technologies. Individual companies that cannot keep pace with these multiple technologies often rely on other technology sources, forming alliances with other companies rather than exploring conventional arms-length markets. Mowery (2009) finds that cooperation in R&D and related technology-development

activities with other enterprises is driving a major change trend in the structure of industrial R&D.

Interaction with suppliers, customers, public research agencies, industry associations, or foundations may also provide missing external inputs that firms cannot easily develop. Such interaction might be undertaken to gather information about technologies and markets or to obtain other inputs to complement the internal learning process (Rothwell and Dogson, 1991; Dogson, 1993; Lundvall, 1988, 1992; Edquist, 1997; Freeman, 1991, 1995; Panda and Ramanathan, 1996). Firm interdependence for innovation has been spreading in recent years (Chesbrough, 2003), as suggested by growth in innovation-related strategic alliances (Hagedoorn, 2002).

#### *2.2.4 Research Questions*

In this paper, we analyze a variety of innovation activities and sources of knowledge that contribute to a range of innovation, and study the impact of R&D cooperation on innovation activities, based on the following research questions:

*Research Question 1:* How do innovation activities and sources of innovation affect different types of innovation pursued by Hong Kong-owned manufacturing firms in Guangdong?

*Research Question 2:* How does R&D cooperation affect types of innovation, innovation expenditure, and turnover among Hong Kong-owned manufacturing firms in Guangdong?

### **3. METHODOLOGY**

#### *3.1 Measures*

In this study we employed survey instruments based on the questionnaire included in the Fourth Community Innovation Survey (CIS4), adding questions reflecting issues unique to Hong Kong. The authors conducted the survey in March 2008. CIS4 offers a comprehensive instrument for measuring firm-level innovation performance and activities and has been used to measure innovation performance in Europe and other regions (Frenz and Ietto-Gillies, 2009; Heidenreich, 2009; Castellacci, 2008). Thus, the constructs derived from CIS4 selected for this study have been verified through extensive data collection practice and innovation research.

Independent variables included whether or not a firm had engaged in a specific innovation activity or received innovation-related public financial support. Sources of innovation were measured using a 4-point Likert scale to indicate both innovation-related information sources and motivation to engage in innovation-related R&D cooperation. The dependent variables of our study included, for the first model, types of innovation represented as a dichotomous variable indicating whether the enterprise had undertaken product, process, marketing, or organizational innovation in 2006-2007. A second model used a dependent variable that the goods and service innovations introduced during 2006-2007 that were new to the market as a percentage of a firm's total turnover.

Following the CIS4 methodological recommendations, we included three control variables in all the logistic regression models. The first two variables were company size in 2006 and 2007, measured by number of employees after a log transformation. We also included type of economic sector using seven dummies in the regression.

### *3.2 Sampling*

The CIS4 methodological recommendations suggest that the sampling unit should be the single enterprise among the total population of enterprises in the industry surveyed. Thus, based on the Hong Kong Standard Industrial Classification (HSIC) 4-digit code, enterprises from agriculture and fishing; manufacturing; electricity, gas and water; construction; and community, social and personal services were selected as the sample frame in this survey. To ensure data quality, surveys were conducted by phone and face-to face interviews to collect the data. This approach reduced respondent bias due to misunderstanding of the questionnaires. The final sampling frame thus comprised 3170 Hong Kong manufacturers with Guangdong manufacturing activities. To further verify the appropriateness of the samples, respondents provided the addresses of their offices in Hong Kong and manufacturing facilities in Guangdong. We randomly contacted 10% of the respondents to verify that they had operations in both locations, and confirmed that all had manufacturing activities in Guangdong and businesses in Hong Kong, which supported our sampling selection. Of the selected 3170 firms, 493 responded to the survey. After data cleaning, one incomplete response was deleted. Finally, 492 effective questionnaires were analyzed in this study for a response rate of 15.5%.

## **4. Results and Discussion**

### *4.1 Company Profiles*

[Insert Table 1 Here]

Table 1 shows the top three categories of respondents to be manufacturing (73.4%), wholesale, retail and import/export trades, restaurants and hotels (10.8%), and finance, insurance, real estate and business (6.5%). The sample is highly appropriate for our study because most of the respondents operate in local/regional markets within Hong Kong and Guangdong (65.4%),

regional markets in Hong Kong plus Mainland China (61.4%), or global markets (70.7%). On average, respondents employed 1716 staff in 2006 and 1862 in 2007. About 72% of the individuals who responded to our survey were managers or occupied a more senior position, supporting the credibility of the data.

[Insert Table 2 Here]

Table 2 shows the innovation performance of respondents in 2006-2007. Across the sample, in 2006-2007, 54.7% of the enterprises undertook product innovation; 58.1% engaged in process innovation; 49.6% were involved in marketing innovation; and 64.6% carried out some form of organizational innovation. Of these, 22.4% had applied for patents in 2006-07, while 33.9% had registered trademarks during that period. 15% and 17.7% of the enterprises, respectively, had registered an industrial design or claimed copyright. On average, the turnover due to products that were new to the market (innovation turnover) constituted over 20% of total turnover during 2006-07, while surveyed enterprises had spent on average over 20 million Hong Kong dollars in innovation expenditure. These data suggest that Hong Kong manufacturers resemble those of European countries, where more than half of firms are innovators (Eurostat, 2010), but with a relatively larger share of turnover due to new-to-market innovations, which only constituted 10% of turnover among European firms (Eurostat, 2009).

#### *4.2 Analytical Findings: Research Question 1*

In order to examine the first research question, we developed several models using binary logistic regression analysis. The simplified regression equations are as follows:

$$\text{Model 1: ProdI} = a_1 + b_1\text{IA} + c_1\text{CV} + e_1;$$

$$\text{Model 2: ProcI} = a_2 + b_2\text{IA} + c_2\text{CV} + e_2;$$

$$\text{Model 3: MarkI} = a_3 + b_3\text{IA} + c_3\text{CV} + e_3;$$

$$\text{Model 4: OrgaI} = a_4 + b_4\text{IA} + c_4\text{CV} + e_4;$$

where  $a_x$ ,  $b_x$ , and  $c_x$  are estimates of the respective parameters,  $e_x$  refers to error terms, CV refers to control variables (number of employees in 2006 and 2007; type of industry), IA refers to types of innovation activities, ProdI refers to product innovation, ProCI refers to process innovation, MarkI refers to marketing innovation, and OrgaI refers to organizational innovation. Table 3 records the estimates of the impact of innovative activities on types of innovation outputs. The results show that the models were significant at p-value less than 0.01 (Chi-square = 26.633 to 39), with Cox and Snell R-square and Nagelkerke R-square values ranging from 0.114 to 0.196. VIF and tolerance tests were also used to test for possible multicollinearity of innovation activities (independent variables) with innovation types (dependent variables). The results show a range of tolerance for the constructs of 0.86 to 0.99, with the VIF ranging from 1.01 to 1.25, indicating that multicollinearity is unlikely to be a serious problem (Field, 2009).

[Insert Table 3 Here]

The results of the analysis indicate six important impacts of various innovative activities on the four main types of innovation. First, our findings indicate that intramural R&D conducted by Hong Kong-owned manufacturers in Guangdong is positively correlated with product and marketing innovations. Such investments in intramural R&D provide firms with a competitive edge over firms that do not invest in intramural R&D, at least during the early stages of the innovation process. These findings agree with what we find in the literature, namely, that investment in R&D is an important indicator of a firm's level of innovativeness (Dosi, 1988;

Freeman and Soete, 1997; Baldwin and Hanel, 2003).

Second, our study finds that acquiring machinery, equipment, and software is positively correlated with process and organizational innovation. This confirms that purchasing machinery and equipment remains the most important strategy in developing new processes, especially for relatively unsophisticated enterprises. For such firms, process innovation frequently relies on incremental improvements that are made feasible by suppliers of new machinery and equipment (Vega-Jurado et al., 2009; Pavitt, 1984). This accords with Potters' (2009) finding that ICT technologies and specialized machinery were purchased by many companies engaged in low-tech industrial sectors, as well as Wang's (2006) finding that enterprises view the purchase and implementation of an enterprise resource planning (ERP) software system as a major innovation activity.

Third, our results indicate that training is positively associated with marketing and organizational innovations, reflecting the outward-looking, market-oriented nature of Hong Kong-owned manufacturers in Guangdong, to whom close connections with customers is of paramount importance. Staffing firms with better educated, technically qualified, and experienced personnel remains an important innovation-related strategy among these firms—in terms of improving the marketability of their products to international markets as well as in terms of developing new management strategies. A further explanation of these findings is that Hong Kong-owned manufacturing firms in Guangdong leverage training to acquire externally developed technologies (Hoffman et al., 1998; Romijn and Albaladejo, 2002).

Fourth, market introduction of innovation is strongly correlated with all types of innovation

activities, including product innovation, process innovation, marketing innovation, and organizational innovation. Put another way, market-based activities related to innovation is the most important factor affecting innovativeness in Hong Kong–owned manufacturing firms in Guangdong. This finding confirms the market-oriented character of Hong Kong firms, which typically operate in global supply chains in which a producing firm’s market is defined by a selected number of customers who lead the way by prescribing the production processes and activities of the manufacturing firms. This finding also underlines the acute market awareness of these manufacturers and is consistent with the broad characterization of Hong Kong-owned manufacturing firms as embodying innovativeness through: (a) high levels of absorptive capacity from global knowledge sources, adaptation of technology, and recombinative capabilities for synthesizing knowledge into new productive configurations; (b) the ability to learn from advanced customers and markets; agile sensitivity to changing demand and imitative speed/creative imitation; and (c) organizational flexibility, orchestrating loosely coupled networks and business processes and employing quality control (Sharif and Baark 2005).

Fifth, cooperation on innovation activities with other enterprises or institutions is primarily positively correlated with process innovation, followed by product innovation. The nimbleness and flexibility of Hong Kong firms enable them to be deeply integrated into international supply chains in which customers are an overwhelmingly important source of innovative ideas and activity (MacBeth and Ferguson, 1994; Oliver, 1990). Interaction with suppliers and customers often provides otherwise unavailable external inputs into innovation activities for Hong Kong–owned manufacturing firms in Guangdong, enabling firms to gather information about technologies and markets and obtain various other inputs to complement the internal learning process (Rothwell and Dodgson, 1991; Dogson, 1993 Lundvall, 1992; Edquist, 1997;

Panda and Ramanathan, 1996). R&D cooperation is insignificant for organizational and marketing innovation. Both the organizational and marketing innovation rely primarily on non-technological inputs, so R&D cooperation makes only small contributions.

Another binary logistic regression analysis was conducted to examine the relationship between various sources of innovation and modes of innovation (Table 4). The simplified regression equations in this study are as follows:

$$\text{Model 5: ProdI} = a_5 + b_5\text{SI} + c_5\text{CV} + e_5;$$

$$\text{Model 6: ProcI} = a_6 + b_6\text{SI} + c_6\text{CV} + e_6;$$

$$\text{Model 7: MarkI} = a_7 + b_7\text{SI} + c_7\text{CV} + e_7;$$

$$\text{Model 8: OrgaI} = a_8 + b_8\text{SI} + c_8\text{CV} + e_8;$$

where  $a_x$ ,  $b_x$ , and  $c_x$  are estimates of the respective parameters,  $e_x$  refers to error terms, CV refers to the control variables, and SI refers to individual sources of innovation. Through principal component analysis, we identified three major categories of sources of innovation: internal or market sources (combining internal R&D, suppliers, clients/customers, and competitors), consultants or institutional sources (combining consultants, universities, and government agencies), and other sources (combining conferences, journals, and associations). Principle component analysis (varimax with Kaiser normalization), Cronbach's alpha reliability tests, and confirmatory factor analysis using structural equation modeling (with maximum likelihood estimation and several model fit indexes) were conducted to verify sources of innovation (see Appendix).

[Insert Table 4 Here]

Table 4 shows that the models were significant at p-value less than 0.01 (Chi-square = 32.044

to 42.454), with Cox and Snell R-square and Nagelkerke R-square values ranging from 0.098 to 0.171. VIF and tolerance tests were used to test for possible multicollinearity of innovation sources (independent variables) with innovation types (dependent variables). The results show that the tolerance range of the constructs was 0.47 to 0.82 and that of the VIF was 1.21 to 2.11, indicating that multicollinearity was unlikely to be a serious problem (Field, 2009).

The data indicate a sixth important impact of innovative activities on types of innovation, namely that internal or market sources remain the pre-eminent sources of knowledge for all types of innovation. This finding agrees with previous findings, which underscores that, in addition to internal R&D, firms depend mainly on customers or suppliers to input new product information and technologies (Enright et al., 1997; Hyland et al., 2006; von Hippel, 1988). These patterns of knowledge inputs are particularly common in developing countries (Lall, 1992) and small and medium-sized enterprises (Varis and Littunen, 2010). But the data collected for European firms by CIS4 also indicated that “enterprises engaged in innovation tend to use internal sources and market sources more often than institutional sources” (Eurostat, 2007, p. 3)

It is worth noting that consultants and institutional sources are positively correlated only with organizational innovation, while showing no significant impact on product, process, or marketing innovations. This finding may suggest that there are competent managerial consultants that could help Hong Kong firms undertake organizational innovation. It may be equally noteworthy that innovations developed in universities and public research institutes have no effect on any type of innovation. It is possible that these sources are generic and derive primarily from basic science, which makes it difficult for firms to see immediate returns (Mowery and Sampat, 2005). However, Eom and Lee (2010) found that university-industry

collaboration in Korea also had no significant effect on the success of technological innovation, but nevertheless affected innovation direction by making it easier for firms to generate patents. Similar findings apply to Japanese small businesses (Okamuro, 2007). Furthermore, knowledge generated by universities and public research institutes may differ markedly from knowledge issuing from applied research conducted by firms. University researchers may create technological or non-technological information with greater scientific than market value (Dasgupta and David, 1994). This problem is particularly challenging given the weak R&D investment record of Hong Kong firms, whose technological know-how is remote from the scientific knowledge created by universities and public institutes. This explanation aligns with our finding of an insignificant relationship between journal publications and various types of innovation as shown in Table 4. Firms may be reluctant to cooperate with universities because their weak internal R&D investment leaves them unable to absorb technological knowledge from universities (Laursen and Salter, 2004; Schmidt, 2005).

[Insert Table 5 Here]

#### *4.3 Analytical Findings: Research Question 2*

To address the second research question, we conducted OLS linear regression analyses to test the impact of R&D cooperation on the relationship between innovation expenditure and innovation-related turnover (which is a measure for the extent of successful innovation output).

The linear regression equations employed for this test are as follows:

$$\text{Model 9a-e: } \text{InnoTurn} = a_9 + b_9 \text{InnoExp} + c_9 \text{CV} + e_9, \text{ whereas CO is equal to 1}$$

$$\text{Model 10a-e: } \text{InnoTurn} = a_6 + b_6 \text{InnoExp} + c_6 \text{CV} + e_6, \text{ whereas CO is equal to 0}$$

where  $a_x$ ,  $b_x$ , and  $c_x$  are estimates of the respective parameters,  $e_x$  refers to error terms, CV refers to the control variables, InnoExp refers to innovation expenditures, InnoTurn refers to

innovation-related turnover in 2007, and CO is a dummy variable for R&D cooperation.

Table 5 shows that when enterprises engaged in R&D cooperation with other organizations, any expenditure on machinery, equipment, and software had a positive effect on innovation-related turnover ( $\beta = 0.335$ ,  $t\text{-value} = 2.798$ ) and with total innovation expenditure ( $\beta = 0.279$ ,  $t\text{-value} = 2.396$ ). In this way, R&D cooperation could provide significant *complementary* assets enhancing investments in equipment and software as well as improving the effects of total investment in innovation. On the other hand, when enterprises engaged in R&D cooperation with other organizations, there were weak or no significant effect on innovation turnover from expenditure on acquiring external R&D ( $p < 0.10$ ,  $\beta = 0.261$ ,  $t\text{-value} = 1.952$ ) or other external sources of knowledge ( $p > 0.10$ ,  $\beta = -0.105$ ,  $t\text{-value} = -0.614$ ). This might suggest that R&D cooperation functions as a substitute for other external sources of knowledge for innovation.

However, when enterprises did not cooperate in R&D, extramural expenditure for acquisition of R&D became significant, showing a positive effect on innovation-related turnover ( $p < 0.01$ ,  $\beta = 0.514$ ,  $t\text{-value} = 3.224$ ). Acquiring other external knowledge was similarly associated with positive effects of innovation output, as indicated by innovation-related turnover ( $\beta = 0.364$ ,  $t\text{-value} = 2.312$ ).

Whether or not firms engaged in R&D cooperation, there is a positive and significant effect of in-house R&D expenditure on innovation-related turnover (for cooperating firms,  $\beta = 0.263$ ,  $t\text{-value} = 2.210$  and, for non-cooperating firms,  $\beta = 0.224$ ,  $t\text{-value} = 1.922$ ). In other words, internal R&D efforts remained the most prominent factor in the generation of sales through innovative products. Such efforts would be enhanced through R&D cooperation. R&D

cooperation also had a positive effect on the relationship between expenditure on acquisition of equipment and software and innovation-related turnover. Alternatively, expenditure on outsourcing of R&D and exploitation of external knowledge sources by firms that did not engage in R&D cooperation had the most significant effects on innovation-related turnover .

In general, firms were motivated to undertake R&D cooperation as a means of reducing the cost of R&D. Cooperation may enable firms to learn more effectively through open-ended learning and knowledge sharing between partners (Grant, 1996), which may be useful for Hong Kong firms with low internal R&D investment. Table 6 shows that Hong Kong firms cooperate in innovation activities with other firms in order to reduce costs (60.1%) and stay close to market and customers (34.7%), but are usually not motivated by favorable government policies (17%) or by close proximity to universities and scientific institutions (10.8%).

[Insert Table 6 Here]

## **5. Conclusions and Limitations**

A newly industrialized economy like Hong Kong depends on effective innovation to maintain the competitiveness of its manufacturing firms. Our study shows that Hong Kong firms with manufacturing activities in Guangdong province respond to such challenges in ways that are similar to those of small and medium-sized firms in industrialized economies, but also follow patterns of innovation that may be slightly different from those of firms in comparable economies.

We found generally that Hong Kong firms do innovate—with 50% of the sampled firms reporting significant innovation outputs (Table 2). Fundamentally, intramural R&D is

employed by these firms to enhance performance in product and marketing innovation. On the other hand, acquisition of machinery, equipment, and software is the preferred approach to enhancing process and organizational innovation. Training is utilized to enhance marketing and organizational innovations, while R&D cooperation with other organizations has a positive effect on the product and process innovation. Characteristically (for Hong Kong firms), efforts to enhance market introduction of innovations remains a significant backbone for any type of innovation.

The key sources of knowledge for all types of innovation remain the innovative inputs generated by internal R&D and inputs received from the market—predominantly from customers and suppliers. In addition, consultants and institutions such as universities contribute to organizational innovation, while sources such as conferences, journals, and so on contribute primarily to marketing innovations. These patterns reflect the strongly market-oriented character of innovation among Hong Kong firms, and indicate the extent to which firms consider inputs from internal or value-chain networks essential to their innovative output. Given that the Hong Kong government's policies on promoting innovation is oriented towards supporting university-industry links (Sharif and Baark, 2008), the conspicuous absence of reliance on universities and public research organizations for product and process innovation is particularly worrisome. Perhaps additional incentives to make full use of available innovative knowledge would pay off in this area.

Our data also reveals that R&D cooperation can provide important effects on the impact of particular types of innovation expenditures on innovation-related output, measured as turnover related to new products. R&D cooperation can thus enhance the effects of in-house R&D and expenditure on acquisition of equipment and software. Firms also carry out R&D cooperation

to overcome excessive risk and financial constraints in innovative expenditure (Abramovsky, et al., 2005). In contrast, firms that did not engage in R&D cooperation experienced the most significant effects on expenditure in acquiring external R&D and knowledge.

In terms of organizational research, our study suggests that firms could enhance their innovation performance by differentiating their efforts related to types of innovation. This result coheres with those of other studies that have shown how various types of R&D cooperation and innovation activities are associated with specific types of innovation in certain industries (Vega-Jurado et al., 2009; Freel, 2003). In the particular situation of Hong Kong–owned manufacturing firms, it is evident that marketing activities, including market research and advertising, are essential to all types of innovation. Intramural R&D is primarily pursued for product and marketing innovation. Training enhances marketing and organizational innovation. Finally, process innovation is largely driven by the acquisition of machinery, equipment, and software and by R&D cooperation, but is not significantly related to extramural R&D or the acquisition of other external knowledge.

## References

- Abramovsky L., Kremp, E., Lopez, A., Schmidt, T. and Simpson, H., 2005. Understanding cooperative R&D activity: evidence from four European countries, The Institute for Fiscal Studies, working paper no. WP05/23, pp. 1-30.
- Amara, N., and Landry, R., 2005. Source of information as determinants of novelty of innovation in manufacturing firms: evidence form the 1999 statistics Canada innovation survey. *Technovation*, 25, pp. 245-259.
- Ancona, D. and Caldwell, D., 1987. Management issues facing new product teams in high technology companies. In: D. Lewin, D. Lipsky, and D. Sokel, ed, *Advances in industrial and labour relations*, Vol. 4. Greenwich, CT: JAI Press. pp. 191-221.
- Baark, E. and Sharif, N., 2006. Hong Kong's innovation system in transition: challenges of regional integration and promotion of high technology. In: B. A. Lundvall, P. Intarakumnerd, and J. Vang, ed, *Asia's innovation systems in transition*. Edward Elgar Publishing, pp. 123-147.
- Baldwin, J.R. and Hanel, P., 2003. Innovation and knowledge creation in an open economy: Canadian industry and international implications. Cambridge, UK: Cambridge University Press.
- Baldwin, J.R., and J. Johnson, 1996. Business Strategies in More- and Less- Innovative Firms in Canada. *Research Policy*, 25(5), pp. 785-804.
- Berger, S. and Lester, R.K., 1997. *Made by Hong Kong*. Oxford, UK: Oxford University Press.
- Bogliacino, F., Perani, G., Pianta, M. and Supino, S., 2009. Innovation in developing countries: the evidence form innovation surveys. FIRB conference research and entrepreneurship in the knowledge-based economy, Bocconi University, Milan, Sep., pp. 7-8.
- Brahmbhatt, M. and Hu, A., 2009. Ideas and innovation in East Asia. *The World Bank Research Observer Advance*, 25 (92), pp.177-207.
- Caloghirou, Y., Kastelli, I. and Tsakanika, A., 2004. Internal capabilities and external knowledge sources: complements or substitutes for innovative performance. *Technovation*, 24, pp. 29-39.
- Castellacci, F. 2008. Technological paradigms, regimes and trajectories: manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy*, 37, pp. 978-994.
- Chesbrough, H.W. 2003. *Open innovation: the new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Press.
- Cohen, W.M. and Levinthal, F.A., 1989. Innovation and learning: the two faces of R&D. *Economic Journal*, 99 (397), pp. 56-59.
- Cooke, P., 2001. Regional innovation systems, clusters and knowledge economy. *Industrial and Corporate Change*, 10 (4), pp. 945-974.
- Cooke, P., Uranga, M.G. and Etxebarria, G., 1997. Regional innovation system: institutional and organizational dimensions. *Research Policy*, 26 (4), pp. 475-491.
- Coombs, R., Harvey, M. and Tether, B.S., 2003. Analysing distributed processes of provision and innovation. *Industrial and Corporate Change*, 12 (6), pp.1125-1155.
- Dasgupta P. and David P.A., 1994. Toward a new economics of science. *Research Policy*, 23, pp.487-521
- Davies, H., 1999. The future shape of Hong Kong's economy: why high-technology manufacturing will prove to be a myth. In: P. Fosh et al., ed. *Hong Kong management and labour*. Routledge, London.
- Dodgson, M., 1993. Organizational learning: a review of some literature. *Organization Studies*, 14 (3), pp. 375-394.

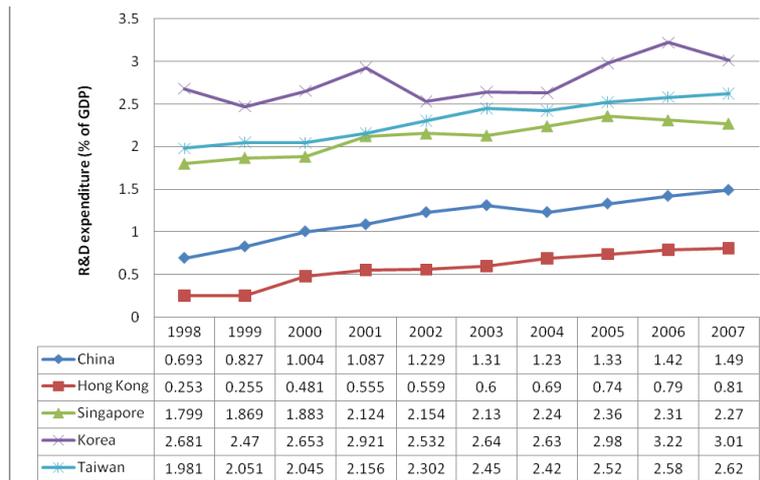
- Dosi, G., 1988. Sources, procedures and microeconomic effects of innovation. *Journal of Economic Literature*, 26, pp. 1120–1171.
- Edquist, C., 1997. Systems of innovation: technologies, organizations and institutions. London: Pinter.
- Enright, M.J., 2000. Globalization, regionalization and the knowledge-based economy in Hong Kong. In: J. Dunning, ed. Regions, globalization, the knowledge-based economy, Oxford University Press, UK, pp.381-406.
- Enright, M., Scott, E. and Chang, K., ed., 2005. Regional powerhouse: the greater Pearl River Delta and the rise of China. Singapore; Hoboken, N.J.: John Wiley & Sons (Asia) Pte. Ltd..
- Enright, M. J., Scott, E.E. and Dodwell, D., 1997. The Hong Kong Advantage. Hong Kong: Oxford University Press.
- Eom, B.Y. and Lee, K., 2010. Determinants of industry-academy linkages and their impact on firm performance: the case of Korea as a latecomer in knowledge industrialization. *Research Policy*, 39, pp. 625-639.
- Eurostat, 2007. Weak link between innovative enterprises and public research institutes/universities. *Statistics in focus*, 81/2007 [online] Available at: <http://ed.europa.eu/eurostat> [accessed 27 November 2010]
- Eurostat, 2009. Quality in the focus of Innovation. *Statistics in focus*, 33/2009 [online] Available at: <http://ed.europa.eu/eurostat> [accessed 27 November 2010]
- Eurostat, 2010. More than half of EU27 enterprises are innovative. *Eurostat Newsrelease*, 166/2010 [online] Available at: <http://ed.europa.eu/eurostat> [accessed 27 November 2010]
- Freel, M.S., 2003. Sectoral patterns of small firm innovation, networking and proximity. *Research Policy*, 32 (5), pp. 751-770.
- Freel, M.S., 2005. Patterns of innovation and skills in small firms. *Technovation*, 25(2), pp. 123-134.
- Frenz, M. and Letto-Gillies, G., 2009, The impact on innovation performance of different sources of knowledge: evidence from the UK community innovation survey. *Research Policy*, 38(7), pp. 1125-1135.
- Fagerberg, J. and Godinho, M.M., 2005. Innovation and catching-up. In: J. Fagerberg, D.C. Mowery, and R.R. Nelson, ed. The Oxford handbook of innovation. Oxford: Oxford University Press, pp. 514-542.
- Fan, P., 2006. Catching up through developing innovation capability: evidence from China's telecom-equipment industry. *Technovation*, 26, pp. 359-368.
- FHKI (Federation of Hong Kong Industries), 2003. Made in PRD-the changing face of Hong Kong manufacturers. Federation of Hong Kong Industries. [online] Available at: <<http://www.fhki.org.hk>> [accessed 8 June 2010].
- Field, A., 2009. Discovering statistics using SPSS, 3rd ed. London, Sage Publication, pp.137.
- Foray, D., 2000. Characterizing the knowledge base: available and missing indicators. In: Centre for education research and innovation, ed. Knowledge management in learning society. Paris: OECD, pp. 239-257.
- Freeman, Christopher, 1991. Network of Innovators: A Synthesis of Research Issues. *Research Policy*, 20(5), pp. 499-514.
- Freeman, Christopher, 1995. The National Innovation System in Historical Perspective. *Cambridge Journal of Economics*, 19(1), pp. 41-60.
- Freeman, C., 2002. Continental, national and sub-national innovation systems - complementarity and economic growth. *Research Policy*, 31, pp. 191-211.
- Freeman, C. and Soete, L., 1997. The economics of industrial innovation. 3rd ed. London; Washington: Pinter.

- Frenkel, A., D. Shefer, K. Koschalzky, and G.H. Walter, 2001. Firm Characteristics, Location and Regional Innovation: A Comparison between Israeli and German Industrial Firm. *Regional Studies*, 35(5), pp. 413-27.
- Grant, R.M., 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 15 (Winter Special Issue), pp.109–122.
- Griliches, Z., 1995. R&D and Productivity: Econometric Results and Measurements Issues, in S. Paul (ed.), *Handbook of the Economics of Innovation and Technological Change*. Oxford, UK: Blackwell.
- Grossman, G. and Helpman, E., 1994. Technology and trade. National Bureau of Economic Research, Inc. Working Paper 4926.
- Guan, J. and Chen, K., 2010. Measuring the innovation production process: a cross-region empirical study of China's high-tech innovations. *Technovation*, 30(5-6), pp. 348-358.
- Guan, J.C., Yam, R.C.M., Tang, E.P.Y. and Lau, A.K.W., 2009. Innovation strategy and performance during economic transition: evidences in Beijing, China. *Research Policy*, 38(5), pp.802-812.
- Guangzhou Hu, A., 2003. Organization, Monitoring Intensity, and Innovation Performance in Chinese Industry. *Economics of Innovation and New Technology*, 12(2), pp. 117-44.
- Gulati, R., N. Nohria, and A. Zaheer, 2000. Strategic Networks. *Strategic Management Journal*, 21(3), pp. 203-15.
- Hagedoorn, J., 2002. Inter-Firm R&D Partnerships: An Overview of Major Trends and Patterns since 1960. *Research Policy*, 31(4), pp. 477-92.
- Hall, B.H., 1996. The Private and Social Returns to Research and Development, in B. Smith and C. Barfield (ed.), *Technology, R&D and the Economy*. Washington, DC: AEI - Brookings Institution.
- Hall, B.H., and J. Reenen, 2000. How Effective Are Fiscal Incentives for R&D? A Review of Evidence. *Research Policy*, 29 (4-5), pp. 497-529.
- Haque, I.U. et al., 1995. Trade, technology, and international competitiveness. The World Bank, Washington, D.C.
- Harland, C.M., 1996. Supply Chain Management: Relationships, Chains and Networks. *British Journal of Management*, 7(Special Issue), pp. S63-S80.
- Heidenreich, M., 2009. Innovation patterns and location of European low- and medium-technology industries. *Research Policy*, 38, pp.483-494.
- Henderson, R. and Cockburn, I., 1996. Measuring competence? exploring firm effects in pharmaceutical research. *Strategic Management Journal*, 15(Winter Special Issue), 63-84.
- Higgins, J.M., 1995. Innovate or evaporate. New York: New Management Publishing Company Inc.
- Hobday, M., 1995. East Asian latecomer firms: learning the technology of electronics. *World Development*, 23(7), pp. 1171-1193.
- Hobday, M., 2007. Editor's introduction: the scope of Martin Bell's contribution. *Asian Journal of Technology Innovation*, 15(2), pp.1-18.
- Hoffman, K., Milady, P., Bessant, J. and Perren, L., 1998. Small firms R&D, technology and innovation in the UK: a literature review. *Technovation*, 18, pp. 39–55
- Hong Kong Census and Statistics Department, 2007. Report on 2007 Annual Survey of Industrial Production.
- Hong Kong Trade Development Council (HKTDC), 1998. Hong Kong's manufacturing industries: current status and future prospects. Hong Kong.
- Huang, C. and Sharif, N., 2009. Manufacturing dynamics and spillovers: the case of Guangdong province and Hong Kong, Macau, and Taiwan (HKMT). *Research Policy*, 38(5), pp. 813-828.

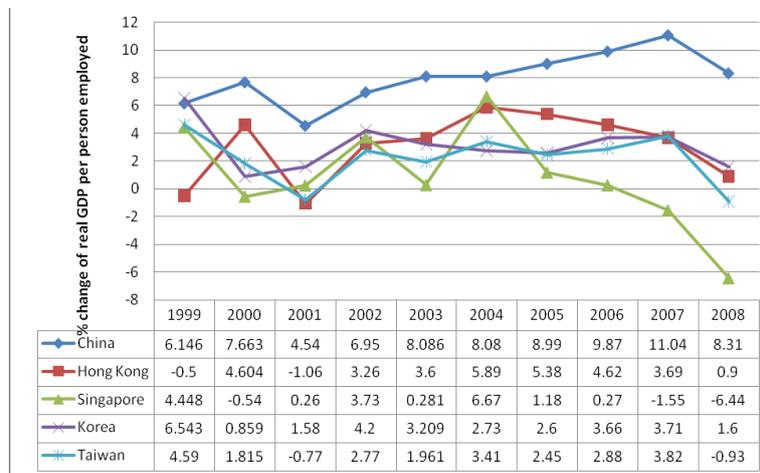
- Huber, G.P., 1991. Organizational learning: the contributing processes and the literatures. *Organization Science*, 2(1), 88-115.
- Hyland, P.W., Marceau, J. and Sloan, T.R., 2006. Sources of innovation and ideas in ICT firms in Australia. *Creativity and Innovation Management*, 15(2), pp. 182-194.
- IMD, 2010. IMD World Competitiveness Yearbooks 2000-2009. Switzerland, IMD.
- Kam, W.P., M. Kiese, A. Singh, and F. Wong, 2003. The Pattern of Innovation in Singapore's Manufacturing Sector. *Singapore Management Review*, 25(1), pp. 1-34.
- Kim, L. and Nelson, R.R., 2000. Technology, learning and innovation: experiences of newly industrializing economies. UK: Cambridge University Press.
- Kline, S. and Rosenberg, N., 1986. An overview of the process of innovation. In: G. Landau and N. Rosenberg, ed. *The positive sum strategy: harnessing technology for economic growth*. Washington: National Academy Press.
- Koeller, C.T., 1996. Union Membership, Market Structure, and the Innovation Output of Large and Small Firms. *Journal of Labour Research*, 17(4), pp. 683-99.
- Koschatzky, K., U. Bross, and P. Stanovnik, 2001. Development and Innovation Potential in the Slovene Manufacturing Industry: Analysis of an Industrial Innovation Survey. *Technovation*, 21(5), pp. 311-24.
- Lall, S., 1992. Technological capabilities and industrialization. *World Development*, 20 (2), pp. 165-168.
- Lall, S., 2000. Technological change and industrialization in the Asian newly industrializing economies: achievements and challenges, In: L. Kim and R.R. Nelson, ed. *Technology, learning an innovation experiences of newly industrializing economies*, Cambridge, UK: Cambridge University Press.
- Lall, S. and Urata, S., 2003. Competitiveness, FDI and technological activity in East Asia. Edward Elgar, UK.
- Laursen, K. and Salter, A., 2004. Searching high and low: what types of firms use universities as a source of innovation. *Research Policy*, 33: pp. 1201-1215.
- Lengrand, L. and Chatrie, I., 1999. Business networks and the knowledge-driven economy. European Commission, Brussels.
- Li, J., Chen, D. and Shapiro, D.M., 2010. Product innovations in emerging economies: the role of foreign knowledge access channels and internal efforts in Chinese firms. *Management and Organization Review*, 6(2), pp. 243-266.
- Lundvall, Bengt-Ake, 1988. Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation, in Giovanni Dosi (ed.), *Technical Change and Economic Theory*. London and New York: Pinter Publishers.
- Lundvall, Bengt-Ake, 1992. National systems of innovation: towards a theory of innovation and interactive learning. London: Printer.
- MacBeth, D.K., and N. Ferguson, 1994. Partnership Sourcing: An Integrated Supply Chain Approach. London, UK: Pitman.
- Meyer, D.R., 2000. Hong Kong as a global metropolis. Cambridge, UK: Cambridge University Press.
- Meyer, D.R., 2008. Structural changes in the economy of Hong Kong since 1997. *The China Review*, 8(1), pp.7-29.
- Mowery, D.C. and Sampat, B.N., 2005. The Bayh-Dole Act of 1980 and university-industry technology transfer: a model for other OECD government. *Journal of Technology Transfer*, 30, pp. 115-127.
- Nelson, R.R. and Pack, H., 1999. The Asian miracle and modern growth theory. *The Economic Journal*, 109(July), pp. 416-436.
- OECD, 2005. Oslo manual: guidelines for collecting and interpreting innovation data. 3rd ed. OECD: Paris.

- OECD, 2010. The OECD innovation strategy: getting a head start on tomorrow. OECD, Paris.
- Okamuro, H., 2007. Determinants of successful R&D cooperation in Japanese small businesses: the impact of organizational and contractual characteristics. *Research Policy*, 36, pp.1529-1544.
- Oliver, C., 1990. Determinants of Inter-Organizational Relationships: Integration and Future Directions. *Academy of Management Review*, 15(2), pp. 241-65.
- Panda, H. and Ramanathan, K., 1996. Technological capability assessment of a firm in the electricity sector, *Technovation*, 16(10), pp. 561-588.
- Pavitt, K., 1984. Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory. *Research Policy*, 13(6), pp. 343-73.
- Porter, M.E., 1990. The competitive advantage of nations. New York: Free Press.
- Prahalad, C.K. and Hamel, G., 1990. The core competence of the corporation. *Harvard Business Review*, 68(3), pp. 79–91.
- Romijn, H. and Albaladejo, M., 2002. Determinants of innovation capability in small electronics and software firms in Southern England. *Research Policy*, 31, pp. 1053-1067.
- Rothwell, R. and Dodgson, M., 1991. External linkages and innovation in small and medium-sized enterprises. *R&D Management*, 21(2), pp. 125–137.
- Rowley, C. and Warner, M., 2005. Globalization and competitiveness: big business in Asia. Routledge, USA.
- Santamaria, L., Nieto, M.J. and Barge-Gil, A., 2009. Beyond formal R&D: taking advantage of other sources of innovation in low- and medium-technology industries. *Research Policy*, 38, pp. 507-517.
- Schmoch, U., Rammer, C. and Legler, H., 2006. National systems of innovation in comparison. Springer, Netherlands.
- Schmidt, T., 2005. Knowledge flows and R&D co-operation: firm-level evidence from Germany. ZEW Discussion Papers 05-22 [rev.], ZEW/ Center for European Economic Research.
- Sharif, N. and Baark, E., 2005. The tamed tigers? understanding Hong Kong's innovation system and innovation policies. *International Journal of Technology and Globalization*, 1(3-4), pp.462-479.
- Sharif, N. and Baark, E. 2008. Mobilizing Technology Transfer from University to Industry: The Experience of Hong Kong Universities. *Journal of Technology Management in China* 3(1), pp. 47-65
- Shefer, D., and A. Frenkel, 1998. Local Milieu and Innovation: Some Empirical Results. *The Annals of Regional Science*, 32(1), pp. 185-200.
- Sit, V.F.S., 1998. Hong Kong's transferred industrialization and industrial geography. *Asian Survey*, 38(9), pp. 880-904.
- Sit, V.F.S., 2005. China's extended metropolitan regions: formation and delimitation. *International Development Planning Review*, 27 (3), pp. 297-331.
- Sit, V.F.S., 2006. Dynamic Hong Kong – Pearl River Delta relationship under globalization and one country two systems, In: A. G. Yeh, V.F.S. Sit, G. Chen, and Y. Zhou, ed. Developing a competitive Pearl River Delta In South China under one country-two Systems. Hong Kong: Hong Kong University Press, pp.3-26.
- Souitaris, V., 2002. Technological trajectories as moderators of firm-level determinants of innovation. *Research Policy*, 31(6), pp.877-898.
- Strokey, N.L., 1995. R&D and Economic Growth. *Review of Economic Studies*, 62(3), pp. 469-89.
- Teece, D.J., Pisano, G. and Shuen, A., 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), pp. 509-533.

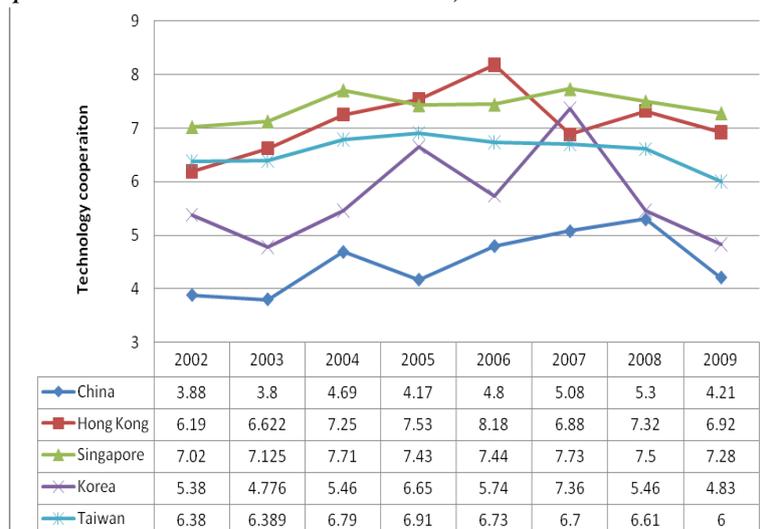
- Tidd, J., 2006. A review of innovation models. Discussion Paper, Imperial College London, pp. 1-16.
- Tsang, 2008. 30 January. Delta factories face more curbs on production. *South China Morning Post*, pp. B2.
- Varis, M. and Littunen, H., 2010. Types of innovation, sources of information and performance in entrepreneurial SMEs. *European Journal of Innovation Management*, 13(2), pp.128 – 154.
- Vega-Jurado, J., Gutierrez-Gracia, A. and Fernandez-de-Lucio, I., 2009. Does external knowledge sourcing matter for innovation? Evidence from the Spanish manufacturing industry. *Industrial and Corporate Change*, 18(4), pp. 637-670.
- Verspagen, B., 2005. Innovation and economic growth. In: J. Fagerberg and D.C. Mowery, ed. *The Oxford handbook of innovation*. Oxford: Oxford University Press, pp.487-513.
- Von Hippel, E., 1988. *The Source of Innovation*. New York: Oxford University Press.
- WEF, 2010. *The global competitiveness report, 2009-2010*. World Economic Forum, Geneva.
- Yu, F.L.T., 2005. Technological strategies and trajectories of Hong Kong's manufacturing firms. *International Journal of Technology Management*, 29(1/2), pp. 21-39.
- Zhao, H., Tong, X. Wong, P.K. and Zhu, J., 2005. Types of technology sourcing and innovative capability: an exploratory study of Singapore manufacturing firms. *The Journal of High Technology Management Research*, 16(2), pp. 209-224.



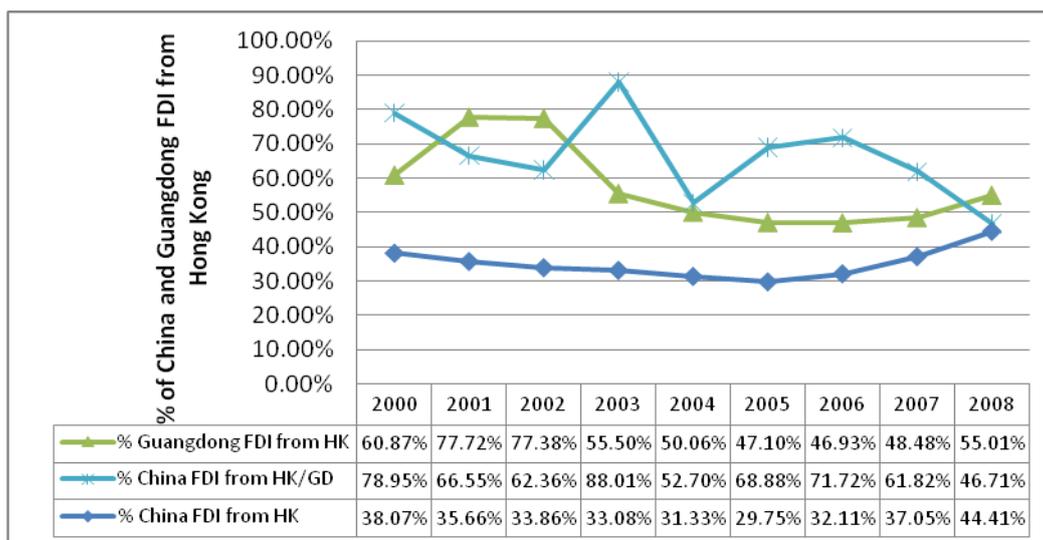
**Figure 1a:** R&D expenditure as a percentage of GDP by country (*Sources: IMD World Competitiveness Yearbooks 2000-2009*)



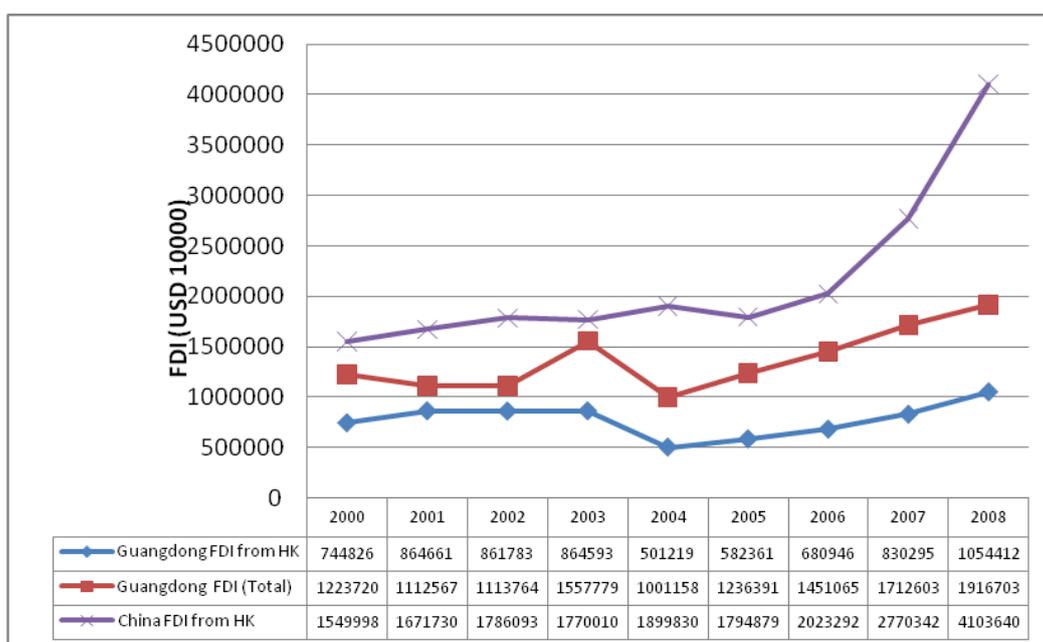
**Figure 1b:** Overall productivity growth by country (*Sources: IMD World Competitiveness Yearbooks 2000-2009*)



**Figure 1c:** The perceived technological cooperation\* in the countries (*Sources: IMD World Competitiveness Yearbooks 2000-2009*) \* As identified through an annual executive opinion survey conducted by IMD, measured by asking respondents the extent to which “technological cooperation between companies is lacking or developed” (along a 10 point scale).



**Figure 2a:** The percentage of actual foreign investment of China and Guangdong from Hong Kong (Sources: China statistical yearbooks 2000-2009; Guangdong statistical yearbooks 2000-2009)



**Figure 2b:** Actual foreign investment in China and Guangdong from Hong Kong (Sources: China statistical yearbooks 2000-2009; Guangdong statistical yearbooks 2000-2009)

**Table 1: Company Profile**

	<b>Frequency</b>	<b>Percent</b>
<b>Types of industry</b>		
Agriculture and fishing	1	0.2%
Manufacturing	361	73.4%
Electricity, gas and water	8	1.6%
Construction	12	2.4%
Wholesale, retail and import/export trades, restaurants and hotels	53	10.8%
Transport, storage and communication	14	2.8%
Finance, insurance, real estate and business	32	6.5%
Community, social and personal services	3	0.6%
Nil	8	1.6%
<b>Geographic markets in 2006-2007</b>		
Local/regional within Hong Kong and Guangdong	332	65.4%
Hong Kong plus Mainland China	302	61.4%
All other countries	348	70.7%
<b>Company size</b>		
	<b>Mean (SD)</b>	<b>Maximum – Minimum</b>
No. of employee in 2006	1716 (6432)	90000 - 0
No. of employee in 2007	1862 (6787)	91000 - 0
<b>Respondent's position in the company</b>		
Director, President or General manager	256	52%
Departmental Manager	98	20%
Engineer	33	7%
Administrative officer	95	19%
Others	10	2%

**Table 2: Company Innovation Profile**

	<b>Frequency</b>	<b>Percent</b>
<b>Intellectual property rights used in 2006-07 (Yes/No)</b>		
Apply for a patent	110	22.4
Register an industrial design	74	15.0
Register a trademark	167	33.9
Claim copyright	87	17.7
<b>Having innovation outputs in 2006-2007 (Yes/No)</b>		
Product innovation	269	54.7
Process innovation	286	58.1
Marketing innovation	244	49.6
Organizational innovation	318	64.6
	<b>Mean (SD)</b>	<b>Maximum – Minimum</b>
<b>The percentage of total turnover in 2006-2007 (%)</b>		
Turnover % due to product innovation introduced that were new to the market	21.32% (19.71)	100.00% – 0.00%
Turnover % due to product innovation introduced that were new to the firm	25.89% (21.17)	100.00% – 0.00%
Turnover % due to products sold that were unchanged or only marginally modified	58.63% (26.91)	100.00% – 0.00%
<b>Innovation expenditure in 2007 (HKD)</b>		
Intramural (in-house) R&D	\$10262531 (\$42843388)	\$500000000 - \$10000
Acquisition of R&D (extramural R&D)	\$6591661 (\$38044397)	\$400000000 - \$5000
Acquisition of machinery, equipment and software (exclude expenditures on equipment for R&D)	\$16431472 (\$136387727)	\$2000000000 - \$1000
Acquisition of other external knowledge	\$995058 (\$3648790)	\$34495000 - \$1000
Total (combining the above 4 expenditures)	\$23968940 (\$164946285)	\$2500000000 - \$10000

**Table 3:** Relationships between Types of Innovation and Innovation Activities

	<b>Product innovation</b>	<b>Process Innovation</b>	<b>Marketing innovation</b>	<b>Organizational innovation</b>
	Coefficient (S.E., Wald value)			
	Model 1	Model 2	Model 3	Model 4
<b>Control variables</b>				
No of employee in 2006 (log)	0.799	0.132	0.307	1.052
No of employee in 2007 (log)	0.871	0.222	0.147	0.116
Type of Industry (7 dummy variables)	0.000 to 1.423	-2.826* to 2.067	-2.300* to 2.619	0.032 to 1.459
<b>Innovation activities</b>				
Intramural R&D	<b>0.899 ***</b> <b>(0.300, 8.984)</b>	-0.188	<b>0.611 **</b> <b>(0.296, 4.254)</b>	0.014
Extramural R&D	-0.196	-0.075	0.082	0.614
Acquisition of machinery, equipment and software	-1.701	<b>0.825 **</b> <b>(0.357, 5.344)</b>	0.098	<b>0.743 **</b> <b>(0.336, 4.871)</b>
Acquisition of other external knowledge	-0.063	-0.112	0.366	0.387
Training	-0.147	-1.742	<b>0.533 *</b> <b>(0.286, 3.481)</b>	<b>0.795 ***</b> <b>(0.299, 7.064)</b>
Market introduction of innovations	<b>0.592 **</b> <b>(0.296, 4.001)</b>	<b>0.679 **</b> <b>(0.319, 4.533)</b>	<b>0.889 ***</b> <b>(0.252, 12.495)</b>	<b>0.801 ***</b> <b>(0.294, 7.404)</b>
Other preparations	<b>0.847 ***</b> <b>(0.321, 6.970)</b>	0.177	1.460	<b>0.573 *</b> <b>(0.315, 3.301)</b>
R&D cooperation on any of your innovation activities with other enterprises or institutions	<b>0.584 *</b> <b>(0.338, 2.987)</b>	<b>1.409 ***</b> <b>(0.440, 10.243)</b>	0.779	1.933
Constant	2.631 *** (0.361, 53.170)	4.071 *** (1.195, 11.609)	1.513 *** (0.314, 23.205)	1.509 *** (0.546, 7.648)
No. of observation	303	303	303	303
-2 Log Likelihood	302.323	264.080	376.805	311.179
Cox and Snell R-Square	0.121	0.124	0.114	0.131
Nagelkerke R-Square	0.179	0.196	0.153	0.191
Chi-square (Sig.)	39.000 (0.000)	26.633 (0.000)	29.733 (0.000)	34.244 (0.000)

Binary logistic regression analysis with a stepwise backward-likelihood ratio was used. As this study was exploratory in nature, a stepwise method was used and the backward-likelihood ratio method was selected to minimize Type II errors and this type of method usually results in the most parsimonious model (Field, 2009). The statistically insignificant variables were not entered into the model, since they would not have significant values less than 0.05, so their standard error could not be reported.

\* P<0.10; \*\* P<0.05; \*\*\* P<0.01

**Table 4:** Relationships between Types of Innovation and Sources of Innovation

	<b>Product innovation</b>	<b>Process Innovation</b>	<b>Marketing innovation</b>	<b>Organizational innovation</b>
	Coefficient (S.E., Wald value)			
	Model 5	Model 6	Model 7	Model 8
<b>Control variables</b>				
No of employee in 2006 (log)	1.342	0.185**	0.164	1.466
No of employee in 2007 (log)	1.452	0.181	0.048	0.172**
Type of Industry (7 dummy variables)	0.000 to 0.743	-2.685** to 1.960	-1.953* to 1.378	0.014 to 1.422
<b>Sources of innovation</b>				
Internal and Market sources <sup>1</sup>	<b>0.864***</b> <b>(0.226, 14.555)</b>	<b>1.036***</b> <b>(0.254, 16.611)</b>	<b>0.689***</b> <b>(0.229, 9.054)</b>	<b>0.610**</b> <b>(0.245, 6.197)</b>
Consultant and Institutional sources <sup>2</sup>	0.026	0.276	0.652	<b>0.565***</b> <b>(0.210, 7.228)</b>
Other sources <sup>3</sup>	0.263	0.220	<b>0.613***</b> <b>(0.182, 11.315)</b>	0.830
Constant	-0.664	-0.047 (1.217, 0.001)	-1.534*** (0.541, 8.032)	-1.717*** (0.613, 7.842)
No. of observation	312	312	312	312
-2 Log Likelihood	335.714	277.078	387.450	330.248
Cox and Snell R-Square	0.047	0.103	0.114	0.095
Nagelkerke R-Square	0.070	0.164	0.153	0.139
Chi-square (Sig.)	15.183 (0.000)	17.745 (0.000)	31.882 (0.000)	22.628 (0.000)

Note: Binary logistic regression analysis with a stepwise backward-likelihood ratio was used. As this study was exploratory in nature, a stepwise method was used and the backward-likelihood ratio method was selected to minimize Type II errors and this approach usually results in the most parsimonious model (Field, 2009). The statistically insignificant variables were not entered into the model, since they would not have significant values less than 0.05, so their standard error could not be reported.<sup>1</sup> Averaged value of internal R&D, suppliers, clients/customers, and competitors

<sup>2</sup> Averaged value of consultants, universities, and government

<sup>3</sup> Averaged value of conferences, journals, and associations

\* P<0.10; \*\* P<0.05; \*\*\* P<0.01

**Table 5: Impact of R&D Cooperation on the Relationship between Innovation Expenditure and Innovation Turnover**

Innovation Turnover (turnover due to products new to the market)											
Standardized coefficients (t-value, S.E.)											
	Baseline <sup>#</sup>	Companies have R&D cooperation					Companies have no R&D cooperation				
		With in-house R&D expenditure	With acquisition of R&D expenditure	With acquisition of machinery, equipment & software expenditure	With acquisition of other external knowledge expenditure	With total innovation expenditure	With in-house R&D expenditure	With acquisition of R&D expenditure	With acquisition of machinery, equipment & software expenditure	With acquisition of other external knowledge expenditure	With total innovation expenditure
		Model 9a	Model 9b	Model 9c	Model 9d	Model 9e	Model 10a	Model 10b	Model 10c	Model 10d	Model 10e
<b>Control variables</b>											
No of employee in 2006 (log)	-0.647 (-1.348, 4.782)	0.070 (0.562)	0.107 (0.761)	0.049 (0.389)	0.144 (0.775)	0.066 (0.542)	-0.131 (-0.967)	0.093 (0.562)	-0.024 (-0.204)	0.007 (0.045)	0.076 (0.619)
No of employee in 2007 (log)	0.652 (1.362, 4.821)	0.078 (0.628)	0.117 (0.824)	0.063 (0.501)	0.168 (0.904)	0.076 (0.619)	-0.098 (-0.741)	0.058 (0.348)	-0.20 (-0.174)	0.018 (0.110)	0.029 (9.236)
Type of Industry (7 dummy variables)	-0.008 (-0.081, 12.162) to 0.022 (0.224, 12.840)	-0.151 (-1.278) to 0.067 (0.554)	-0.152 (-1.142) to 0.082 (0.601)	-0.162 (-1.365) to 0.093 (0.769)	-0.224 (-1.078) to 0.192 (1.132)	-0.154 (-1.331) to 0.103 (0.877)	-0.150 (-1.288) to 0.281** (2.409, 13.462)	-0.226 (-1.354) to 0.148 (0.924)	-0.093 (-0.849) to 0.337*** (3.096, 19.976)	-0.088 (-0.550) to 0.166 (1.046)	-0.137 (-1.239) to 0.247 (2.399, 14.067)
<b>Innovation expenditure</b>											
In-house R&D		<b>0.263**</b> (2.210, 0.000)					<b>0.224*</b> (1.922, 0.000)				
Acquisition of R&D			<b>0.261*</b> (1.952, 0.000)					<b>0.514***</b> (3.224, 0.000)			
Acquisition of machinery, equipment & software				<b>0.335***</b> (2.798, 0.000)					0.017 (0.155)		
Acquisition of other external knowledge					-0.105 (-0.614)					<b>0.364**</b> (2.312, 0.000)	
Total innovation expenditure						<b>0.279**</b> (2.396, 0.000)					0.095 (0.924)
Constant (un-standardized)	25.101** (2.570, 9.765)	22.660*** (10.183, 2.225)	22.816*** (8.578, 2.660)	22.318*** (9.426, 2.368)	25.429*** (7.566, 3.361)	22.718 (10.349, 2.195)	17.496*** (6.891, 2.550)	13.800*** (6.509, 2.120)	18.145*** (7.971, 2.276)	17.534*** (6.450, 2.718)	16.225*** (7.185, 2.258)
No. of observation	216	68	54	64	36	70	68	31	77	37	91
F-value (sig.)	0.617	<b>4.886**</b>	<b>3.809*</b>	<b>7.828***</b>	0.377	<b>5.740**</b>	<b>4.412**</b>	<b>10.392***</b>	<b>9.588***</b>	<b>5.345**</b>	<b>3.183**</b>
R <sup>2</sup>	0.026	0.069	0.068	0.112	0.011	0.078	0.120	0.264	0.113	0.132	0.067
Adjusted R <sup>2</sup>	-0.16	0.055	0.050	0.098	-0.018	0.064	0.092	0.238	0.102	0.108	0.046

OLS Linear regression (stepwise) analysis with three control variables (i.e., number of employees in 2006 and 2007 and type of industry) was used. In stepwise approach, the variables which were statistically insignificant were excluded from the regression models, so no standard error was reported.

<sup>#</sup>In the regression analysis, the baseline model used enter approach as no control variable was statistically significant.

\* P<0.10; \*\* P<0.05; \*\*\* P<0.01

**Table 6:** Motivation for R&D Cooperation for Innovation Activities in 2006-07

Reason	N	Degree of importance (Freq. (%))			
		High	Medium	Low	Not relevant
1. Low cost	178	107 (60.1)	51 (28.7)	12 (6.7)	8 (4.5)
2. Close to market and customers	176	61 (34.7)	56 (31.8)	35 (19.9)	24 (13.6)
3. Close to qualified R&D personnel	176	38 (21.6)	78 (44.3)	39 (22.2)	21 (11.9)
4. Favorable government policy	176	30 (17)	50 (28.4)	46 (26.1)	50 (28.4)
5. Close to competitors	176	27 (15.3)	59 (33.5)	54 (30.7)	36 (20.5)
6. Close to local collaborators	176	24 (13.6)	70 (39.8)	49 (27.8)	33 (18.8)
7. Close to knowledge source (universities and scientific institutions)	176	19 (10.8)	51 (29)	66 (37.5)	40 (22.7)