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No. 1445 | Sept. 2008

Web: www.ifw-kiel.de

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Keywords: electronics, innovation, innovation policy, regional survey, Hong Kong, China

JEL classification: D21, L60, O31, O33, O38, R10, R28

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*This paper is an output of the cooperative project "Informal Dynamics of Agile Firm Organisation in the Greater Pearl River Delta (Priority Program 1233: Megacities – Megachallenge: Informal Dynamics of Global Change)", funded by the German Research Foundation (DFG). I would like to thank Frank Bickenbach, Dirk Dohse, Rüdiger Soltwedel and Paul Kramer at the Kiel Institute for the World Economy for their valuable comments and suggestions.

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1 Introduction

The year 1997 was crucial for political and economic development in Hong Kong (HK). Politically, the sovereignty over HK was transferred back to the People's Republic of China after having been a British colony for more than 150 years. Since its transfer, the HK special administrative government has obtained autonomy for applying policies in HK under the specific "one country, two systems" regime. It is often argued that this change in the political status has stimulated the newly established HK government to focus on building a long-term perspective for the overall development in HK. Economically, the Asian financial crisis in 1997 struck HK's economy hard and revealed HK's major economic weakness, namely its unilaterally strong reliance on the services sectors. Since then, the HK government has undertaken industry and innovation policies in a more active way than before, changing its role from a mere institution provider to an active innovation promoter.

This change in the attitude of the HK government towards implementing more active industrial and innovation policies is reflected in its political measures to promote innovation activities in HK. These policies focus especially on creating new funding opportunities and establishing several R&D centres to facilitate information flow and innovation cooperation between universities and industries, based on the consideration of the possible positive impacts of academic research on industrial innovation. Such positive impacts may be realised, according to the findings of several empirical studies, by acquiring academic research results, by directly cooperating with universities or R&D centres or by hiring highly-qualified students, graduates and researchers for innovation activities.[1] This paper examines, using data collected from a questionnaire survey, whether the active innovation policies in HK have stimulated innovation activities and whether the abovementioned channels have been applied to realise the positive impacts of academic research on industrial innovation. To do so, it focuses on the innovation activities of the HK electronics small- and medium-sized enterprises (SMEs) operating in the Greater Pearl River Delta (GPRD)[2], as the electronics industry is an industry in which innovation activities have been especially heavily promoted.

The remainder of this paper is organised as follows. In Section 2, major points of the innovation policies in HK before and after 1997 are delineated. In Section 3, selected official

[1] Some of them are Dorfman 1983, Lund 1986, Jaffe 1989, Ling and Rees 1990, Mansfield 1990, Feldman 1994, Anselin et al. 1997, Sternberg 2000, Varga 2000, Feldman et al. 2002, Audretsch and Feldman 2003, Fischer and Varga 2003, Fritsch and Slavtchev 2005.

[2] GPRD, in general, refers to HK, Macao, and the Pearl River Delta in China (PRD). Here we focus on HK and the PRD. Macao is ignored due to its small scale of economy.

statistics are briefly analysed to sketch the impacts of the active innovation policies on innovation activities in HK in general. In Section 4, first-hand questionnaire survey data are analysed in detail to explore the possible impacts of the active innovation policies on the innovation activities of the HK electronics SMEs. Section 5 concludes.

2 Innovation policies in HK

2.1 Before 1997

Depending on the attitude of the HK government towards industrial development and technological progress, innovation policies in HK can be separated into two phases, with the year of 1997 as the watershed year. It is often argued that there was effectively no industrial and innovation policy in HK before 1997 (Kwong 1997). The HK government's adherence to market principles was translated into its laissez-faire attitude and its non-intervention industrial policies. In this phase, the HK government was a mere institution provider for the economic development in HK. It did not actively intervene in the industrial development (Tuan and Ng 1995). It just attempted to provide sufficient infrastructural and developmental support for sustaining the economic development in HK. Infrastructural support included not only functional physical infrastructure such as communications, electricity and water systems etc., but also soft infrastructure, for example, diverse business services. The developmental support which included, for example, offering technical information, aimed at lowering impediments faced by HK companies to help improve their productivity (Yeh and Ng 1994). In this way, HK companies were granted great latitudes to make their own decisions, following their own interests. Keeping its laissez-faire attitude, HK government strengthened its involvement slightly in promoting companies' technological advancements after late 80s. New universities were founded to overcome HK's weakness in training students in the scientific areas and in conducting technological research.

2.2 After 1997

The Asian financial crisis in 1997 strongly hit HK's economy which has been mainly dependent on the service sectors, e.g. banking and retailing (Enright et al. 1997). To promote a healthier and more balanced economy, the Commission on Innovation and Technology (CIT) was set up. Its main assignments were to clarify the role of innovation activities for HK's future and identify which measures the HK government should undertake to encourage innovation activities (Baark and Sharif 2006). The CIT's first and second report (1998; 1999) highlighted the importance of innovation and technology for sustainable long-term economic

stability and growth in HK. The suggestions made in these two reports served as a crucial basis for the HK government in designing their innovation policies later on (HKSAR 1998, ITC 2004). Since then, the HK government has continuously increased its direct involvement in promoting industrial and economic development in HK and has changed its role from a mere institution provider to an active innovation promoter. The Innovation and Technology Commission (ITC) was established as the successor of CIT in 2000 to coordinate related policies to promote technological advancements and different kinds of innovation activities in different sectors in HK (ITC 2007a). Since 1997, the HK government has placed special focus on promoting and intensifying the linkages between universities and HK companies with regard to innovation activities. The University-Industry Collaboration Programme (UICP) has been explicitly added to the newly founded Innovation and Technology Fund (ITF) amounting to 5 billion HKD in 1999.[3] Only private companies registered in HK are eligible to apply for UICP funding. However, such companies are asked to search for adequate local universities in HK as innovation cooperation partners in advance (HKCSD 2003a). In addition, the importance of the production base of many HK manufacturing companies in the PRD for technological advances in HK has been emphasised. The aim is for companies to adequately utilise the PRD when developing applied R&D and commercialising their results (ITC 2005). Moreover, the Hong Kong Applied Science and Technology Research Institute (ASTRI) was established in 2000 to conduct applied R&D based on the research results from the universities and then to transfer the outcomes of the applied R&D to industries. ASTRI should play a role like a bridge facilitating the information and technology flows between universities and industries.[4]

According to our interviews with the senior executives from the four research groups in ASTRI, industrial participation or involvement is required for every proposed R&D project in ASTRI to ensure the industrial orientation of the R&D of ASTRI. Companies coming to ASTRI for innovation support are diverse in their size, location and working and patent arrangements with ASTRI. HK companies operating in the GPRD belong to the first target group for receiving technological help from ASTRI. Other companies operating in the PRD comprise the second target group. Only if there are still available resources, ASTRI will provide its technological support to the companies from the rest of China or even from the

[3] Since 1983, the HK dollar (HKD) has been linked to the US dollar ($) at the fixed rate of 7.8 (HKD/$), HKCSD 2008a.

[4] The Industrial Technology Research Institute in Taiwan, the Korean Advanced Institute of Science and Technology in Korea and thirteen industry-specific research institutes and centres in Singapore have been taken as reference models for the construction of the ASTRI.

other countries. Companies of different sizes work with ASTRI in different ways. Large or medium-sized companies have a relatively longer-term cooperation relationship with ASTRI so that corporate R&D can be carried out by the researchers from ASTRI and the participating companies together. In contrast, small companies tend to acquire usage rights to the patented technologies developed by ASTRI. In this case, companies normally pay less money for the technologies than if they acquire these technologies from foreign suppliers. However, companies do not obtain exclusive patent rights to the technologies they acquire, implying that they may not gain a unique competitive edge over their competitors. If companies want to obtain exclusive patents on technologies, they must take part in the costs of developing the technologies, which is more expensive than paying for common usage rights and therefore is in general not affordable for most HK SMEs. In addition, due to the low innovation capabilities of traditional electronics SMEs in the GPRD, ASTRI has to develop technologies to an almost product-ready level, so that the developed technologies can be directly applied to the production processes of transferee companies. (Own HK Survey 2007).

Although HK's economy has continuously improved since 2004, this does not mean that the magnitude of the innovation promotion by the HK government would be reduced.[5] On the contrary, according to our in-depth interview with the ITC, the HK government still regards upgrading and innovation as substantial elements for sustainable economic development in HK. The competition intensity faced by HK companies has increased strongly over time due to the emerging labour shortage problem in the PRD, the explosion of energy prices, the appreciation of the Chinese currency RMB and the unfavourable changes in Chinese economic policy against low-tech industries. Innovation activities, regardless of whether they are technological or non-technological, should, thus, be further encouraged to help HK companies efficiently cope with these challenges and further enhance their competitiveness in global markets. In addition, the HK government intends to increase indigenous innovation activities so that the strong reliance of HK companies on the high-tech machines and technologies imported from the external suppliers may be gradually reduced and the innovators in HK may obtain higher returns on their innovation investments (Own HK Survey 2007). To do so, the ITC has announced the "new strategy" in 2005, which consisted of two key initiatives. The first one was to identify the technology focus areas where innovation should be especially heavily promoted. Criteria considered for identifying focus areas

[5] The average annual growth rate of the gross domestic product (at constant price) in HK amounted to 7.3% over the period from 2004 to 2007, compared to -6% in 1998 and 3.2% on average from 1999 to 2003 (HKCSD 2008b).

included (i) existing research capabilities of universities and other research institutes, (ii) HK companies' competitive advantages, (iii) industrial needs and (iv) market potentials. Among nine technology focus areas, the following four are especially strongly related to the electronics industry: communications technologies, consumer electronics, integrated circuit design and opto-electronics.[6] The second key initiative was to set up R&D centres to conduct applied R&D and to facilitate the information and technology transfer between universities and industries.[7] In total, six R&D centres have been founded.[8] Because ASTRI's research is strongly related to the four electronics-related focus areas, the R&D centre of information and communications technologies is subsumed under ASTRI (ITC 2005).

According to our interview with the ITC, the lack of financial resources is seen as the severest impediment for HK companies to innovate, followed by deficiencies in know-how and technological capabilities and by the shortage of highly-qualified labour. To reduce the effects of these impediments and to make indigenous innovation activities more feasible for more companies in HK, the HK government has increased funding opportunities for R&D activities and strongly supports the six newly founded R&D centres, including that subsumed under ASTRI. The importance of the R&D centres for technological advancements in HK is reflected in the ITC budget structure in general and in the new three-tier funding structure of the ITF in particular.[9] Taking the ASTRI as an example, the ITC provided ASTRI 119.9 million HKD for its research operation in the budget year 2006-2007, which was approximately 25% of the ITC's total annual budget for the same budget year (ITC 2006).[10] Regarding the funding structure of the ITF, R&D centres are taken as the first tier receivers. This means that the ITF provides further support to the focus areas by financially supporting the research operation of the founded R&D centres and the innovation projects undertaken by these centres (ITC 2005). In other words, HK companies among these selected focus areas are encouraged to seek more intensive cooperation relationships with these R&D centres.

[6] See. Table 2.1 for information on the other 5 focus areas..
[7] Six universities in HK are considered. They are Chinese University of HK, City University of HK, HK Baptist University, HK Polytechnic University, HK University of Science and Technology and University of HK.
[8] R&D centres were founded for every focus area mentioned in the second reference. The sixth one is the "R&D centre of the information and communications technologies", covering the four focus areas "Communications Technologies", "Consumer Electronics", "Integrated Circuit Design" and "Opto-Electronics".
[9] The amount approved under the Innovation and Technology Support Programme amounted to about 83% of the whole ITF from its initiation to May 2008 (ITC 2008a).
[10] According to the Estimates of Expenditure of the ITC (2006/2007b/2008b), the HK government has supported/ has planned to support ASTRI's research operation via the ITC by providing financial funding amounting to 93.3 million HKD (2005-2006), 119.9 million HKD (2006-2007), 119.9 million HKD (2007-2008) and 121.4 million HKD (2008-2009), respectively. The funding increase from 2005-2006 to 2006-2007 was to support the additional assignment of ASTRI regarding the operation of the R&D centre of information and communications technologies.

Individual innovation projects belonging to the other innovative areas identified in the ITC's consultation paper (2004) but not chosen as focus areas under the "new strategy" would be promoted by the ITF as the second tier. The third tier covers the projects whose innovation outcomes can not be applied commercially immediately.

In summary, the newly active innovation policies in HK are characterised by selected sectoral focuses, more funding opportunities, the founding of R&D centres to facilitate the interaction and innovation cooperation between universities and industries and the specific consideration of the PRD as a platform for commercialising the applied R&D results. Table 2.1 summarises the main points of innovation policies in HK for the phase before and after 1997.

Table 2.1: Innovation policies in HK – an overview

Before 1997: Government as a mere institution provider

- Providing infrastructural and developmental support
- [late 80s]: new universities founded to enhance the labour qualification

After 1997: Government as an active innovation promoter

- [1998] CIT (Commission on Innovation and Technology) founded
  - Mission: clarify the role of innovation for HK's future
  - CIT report (1998; 1999): base for the active innovation policies in HK
    (1) Strengthen technological infrastructure
    (2) Promote technological entrepreneurship
    (3) Build up human capital
    (4) Enhance technological collaboration with the Mainland
    (5) Promote university-industry partnership
    (6) Lower barriers regarding information transfer, financing and regulations
- [1998] ARF (Applied Research Fund) founded
  - Funding support to technology ventures and R&D projects with commercial potential
  - Initial injection into ARF: 0.75 billion HKD ($96 million)
- [1999] ITF (Innovation and Technology Fund) founded
  - Initial injection into ITF: 5 billion HKD ($641 million)
  - 4 programs:
    (1) ITSP (Innovation and Technology Support Program)
    (2) UICP (University-Industry Collaboration Program)
    (3) GSP (General Support Program)
    (4) SERAP (Small Entrepreneur Research Assistance Program)
- [2000] ITC (Innovation and Technology Commission) founded
  - Successor for CIT
  - Mission: coordinate related policies to promote innovation
- [2000] ASTRI (Applied Science and Technology Research Institute) founded
  - Mission: facilitate information and technology flows between universities and industries
  - 4 research groups:
    (1) Communications Technologies
    (2) Enterprise and Consumer Electronics
    (3) IC Design
    (4) Material and Packaging Technologies
- [2004] Consultation paper for the "new strategy" (published by the ITC)
  - 13 focus areas (Advanced Manufacturing Technologies; **Automotive Parts and Accessory Systems; Chinese Medicine; Communications Technologies; Consumer Electronics;** Digital Entertainment; Display Technologies; **Integrated Circuit Design; Logistics/ Supply Chain Management Enabling Technologies;** Medical Diagnostics and Devices; **Nanotechnology and Advanced Materials; Opto-electronics; Textile and Clothing**)

Table 2.1 (continued): Innovation policies in HK – an overview

- [2005-] New strategies (initiated by the ITC)
  - 5 elements
    (1) Focus on key technology areas
    (2) Market relevance
    (3) Industry participation
    (4) Leverage on the Mainland: PRD as platform for developing applied R&D and commercialization of applied R&D results
    (5) Better coordination among related institutions
  - 9 of 13 focus areas (consult. paper) have been specified as technology focus **(Bold, above)**
  - 6 R&D centres founded [5 in 2006; 1 (R&D Centre of the Chinese Medicine) in 2001]
    (1) R&D centre of information and communications technologies (subsumed to the ASTRI) for technology focuses: Communications technologies, Consumer Electronics, Integrated Circuit Design and Opto-electronics
    (2) 5 R&D centre founded for the 5 remaining technology focuses
  - Newly funding structure of the ITF
    (1) 1. tier: R&D centres
    (2) 2. tier: innovation projects from the 4 focus areas without R&D centres (consult. Paper: not bold, above)
    (3) 3. tier: innovative projects with market potential but no immediate application

Source: own compilation based on information from Baark and Sharif (2006); ITC 2004/2005/2006/2007a.

3 Overall innovation activities in HK

In this section, the current state and developing trends of innovation activities in HK will be analysed, using selected official statistics. The role of the new active innovation policies for the changes in innovation activities in HK will also be examined.

3.1 Innovation input indicators

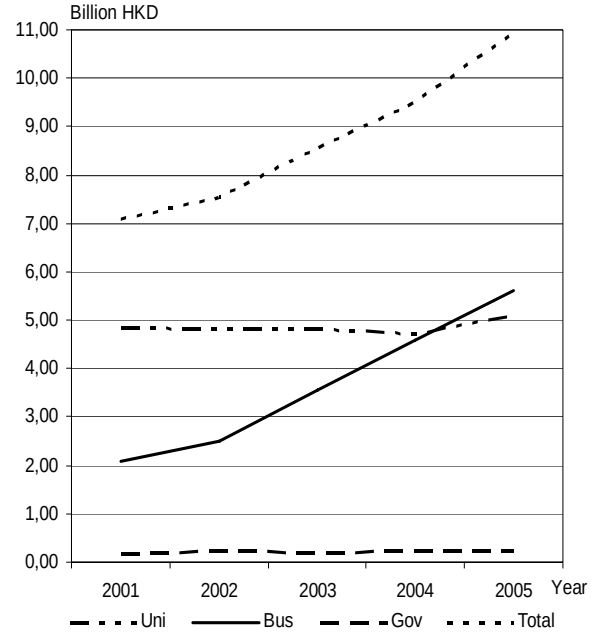
R&D expenditure

Compared with the other Newly Industrialising Economies in Asia, HK does not have a very strong R&D base (Chiu and Wong 2001, HKCSD 2007a). However, the rising R&D expenditure (GERD)[11] in HK from 5.6 (1998) over 7.1 (2001) to 10.9 billion HKD (2005, $1,397 million) indicates a remarkable increase in innovation efforts in general (Figure 3.1). The GERD-GDP ratio has risen from 0.43% (1998) over 0.55% (2001) to 0.79% (2005). Classifying GERD by the funding sectors, Figure 3.2 indicates a continuous and constant governmental financial support for innovation and upgrading after the setting-up of the ITC which is responsible for promoting overall innovation in HK (55.2% of all GERD on average). [12] However, the government sector itself, including the public technological supporting institutions, has only played a quite minor role as innovation performer with an average share of 2.3% of the GERD. Instead, the major innovation performers in HK are the local universities and the business sector, with an average share of 57% and 40% over the

[11] GERD refers to "Gross Domestic Expenditure on R&D".
[12] Statistical information on GERD differentiated by funding sector from 1998 to 2000 is not available.

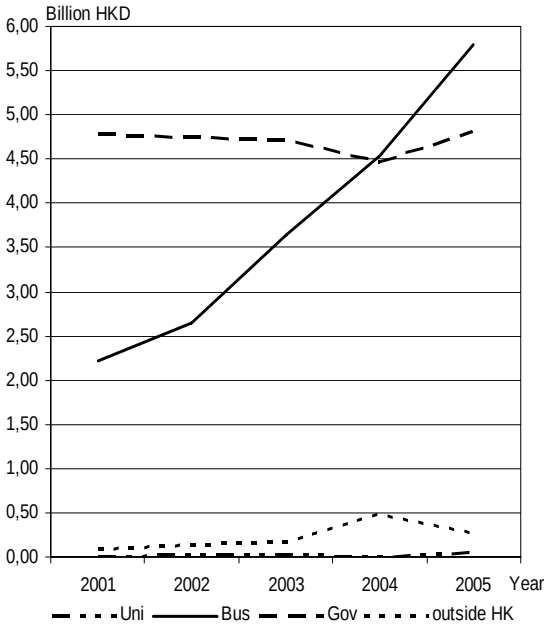
same period, respectively. Both Figures suggest that the business sector has become the main driver behind the increasing innovation efforts undertaken in HK over time. In 2005, the business sector surpassed the universities as the chief innovation performer in HK (52%) for the first time. While the innovation expenditure of the universities were mainly financed by the HK government, the corresponding strong increase in the GERD funded by the business sector from 2.2 (2001) to 5.8 billion HKD (2005, $744 million) suggests that the innovation activities of the HK business sector have been mainly self-financed (HKCSD 2007a, 2007b).

Figure 3.1: GERD by performing sectors



Data source: HKCSD 2007a, 2007b

Figure 3.2: GERD by funding sectors



Data source: HKCSD 2007a, 2007b

Innovation and Technology Fund statistics on approved projects

"The annual amount of the Innovation and Technology Fund (ITF) for approved projects" is one of the most appropriate indicators for describing the HK government's financial support for innovation over time, because ITF, which was set up in 1999, is the major public innovation funding system in HK. The amount approved has doubled from 0.32 to 0.64 billion HKD ($82 million) from 2000 to 2006 (HKCSD 2003a, 2007c).[13] 59% of the total amount approved for the period from 2000 to May 2008 (3.5 billion HKD, about $449 million) went to technology areas like "electrical and electronics" and "information technology", indicating that strong innovation attempts were undertaken in the electronics-related

[13] About 0.8 billion HKD for 2007 to May 2008. No separate data for 2007.

industries (ITC 2008a).[14] Among the four sub-programs of the ITF, the amount approved under the "University-Industry Collaboration Programme", which amounted to approximately 20% of the total amount of the ITF approved in 2000, has dropped dramatically to 5% of the total amount of the ITF approved for the whole period till May 2008 (HKCSD 2003a, ITC 2008a). This suggests a relatively low willingness or lacking capabilities of the industrial applicants to engage in cooperation relationships with local academic counterparts. This is consistent with the annual survey of innovation activities conducted by the HK Census and Statistics Department (HKCSD), which showed that companies in HK tend to cooperate with other companies, instead of cooperating with universities, especially as regards "technological innovation cooperation" (HKCSD 2001, 2003b, 2004, 2005a, 2006).[15]

Innovation expenses of companies

"Innovation expenses of companies" is selected as the third indicator so as to allow a more disaggregated analysis of the industrial innovation activities in HK. The share of innovative companies increased from 21.8% in 2002 to 42.3% in 2006 and the number of both innovative SMEs and large companies doubled.[16] In 2006 almost 99% of innovative companies undertook non-technological innovation, while just 11% undertook technological innovation.[17] Note that, as shown in Figure 3.3, only 4% of all HK SMEs undertook technological innovation in 2006, compared to the 6% in 2002, although the annual average expenditure per technologically innovative SME strongly increased from 0.25 to 0.75 million HKD ($96,154) over the same period. In contrast, the share of large companies engaging in technological innovation increased to 28% from 13%, with, however, expenditure fluctuating from 7.3 (2002) to 9.4 (2004) and down to 4.3 million HKD (2006, $0.6 million). This seems to suggest that overall constraints regarding financial sources for technological innovation exist upon HK companies. Correspondingly, as investigated by the HKCSD, "high innovation costs", "the lack of financial sources" and "excessive perceived economic risks" are deemed

[14] On average, more than 57% of the total ITF from 2000 to 2006 was spent in these two focus areas from 2000 to 2006. Other areas are "biotechnology", "Chinese medicine", "environmental technology", "manufacturing technology", "material science", "nanotechnology" and "others".

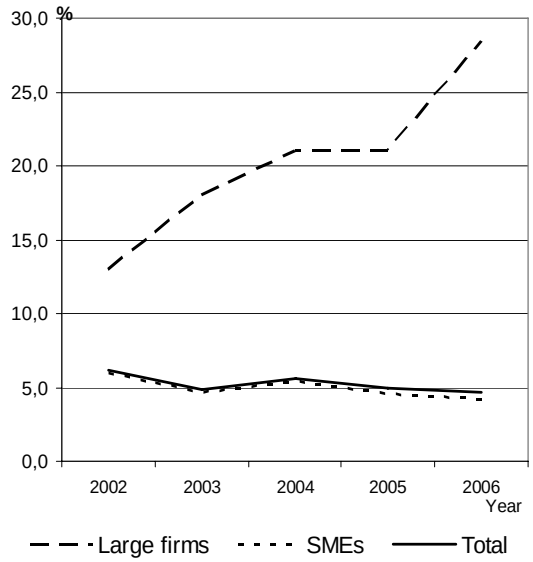
[15] Technological innovation is used to mean technologically new or significantly improved product introduced to the market or the application of technologically new or significantly improved process within a firm. (HKCSD 2006). In 2006 only 0.04% (0.5%) of HK innovative companies cooperated with public technological support institutions, including ASTRI and other R&D centres (universities) for technological innovation. About 98% HK innovative companies did not even make use of public support institutions or universities as sources of innovation-related information (HKCSD 2006).

[16] The HKCSD began conducting the "Annual Survey of Innovation Activities in the Business Sector" in 2001. However, technological innovation has been separately specified since 2002. To be consistent when analysing the innovation expenses of companies, I focus only on the information from 2002 to 2006.

[17] 10% of HK innovative SMEs, but almost 35% of large innovative companies undertook technological innovation in 2006. (HKCSD 2001, 2006).

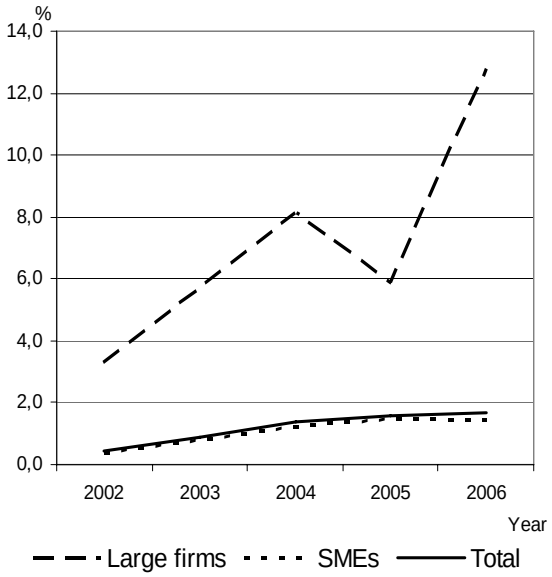
by many HK companies to be highly important factors hindering their technological innovation ((HKCSD 2001, 2003b, 2004, 2005a, 2006). Focusing on R&D activities, the share of HK SMEs with R&D rose from 0.4% to 1.4% from 2002 to 2006, and from 3% to 13% for large companies (Figure 3.4). However, the in-house R&D expenditure per company did not increase over time. A continuous decrease (from 9.4 to 4 million) can even be recognised for large companies. It is, thus, hard to argue that there has been a continuous increase in the intensity of R&D and other R&D-based indigenous innovation activities in HK.

Figure 3.3: Share of firms with technological innovation by firm size



Data source: HKCSD 2001, 2003b, 2004, 2005a, 2006

Figure 3.4: Share of firms with R&D activities by firm size



Data source: HKCSD 2001, 2003b, 2004, 2005a, 2006

3.2 Innovation output indicators

Academic research output

Innovation policies in HK strongly supporting research activities at universities are thus expected to encourage the improvement of academic research expertise. Although academic research output indeed increased from 20,886 (1998/1999) to 23,058 units (2005/2006), that per university researcher gradually decreased from 3.7 to 2.6 units annually (HKCSD 2003a, 2007a, 2007e).[18] Most of the academic research output in HK is presented as journal publications and consulting papers. Only a few of it is presented in form of patents,

[18] Note that the number of academic research output refers to a period beginning on July 1st of one particular year and ending on June 30th of the following year, while the number of university researchers refers to the end of the year. The academic research output per university researcher reached its peak (4.3 items) in 2000, after that a continuous decrease can be observed.

agreements and spin-off companies etc. (HKUGC 2007, Poon and Chan 2007).[19] This may again suggest that the relationship between universities and industries regarding research and other innovation activities is relatively weak. Note that the dominant role of "social science research (including business studies and research into humanities)" over the other three research focuses ("biology and medicine", "engineering" and "physical science") has been weakened since 2000. The share of "social science research" has decreased from 44% to 37%, while that of "engineering" has gradually increased from 23% to 26% from 2000/2001 to 2005/2006.[20] Such a gradual increase in academic research willingness or capabilities in "engineering" is suggested to be advantageous for supporting the technological progress of the electronics industry in HK.

Patent and design application

Under the Patent Ordinance, which became effective in 1997, there are standard patents and short-term patents in HK. The application procedure and the related requirements for the standard patents are much more complex than those for short-term patents.[21] 1% of the total standard patents in 1999 but about 1.3% of those in 2005 were granted to proprietors originating from HK, while in the case of short-term patents the corresponding share decreased from 54.7% to 53.2% (HKIPD 2008b, 2008c).[22] The higher technological requirements for the standard patents applied by the three designated patent offices overseas may restrict HK companies or individuals from applying for standard patents. Unlike with patents, the registration of designs, which is specific in HK, aims solely at protecting the appearance of products from illegal manufacturing, importing, or selling, etc. (HKIPD 2008d). The corresponding share here increased even more strongly from 43% in 2001 to 51% in 2005, with a total number of 2527 designs registered by registers from HK in 2005 (HKIPD 2008e).

[19] The six categories are "scholarly books, monographs and chapters", "journal publications", "conference papers", "creative and literary works, consulting reports and case studies", "patents, agreements, assignments and companies" and "other outputs".

[20] The share of research in the area of "biology and medicine" strongly increased from 22% to 27% over the same period, while that of "physical science" decreased slightly from 10.6% to 10.3%.

[21] Companies or other institutions can only complete the 2-stage application procedure and get standard patents granted in HK, if one of the three designated patent offices overseas accepts the applicants' patent applications and grants patents later on (designated patent application procedures).These three designated patent offices are the State Intellectual Property Office (China), the European Patent Office, in respect of a patent designating the United Kingdom and the United Kingdom Patent Office (HKIPD 2008a).

[22] The number of standard patents granted to proprietors originating from HK (87 of 6518 in 2005) has fluctuated over time, while that of short-term patents (223 of 416 in 2005) has relatively continuously increased. Regarding to the number of standard patents, most of them were granted to proprietors originating from USA (1991), Japan (1656) and Germany (659) in 2005. Regarding to the number of short-term patent granted, China (81) and Taiwan (44) ranked as second and third origin of the proprietors in 2005. Statistics on patents granted by the origin of proprietors are only available till 2005.

In addition to patents directly granted in HK, the patents granted to HK residents by the United States Patent and Trademark Office are also worth considering.[23] The absolute number of US patents granted to HK residents increased by about 1.4-fold from 413 to 596 from 1999 to 2005 and the corresponding share also increased from 0.24% to 0.38% over the same period (USPTO 2008). Although, in absolute term, more US patents than HK standard or short-term patents have been granted to HK residents, the increase in the US patents granted to HK residents over time has been much weaker than the increase in HK standard (3.6-fold) and short-term patents (3.5-fold). This suggests a gradual change in the patenting behaviour of HK innovators towards favouring patents granted in HK. The findings on the increasing patents (from HK as well as from the US) granted to HK residents suggest that they also seek at least some legal protection for their innovation outcomes. However, their preference for patents with lower technological requirements also suggest that their patenting efforts are rather constrained with respect to the possible benefits from applying for patents given certain technological deficits and the rapidly changing business environment.

Based on the official HK statistics, only the relatively strong increase in the innovation efforts in general but not grandiose innovation success over time can be identified. This may be attributable not only to the inherent risks of the innovation activities, several of which may fail, but also to the time lag between the initiation of innovation activities and the achievement of innovation results. In addition, interactions between universities and industries for innovation activities in HK are still relatively weak, despite several favourable political arrangements. However, it is still possible that universities and R&D centres are more relevant for companies in industries where more technological progress is required and innovation activities are especially promoted. To examine this supposition, a sector-specific questionnaire survey was conducted, focusing on the HK electronics SMEs in the GPRD.

4 Questionnaire survey on HK electronics SMEs in the GPRD

4.1 Framework

Three of the four Special Economic Zones initiated by the Chinese open-door policy in 1979 were established in the PRD, making the PRD the pioneer region in the Chinese transformation process over the past decades. It has become a fast–growing world factory for years, to which, in particular, the relocations of HK companies, including those from the

[23] I considered the US patents instead of patents from other countries, because the number of patents granted by the US Patent Office to HK residents has been much higher than the number of patents granted by other foreign patent offices (HKCSD 2005b).

electronics industry, have contributed substantially (Enright et al. 2005). To promote industrial upgrading, the HK government has also emphasised the role of the PRD, the main production base of many HK companies. In 2006, HK's gross domestic product reached 1,476 billion HKD ($189 billion), while 2,620 billion RMB ($328 billion) were produced domestically in Guangdong, of which more than 80% was produced in the PRD (GPBS 2007, HKCSD 2007d).[24] The electronics industry was selected for our sector-specific innovation research because, firstly, it is one of the focus areas of the innovation policies in HK. Secondly, the electronics industry is of substantial importance for the economies in HK and the PRD. In 2006, the gross output value of the electronics industry amounted to 41% of all industries above a designated size in Guangdong as a whole (GPBS 2007).[25] Taking the electronics industry in other regions in China into account, about 45% of the exports of electronics products (value) from China were from Guangdong in 2006, which reflects the prominent position of this research region among all the regions in China with respect to the development of the electronics industry (GPBS 2007, NBSC 2007).

Standardised questionnaires were used for this survey on the HK electronics SMEs operating in the GPRD to obtain more detailed information about their innovation activities so that possible policy-driven linkages between universities and R&D centres and industrial innovation in HK can be better identified. The relevant questions from the questionnaires are summarised in the Appendix. I focus on SMEs, because of their prevalence among all the companies registered in HK. The electronics companies interviewed were randomly selected from the company data bank of the HK Trade Development Council (TDC).[26] In the TDC data bank, 4,590 companies (Sept. 2007) are registered as electronics SMEs with operations in the PRD. Personal interviews with the companies' senior executives were conducted to finish the questionnaires; in addition, follow-up work was carried out to clarify misunderstandings. I was aware that such a survey procedure would be too time- and resource-consuming to get a large number of companies to join the survey. But only in this way, the information about companies' innovation activities obtained could be ensured to be of high quality.

[24] The average exchange rate (RMB/$) amounted to 7.98 for 2006 and 7.61 for 2007 (PBC 2006, 2007).
[25] Gross output value of industry above a designated size consists of the output value of "all state-owned enterprises" and that of "non-state-owned enterprises with an annual business revenue of over 5 million RMB". In 2006, the gross output value of industry above a designated size accounted for about 87% of the gross output value of industry for all enterprises.
[26] The TDC is an industrial association with a strong linkage to the HK government. It offers a wide range of services to facilitate the creation of opportunities in international trade for the HK-based companies, especially HK SMEs. URL: http://www.hktdc.com/.

4.2 Sample representativeness

In total, 104 questionnaires with first-hand data of high quality were finished. Constrained by the availability of data from the TDC data bank, the representativeness of the interviewed companies for the HK electronics SMEs can be examined using the following two criteria: firm size in HK, firm size in the PRD/China.[27]

Firm size in HK

Firm size is measured by the number of employees. All 104 interviewed companies were asked to indicate the number of their employees in HK at the end of 2006 (Appendix A-4). However, to comply with the public definition of the SMEs in HK, I exclude 2 companies with more than 100 employees in HK.[28] So I end up with 102 effective questionnaire surveys.[29] The number of employees indicated by the 102 companies is grouped into six categories that are consistent with the staff range categories specified in the original data bank. Table 4.1 presents the share of companies by staff range in HK for the sample and for the whole population. A chi-square test showed no significant difference between the distribution of the 102 companies interviewed with respect to their staff range in HK and that of the whole population ($p = 0.571$). This suggests the sample is representative for the whole population of HK electronics SMEs in the GPRD from the point of view of the firm size in HK.

Table 4.1: Share of firms by staff size in HK (102-company sample & whole population)

Staff number	≤ 5	6-10	11-15	16-25	26-50	51-100	Total
102-company sample	52%	27%	6%	8%	4%	3%	100%
Population (N=4468)	44%	28%	9%	9%	7%	3%	100%

Source: Own HK Survey 2007 and TDC data bank

Firm size in the PRD/China

Companies' staff ranges in the whole of mainland China are also specified in the TDC data bank. However, the companies interviewed were asked to indicate the number of their employees only in the PRD (Appendix A-4). The responding companies are, according to their employee numbers, grouped into six categories corresponding to the categories of staff range in the data bank. The shares of companies with respect to the staff range in the PRD

[27] We also asked firms to indicate their sales range in 2006. Corresponding information (annual turnover) is also available in the TDC data bank. However, less than 25% of the whole 4468 companies with indication of staff range in HK in the data bank indeed offer this information. It makes the "range of annual turnover" as another criterion less relevant for examining the representativeness of the survey sample.

[28] See, for example, HKCSD 2007e for HK's definition of SMEs.

[29] This exclusion rate (1.9%) is consistent with that in the population of all registered electronics SMEs, where the staff range of 92 of 4,560 companies (2%) is beyond the upper bound of the SME definition in HK. 30 of the 4590 electronics companies registered in TDC data bank do not indicate the staff range in HK.

(China) for the company sample (whole population) are summarised in Table 4.2. If the operations of the HK electronics SMEs concentrate mainly in the PRD but not the rest of China, the distribution of companies interviewed with respect to staff range in the PRD should be insignificantly different from that of the whole company population in the whole mainland China. However, a chi-square test rejects this supposition with a significance level of 1%. In Table 4.3 the observed number of companies with a different staff range in the PRD and the expected number of companies derived from the share of companies in the corresponding categories in the whole population are presented. It suggests that the firm size of our interviewed companies is smaller than expected under the assumption that HK electronics SMEs operate mainly in the PRD. These findings suggest that that the operations of the HK electronics SMEs may not concentrate in the PRD as strongly as expected. In contrast, they also have some operations in the other regions in China. Due to the different regions captured by the survey and the original data bank, the representativeness of the sample can not be denied just based on the abovementioned chi-square test result.

Table 4.2: Share of firms by staff size in the PRD (102-company sample) & in China (whole population)

Staff number	≤ 50	51-100	101-200	201-500	501-1000	≥ 1001	Total
102-company sample	35%	19%	10%	15%	15%	7%	100%
Population (N=4120) [1)]	9%	14%	17%	28%	17%	15%	100%

Note: 1) 348 of 4468 companies do not indicate their staff ranges in mainland China.
Source: Own HK Survey 2007 and TDC data bank

Table 4.3: Observed and expected number of firms by staff size in the PRD (102-company sample)

Staff number	≤ 50	51-100	101-200	201-500	501-1000	≥ 1001	Total
Observed number	36	19	10	15	15	7	102
Expected number	9.2	14.3	17.3	28.6	17.3	15.3	102
Residul	26.8	4.7	-7.3	-13.6	-2.3	-8.6	0

Source: Own HK Survey 2007 and TDC data bank

4.3 Results

4.3.1 Company characteristics

In addition to the distribution of HK electronics SMEs with respect to their staff range in HK as well as in the PRD mentioned in Section 4.2, the following points are also worth specifying, based on our survey results, to better characterise HK electronics SMEs: “operations begin”, “size difference across regions and years”, “ownership” and “business module”.

The year an SME ***began operations*** in HK and the year it did so in the PRD were asked separately in the questionnaires (Appendix A-3). The operations of the responding companies were started as early as in 1967 in HK, while the earliest operations in the PRD were started

16 years later. On average, companies started their operations in HK at the end of 1992, whereas they started operations in the PRD at the end of 1995 for the PRD. A dependent t-test verified the statistical significance (p = 1%) of this difference, which is compliant with the general time-frame assumption regarding the relocation of the HK companies to the PRD.

Determining the ***size differences of the companies interviewed across regions and years*** allows the relative relevance of different locations for the operations of the HK electronics SMEs to be assessed. From 2001 to 2006, the average size of the HK electronics SMEs decreased from 10.8 to 9.3 employees, while that in the PRD increased from 289.2 to 330.4 employees.[30] The corresponding t-tests cannot reject the null of the difference between the average size in HK in 2001 and that in 2006, but find significant difference between the average sizes in the PRD over time (p=0.054). This implies a gradually rising importance of the PRD relative to HK for the HK electronics SMEs, which suggests the increasing relevance of the PRD for the innovation policies in HK.

In the questionnaires, companies were also asked to sketch their ***ownership structures*** by indicating the shares owned by HK, Taiwan, Chinese mainland, foreign countries and floating shareholders (Appendix A-2). 78 of the 102 companies in our sample are 100% HK-owned. In addition, the ownership structure of 8 companies is dominated by HK (<100% but >50%). Same languages used may reduce difficulties faced by companies in obtaining information regarding funding opportunities and changes in the innovation policies in HK. In addition, social and cultural similarities may also make it easier for them to work with local academic researchers. All these factors should be advantageous for achieving the expected effects of the active innovation policies upon the innovation behaviours of our responding companies.

To examine whether industrial innovation activities can be expected to occur, companies were asked to indicate the percentage shares of sales realised by the following four ***business modules***: "manufacturing arm of parent company (MPC)", "original equipment manufacturing (OEM)", "original design manufacturing (ODM)" and "original brand

[30] Companies beginning their operations earlier than 2001 were asked to indicate the number of their employees in HK, in the PRD and elsewhere at the end of 2001. Companies beginning their operations later than 2001, but earlier than 2006, were asked to indicate the corresponding number of employees at the end of the year in which they began operations. In total, 99 effective answers of employee number in 2001, because there are 3 companies which first started in 2006.

manufacturing (OBM)" (Appendix A-1).[31] I find that sales of 15% (2%) of companies interviewed were 100% realised by using the OEM (MPC) business module, while sales of 4% (5%) of companies were 100% realised by using the OBM (ODM) business module (Table 4.4). Additionally, the OBM (ODM) business module was of non-ignorable relevance (<100% but >25%) for sales of 14% (22%) of companies interviewed. It is therefore plausible to suggest that some of the interviewed companies are rather to undertake certain (technological) innovation activities to support their product development.[32]

Table 4.4: Share of firms with respect to the sales shares realised by different business modules

Module \ Sales share	0%	1-25%	26-50%	51-99%	100%	Total
MPC (n=102)	73%	12%	7%	7%	2%	100%
OEM (n=102)	22%	17%	18%	29%	15%	100%
ODM (n=101)[1)]	40%	34%	14%	8%	5%	100%
OBM (n=101)[1)]	65%	17%	12%	2%	4%	100%

Note: 1) One company had difficulties in determining the relative shares for ODM and OBM.
Source: Own HK Survey 2007

4.3.2 Innovation strategies and innovation activities

As mentioned in Section 3, the realisation of innovation outcomes may take quite some time after starting long-term investment in innovation activities. Our survey, therefore, focuses solely on the following variables from the innovation input side to explore whether the active innovation policies strongly stimulate HK electronics SMEs to interact with R&D centres and universities more intensely and to engage more in innovation activities:[33]

- Business strategy
- Innovation types
- Sources of innovation-related information and technology
- Innovation organisation and criteria for selecting innovation partners
- Innovation locations and selecting criteria.

Business strategy

Companies' strategic orientation plays a crucial role for their overall operation. It determines the direction companies go or may go in the future and influences companies' decisions in different operational aspects. Innovation requires, in general, long-term capital investment, and innovation returns are subjected to high risks and uncertainties. It implies that innovation

[31] MPC includes the cases in which companies produce products following the product design and specifications determined by the parent company or other companies within the same enterprise group.
[32] OEM played a highly dominant role. See Baark and Sharif (2006), Berger and Lester (1997).
[33] The robustness of the survey findings is assured by using alternative tests such as sign tests, chi-square tests and kendall-tau-b tests, in addition to the wilcoxon signed rank tests and spearman-rho tests presented below.

activities may, generally, be expected in companies with innovation-friendly strategic orientations. Companies were, therefore, asked to choose, amongst six alternatives, the most appropriate description for their current strategic orientation (Appendix B-1). These six orientation alternatives can be categorised into three main groups according to their implicit likelihood to stimulate companies' innovation activities: pro-active, intermediate and re-active groups (Table 4.5). "Long-term focus on upgrading its capabilities and positions in the value chain" and "introducing new brands or new products into markets" belong to the "pro-active group", with clear reference to companies' innovation ambitions. The former alternative is selected by most of the companies (35%) and around 12% select the latter alternative. Companies with strategic orientations in the "intermediate group" are expected to have weaker innovation willingness than those with the orientations in the "pro-active group". In total, only 24% of the responding companies indicate that they have strategic orientations belonging to the "intermediate group". Slightly more companies (29%) choose "just responding to incoming orders" and "focusing on short-term business opportunities from the existing markets" ("re-active group"). These companies tend to react passively to market requirements. This keeps them rather away from long-term innovation investment. Because most of the responding companies (47%) have pro-active strategic orientations, it is to be expected that a predominant part of the HK electronics SMEs is willing to innovate.

Table 4.5: Strategic orientation

n=100[1)]	Strategic orientation	Share of firms
Pro-active	Long-term focus on upgrading	35%
	Introducing new brands or products to set new market trends	12%
Intermediate	Entering specialised markets with low competition	14%
	Following the emerging trends	10%
Re-active	Just responding to incoming orders	16%
	Oriented at short-term business opportunities in established market	13%

Note: 1) Two of 102 companies had difficulties in answering the question about the strategic orientation.
Source: Own HK Survey 2007

To cope with intensifying competition, companies can reduce their operational costs to become competitive with respect to prices or they can increase their innovation activities to create additional comparative advantages. Following their strategic orientations, companies may probably determine and apply an appropriate mix of measures related to both "cost reduction" and "innovation" in practice. HK companies traditionally rely strongly on cost reduction measures to maintain their competitiveness.[34] However, the HK innovation policies,

[34] HK companies relied strongly on relocating to developing countries, e.g. the PRD in China, to deploy cheaper production factors to maintain their price competitiveness. See, for example, Chiu and Wong 2001 and Lau and Green 2001.

which take the electronics industry as one of the focus areas to promote technological progress, and the increasing challenges facing companies in unilaterally deploying cheaper production factors to reduce operational costs may stimulate HK electronics SMEs to emphasise innovation over cost reduction more strongly than before. The survey addressed this by asking companies to evaluate the importance of "cost reduction" and "innovation" separately (Appendix B-2). A five-level scale was applied in this question, with "1" indicating very important and "5" not important. About 74.5% of the 102 responding companies evaluate "cost reduction" as a very important or important strategy, while 71.6% evaluate "innovation" as very important or important (Table 4.6). A 2-tailed wilcoxon signed rank test (WSRT) is applied to examine the distribution of the variables according to the differences between the pair of answers given by every responding company. The hypothesis of the same distribution can not be rejected ($p = 0.362$), suggesting a similar importance between innovation and cost reduction for HK electronics SMEs.

Table 4.6: Importance of cost reduction and innovation activities

n= 102	Cost reduction	Innovation activities
1 (very important)	50.0%	44.1%
2 (important)	24.5%	27.5%
3 (of normal importance)	16.7%	17.6%
4 (of little importance)	3.9%	4.9%
5 (not important)	4.9%	5.9%

Source: Own HK Survey 2007

Innovation types

To better sketch the innovation activities undertaken by the HK electronics SMEs, non-innovative companies were filtered out by asking companies directly whether they carry out innovation activities or not (Appendix B-3). 88 of 102 HK SMEs (86.27%) respond that they carry out innovation activities. The share of companies with innovation activities in our sample is much larger than that of all HK companies (42.3%) based on the official statistics indicated in Section 3. This suggests that HK electronics SMEs are more willing to undertake innovation activities than HK companies in general.

According to the Oslo Manual of the OECD, innovation refers to the implementation of a new or significantly improved product, process, marketing method or organisational method in business practices, workplace organisation or external relations. Based on this definition, innovations can be differentiated into four main types – product innovation, process innovation, marketing innovation and organisational innovation (OECD 2005). Companies with innovation activities were asked to evaluate the importance of these four innovation

types in order to determine their relative importance for the HK electronics SMEs (Appendix B-3). 77.3% of 88 innovative electronics SMEs evaluate product innovation as very important or important. In contrast, only 43.2 % of the responding companies evaluate organisational innovation as equally important. The importance of process (62.5%) and marketing innovation (58%) are ranged between product innovation and organisational innovation (Table 4.7). 1-tailed WSRTs are applied to test the significance of the distribution differences between every pair of innovation types.[35] Test results indicate the higher importance of product innovation over that of process innovation, organisational innovation and marketing innovation at the significance level of 1% for all three cases. In addition, process innovation is significantly more important than organisational innovation, while process innovation does not appear to be significantly more important than marketing innovation.

Product and process innovation are in general related to higher requirements and challenges with respect to technological and technical specifications, suggesting a greater need for R&D activities (OECD 2005). The relatively high importance of product and process innovation suggests that technological innovation is more important than non-technological innovation for the HK electronics SMEs, while technological innovation is less relevant for HK companies in general as indicated in Section 3. This may be attributable to specific focus of the HK innovation policies on the electronics industry on the one hand, and to the specific needs and market characteristics of the electronics industry on the other hand.

Table 4.7: Importance of different innovation types

n= 88	Product	Process	Organisational	Marketing
1 (very important)	52.3%	23.9%	15.9%	28.4%
2 (important)	25.0%	38.6%	27.3%	29.5%
3 (of normal importance)	14.8%	21.6%	26.1%	25.0%
4 (of little importance)	2.3%	5.7%	15.9%	4.5%
5 (not important)	5.7%	10.2%	14.8%	12.5%

Source: Own HK Survey 2007

Sources of innovation-related information and technology

To carry out innovation activities, companies either need to create innovation-related knowledge and technologies or they need to acquire such knowledge or technologies from external sources. To explore the sources of innovation-related knowledge and technologies and to better recognise the role of the universities and R&D centres in this regard, innovative companies were asked to assess the importance of eight alternative sources in total (Appendix

[35] I apply 1-tailed but not 2-tailed WSRTs here because I hypothesise that one innovation type (e.g. product innovation) is more important than the other innovation type (e.g. organisational innovation).

B-4). These alternatives can be roughly separated into 2 groups: internal and external sources. Internal sources consist of own R&D department (Own RDD), own production-related department (Own PDD), own marketing-related department (Own MKD) and hiring highly-qualified workers (HQ Workers). Both production-related and marketing-related department were considered in addition to the R&D department because of their closeness to factor and sales markets. Such closeness makes it easier for these two departments to evaluate information about current or potential market needs, facilitating the generation of innovation ideas. Externally, companies can source innovation-related knowledge and technologies from universities and R&D centres (Academia), other companies or individuals (Other Com) or by directly acquiring innovation products from other innovators (Direct Acq).[36] As presented in Table 4.8, all four internal sources are assessed by more than 50% of our responding electronics SMEs as being very important or important innovation sources. The shares of companies marking own R&D department and own marketing department as very important or important sources even amount to about 70%. In contrast, the universities and R&D centres as innovation sources are least important for HK electronics SMEs. Only 14.7% of the 88 responding companies evaluate the universities and R&D centres as very important or important sources and about 35% evaluate them as not important at all.[37] However, this is still in marked contrast to the information based on the official statistics as presented in Section 3, according to which about 0.3% of HK companies in general assessed universities and R&D centres as highly important innovation sources and 98% of HK companies did not make use of such institutions for their technological innovation in 2006. This marked contrast between HK electronics SMEs and HK companies in general suggests that universities and R&D centres as innovation sources may probably be of higher relevance and importance for the HK electronics SMEs than for average HK companies. Even though, compared to other possible innovation sources, universities and R&D centres are selected by extremely few interviewed electronics SMEs as being very important or important innovation sources.

Table 4.8: Importance of different innovation sources

n= 88	Own RDD	Own PDD	Own MKD	HQ Workers	Academia	Other Com	Direct Acq
1	39.8%	17.0%	29.5%	23.9%	4.5%	12.5%	11.4%
2	29.5%	34.1%	38.6%	34.1%	10.2%	33.0%	19.3%
3	14.8%	22.7%	19.3%	25.0%	28.4%	35.2%	36.4%
4	2.3%	11.4%	1.1%	6.8%	21.6%	6.8%	9.1%
5	13.6%	14.8%	11.4%	10.2%	35.2%	12.5%	23.9%

Source: Own HK Survey 2007

[36] The last sourcing alternative is "others". Only 5 companies ever used other sources than the 7 specified ones.
[37] Among the other 2 external sources, other companies or individuals are taken by more HK electronics SMEs as very important or important than the direct acquisition of innovation products.

Whether the relatively high importance of technological innovation can be claimed to be one of the substantial factors for the higher relevance of universities and R&D centres as sources for the electronics SMEs than for HK companies in general is tested by using spearman-rho tests on the correlation coefficients between different innovation types and universities and R&D centres as innovation sources. They show no positive significant correlation between the importance of universities and R&D centres as sources and that of product and process innovation. However, positive significant correlations are found to exist between the importance of the universities and R&D centres and that of organisational and marketing innovation, indicating that the non-technological expertise of universities and R&D centres is rather utilised by the HK electronics SMEs for their innovation activities (Table 4.9).

Table 4.9: Spearman-rho tests on correlation coefficients between different innovation types and universities and R&D centres as innovation sources

n= 88		Prod. Inno	Proc. Inno	Organi. Inno	Mkt. Inno
Universities/	Correlation	.071	.107	.314***	.159*
R&D centres	Sig. (1-tailed)	.255	.162	.001	.070

*** significant at 1% level; *significant at 10% level.
Source: Own HK Survey 2007

Comparing universities and R&D centres with the other six innovation sources, 1-tailed WSRTs indicate, however, HK electronics SMEs perceive universities and R&D centres to be of strictly lower importance for obtaining innovation-related information and technologies than the other sources (p = 1%). Against the background of the survey results, I argue that the effects of the active innovation policies to foster academia-industry relationships on the knowledge transfer from universities to companies seem to be restricted even in the electronics industry, though to a much lesser extent than indicated by the official statistics for the HK industry as a whole. The low relevance of universities and R&D centres relative to other sources may be explained in two ways, depending on whether the supply of and demand for academic technological support matches each other qualitatively.[38] Insufficient academia-industry interaction and communication may result in a qualitatively low correspondence between the technological support offered by the universities and R&D centres and the factual technological needs of the industrial innovators. In this case, the transformation of the academic technological expertise into industrial innovations is, thus, limited.

The incentive to take recourse to universities and R&D centres may be weak, if companies are able to satisfy their technological needs through other technology sources. Especially if

[38] In Section 3 we showed that quantitatively academic technological research outcomes are comparable with non-technological ones based on the official statistics.

companies engage in an OEM business module for sales, they have relatively stable long-term relationships with their partners, from where they can obtain the technological support they really need. Although our survey results suggest that sourcing innovation-related knowledge from other companies or individuals is more important if companies rely more on OEM business,[39] no significant correlation between sourcing from universities and R&D centres and different kinds of business modules can be found. Therefore, the hypothesis of voluntarily refraining from sourcing from the universities and R&D centres can not be supported by the results. The low relevance of universities and R&D centres may not be a voluntary phenomenon, but may be driven by some forcing factors. In addition to the abovementioned possible qualitative inconsistency between the support offered by universities and R&D centres and the support really needed by the HK electronics SMEs, their low innovation capability may be another forcing factor restricting them from benefiting from academic research results by exploring crucial information on their own, especially when local academic research results from the universities are mainly presented as journal publications.

Innovation organisation and criteria for selecting innovation partners

In addition to simply absorbing research results from universities and R&D centres in a one-way fashion, companies may actively cooperate with universities and R&D centres on innovation projects to benefit from their expertise. The proximity between innovation cooperation partners enables frequent interaction and communication, which, in turn, positively affects the innovation outcomes. To clarify whether HK electronics SMEs do cooperate with universities and R&D centres to make use of their research results, I, thus, concentrate on exploring the modes of innovation organisation applied by HK electronics SMEs innovating in the nearby PRD. The survey indicates that 70 of 88 HK electronics SMEs with innovation activities carry out innovation in the PRD (79.5%). Besides this, the PRD is taken by about 70% of these 70 companies as very important or important for their innovation activities (Appendix B-5).

These 70 companies were asked to evaluate the importance of four different innovation organisational modes, if they apply them (Appendix B-7) – "own R&D", "cooperation with partners", "acquisition of licenses and innovations" and "reverse engineering". "Acquisition of licenses and innovations" is the least applied innovation organisational mode for HK electronics SMEs (Only about 53% of these 70 companies), as specified in Table 4.10. The

[39] The correlation coefficient is significant at the 10% level.

financial and technical difficulties faced by most of the HK SMEs may strongly reduce their incentives to buy innovation results from other innovators, including universities and R&D centres. This implies that the transformation of academic expertise into industrial innovations may be relatively restricted if no other possible way except for buying finished innovation goods from universities and R&D centres was available. While only about 53% of these 70 companies directly acquire licenses and innovations, over 90% of these 70 companies innovate on their own and about 75% (73%) engage in reverse engineering (cooperate with innovation partners). In addition, a slightly smaller share of companies evaluates the cooperation (41.4%) as a very important or important innovation organisational mode than the reverse engineering (47.1%) or own R&D activities (48.6%).

Table 4.10: Importance of organisational modes for innovation

n= 70	Own R&D	Cooperation	Acquisition	Rev. Engineering
1 (very important)	24.3%	15.7%	5.7%	17.1%
2 (important)	24.3%	25.7%	22.9%	30.0%
3 (of normal importance)	30.0%	27.1%	21.4%	15.7%
4 (of little importance)	10.0%	4.3%	0.0%	12.9%
5 (not important)	2.9%	0.0%	2.9%	0.0%
Not applied	8.6%	27.1%	47.1%	24.3%

Source: Own HK Survey 2007

As shown in Table 4.10, 51 of 70 responding companies engage in cooperative innovation activities. Companies were asked to assess the importance of different kinds of criteria for deciding on their innovation partners (Appendix B-8). I find that most of them assess "partners' good reputation (Reputation)", "partners' expertise (Expertise)" and "good experiences in former business with partners (Bus Exp)" as very important or important. In contrast, "requirements of the Chinese laws and regulations (CN Law)", "personal or family ties (Personal)", "to get along with local workers and suppliers (Local WS)" and "to get along with public officials well (Pub Official)" do not play important roles for the HK electronics companies when choosing their innovation cooperation partners (Table 4.11).

Table 4.11: Importance of criteria on innovation partner

n=51	CN Law	Expertise	Bus Exp	Reputation	Personal	Local WS	Pub Official
1	3.9%	37.3%	35.3%	31.4%	3.9%	3.9%	3.9%
2	2.0%	29.4%	31.4%	41.2%	25.5%	23.5%	11.8%
3	15.7%	21.6%	25.5%	19.6%	29.4%	29.4%	21.6%
4	11.8%	7.8%	5.9%	3.9%	15.7%	11.8%	13.7%
5	66.7%	3.9%	2.0%	3.9%	25.5%	31.4%	49.0%

Source: Own HK Survey 2007

I apply, on the one hand, 2-tailed WSRTs for each pair of the three most important criteria to examine the pair-wise distribution differences between them. On the other hand, I apply 1-tailed WSRTs to investigate the relative importance between these three criteria and the remaining ones. The 2-tailed WSRTs indicate that distributional differences between each pair of the three most important criteria are not statistically significant, showing that it is difficult to rank the relative importance among them. However, the importance of "partners' good reputation", "partners' expertise" and "good experiences in former business" over that of the remaining four criteria is found to be statistically significant (p = 1% for all).

Because of their expertise as shown in the number of academic research output mentioned in Section 3, it seems that universities may become one of the cooperation partners for the HK electronics SMEs for innovation. However, most of the companies that use the cooperative innovation organisational mode choose their customers (66.7%) or suppliers (52.9%) as cooperation partners.[40] In contrast, only less than 10% of them cooperate with universities or R&D centres for innovation. This, in turn, implies that 7% of 70 HK electronics SMEs innovating in the PRD cooperate with universities or R&D centres for their innovation activities. Compared to the 0.5% (0.04%) for the case of overall HK innovative companies cooperating with universities (research institutes) specified in Section 3, the academia-industry innovation cooperation relationships in the electronics industry can be claimed to be more intensive. This may be attributable to the sectoral emphasis of the HK innovation policies and the establishment of ASTRI explicitly for the electronics industry. However, note again that most of the HK electronics SMEs still rely on their own R&D or reverse engineering to organise their innovation activities, and the relevance of universities and R&D centres as innovation partners is still much lower than companies' customers or suppliers.

Innovation locations and selecting criteria

The analysis above indicates a relatively low importance of universities and R&D centres as innovation sources or partners for the innovation activities of the HK electronics SMEs. Thus, it seems to suggest that the existence of universities and R&D centres may not be a substantial criterion considered by HK SMEs when deciding on concrete innovation locations. In the survey, companies innovating in the PRD were asked to assess the importance of eight criteria behind their decision to locate their innovation activities mainly in a certain city in the PRD, with "1" indicating very important and "5" not important (Appendix B-6). Criteria specified

[40] This result is consistent with results from other surveys. See, for example, FHKI 2003, 2007 and HKCSD 2001, 2003b, 2004, 2005a, 2006.

were “availability of highly qualified workers and researchers (AvaiHQ)”, ”innovation structure, e.g. universities, science parks etc. (InnoSTR)”, “proximity to companies from the same or related industries (Proximity)”, “tax exemptions and other governmental preferential treatments (PrefTRM)”, “fewer governmental interventions (FGovINT)”, “established legal system (EstabLS)”, “personal or family ties (PersTIE)” and “others”.

Because it is possible that SMEs do not make separate decisions on innovation locations but innovate directly close to their production plants, I classify the 70 innovative companies in the PRD into two groups according to the difference between their innovation and production locations. SMEs in the first group carry out innovation activities somewhere else than their production locations in the PRD (11 of 70), while the most important innovation location and the production locations of the second-group of SMEs are the same (59 of 70). In this way, I can better clarify whether different criteria were emphasised when companies make independent decisions on innovation locations. Table 4.12 presents a comparison of the results derived from the corresponding WSRTs. It shows that the importance of the 7 locational criteria is ranked in the similar way by companies with and without independent locational decisions for innovation. While the importance of “availability of highly-qualified workers and researchers” dominates that of other six criteria in the case of independent locational decisions, no significant difference between the importance of “availability of highly-qualified workers”, that of “proximity to companies from the same or related industries” and that of “few governmental regulations on innovation” can be identified for the case of dependent locational decisions. It implies that SMEs with independent locational decisions focus more on the criteria strongly related to innovation activities, while companies with the same innovation and production locations indeed take more criteria into account at the same time.

Table 4.12: Importance ranking of criteria for innovation locations (3 classes)

	Innovation location ≠ Production location	Innovation location = Production locoation
1. Class	- Availability of highly qualified workers	- Availability of highly-qualified workers - Proximity to firms of same/related industries - Few governmental regulations on innovation
2. Class	- Innovation structure - Proximity to firms of same/related industries - Few governmental regulations on innovation - Well-established legal system	- Innovation structure - Well-established legal system - Tax exemption and other governmental prefe-rential treatments
3. Class	- Tax exemption and other governmental prefe-rential treatments - Personal and family ties	- Personal and family ties

Source: Own HK Survey 2007

Despite similar importance ranking among all the criteria considered, some different distributions of corresponding companies with respect to different locational criteria can be identified. Table 4.13 shows that the availability of highly-qualified workers or researchers is taken as very important or important by most of the responding companies for all three cases.

Table 4.13: Importance of criteria on innovation location (share of total firms in corresponding category)

	Inno≠Pro n=11	Inno=Pro n=59	Total n=70		Inno≠Pro n=11	Inno=Pro n=59	Total n=70
AvaiHQ				InnoSTR			
1	36.4%	22.0%	24.3%	1	0.0%	8.5%	7.1%
2	54.5%	23.7%	28.6%	2	63.6%	11.9%	20.0%
3	9.1%	28.8%	25.7%	3	18.2%	25.4%	24.3%
4	0.0%	13.6%	11.4%	4	9.1%	22.0%	20.0%
5	0.0%	11.9%	10.0%	5	9.1%	32.2%	28.6%
Proximity				PrefTRM			
1	9.1%	11.9%	11.4%	1	0.0%	8.5%	7.1%
2	45.5%	28.8%	31.4%	2	9.1%	11.9%	11.4%
3	27.3%	28.8%	28.6%	3	36.4%	16.9%	20.0%
4	0.0%	10.2%	8.6%	4	36.4%	25.4%	27.1%
5	18.2%	20.3%	20.0%	5	18.2%	37.3%	34.3%
FGovINT				EstabLS			
1	0.0%	16.9%	14.3%	1	27.3%	11.9%	14.3%
2	27.3%	16.9%	18.6%	2	9.1%	10.2%	10.0%
3	45.5%	27.1%	30.0%	3	27.3%	25.4%	25.7%
4	27.3%	18.6%	20.0%	4	27.3%	27.1%	27.1%
5	0.0%	20.3%	17.1%	5	9.1%	25.4%	22.9%
PersTIE							
1	0.0%	3.4%	2.9%				
2	0.0%	6.8%	5.7%				
3	36.4%	20.3%	22.9%				
4	27.3%	13.6%	15.7%				
5	36.4%	55.9%	52.9%				

Source: Own HK Survey 2007

However, in case the of independent locational decisions, more than 90% of the companies assign such importance level to the availability of highly qualified workers, while the share of companies in the case of dependent locational decisions amounts only to 45%. In addition to the availability of highly qualified workers, the following criteria – innovation structure, proximity to companies from the same or related industries, fewer governmental regulations on innovation and well-established legal systems, are also assessed as having higher importance by most of the companies in the case of independent locational decisions than in the case of dependent locational decisions. Regarding innovation structure, e.g. universities and science parks, although no company with independent locational decisions considers this criterion as being very important, more than 60% of them consider it important, relative to 9% (very important) and 12% (important) for the case of dependent locational decisions. This

seems to indicate that the existence of universities and R&D centres may indeed play an important role for companies' decisions on innovation location, which, however, would be strongly underestimated, if the importance assessments of companies with the same locations for innovation and production are not separately analysed. The differences between the relevance of universities and R&D centres for innovation location and that for sourcing innovation-related knowledge and technologies and innovation cooperation may be attributable to the other functions of universities and R&D centres such as teaching and training students and researchers in addition to academic research activities. Because of the substantial importance of highly-qualified workers for innovation, the existence of universities and R&D centres as training bases for highly-qualified labour is also emphasised.

5 Conclusion

Since 1997 the HK government has markedly changed its role from being a mere institution provider to being an active innovation promoter. Its newly active innovation policies concentrate especially on establishing several R&D centres to facilitate information flows and further the innovation cooperation between universities and industries. To examine whether the innovation policies favouring more academia-industry innovation interactions and cooperation may positively affect innovation intensity in HK, I analysed, on the one hand, the official statistics to characterise the overall innovation activities in HK. On the other hand, I deepened the research on the innovation activities of the electronics industry, which has been determined by the HK government as one of the focus areas of the active innovation policies, by conducting in-depth interviews with the ITC and ASTRI as well as by conducing the questionnaire survey of the HK electronics SMEs operating in the GPRD. In total, 104 questionnaires with first-hand data of high quality were finished. The survey sample is representative for the HK electronics SMEs according to a chi-square test based on the staff range in HK.

Official statistics and our own survey results indicate that innovation activities are gaining great importance for HK companies in general and for HK electronics SMEs in particular. These findings seem to suggest that active innovation policies do strengthen companies' incentives to engage in different kinds of innovation activities. The survey results also suggest, however, that universities and R&D centres do not play important roles as innovation sources or active innovation partners for HK electronics SMEs. This suggests that the positive impacts of universities and R&D centres on industrial innovation realised through companies' acquisition of research results from universities and R&D centres or through directly

cooperating with universities and R&D centres may actually be limited for HK electronics SMEs. Rather, the main way through which universities and R&D centres support HK electronics SMEs' industrial innovation activities seems to be the provision of a highly-qualified labour-force that serves as transmitters of academic knowledge to companies. This finding indicates that the role of the universities and R&D centres for industrial innovation should not be restricted to their roles as direct innovation sources or innovation partners. Their real importance for industrial innovation in HK seems to lie in the education and training of a highly-qualified labour-force, which should be given greater attention in determining future innovation policies.

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Appendix

Company Survey Hong Kong 2007 (Relevant part)

A. Company characteristics

1. **Please indicate the share of your company's sales in 2006 according to the following categories.**

   ____% **Manufacturing arm of parent company**: products manufactured by your company according to design specifications provided by parent company or associate in the corporate group

   ____% **Original equipment manufacturing (OEM)**: products manufactured by your company according to design specifications provided by buyers

   ____% **Original design manufacturing (ODM)**: products developed and designed by your company according to performance requirements of buyers

   ____% **Original brand manufacturing (OBM)**: products developed and designed by your company and sold under your own brand

2. **What is the ownership structure of your company in Hong Kong?**

   _____% Hong Kong
   _____% Taiwan
   _____% Chinese owned
   _____% foreign (incl. Macau) ➔ Nationality of main foreign owner: _____
   _____% free floating shareholders

3. **In what year did your company start its operations in HK and PRD?** ***Please see map***

   HK _____ PRD _____

4. **How many employees were/are employed in your company in total?**

   31/12/2001: HK_____ PRD_____ Other_____
   31/12/2006: HK_____ PRD_____ Other_____
   Next 5 years: HK + 0 - PRD + 0 - Other + 0 -

B. Innovation strategies and innovation activities

1. **Which statement is most suitable to describe the strategic orientation of your company? Your company….**

   ❑ is oriented towards short-term business opportunities in established markets
   ❑ has a long-term focus on upgrading its capabilities and position in the value chain
   ❑ just responds to incoming orders
   ❑ follows emerging trends
   ❑ is introducing new brands or products to set new market trends
   ❑ tries to enter specialised markets with low degree of competition

2. **How important are the two following strategies for your company?** (1 - very important, 5 - not important)

   1 2 3 4 5 Cost reduction
   1 2 3 4 5 Increase innovation activities

3. **Does your company carry out any innovation activities? How important are the following innovation activities for your company?** (1 – very important; 5 – not important)

   ❑ The company does not carry out any innovation activities ➔ *go to Q39*

   1 2 3 4 5 Product innovation
   1 2 3 4 5 Process innovation
   1 2 3 4 5 Organisational innovation
   1 2 3 4 5 Marketing innovation

4. **How important are the following sources for your company to obtain innovation-related technology and know-how?** (1 - very important, 5 - not important)

1 2 3 4 5 Own R&D department
1 2 3 4 5 Own Production-related departments
1 2 3 4 5 Own Marketing-related departments
1 2 3 4 5 Universities or research institutes
1 2 3 4 5 Other companies or individuals (e.g. competitors, suppliers, customers)
1 2 3 4 5 Buying existing products or technologies
1 2 3 4 5 Hiring of highly-qualified employees
1 2 3 4 5 Other sources: _____

5. **a) How important is PRD for your company's innovation activities?** (1 – very important, 5 – not important)

❑ No innovation activities in PRD → *Go to Q39*.

Importance of PRD: 1 2 3 4 5

b) Which city in PRD is the most important innovation location for your company? ____

6. **How important are the following criteria for your company to perform its innovation activities in this city in PRD?** (1 - very important, 5 - not important)

1 2 3 4 5 Qualified labour and/or researchers
1 2 3 4 5 Innovation structure (e.g. universities, science parks, venture capital companies)
1 2 3 4 5 Proximity to other companies in the same or related sectors
1 2 3 4 5 Tax exemptions or preferential treatments from local government
1 2 3 4 5 Few governmental regulations or rules on innovation activities
1 2 3 4 5 Well-established legal systems
1 2 3 4 5 Personal and/or family ties
1 2 3 4 5 Others:_____

7. **Does your company apply the following forms to organise its innovation activities in PRD? If yes, how important are they?** (1 - very important, 5 - not important, 0 – not applied)

1 2 3 4 5 - 0 Acquisition of licenses and/or innovations
1 2 3 4 5 - 0 Reverse engineering
1 2 3 4 5 - 0 Own R&D and innovation activities
1 2 3 4 5 - 0 * Cooperation with partners

** If not applied → skip Q38; if applied,* **Who are partners?**

☐Universities/Research institutes ☐Suppliers
☐Customers ☐Others:_____

8. **How important are the following reasons for your company to choose its partners for innovation activities in PRD?** (1 - very important, 5 - not important)

1 2 3 4 5 Required by Chinese laws or regulations
1 2 3 4 5 Expertise of the partners
1 2 3 4 5 Good experiences in former business
1 2 3 4 5 Good reputation of the partners
1 2 3 4 5 Existence of personal relationships
1 2 3 4 5 Get along with local workers/suppliers well
1 2 3 4 5 Get along with public officials well
1 2 3 4 5 Others:_____