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INNOVATION & HIGHER EDUCATION:

A Comparative Study of Five Asian Societies

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Introduction

The rise of the knowledge economy has generated new global infrastructures with information technology playing an increasingly important role in the global economy. The popularity and prominence of information technology not only changes the nature of knowledge but also restructures higher education, research and learning. It is in such a wider policy context that an increasing number of institutions of higher learning are being established with new missions and innovative configurations of training, serving populations that previously had little access to higher education. Apart from accommodating a larger number of students, higher education institutions are under pressures not only to perform outstandingly in terms of research and teaching but also in entrepreneurial activities through promoting the third mission of the university, namely, economic and social development. The new mission opens up lots of opportunities for universities to establish linkages with the industry sector, particularly through the setting up of university spin-off companies, conducting licensing activities and contract research, providing consulting services, and exploring graduate and researcher mobility between the two sectors (Wright et al, 2008).

In recent decades, the growing influences of globalization have significantly transformed the university sector across different parts of the globe. Universities, nowadays, are driven to become more entrepreneurial and enterprising not only for income generation but also for enhancing the national competitiveness in innovation, research development and technological advancement in order to benchmark favourably in international ranking exercises like the global university leagues and EPU study. Hence, we have witnessed significant transformations and governance changes taken place in many university systems across the globe with restructuring along the line of “marketization”, “corporatization”, “privatization” and “commercialization” (Mok, 2006). Universities’ quest for becoming entrepreneurial has inevitably changed the role of the university sector and its relationship with the state, the market and the industry, especially when universities are becoming more proactive in promoting innovation, economic development and academic entrepreneurship (Mok, 2005). A Triple Helix network system has evolved which ‘opens a window on a universe of discourse that generates a set of coordinates transcending the points of reference of discourses that previously took place within separate institutional spheres” (Leydesdorff and Etzkowitz, 2001, p.4).

This report aims at critically reviewing major policies and strategies adopted by the selected East Asian economies in fostering and advancing innovational mindset, research and entrepreneurship, particularly with a focus on the role of higher education in promotion of innovation. We have selected five cases for review, including Hong Kong, Taiwan, South Korea, Singapore and Japan, with particular reference to examine the interactions among the state, the universities/research institutes, and the industrial/business sector in promoting innovation.

The first part of this report will briefly outline the past and present of the National Innovation System (NIS) of all the selected cases, followed by a discussion on recent reform or development of their higher education sectors respectively. As for the second part of this report, emphasis will be given to the role of higher education in innovation from a comparative perspective. The discussion would subsequently be followed by an assessment that attempt to draw lessons from these comparable East Asian cases which are both similar and dissimilar in many aspects.

Triple Helix Network System in Promoting Entrepreneurship: *An Overview of National Innovation Systems in Asia*

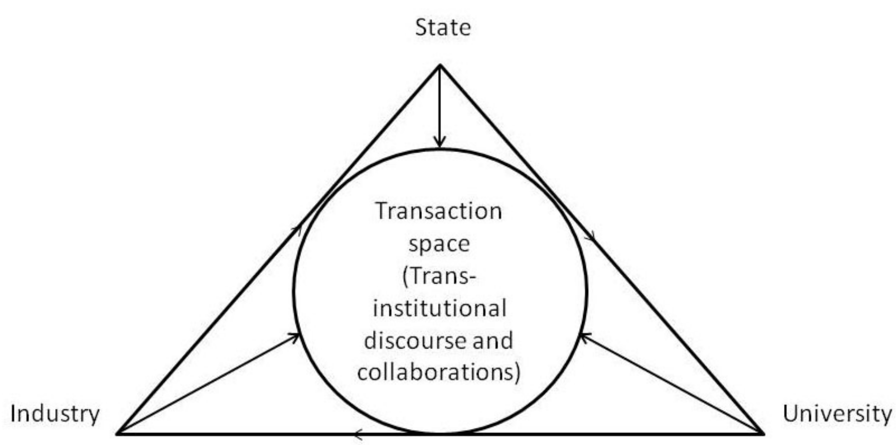
Attaching far more weight to entrepreneurial efficiency and effectiveness, contemporary universities are under immense pressures to transform their roles to adapt to rapid socio-economic and socio-political changes. Besides the repositioning of the universities' visions and missions, university staffs also have to adjust their roles in the university bureaucracy. As Slaughter and Lesile (1997: 9) described that under the emerging trend of "academic capitalism", "…faculty and professional staff extend their human capital stocks increasingly in competitive situations…[that] university employees are employed simultaneously by the public sector and are increasingly autonomous from it. They are academics who act as capitalists from within the public sector; they are state-subsidized entrepreneurs". These developments are particularly true when universities have to explore and diversify the sources of funding since modern governments have encountered reduced financial capacity to continue financing growing demands for higher education, particularly against the current global economic crisis context.

It is against the socio-economic context discussed above that the processes of academic capitalization in general and the pursuit of academic entrepreneurship in particular has become increasingly popular in shaping the relationship between government, university, business and industry. Therefore, new "university-academic-productive sector relations" have emerged (Sutz, 1997). Notions such as "corporate academic convergence" (Currie and Newson, 1998), "entrepreneurial universities" (Marginson, 2000), "campus inc." (White and Hauck, 2000), "capitalization of knowledge", "Strong executive control" and "corporate characters" are used to conceptualize current changes in contemporary universities (Etzkowitz and Leydesdorff, 1997). In the context of reduced financial support from the state, higher education systems across different parts of the world have attempted to generate incomes through entrepreneurial activities (see, for example, Marginson and Considine, 2000; Mok, 2003, 2004). It is, therefore, not surprising that "the language of human capital dominates official policy recommendations dealing with growing economic and social problems" (Spring, 1998, p.163).

Innovations play an increasingly important role as a driving force for economic growth and hence many developing countries in East Asia have taken research and development more seriously, especially when governments in the region have realized the national competitiveness is no longer dependent upon cheap labour for manufacturing sector (Brokel and Binder, 2009). Recognizing innovation and creativity is the lifeblood in the knowledge-based economy, promotion of innovation and knowledge transfer is becoming increasingly popular among the Asian countries. It is against this context that universities are encouraged to move beyond the ivory tower to reach out to the industry, business and community to develop new synergy for promoting innovation and entrepreneurship (OECD, 2008).

When examining the promotion of entrepreneurship and innovation enhancement in East Asia, this project draws on Leydesdorff and Etzkowitz's (2001) **Triple Helix Model** of interactive spirals between the government, the university sector, and the industry and business sector to promote economic and academic entrepreneurship (see Figure 1).

Figure 1. Three Major Driving Forces for Innovation



Source: Drawn by the author

Overall speaking, comparing the role of the government with the industry and university in innovation promotion, we have discovered the government has played a very significant leading role in driving the agenda of innovation promotion in Asia. Our comparative cases clearly show us the governments in Singapore, South Korea Taiwan and Japan having been steering the development of research and development and promotion of innovation, especially during the inception phase, while the role of the industry has then become increasingly important and active against the policy context of strong government support. Among all the selected case studies, only Hong Kong is the exception since the government in Hong Kong before and after the changeover has maintained a governance philosophy of ‘positive non-interventionist’ government. Upholding a free market economy approach, the Hong Kong government has the least ‘intervention’/ motivation in the promotion of technology and innovation among the selected Asian economies. The following part reviews the national innovation systems (NIS) in selected Asian countries.

Hong Kong

Before the Asian financial crisis started in 1997, Hong Kong has successfully relied upon “four traditional economic pillars”, including financial services, trade & logistics, tourism, and professional & other producer services. Yet these industries are facing ever-mounting challenges from regional competitors like Shenzhen, Shanghai and Singapore in recent years. Hence, there has long been a call for economic restructuring in the society, searching for new drives to sustain the economic development. The strive for a knowledge economy has become even more acute after the 1997 handover and the Asian Financial Crisis in 1997-98, when Hong Kong’s finance-centered economy was put into doubt.

According to the Global Competitiveness Index, Hong Kong’s ranking remains quite stable in recent years: 10th in 2006/07, 12th in 2007/08, and 11th in 2008/09. As for the World Bank’s Knowledge Economy Index, Hong Kong was set on 23rd in 1995 and 26th in 2008. Yet when it comes to actual results, the number of US patents acquired by Hong Kong for the past five years has increased mildly. However, the number is still substantially lower than its competitors, e.g. Taiwan. Taking 2008 as example, Taiwan has been issued 6339 US utility patents and 1423 US design patents respectively; while Hong Kong could only acquire 311 and 405 respectively, accounting only 4.9% and 28.5% of that of Taiwan’s (see Table 1).

Table 1. Number of US Patents from Hong Kong

	2004	2005	2006	2007	2008
Utility Patent	311	283	308	338	311
Design Patent	329	311	445	418	405

Source: US Patent and Trademark Office.
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_dsn.htm
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

In fact, during the colonial period, the Hong Kong government had put little emphasis on industrial development than on service/financial industry. As Tsui-Auch

(1998) points out, this was due to the fact that its expenditure was restricted by fiscal conservatism adopted by the British rulers. The core establishment came from banking and service sectors instead of industrial sector; while businessmen and bankers were reluctant to engage in long-term industrial investment in face of the return of Hong Kong's sovereignty to China. Thus before the 1990s, Hong Kong government's role regarding the industrial development was mainly as a provider of infrastructure (e.g. support of industrial land, trained manpower, transport & communications, water, electricity, fuels & raw materials, financial & business services) and a facilitator (e.g. supply of technical information & advice, laboratory & bureau services that help entrepreneurs to enhance their productivity, quality and innovation) (Yeh & Ng, 1994: 460). At that time, R&D linkages among manufacturers, governmental supportive organizations and HEIs were underdeveloped (Leung & Wu, 1994). It was until recent years that the government has started to develop strategies in supporting industrial innovation.[1]

Hong Kong's innovation system has been expanded over the past few years. In terms of research capacity, R&D personnel from the three sectors of business, higher education and government have all been increased, though to various degrees. From 2003 to 2007, the business sector's share of R&D personnel increased significantly from 44% to 54%, while the HE's share decreased from 53% to 44%. The government' share remains at a low rate of around 2% during this period. Overall, the demand for R&D personnel is expected to increase since Hong Kong has declared its interest in S&T development (see Table 2).

Table 2. Number of R&D Personnel, Hong Kong (2003-2007)

	2003	2004	2005	2006	2007
Business	7,452 (44%)	9,482 (50%)	12,184 (55%)	12,681 (55%)	12,673 (54%)
Higher Education	8,995 (53%)	9,010 (48%)	9,502 (43%)	9,863 (43%)	10,491 (44%)
Government	417 (3%)	353 (2%)	368 (2%)	433 (2%)	480 (2%)
Total	16,864 (100%)	18,845 (100%)	22,054 (100%)	22,977 (100%)	23,644 (100%)

Source: Census and Statistics Department. 2009. *Hong Kong Monthly Digest of Statistics*: Statistics on Research and Development of Hong Kong, 2003 to 2007.
http://www.statistics.gov.hk/publication/feature_article/B70905FA2009XXXXB0100.pdf

[1] For example, in the 2008/09 Policy Address, the Chief Executive declared an increase of financial and infrastructural support for Hong Kong's technological development (Hong Kong SAR Government, 2008: 9). In the same year's Budget, the Financial Secretary also emphasized the importance of the use of technology towards the goal of high value-added and knowledge-based economy (Hong Kong SAR Government, 2009: 26).

More specifically, since the majority of establishments in Hong Kong are small and medium-sized enterprises, their needs should be core to the government's innovative policies. Hence Hong Kong government has set up various research funds for the SMEs to apply:

Table 3. Statistics of Approved Projects, Innovation & Technology Fund, Hong Kong (as at 30th November 2009)

Program	Approved Projects	Funds Approved (HK$ Million)	Funds Approved (US $ Million)
Innovation & Technology Support Program	861	4,094.2	524.9
General Support Program	427	188.6	24.2
University-Industry Collaboration Program	182	198.6	25.5
Small Entrepreneur Research Assistance Program	311	331.5	42.5
Total	1,781	4,813.0	617.1

Source: Innovation & Technology Fund, Innovation & Technology Commission, HKSAR. http://www.itf.gov.hk/eng/statistics/viewStat101.asp

Note: The currency exchange rate is about US$ 1 to HK$ 7.8.

Moreover, the government has continued to enhance its support for these programs (see Table 3). Taking the Small Entrepreneur Research Assistance Program as example, in 2007, it relaxed the eligibility of applicants from companies of less than 20 employees to less than 100, so that the Program could cover up to 99% of the establishments in Hong Kong. Secondly, to enable a smooth research and product development process, the Program would be modified from a two-phase system into a single-phase one, so that companies did not have to terminate their work during the gap between two phases. Thirdly, recognizing that products derived from this program may easily be outdated in a couple of years in this fast-changing world, it has decided not to fully recoup the revenues generated, instead introducing a six-year cut-off period for the recoupment (Legislative Council Panel on Commerce & Industry, 2007). And finally, in 2009, it has also increased the matching fund for SMEs under this program from HK$2 million to HK$4 million per project.[2]

In response to the growing challenges from the unstable global financial and economic environment, the Government of the Hong Kong Special Administrative Region (HKSAR) has made attempts to restructure its economy, knowing that depending on the traditional economic pillars would not sustain the economic

2 http://www.itc.gov.hk/en/sme/

development of the city-state. Most recently, the Chief Executive of the HKSAR outlined the plans of the government to develop six new industries — education services, medical services, testing and certification services, environmental industries, innovation and technology, and cultural and creative industries. Despite the fact that the Government of the HKSAR seems to take technology and innovation more serious, we have not seen a fundamental shift in the policy orientation. The Chief Executive stated in his policy address that: ‘The Government will allocate about $200 million to launch an “R&D Cash Rebate Scheme”, under which enterprises conducting applied R&D projects with the support of the Innovation and Technology Fund or in partnership with local designated research institutions will enjoy a cash rebate equivalent to 10% of their investments’ (Policy Address 2010, The Government of the HKSAR, 2009). In this regard, the government still maintains as a facilitator and enabler for promotion of innovation and technology, leaving the industry and the university to decide what to do instead of performing a strong leading role in directing R & D development in the city-state. Analyzing the Hong Kong case in the light of the Triple Helix Model, the promotion and development of innovation and technology in Hong Kong is more market-driven and firm-led.

Taiwan

Comparing to other Asian economies, Taiwan is one of the strongest R&D promoters in East Asia; it has been internationally renowned for its electronic and computer goods. Its semiconductor industry was particularly praised as the “Silicon Valley of the East” (Mathews, 1997). Since the commencement of its industrialization in the 1960s, Taiwanese government has actively pushed for the development of industry, based on the presumption that industrial and technological latecomers like Taiwan urgently entail the state’s solid support to jumpstart and secure the development process.

In the midst of Asian Financial Crisis in 1997/1998, Taiwan stated explicitly to develop itself into a “technologically advanced nation”. On April 2 1998, the Executive Yuan of Taiwan proposed the “Action Plan for Building a Technologically Advanced Nation” (Executive Yuen, 1998). The Plan stated that S&T development in Taiwan means to (1) raise the standards of S&T as a whole; (2) promote economic development; (3) raise the standard of living; and (4) establish an autonomous national defense capability. Accordingly, the government is very eager to make Taiwan into an “academic research and knowledge creation hub in Asia-Pacific region” (National Science Council 2003: 14).

Taiwan’s technological and innovative capacities have long been internationally recognized ever since its efforts of industrial upgrading in the 1970s-80s. One of the prominent indicators is that the number of US patents that Taiwan acquired increases steadily each year (see Table 4). Although Taiwan's ranking in the Global Competitiveness Index falls on a declining trend from 13th in 2006/07 to 14th in 2007/08 and to 17th in 2008/09, its ranking in the World Bank's Knowledge Economy Index has nevertheless jumped from 24th in 1995 to 17th in 2008, which was ahead of Japan, Hong Kong, Singapore, China and Malaysia. Furthermore, its Innovation Index was ranked 10th in 2008.

Table 4. Number of US Patents from Taiwan

Year	2004	2005	2006	2007	2008
Utility Patent	5938	5118	6361	6128	6339
Design Patent	1268	870	1553	1355	1423

Source: US Patent and Trademark Office.
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_dsn.htm;
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

As a technology latecomer as compared to the developed western countries, Taiwanese government ceaselessly plays a great role in jumpstarting and initiating R&D activities, as well as cultivating enabling environment. This effort started as early as the 1960s, for example duty free policy for the production and exportation concerned. A dozen of industrial estates were also built by the government to accommodate more labors. In addition to these was the low wages of Taiwanese labors. All these have created a favorable environment for foreign direct investment (FDI) (Cheng, 2001). Not only that, right from the very outset of industrialization, the government has dabbled in R&D activities directly; the National Science Council (NSC) and the Industrial Technology Research Institute (ITRI, the most important public research institute) are two of the most important responsible bodies. NSC was established in 1959 as a branch of the Executive Yuan, playing the role of the Ministry of S&T in Taiwan. [3] Under its supervision, science parks like the Hsinchu Science-Based Industrial Park, which was established in 1980, has achieved a world-class status.

In terms of governance, inspired by the US's Bayh-Dole Act and the UK's Patent Law in the 1990s, Taiwanese government enacted the **Fundamental Science and Technology Act** in 1999 to lay down broad principles and future directions for S&T development. The Act stipulates that the government should issue the **National S&T Development Plan** and the **White Paper on S&T** periodically to document the progress of S&T development in Taiwan.[4]

[3] NSC website: http://web1.nsc.gov.tw/ct.aspx?xItem=9205&CtNode=995&mp=7

[4] As required by the Act, the Taiwanese government has released the *National Science and Technology Development Plan (2001-2004)* and *National Science and Technology Development Plan (2005-2008)*; both of them are four-year development plans that outline the missions, strategies and specific measure of technological and innovation policies. In order to better monitor and evaluate the execution and

Taiwan's NIS has consequently benefited greatly from all these measures. For research input, as noted in Table 5, the amount of R&D expenditure and its share of GDP have risen modestly over the years, indicating Taiwan's ever-increasing emphasis on R&D activities. In terms of the distribution of R&D expenditures by type of research, experimental development research remains the top kind of Taiwan's R&D activities, indicating that its strength is on product development (see Table 6). In recent years, Taiwan's research capacity has also been strengthened with the increase of R&D personnel; a majority of them were recruited by business enterprises, followed by the government and HEIs (see Table 7).

Table 5. R&D Expenditure (US$ Million) by Sector, Taiwan (2003-2007)

	Total Expenditure	Business Enterprise	Government	Higher Education	Private Non-Profit	As share of GDP (%)
2003	7,591.9 (100%)	4,769.2 (62.8%)	1,872.8 (24.7%)	902.8 (11.9%)	47.2 (0.6%)	2.31
2004	8,227.2 (100%)	5,321.7 (64.7%)	1,910.8 (23.2%)	948.4 (11.5%)	46.4 (0.6%)	2.38
2005	8,780.6 (100%)	5,887.2 (67.0%)	1,848.2 (21.0%)	1,002.9 (11.4%)	42.3 (0.5%)	2.45
2006	9,594.9 (100%)	6,476.2 (67.5%)	1,905.2 (19.9%)	1,173.9 (12.2%)	39.7 (0.4%)	2.58
2007	10,355.8 (100%)	7160.2 (69.1%)	1,895.1 (18.3%)	1,262.5 (12.2%)	38.1 (0.4%)	2.62

Source: National Science Council. 2008. *Indicators of Science and Technology 2008*.
http://www.nsc.gov.tw/tech/pub_data_main.asp
Note: The currency exchange rate is about US$ 1 to NT$ 32.

Table 6. R&D Expenditure (US$ Million) by Type of R&D, Taiwan (2003-2007)

	Basic Research	Applied Research	Experimental Development
2003	890.8 (11.7%)	2,001.9 (26.4%)	4,699.2 (61.9%)
2004	926.0	2,084.2	5,217.1

feedback of programs outlined by the Plan, the government also released the *White Paper on Science and Technology (2003-2006)* and *White Paper on Science and Technology (2007-2010)* respectively. Therefore, the White Paper can be conceived as the mid-term progress report of the Plan.

	(11.3%)	(25.3%)	(63.4%)
2005	905.0 (10.3%)	2,319.3 (26.4%)	5,556.3 (63.3%)
2006	975.9 (10.2%)	2,539.7 (26.5%)	6,079.3 (63.4%)
2007	1,037.2 (10.0%)	2,660.1 (25.7%)	6,658.6 (64.3%)

Source: National Science Council. 2008. *Indicators of Science and Technology 2008*. http://www.nsc.gov.tw/tech/pub_data_main.asp.
Note: The currency exchange rate is about US$ 1 to NT$ 32.

Table 7. Number of R&D Personnel by Sector, Taiwan (2003-2007)

	Total	Business Enterprise	Government	Higher Education	Private Non-Profit
2003	127,628 (100%)	80,525 (63.1%)	24,449 (19.2%)	21,643 (17.0%)	1,011 (0.8%)
2004	138,604 (100%)	89,882 (64.8%)	24,674 (17.8%)	23,017 (16.6%)	1,031 (0.7%)
2005	149,153 (100%)	96,714 (64.8%)	25,673 (17.2%)	25,752 (17.3%)	1,014 (0.7%)
2006	160,303 (100%)	106,262 (65.9%)	25,673 (17.2%)	27,439 (17.0%)	929 (0.6%)
2007	175,742 (100%)	118,005 (67.1%)	27,409 (15.6%)	29,351 (16.7%)	977 (0.6%)

Source: National Science Council. 2008. *Indicators of Science and Technology 2008*. http://www.nsc.gov.tw/tech/pub_data_main.asp.

Nevertheless, despite the government's significant role in shaping the rules and regulations for R&D activities in Taiwan; it is actually the scientific community and the market that determine its direction (Chen, 1997; Hsu & Chiang, 2001), such that "Innovation in Taiwan…is a result of domestic individuals and independent firms" (Mahmood and Singh, 2003: 1052). SMEs are the driving force of innovation in Taiwan's economy, and they have constituted nearly 98% of all the Taiwanese enterprises:

Table 8. Number of Enterprises, Taiwan (2003-2006)

	Total	SMEs (%)	Large Enterprises (%)
2003	1,172,633	1,147,200 (97.83%)	25,433 (2.17%)
2004	1,204,343	1,176,986 (97.73%)	27,357 (2.27%)
2005	1,253,694	1,226,095 (97.80%)	27,599 (2.20%)
2006	1,272,508	1,244,099 (97.77%)	28,409 (2.23%)

Source: SMEA, Ministry of Economic Affairs, ROC.
http://www.moeasmea.gov.tw/public/Data/81711253871.pdf.

In view of this, the Small and Medium Enterprise Administration (SMEA) of the Ministry of Economic Affairs has undertaken a series of programs to assist SMEs in recent years. Examples are the Small Business Innovation Research Program, Industrial Technology Development Plan, Innovative Technology Applications and Services Program, Conventional Industry Technology Development Initiative, and the Assist Service Sector Technology Development Plan. These programs aim to facilitate the start-up of SMEs and their technical upgrading, through which university-industry collaborations are carried out. Unlike the vertically-integrated big corporations in South Korea that aims at economies of scale, the horizontally-networked SMEs in Taiwan has more organizational flexibility to adapt to the changing export demands. Yet because of their small sizes, they have to depend on state and university support on R&D. (Wang, 2007). A recent statistical study indicates that, SMEs tend to cooperate with public universities which have more resources than private universities to help SEMs in the emerging industries like biotechnology and nanotechnology (Hu and Mathews, 2009).

After reviewing the research and development, especially examining the role of different sectors including the state, industry and the university in promoting technology and innovation in Taiwan, we have witnessed the driving force for innovation and technology development originated from a state-led model towards a more firm-led approach in Taiwan. In most recent years, the role of the firms is becoming increasingly significant in advancing the technology and innovation in Taiwan, particularly the closer collaborative relationship between SEMs and universities through various technology / innovation development initiatives strongly encouraged by the state with positive responses and active participation of the industry / firms and universities. The Taiwan case has clearly demonstrated a continuum of state-industry-university collaborations, with a growing prominence of the industry / firms in collaborations with the university sector in promoting technology / innovation.

South Korea

South Korea is a fast-catcher in S&T since its inception of industrialization. Throughout the process, the state has played an aggressive role particularly during the 1970s-80s by setting up government research institutes and science parks. Unlike Taiwan and Hong Kong where SMEs acquire a core role in the economy, South Korean economy is dominated by Chaebols (big corporations) with the state's strong support. Since the Chaebols have abundant resources to set up their own in-house research units, their reliance on university-industry linkages are rare. In light of this, the Korean government has actively pushed for the university-industry collaboration and has ultimately transformed the role of Korean universities from teaching into research and entrepreneurial activities.

South Korea is catching up with the technologically-advanced countries by expanding its innovation system in recent years, and its determination has clearly revealed in the **Plan to Construct a National Innovation System** announced in 2004. According to the Global Competitiveness Index, South Korea's ranking has significantly improved from 23rd in 2006/07 to 11th in 2007/08 and to 13th in 2008/09. However, it was ranked 31st in the World Bank's Knowledge Economy Index in 2008, slightly dropped from 28th in 1995. Comparatively, its Innovation Ranking was 23rd. Regardless of the different results of rankings, the improvement of South Korean innovation system is best illustrated in its hard outputs, namely the significantly increased number of US patents acquired (see Table 9).

Table 9. Number of US Patents from South Korea, 2004-2008

	2004	2005	2006	2007	2008
Utility Patent	4428	4352	5908	6295	7549
Design Patent	238	233	589	957	1159

Source: US Patent and Trademark Office.
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_dsn.htm;
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

In meeting the goal of constructing an innovation-based economy, the status of the research capacity of South Korean innovation system seems to suggest a possible future. As shown in Table 10, the number of its R&D personnel (researchers, research assistants, and other supporting persons) has increased constantly since the 2000s:

Table 10. Number of R&D personnel, South Korea (2000-2005)

Year	Total		Researchers		Research Assistants	Other Supporting Persons
		FTE		FTE		

2000	237,232	138,077	159,973	108,370	61,027	16,232
2001	261,802	165,715	178,937	136,337	62,738	20,127
2002	279,806	172,270	189,888	141,917	69,021	20,897
2003	297,060	186,214	198,171	151,254	75,283	23,606
2004	312,314	194,055	209,979	156,220	76,730	25,605
2005	335,428	215,345	234,702	179,812	75,179	25,547

Source: Website of the Ministry of Education, Science and Technology (MEST), South Korea. http://english.mest.go.kr/main.jsp?idx=0402020101

The research talents of South Korea are well-equipped in terms of their educational qualifications. More than a third of the S&T researchers possessed a bachelor degree, and about another one-third of them have a master's degree, while over 20% of others have earned a doctoral degree (see Table 11). As of 2005, a majority of the researchers were graduated from the field of engineering (72.1%), 14.2% of them came from the background of natural science. Only a very small portion of them studied in medical science (6.5%), agriculture, forestry, fishery (2.9%) or other professions (4.4%) (see Table 12).

Table 11. Number of S&T Researchers by Degree, South Korea (2000-2005)

Year	2000	2001	2002	2003	2004	2005
Total	159,973	178,937	189,888	198,171	209,979	234,702
Bachelor (%)	33.8	35.9	35.6	35.3	37.1	37.4
Master (%)	32.0	32.4	33.8	34.2	32.5	33.5
Doctor (%)	28.8	26.1	26.2	26.5	26.9	24.7
Others (%)	5.4	5.7	4.5	4.0	3.5	4.4

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402020301

Table 12. Distribution of S&T Researchers by Major Field of Study, South Korea (2005)

	Number of Researchers	Share of Total (%)
Natural science	33,248	14.2
Engineering	169,145	72.1
Medical Science	15,143	6.5
Agriculture, Forestry, Fishery	6,813	2.9
Others	10,353	4.4
Total	234,702	100

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402020401

Examining the distribution of researchers across sectors, it is shown in Table 13 that the majority of researchers reside in companies (over 60%), followed by universities (about 30%) and public research institutes (less than 10%). Among the companies, large companies have dominated the share of researchers (see Table 14). It is such a remarkable concentration that by 2005, the top 20 companies in South Korea in fact possessed 39.7% of researchers in this sector (see Table 15).

Table 13. Number of Researchers by Sector of Performance, South Korea (2000-2005)

	Total	Public Research Institutes (%)	Universities (%)	Companies (%)
2000	159,973	8.7	32.3	59.0
2001	178,937	7.8	30.0	62.2
2002	189,888	7.4	30.4	62.2
2003	198,171	7.3	30.1	62.7
2004	209,979	7.5	28.5	64.0
2005	234,702	6.6	27.6	65.7

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402020201

Table 14. Number of Researchers by Size of Companies, South Korea (2003-2005)

	2003	2004	2005
Large Companies	71,698 (57.8%)	79,910 (59.5%)	91,514 (59.3%)
Small and Medium-Sized	27,390 (22.1%)	28,683 (21.4%)	30,619 (19.8%)
Venture Business	24,942 (20.1%)	25,707 (19.1%)	32,193 (20.9%)
Total	124,030 (100%)	134,300 (100%)	154,306 (100%)

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402040301

Table 15. Concentration Rate of Researchers in Top Companies, South Korea (2000-2005)

	2000	2001	2002	2003	2004	2005
Top 5	29.6	24.7	24.7	27.5	29.9	30.6
Top 10	34.8	28.8	28.3	30.9	33.7	34.8
Top 20	40.2	33.0	33.1	48.4	38.8	39.7

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402040201

With the increase in R&D personnel, the amount of total R&D expenditures and their shares of GDP kept rising since the 2000s accordingly (see Table 16). It points to the fact that R&D has continuously occupied a more important place in the economy. Private companies, with their huge team of researchers, undoubtedly spend the most on R&D (over 70%). Likewise, R&D expenditures were highly concentrated in top companies. As of 2005, the top 20 companies spent about 55.6% of the R&D expenditures in this regard (see Table 17). Table 18 also indicates that private sector is the dominant source of R&D funding in South Korea. The ratio of private sector to government in terms of funding maintains a stable pattern since 2000. As of 2005, the percentage ratio of private to public was 76 to 24.

Table 16. R&D Expenditure by Sector of Performance, South Korea
(in US$ Million)

	Total	Public Research Institutes		Universities		Companies		Total Expenditure as Share of GPD
			%		%		%	(%)
2000	12,298.8	1,804.6	14.7	1,387.1	11.3	9,107.2	74.0	/
2001	14,307.7	1,918.5	13.4	1,489.2	10.4	10,900.2	76.2	2.59
2002	15,386.4	2,267.0	14.7	1,596.0	10.4	11,523.4	74.9	2.53
2003	16,934.9	2,332.5	13.8	1,716.4	10.1	12,886.1	76.1	2.63
2004	19,702.8	2,632.9	13.4	1,954.6	9.9	15,115.3	76.7	2.85
2005	21,452.4	2,835.6	13.2	2,129.9	9.9	16,486.9	76.9	2.99

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402010301.
Note: The currency exchange rates of Korean Won to US dollars fluctuate a lot in recent years. We take the exchange rate on 20th January 2010 for analysis, which was about US$ 1 to KRW$ 1,126.

As shown in Table 16, universities in South Korea are the least spender on R&D activities (constituting about 10% of the total R&D expenditures), lagging behind the government (about 13 to 14%) and companies (over 70%). It is illustrated that universities do not play a leading role in driving innovation in South Korea because major firms / industries have played a far more important role in promoting R & D (It will be discussed more in later sections).

Table 17. Concentration Rate of R&D Expenditure in Top Companies, South Korea (%)

	2000	2001	2002	2003	2004	2005
Top 5	34.8	35.6	37.5	37.0	40.4	42.0

Top 10	45.9	43.4	43.2	43.7	47.7	48.4
Top 20	55.4	49.8	49.6	51.7	55.0	55.6

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402040201

Table 18. Trend of R&D Expenditure by Source of Fund, South Korea (in Million US dollars)

	2000	2001	2002	2003	2004	2005
Total	12,298.8	14,307.7	15,386.4	16,934.9	19,702.8	21,452.4
Government & Public	3,389.8	3,873.4	4,209.6	4,330.6	4,836.6	5,219.5
Private	8,901.8	10,367.1	11,109.1	12,534.3	14,769.9	16,080.6
Foreign	7.3	67.2	67.8	70.1	96.3	152.2
Government : Private (Percentage Ratio)	28:72	27:73	27:73	26:74	25:75	24:76

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402010201
Note: The currency exchange rates of Korean Won to US dollars fluctuate a lot in recent years. We take the exchange rate on 20th January 2010 for analysis, which was about US$ 1 to KRW$ 1,126.

In sum, the national innovation system of South Korea has evolved from one that was public-institutes-centered to private-companies-centered since the 1980s (Lee, 2006), and the trend continues till now. It can also be observed that this private-driven national innovation system is “bipolarized” in nature, referring to the dual structure of strong *chaebols* on the one end and weak SMEs on the other (Lim, 2008). Analyzing the South Korea case in the light of the Triple Helix Model, the national innovation system, as similar to Singapore’s, is inclined to state-led approach but at the same time more firm-led.

Singapore

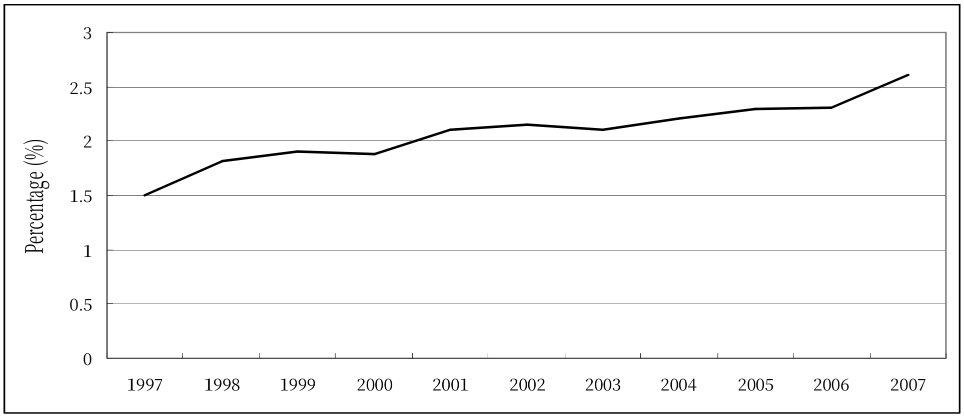
Since its independence from the British in 1965, Singapore has gone through multiple stages of industrialization and economic revitalization, which are always taken into comparison with other “Asian Miracle” economies — Hong Kong, Taiwan, and South Korea. Many would argue that its economic take-off as latecomer over the last few decades is likewise attributed to its effective industrial policy making by the government to attain a desired macro-economic environment for industrial development (Goh, 2005; Hu and Mathews, 2005).

Under the small-open economic framework, as a market price-taker Singapore government has adopted strong interventions in labour, land, and industrial development to ensure its transition from a third-world to a first-world country. During 1960s and 1970s, facing the scarcity of natural resources, Singapore directed the industrial policies towards employment-creation, using favorable incentives to attract foreign direct investment and multi-national companies (MNCs) to increase productive capacity. Gradually, a vibrant manufacturing sector was formed and dominated the economy. Unlike other "Asian Miracles", Singapore primarily relied upon MNCs to produce the knowledge spillovers and technology transfers necessary to develop its national technological capability rather than indigenous R&D, for example, the initial intention of the government to establish a Singapore Science Park was to attract Foreign Direct Investment (FDI) and MNCs. But past experiences show that such over-reliance on FDI and MNCs had constrained the country's ability to resist external economic crisis as global competition intensifies (Goh, 2005).[5] Thereafter, Singapore began the pursuit of sustainable economic growth through promoting entrepreneurship and raising the quality of indigenous human capital to international standards (Tan 2003). In 1989, Singapore government created the first Small and Medium-Sized Enterprise (SME) Master Plan to introduce measures and assistant schemes for SME development and to improve entrepreneurial infrastructure. Moreover, entrepreneurial mindset was introduced in civil services through the Public Service for the 21st Century in 1995; a deliberate exercise aimed at nurturing entrepreneurial attitude of excellence and fostering an entrepreneurship-friendly environment in the public service. In 2000, the Enterprise Challenge (a branch under the Prime Minister's Office) even set up a S$10 million fund to sponsor innovative projects which may improve the provision of public service. Hit by the 1997 Asian financial crisis, the government released the second Master Plan (SME21) in 2001, calling for urgency to inspire entrepreneurship yet again in Singapore. Meanwhile, it also actively promoted spending in the private sector through various incentives.

To maintain its attractiveness as a place for business of the future, in recent years Singapore has gradually switched its developmental focus from a large manufacturing base for MNCs to a dynamic innovation hub that supports high-tech manufacturing and R&D, which is best indicated by the steady and continuous increase of R&D expenditure as a percentage of annual GDP (see Figure 2). Singapore's S&T advancement in the last two decades is accomplished through four five-year National S&T Plan (1991-1995, 1996-2000, 2001-2005, and 2006-2010).

[5] Having experienced the Asian financial crisis 1997-98 and the recent global economic crisis, the Singapore government has realized the importance of diversifying its national investment and recognized the problems of relying heavily on FDI and MNCs since they may be unstable during times of economic crisis.

Figure 2. Gross Domestic R&D Expenditure as a Percentage of GDP, Singapore (1997 -2007, GRDE/GDP)



Source: A*STAR, Singapore National Science and Technology Survey (various years).

Realizing its over-dependence on foreign MNCs for technological upgrades and its week indigenous technology development after the first economic recession, in the early 1990s the Singaporean government planned to double R&D investment in the coming years, targeting primarily long-term strategic research (Koh, 2006). The first five-year National S&T Plan has invested a total of S$2 billion to develop key resources in technology, manpower and skills to meet the needs of industry. During the plan, the National Science and Technology Board (NSTB) was assigned to develop new research institutes for a number of identified key research areas, including biotechnology, food and agro-technology, information technology and telecommunication, microelectronics and semi-conductors.

In the second plan from 1996 to 2000, the government envisioned "an innovative and enterprising society that embraces science and technology to develop a thriving knowledge economy and good quality of life", and therefore shifted its developmental strategy to domestic capacities in applied and basic scientific researches. In order to meet the world-class science and technological capacities, it had been set that by the end of this period, government's R&D expenditure should reach 2.6 percent and the research talent pool should be strengthened to achieve the level of 65 research scientists per 10,000 workers. These targets were achieved two years ahead of time with S$4 billion of investment funding. A number of new policy initiatives promoting technology entrepreneurship were also released at the same time in order to firm up coordination between scientific infrastructure and industrial capacity.[6]

[6] In 1997, an inter-agency team comprising representatives from the NSTB, the Economic Development (EDB), and the Singapore Productivity and Standards Board (SPSB) was formed to make an extensive discussion on strategies for innovation in consultation with various industrial departments. Subsequently, a **National Innovation Framework for Action (NIFA)** was drafted in the following year to identify critical success factors for innovation to flourish, and to recommend the government

In the first two S&T National Plans, the government started to realize that it should work more efficiently with private companies in exploiting technological innovation by facilitating them to develop their innovation capacities. In this regard, a number of financial assistances and tax incentive programs were therefore designed to promote innovation, especially among the SMEs.[7] Major financial schemes which aim at promoting technology commercialization include the Research Incentive Scheme for Companies, the Research and Development Assistance Scheme, and the Patent Application Fund.

The third S&T National Plan from 2001 to 2005 marked another phase of R&D in Singapore as it emphasized the crucial role of research institutions and universities in undertaking research of several strategic areas with medium-to-long run relevance (MTI, 2006). Half of the S$7 billion budget was channeled into technology development and R&D experiments, while 30 percent was used to encourage corporate labs to set up research centers in Singapore. The remainder has been pumped into broad-based manpower development, which includes fellowship training programs and postgraduate scholarships. In addition, the fourth S&T National Plan from 2006 to 2010 intended to strengthen the support to SMEs, promote technology transfer and intellectual property management, and to create incentives that could attract international talents to Singapore.

With the assistance of the government policies, universities started to take up a more significant role in the recent decade, especially in the establishment of science parks. In 2000, the government announced a devolvement of S$15 billion to establish a new science park targeting bio-sciences and information technology as new growth engines of Singapore's economy (A*STAR, 2009). This **One-North Project** was modeled after Silicon Valley to create a multifaceted high-tech research community. With a focus on knowledge-intensive activities in critical growth sectors, it would provide an intellectually stimulating and creative physical environment for entrepreneurs and researchers to congregate and exchange ideas. Focusing on the full range of production activities, it includes not only research institutes and business offices, but residential properties, shopping, public parks and other facilities as well. Like any other science parks around the world, the new science parks are located adjacent to several universities: the National University of Singapore, the Institute of Technical Education, the Singapore Polytechnic, and the National University Hospital.[8] The efforts being put together by the Singapore Government has paid off

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accordingly. The eight critical success factors include education & training, government policies, government support, information, infrastructure, technology, market, and human resources.

[7] For example, it extends the pioneer or post-pioneer status for SMEs who undertake approved R&D activities with a concessionary tax rate; provides more liberalized double deduction for R&D expenses; permits investment allowance for all capital expenditure incurred for approved R&D activities; and allows for a tax-exempted R&D reserve for companies.

[8] Developed by JTC at a cost of S$500 million, the first phase of Biopolis, a custom-built biomedical R&D hub at One-North, comprises a seven-building complex and five biomedical sciences

since the ranking of the city-state in global ranking related to innovation has improved in the most recent years (see discussion below).

Analyzing the development of innovation and technology development in Singapore, it is clear that the national innovation system is more government-led despite the fact that the Singapore government has made attempts to facilitate more deep collaborations between the industry (especially more with SMEs) and the university in driving technology and innovation development in the city-state.

Japan

Having been defeated in the Second World War, Japan quickly positioned itself as an industrial and a manufacturing economy right after the War. Since then, the government has taken various important steps, laid out countless plans and programs to strengthen the industrial base, but it was only until the 1980s and 1990s that the higher education sector began to involve in the industrial world and help it to innovate. While the overall higher education sector continues to reach out to the industry through research, it is the national universities that take the leading and dominant role, alongside with the public and private universities, in advancing university-industry research collaborations. The Japanese government is deeply engaged in this transformation of the role of Japanese universities from providing academic teaching & research to pursuing entrepreneurial activities. This is best indicated by the government's decision to merge the Science and Technology Agency with the Ministry of Education to form the Ministry of Education, Culture, Sports, Science and Technology in the early 2000s. Yet overall speaking, the majority of Science and technological R&D activities in Japan are carried out by business enterprises.

During the 1960s when the Japanese government aspired to strengthen the nation's industrial base, the Ministry of International Trade and Industry launched the Large-Scale Industrial Research and Development System, bridging the partnership between universities and the industrial sector. However, Japanese universities ended up playing a very small role in it; while private enterprises became the major driving force of innovation since then. Yet in addition to other programs initiated by the Science and Technology Agency and the Ministry of Education since the **1980s,** the 90s marked a recent watershed of R&D in Japan when the government decided to promote economic growth through scientific and technological development in face of

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sub-research institutes, which are home to 2,000 scientists. A total of four phases will be finished by 2010. Another milestone in One-North development, the Fusionopolis, is a R&D centre for electronics and information technology launched in 2003. Fusionopolis' research teams will be formed by scientists from multidiscipline, including materials science & engineering, data storage, microelectronics, manufacturing technology, high performance computing, and information & communications. Companies in Fusionopolis could co-locate and engage in R&D collaboration with the Science and Engineering Research Council, making Fusionopolis an icon for public-private joint R&D in the physical sciences and engineering.

economic stagnation. The **Basic Law for Science and Technology** was enacted in 1995, stipulating the government's responsibility to introduce five-year plans for S&T advancement (Jiang et al., 2007). R&D activities in universities were also buttressed by education reforms since the 1990s that enable universities and their personnel to undertake such activities. The implementation of the Basic Law has successfully steered the development of research and development in Japan, making the country more innovative in the last decade (see details in discussion below).

Japan remains strong in innovation in recent years. Despite the fact that Japan's standing in the Global Competitiveness Index has slipped from 5th in 2006/07 to 8th in 2007/08 and to 9th in 2008/09, and that in reference to the World Bank's Knowledge Economy Index, it has dropped from 17th in 1995 to 19th in 2008, the achievements of Japanese S&T talents are still well-received worldwide. In terms of patents, the number of US patents acquired by Japanese remain stable in recent years, though with some fluctuations (see Table 19). Moreover, the numbers of published S&T papers by the Japanese have topped industrial advanced countries like Germany, France and UK in 1994, 1999 and 2004, though they were still significantly behind the US's. In terms of the share of citations of S&T papers across the world, Japan's share has increased from 7.6% in 1994 to 8.7% in 1999 and to 8.9% in 2004, alongside with Germany, France and UK (see Table 20).

Table 19. US Patents from Japan, 2004-2008

	2004	2005	2006	2007	2008
Utility Patent	35,348	30,341	36,807	33,354	33,682
Design Patent	1,568	1,384	2,405	2,416	2,767

Source: U.S. Patent and Trademark Office.
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_dsn.htm;
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

Table 20. Selected Countries' Shares of Published S&T Papers and Citations of S&T papers (in percentage)

Share of published S&T papers (%)							
	Total	Japan	USA	Germany	France	U.K.	Others
1994	603,000	9.5	35.6	8.0	6.4	9.0	31.6
1999	679,000	10.3	32.6	9.1	6.8	9.1	32.1
2004	735,000	9.6	31.7	8.5	6.2	8.4	35.7
Share of citations of S&T papers (%)							
	Total	Japan	USA	Germany	France	U.K.	Others
1994	9,927,000	7.6	51.3	8.3	6.3	10.6	15.7
1999	7,184,000	8.7	47.7	10.1	6.9	11.3	15.3
2004	259,000	8.9	47.8	11.1	6.9	12.1	13.2

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/153.pdf

Similar to South Korea, Japan's innovation system is business-driven. For research capacity, an overwhelming majority of the R&D performing institutions reside in business enterprises (over 80%), significantly outnumbering those in universities & colleges (over 10%), non-profit institutions and public organizations (see Table 21). Accordingly, the industrial sector and the universities & colleges compose the majority of R&D personnel. As of 2005, the former employed about 58.2% of the R&D personnel, while the latter 34.2% (see Table 22).

Table 21. Number of R&D Performing Institutions, Japan (2000-2004)

	Total	Business Enterprises	Non-Profit Institutions	Public Organizations	Universities & Colleges
2000	27,061 (100%)	22,789 (84.2%)	613 (2.3%)	632 (2.3%)	3,027 (11.2 %)
2001	22,056 (100%)	17,903 (81.2%)	523 (2.4%)	615 (2.8%)	3,015 (13.7%)
2002	18,468 (100%)	14,258 (77.2%)	520 (2.8%)	599 (3.2%)	3,091 (16.7%)
2003	29,663 (100%)	25,440 (85.8%)	507 (1.7%)	596 (2.0%)	3,120 (10.5%)
2004	28,608 (100%)	24,290 (84.9%)	488 (1.7%)	601 (2.1%)	3,229 (11.3%)

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/140.pdf

Table 22. R&D Personnel by Occupation, Japan (as share of total, %)

	2000	2001	2002	2003	2004	2005
Total	1,022,079 (100%)	1,000,014 (100%)	972,495 (100%)	968,092 (100%)	994,348 (100%)	1,009,937 (100%)
Industry	604,544 (59.1%)	581,721 (58.2%)	561,735 (57.8%)	555,772 (57.4%)	580,628 (58.4%)	587,414 (58.2%)
Government	59,025 (5.8%)	59,254 (5.9%)	62,768 (6.5%)	63,906 (6.6%)	61,893 (6.2%)	61,769 (6.1%)
Universities & Colleges	330,509 (32.3%)	331,049 (33.1%)	330,654 (34.0%)	331,499 (34.1%)	335,983 (33.8%)	345,274 (34.2%)
Private Research Institutes	28,001 (2.7%)	27,990 (2.8%)	17,338 (1.8%)	16,915 (1.7%)	15,844 (1.6%)	15,480 (1.5%)

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/141.pdf

In terms of research input, the total R&D expenditures have increased very modestly from 2000 to 2004, yet different sectors experienced different trends. While non-profit institutions, public organizations, universities & colleges suffer a decline in R&D expenditures, the share of business enterprises increased from 66.7% in 2000 to 71.2% in 2004 (see Table 23). It is therefore shown that business enterprises has continuously been the most important R&D player in Japan, while the role of the government, comparatively, is much less significant (see Table 24)

Table 23. R&D Expenditure by Sector, Japan (2000-2004)

Year	Total (million US$)	Business Enterprises (%)	Non-Profit Institutions (%)	Public Organizations (%)	Universities & Colleges (%)
2000	178,718.9	66.7	4.3	9.3	19.7
2001	181,337.4	69.3	2.2	9.0	19.6
2002	182,950.8	69.4	2.0	8.9	19.7
2003	184,367.3	70.0	1.9	8.7	19.4
2004	185,831.2	71.2	1.8	8.8	19.3

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/146.pdf
Note: The currency exchange rates of Japanese Yen to US dollars fluctuate a lot in recent years. We take the exchange rate on 20th January 2010 for analysis, which was about US$ 1 to 91.145 Yen.

Table 24. Total and Government-Funded R&D Expenditure, and as Share of GDP, Japan (2000-2004)

Year	Total R&D Expenditures		Government-Funded R&D Expenditures		
	Total (million US$)	As share of GDP (%)	Total (million US$)	As share of total R&D expenditure (%)	As share of GDP (%)
2000	178,718.9	3.17	38,847.6	21.7	0.69
2001	181,337.4	3.30	38,147.4	21.0	0.69
2002	182,950.8	3.35	37,881.2	20.7	0.69
2003	184,367.3	3.35	37,240.5	20.2	0.68
2004	185,831.2	3.35	37,179.9	20.0	0.67

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/145.pdf
Note: R&D expenditures as share of GDP are calculated by the author.

In sum, similar to the situation of its higher educational sector, the Japanese industrial sector is also improving steadily along the years in terms of the stable amount of R&D institutions, R&D personnel and R&D expenditures. Similar to the development of South Korea and Taiwan, the advancement in research and development was steered and started by the state in decades ago but recent drives for technology and innovation advancement has relied heavily on the industry and the university.

Promotion of Innovation and Global Competitiveness: An Assessment

Comparing and contrasting the developments of innovation of the above five selected cases has clearly shown the important role that the government has performed in the promotion of technology and innovation, especially during the inception / initiation phase of the development cycle. Among five Asian economies, Hong Kong is the only exception because the government of Hong Kong has never played a strong steering role in promotion of innovation and technology until recently when the government starts to realize the need to catch up with other technologically-advanced countries, while the rest of cases under review have suggested the role of the government has been crucial in driving the agenda for innovation advancement, acting as the initiator and facilitator of such undertaking. In Taiwan, although the government is very keen on enhancing R&D activities, industry (especially SMEs) and universities also play an important role in it, thus there is a closer and more equal co-operation among the three stakeholders in the Triple Helix Model. Singapore, Japan and South Korea share a similar pattern that their innovation systems are led by both the state and industry (especially big corporations), yet the three countries also differ in one important aspect, that is the nature of those corporations. In Singapore, the government welcomes foreign investments and companies, sometimes we may even find that the government favours foreign companies in order to attract them to invest in Singapore. But in Japan and South Korea, big corporations are mostly local in nature as they regard local industries as their national strengths, which need to be protected and supported. Therefore, while Singapore is described as a “technoglobalist” country, Japan and South Korea can be categorized as “technonationalist” countries (Keller and Samuels, 2002; Kim, 2001). Figure 3 shows the different approaches that the selected Asian economies have adopted in promotion of innovation.

Figure 3. Typology of Triple-Helix network mechanism in five selected countries/cities

	State	Industry	University
Hong Kong	△	○	△
Japan	○	○	△
Singapore	○	○	△
South Korea	○	○	△
Taiwan	○	○	○

Source: Drawn by the author

Note:

1. "○": Significant contribution; ""△: Insignificant yet emerging contribution
2. "○" indicates a significant contribution of that stakeholder to the national innovation system, while the absence of "○" does not infer that the stakeholder has no contribution at all; because each of the three stakeholders must has certain impact on the innovation system, though to different degrees. Besides, the indication of "○" of the same stakeholder of different countries does not imply that the degrees of contribution of that stakeholder are the same in different countries.

After comparing and contrasting the different national innovation systems of the selected Asian societies, we have clearly noted that the role of the government is important in driving the research and development agenda. With the exception of Hong Kong where the government has not performed a leadership role in innovation and technology advancement (perhaps it is to do with the fact that Hong Kong has never been a sovereign state), all other Asian economies have taken the advancement of innovation more seriously, especially when they have transformed their economy from a more manufacturing-based to a more service-based one in the context of knowledge-based economy. In response to growing pressures and challenges generated from the globalizing economy, these Asian states have made attempts to promote innovation in order to move beyond their traditional forms of economic activities and extend to new economic opportunities very much driven by creativity and innovation. Hence, we have witnessed more emphasis is placed upon higher education development by diversifying higher education financing sources, encouraging universities to reach out and collaborate with the industry and business to become entrepreneurial universities, and more collaborations have been promoted between the industry and business and the university in promoting innovation and technology in recent years. Table 25 recapitulates the R & D expenditures of selected Asian societies in advancing innovation and technology as already shown separately above.

Table 25. R&D Investments of the selected five Asian societies, 2000-2004

	Hong Kong	Japan	South Korea	Singapore	Taiwan	Hong Kong	Japan	South Korea	Singapore	Taiwan
	Total R&D Expenditures (in US$ million)					Total R&D Expenditures as share of GDP (%)				
2000	785.7	178,718.9	12,298.8	415.2	6,176.0	0.47	3.17	--	--	1.97
2001	908.6	181,337.4	14,307.7	398.1	6,405.4	0.55	3.30	2.59	0.36	2.08
2002	967.1	182,950.8	15,386.4	402.4	7,013.4	0.61	3.35	2.53	0.36	2.18
2003	1096.0	184,367.3	16,934.9	472.3	7,591.9	0.69	3.35	2.63	0.41	2.31
2004	1218.6	185,831.2	19,702.8	577.6	5,321.7	0.74	3.35	2.85	0.45	2.38

Note: The official data of Japan is only up to 2004, therefore though other countries have more updated data, we can only compare the data on or before 2004 across the five societies.

Taking R & D more seriously by Asian states, Table 26 shows the performance of selected Asian economies in the **Global Competitiveness Index**, the current rankings (2009/10) secured by these East Asian economies (in comparison with several OECD countries as well) ranging widely from 3rd (Singapore) to 29th (Mainland China):

Table 26. Global Competitiveness Index, 2009/10 Ranking

Country/Economy	GCI 2009/10		GCI 2008/09	Capacity for Innovation	University-Industry Collaboration in R&D
	Rank	Score	Rank	Rank	Rank
Switzerland	1	5.60	2	--	--
United States	2	5.59	1	--	--
Singapore	**3**	**5.55**	**5**	**18**	**4**
Sweden	4	5.51	4	--	--
Denmark	5	5.46	3	--	--
Finland	6	5.43	6	--	--
Germany	7	5.37	7	--	--
Japan	**8**	**5.37**	**9**	**1**	**20**
Canada	9	5.33	10	--	--
Netherlands	10	5.32	8	--	--
Hong Kong SAR	**11**	**5.22**	**11**	**43**	**27**
Taiwan	**12**	**5.20**	**17**	**13**	**12**
United Kingdom	13	5.19	12	--	--
Korea, Rep.	**19**	**5.00**	**13**	**15**	**24**

Source: Adapted from World Economic Forum, 2009.

Similarly, a comparison made through their rankings in the World Bank's **Knowledge Economy Index** has shown a rather different picture yet a similar trend, with the exception that Taiwan has topped this Index among the seven selected cases instead of acquiring merely the fourth in the GCI ranking (see Table 27). However, the KEI ranking clearly shows that even the best three performers among this group — Taiwan, Singapore and Japan — could only seize the positions of 18th to 20th in line in the ranking, which is still far behind most of the OECD countries particularly in the aspects of "economic incentive & institutional regime" (see note 9) and "education & human resources" (see note 10). Having said that, it is notable that most of the selected cases are now performing quite well in the aspects of "innovation system" (see note 11) and "information & communication technology" (see note 12) if compared their actual scores concerned to those of the OECD countries.

Table 27. Knowledge Economy Index, World Bank (2009)

Country/Economy	KEI 2009		EIIR[9]	Innovation[10]	Education[11]	ICT[12]
	Rank	Score	Score	Score	Score	Score
Denmark	1	9.52	9.61	9.49	9.78	9.21
Sweden	2	9.51	9.33	9.76	9.29	9.66
Finland	3	9.37	9.31	9.67	9.77	8.73
Netherlands	4	9.35	9.22	9.45	9.21	9.52
Norway	5	9.31	9.47	9.06	9.60	9.10
Canada	6	9.17	9.45	9.44	9.26	8.54
United Kingdom	7	9.10	9.24	9.24	8.49	9.45
Ireland	8	9.05	9.26	9.08	9.14	8.71
United States	9	9.02	9.04	9.47	8.74	8.83
Switzerland	10	9.01	8.79	9.90	7.68	9.68
Australia	11	8.97	8.66	8.88	9.69	8.67
Germany	12	8.96	9.06	8.94	8.36	9.47
Taiwan	**18**	**8.45**	**7.42**	**9.27**	**7.97**	**9.13**
Singapore	**19**	**8.44**	**9.68**	**9.58**	**5.29**	**9.22**
Japan	**20**	**8.42**	**7.81**	**9.22**	**8.67**	**8.00**
Hong Kong SAR	**23**	**8.32**	**9.54**	**9.04**	**5.37**	**9.33**
Korea, Rep.	**29**	**7.82**	**6.00**	**8.60**	**8.09**	**8.60**

Source: Adapted from the website information of "KEI & KI Indexes", Knowledge Assessment Methodology (KAM) 2009, World Bank. http://info.worldbank.org/etools/kam2/KAM_page5.asp

9 The **Economic Incentive & Institutional Regime** is the simple average of the normalized scores on three key variables: tariff & non-tariff Barriers; regulatory quality; and rule of law (KAM 2009, World Bank).

10 The **Innovation System** is the simple average of the normalized scores on three key variables: total royalty payments & receipts; patent applications granted by the US Patent & Trademark Office; and S&T journal articles (KAM 2009, World Bank).

11 **Education & Human Resources** is the simple average of the normalized scores on three key variables: adult literacy rate; secondary enrollment; tertiary enrollment (KAM 2009, World Bank).

12 **Information & Communication Technology** is the simple average of the normalized scores on three key variables: telephone; computer & internet penetrations (per 1000 people) (KAM 2009, World Bank).

A comparison made among these East Asian economies however reveals that although Mainland China and Taiwan are really catching up their knowledge economic development in a remarkable pace, according to the Index, most of them in fact achieved merely an insignificant progress or even a regression between a long period of 1995 and 2009 (see Table 28), indicating an ever-challenging global competition that highlights innovation and educational reforms.

Table 28. Knowledge Economy Index, World Bank, (1995 & 2009 Rankings)

Country/Economy	KEI 1995	KEI 2009	Change in Rank
Taiwan	25	18	+7
Singapore	21	19	+2
Japan	17	20	-3
Hong Kong SAR	23	23	0
Korea, Rep.	26	29	-3

Source: ibid.

Despite the fact that the five Asian societies under review has shown that these governments are more aware of the importance of innovation and technology in the process of development of their societies, they are relatively ‘late comers’ in the innovation, research and development endeavour when compared to those developed economies like the OECD countries. There are a few factors accounting for the relatively lower ranking in terms of these global competitiveness or knowledge economy index as clearly revealed by the above international league tables. Firstly, all these Asian economies were colonies of some kind during the war periods of the First and Second World Wars. Only after the end of the Second World War, these Asian economies began to start economic development in a relatively peaceful environment until the late 1960s and early 1970s. Singapore became an independent state in the 1950s but still experienced significant internal and external rivalries, while Hong Kong was still British colony until 1997. Although Taiwan, Japan and South Korea have been independent political entities (*Taiwan’s independent status is still controversial until now) since the end of the Second World War, they encountered various kinds of warfare between South Korea and North Korea, China mainland and Taiwan in the late 1950s and early 1960s. Until the 1970s, these Asian economies began to experience significant economic growth with the rise of industrialization and manufacturing activities taking shape. In this regard, these Asian economies with the exception of Japan with a relatively rapid economic development with the assistance of the USA in the post-US occupation period, the four Asian Tiger economies developed the so-called East Asian Miracle in the 1980s and 1990s. Before the 1990s, these Asian still relied upon the secondary rather than tertiary production to drive their economic growth. Realizing the coming of the knowledge-based economy, these East

Asian Tiger economies have begun to expand their higher education and invest in research & development. Being late-comers in the enterprise for innovation advancement, it is self-explanatory that they have not ranked well when compare to the developed economies.

Apart from the different stages of development that these Asian economies have experienced, the relatively lower international ranking in knowledge economy index and global competitiveness index is closely related to under development of a conductive environment for facilitating the collaborations between the state, the industry and the university until the more recent decades. Our above comparison has clearly shown that the USA model in innovation advancement has, to a certain extent, resembled in the cases of Taiwan, South Korea and Japan where the promotion of innovation is more driven by the Firm-led approach. Being the ex-colony of the United Kingdom, the tiny city-states of Hong Kong and Singapore have not taken up the tradition in promotion of innovation and technology until the more recent years with the growing emphasis being place on this particular front. But we must realize that the different governance philosophy between Hong Kong and Singapore has clearly shown the variations and patterns in innovation promotion, with a more firm-led approach in Hong Kong and government-led regime in Singapore. Hence, when comparing innovation advancement experiences of these Asian states, we cannot discard the governance style and the ex-colonial and post-colonial influences.

Realizing their limitations, coupled with the confrontation of growing challenges for economic restructuring resulted from the globalizing economy, these Asian states have tried to promote more innovation advancement through facilitating the industry and university to engage in deep collaborations. This growing trend is particularly clear when examining the recent higher education reforms taken place in these Asian societies, particularly when all university systems in these Asian economies have been under great pressures for reform in the quest for becoming enterprise and entrepreneurial university. Despite the fact that these Asian economies are ‘late comers’ in terms of promotion of innovation, especially when compared to their OECD counterparts, it is worthy noting that their concerted efforts in developing and expanding higher education in the last few decades have actually laid a very solid foundation for further enhancement in research and development, as well as technology and innovation advancement. Some lessons which we could draw after reviewing the five Asian societies in terms of their strategies in promoting innovation is closely related to the role of the state in the development of higher education and research and development, particularly at its inception stage.

Our above comparative study has clearly shown these Asian states performed a very important role in initiating higher education development and expansion to provide quality education, which has created potential and qualified personnel for the advancement of innovation. One point which deserves special attention is that these governments have taken quality assurance very serious, thus the development of higher education has taken a relatively cautious approach with the public sector playing a more significant role in research and development before the sector has become more massified with the rise of private education. By adopting this approach, these government can monitor the quality of higher education expansion, while the concentration of state funding on the selected public / state universities again shows the strategic role of the state in promoting of innovation. Once these Asian governments have realized their higher education sector is ‘mature’ enough, they have started involving the industry and commercial sector to collaborate with the university sector for advancing innovation, research and development. Such a selective and cautious approach being adopted by these Asian economies could be useful and relevant to other developing countries.

In short, it is clear that all the five economies concerned have realized the pressing needs to tap innovative human capital through their HEIs. Reforms on both the NIS and HE sector are common phenomena to be found among these cases, yet with different approaches. The natures of the state, market (private enterprises) and HEIs (usually positioned somewhere in between) may well be the focus of concern for future research in relation to the changing role of the state-industry (market)-university in promotion of innovation. Having reviewed the major trends and developments of the national innovation systems of the selected Asian societies, the following part focuses on recent reforms taken place in their higher education systems in promoting the university to engage in deep collaborations with the industry in innovation advancement.

Recent Reform of Higher Education in Selected Asian Societies

Global and Domestic Forces for Higher Education Reforms

The success of promotion of innovation depends not only upon governments’ policies in enhancing R&D but also relates to the development of higher education. In order to enhance their global competitiveness, governments in different parts of the world have started to conduct comprehensive reviews of and implement plans to restructure their higher education systems (Mok and Welch, 2003). In response to the growing pressures generated by the globalization forces, modern states have attempted to reinvent themselves by moving beyond the welfare state to become the competition state (Gill, 1995; Jordana and Levi-Faur, 2005; Moran, 2002). Governments across different parts of the globe, facing similar competitive pressures, have undertaken regulatory reforms such as privatization or corporatization of state-owned industries or publicly owned organizations like post office and university, opening up new markets to multiple providers and the introduction of new regulatory regimes under the control of independent regulators (Drahos and Jospeh, 1995; Levi-Faur, 1998; Scott, 2004). More importantly, the actions and mission of the competition state do not necessarily result in the retreat of the state from the market but rather a reassertion of the role of the state under changing social and economic circumstances (Levi-Faur, 1998: 676).

Over the last two decades or so, in face of the dramatic pace of globalization, all the governments concerned have pushed for a certain degree of higher educational reform in order to cater for their industrial transformations as well as to foster/maintain an S&T-savvy and innovative citizenry. Although the degree and direction may vary substantially, the spirit of entrepreneurship and innovation has always been the core pursuance in the selected Asian societies in terms of their higher education development strategies. In addition to the global forces, a number of key domestic factors have shaped the basic orientation of education policy in Asia. Among the selected Asian countries under review, many of them were colonies of either Japan or Britain. In addition, the strong presence of the USA in the region should have shaped Asia's developments from various fronts (Moore, 2005; Sutter, 2005). With such socio-political and socio-historical backgrounds, obviously the higher education systems of these Asian countries initially were affected by their colonial history. Even when these Asian states are no longer colonies, we can easily find that many of their ideas and practices in education have still deeply rooted in their colonial legacy (Morris and Sweeting, 1995). No matter how hard they have tried to move beyond the colonial influence, we can still witness many of these Asian governments continue to identify and follow the ways that their former colonial states manage education (Mok, 2007; Mok and Lee, 2000). Hence, when examining educational developments of Asia, we cannot entirely discard the colonial legacy. After gaining independence from colonial rule (or changing from a colonial state to a Special Administrative Region of China for the case of Hong Kong), these Asian governments gave education a very important role in social and economic development (Bray, 1997; Tilak, 2000).

Despite the fact that most of the Asian societies under review are primarily anti-welfarist in public discourse and public policy, they all conceive education as an exception (Asher and Newman, 2001). Instead of being treated simply as a necessary public expenditure item, these Asian governments have put emphasis on developing education as an investment for providing their economies with a high quality labour. It is particularly true when these Asian governments have now confronted the intensified pressures generated from the rise of the knowledge-based economy. Without abundant natural resources but being small-scale economies when comparing to other giant developed economies such as the European Union or the United States of America, these Asian states realize the significance to improve the global competence of their citizens in order to strengthen their national competitiveness. Hence, higher education expansion has become a common trend among these Asian countries in recent years.

Another factor shaping educational developments in these societies is social-psychological, focusing more on the values and attitudes perceived to be prerequisites for development. Central to the legacy of Confucianism and Neo-Confucianism is an emphasis on education and cultural enhancement (Morris and Sweeting, 1995; Rozman, 1992; So and Chiu, 1995). Recent studies regarding consumption and private tutoring in Asia have repeatedly confirmed how important Asian parents have attached to education. It has been reported consistently that Asian parents are willing and also committed to pay for their children's education. Hence, private tutoring in Asia has been a growing trend and private school and higher education have therefore become increasingly popular in Asia (Bray and Bunly, 2005; Bray and Thomas, 1998). More importantly, education has long been adopted as an instrument, direct and indirect, of nation building in these Asian societies. Education has helped to create a sense of belonging and nationhood and so has been important in political legitimation in these Asian states. It has also contributed to that legitimation through the economic opportunities it has offered and the contribution it has made to economic growth (Bray and Lee, 2001; Gopinathan, 2001). In response to both the domestic and global challenges, the higher education systems of the selected Asian societies have adopted far more market-driven ideas and strategies to reform their systems by encouraging universities to become more entrepreneurial.

Hong Kong

In Hong Kong, undergraduate students comprise the largest part of its HE sector. Their share has increased from 68.6% in 2002/03 to 79.8% in 2008/09. The share of research postgraduates also increased modestly from 6.1% to 8.6% during the same period, while that of taught postgraduates decreased significantly from 9.3% to 3.8% (see Table 29). This increase in the shares of undergraduates and research postgraduates are vital to the development of manpower and R&D personnel in Hong Kong.

Table 29. Student Enrolment (Full-Time Equivalent) of UGC-Funded Programs by Level of Study, 2002/03-2008/09

Level of Study	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
Sub-Degree	11,046 (16.0%)	11,405 (16.1%)	10,736 (15.5%)	9,070 (13.4%)	6,925 (10.4%)	5,256 (8.0%)	5,279 (7.8%)
Undergraduate	47,201 (68.6%)	48,094 (67.9%)	48,830 (70.4%)	50,009 (73.9%)	51,221 (77.0%)	52,315 (79.2%)	53,992 (79.8%)
First-Year Undergraduate	14,829	14,639	14,719	14,973	15,405	15,427	15,715

Taught Postgraduate	6,371 (9.3%)	6,291 (8.9%)	4,776 (6.9%)	3,428 (5.1%)	2,946 (4.4%)	2,890 (4.4%)	2,596 (3.8%)
Research Postgraduate	4,207 (6.1%)	4,995 (7.1%)	4,971 (7.2%)	5,208 (7.7%)	5,465 (8.2%)	5,627 (8.5%)	5,792 (8.6%)
Total	68,825	70,784	69,313	67,715	66,558	66,088	67,659

Source: University Grants Committee, HKSAR, 2009.
http://www.ugc.edu.hk/eng/doc/ugc/stat/heilevel.pdf

Hong Kong's universities are heavily funded by the government. There are a total of 12 degree-awarding HEIs in Hong Kong: 8 of them are government-funded HEIs; 3 are self-financing institutions; while the remaining one is publicly-funded (see Table 30). In terms of financing, the government has been the dominant stakeholder in Hong Kong's HE sector.

Table 30. Different statuses of Higher Educational Institutions, Hong Kong

Type of Status	Name of Institution
UGC-Funded	City University of Hong Kong
	Hong Kong Baptist University
	Lingnan University
	The Chinese University of Hong Kong
	The Hong Kong Institute of Education
	The Polytechnic University
	The Hong Kong University of Science and Technology
	The University of Hong Kong
Self-Financing	The Open University of Hong Kong
	Hong Kong Shue Yan University
	Chu Hai College of Higher Education
Publicly-Funded	The Hong Kong Academy for Performing Arts

Over the last decade, the government has become eager to develop the city-state into an education hub, both in terms of academic and research. In 1996, the University Grants Committee (UGC), the statutory body responsible for advising the government on higher education, issued a report that encouraged staffs and students of HEIs to engage in pure research, and to develop closer research collaborations with the various government agencies, the industrial sector, as well as the sector of social services. In 2002, the UGC issued an important consultant report entitled *Higher Education in Hong Kong*, reiterated the need for HEIs to engage with local industry and community, meanwhile also encouraged the applied research and commercialization of research outputs. On the one hand, the proposal aims to enable university research contributes to the society more directly; on the other hand, universities can also extend their pools of research money by working closer with the industrial sector (Mok, 2005).

Hong Kong universities are vital to the overall innovation system since they are the largest R&D spender (see Table 31). In this respect, the government is concerned about the way how taxpayer money can be used effectively. In order to hold Hong Kong universities more accountable and efficient, two following policy reports were published by the UGC in 2004. Entitled *Integration Matters* (UGC, 2004a) and *Hong Kong Higher Education: To Make a Difference, To Move with the Times* (UGC, 2004b) respectively, these reports suggested that the government should expand its role in evaluating and monitoring the "performance", "mission" and "differentiation" of each HEI. In short, it shows that the state is increasing its control over the university governance.

Table 31. R&D Expenditure by Performing Sector, (2003-2007)

Sector	R&D Expenditure (US$ million)				
	2003	2004	2005	2006	2007
Business	454.5 (41%)	588.5 (48%)	720.7 (51%)	806.1 (53%)	776.2 (49%)
Higher Education	614.9 (56%)	603.5 (50%)	651.9 (47%)	693.7 (45%)	776.5 (49%)
Government	26.6 (2%)	26.6 (2%)	27.6 (2%)	31.9 (2%)	37.9 (2%)
Total Expenditure	1,096.0 (100%)	1,218.6 (100%)	1,400.2 (100%)	1,531.7 (100%)	1,590.7 (100%)
Total R&D Expenditure as Share of GDP	0.69	0.74	0.79	0.81	0.77

Source: Census and Statistics Department. 2009. *Hong Kong Monthly Digest of Statistics*: Statistics on Research and Development of Hong Kong, 2003 to 2007. http://www.statistics.gov.hk/publication/feature_article/B70905FA2009XXXXB0100.pdf.

Taiwan

As of 2008, there were 162 HEIs in Taiwan, which included 102 universities, 45 colleges, and 15 junior colleges. While the total educational expenditure in Taiwan is expanding (see Table 32), the share of universities & colleges also points to an increasing trend. As shown in Table 33, universities & colleges account for over 30% of the overall educational expenditure.

Table 32. Educational Expenditure, Taiwan (2002-2008)

Fiscal Year	Public & Private Educational Expenditure?				Government Educational Expenditure?		
	Total amount (US$1,000)	Total % of GNP	Public (% of GNP)	Private (% of GNP)	Amount (US$1,000)	Per capita (US$1,000)	% of Gov. Exp.
2002	19,322,944.3	5.87	4.36	1.50	13,259,316.5	588.8	19.78
2003	20,086,248.4	5.92	4.36	1.56	13,486,831.2	596.7	19.47
2004	20,810,839.7	5.82	4.29	1.53	13,873,647.1	611.5	19.77
2005	21,593,064.2	5.88	4.35	1.54	14,341,512.6	629.8	20.02
2006	22,241,510.5	5.82	4.30	1.52	14,739,939.0	644.3	21.30
2007	22,431,101.2	5.53	4.12	1.42	14,930,193.6	650.3	20.86
2008	23,392,737.9	5.91	4.35	1.55	15,386,566.0	667.9	21.03

Source: Ministry of Education, Republic of China (2009)

Table 33. Percentage of Educational Expenditure on Universities & Colleges, Taiwan (2001-2007)

School Year	Universities & Colleges (%)	Per Student
2001	32.63	152,275
2002	35.03	158,866
2003	35.38	160,950
2004	35.82	165,178
2005	36.65	173,195
2006	36.92	175,263
2007	37.42	/

Source: Ministry of Education, Republic of China (2009)

Apart from aiding the universities quantitatively by an increase of funding, the government also commits to quality reform. In order to make Taiwanese universities more competitive in international benchmarking, it has undertaken a series of higher education programs since 2000:

Table 34. Higher Education Reform Programs in Taiwan (Since 2000)

Program	Year
Program for Promoting Academic Excellence of Universities	2000
Program for Improving Basic Education in Universities	2001
Program to Promote International Competitiveness of Universities	2002
Research University Integration Project	2002
Program for Cultivating Science and Engineering Talents at Universities	2002
Program for Improving Research University Infrastructure	2002
Program for Expanding Overseas Student Recruitment	2003
Project for Developing Top-Notch Universities	2004
Program for Rewarding Teaching Excellence of Universities	2005

Source: Song & Tai (2007: 324)

One of the major themes in the Taiwanese higher educational reform is to concentrate resources on a few representative universities and make them world-class. This is to solve the problem of over-expansion of its higher education, which has led to paucity of resources for each university and the underdevelopment of its best universities. Moreover, the **Project for Developing Top Grade Universities and Research Centers** which commences from 2008 to 2015 with a budget of about NT$65 billion, aims to aid those potentially world-class universities to participate in international cooperation, recruit international scholars of excellence, and facilitate academia-industry cooperation. Eligible universities are selected by the Ministry of Education with the prospect of climbing onto the Top 100 List in the world within five years, and 50 universities which can be made into the Top 50 List in Asia within 15-20 years, and schools having prestigious research centers.[13]

Aimed for a better use of resources, the **National S&T Development Plan (2005-2008)** even suggested a merger or integration of research universities to expand the scale of operations (National Science Council, 2005: 21). While it may be too great a step towards merger, forming teaching and research alliance would be an easier route. Taking National Chengchi University as example, in order to ride the wave of building a world-class status, the University started a project in 2006 to develop itself into "Taiwan's Harvard" by following Harvard's footstep of establishing a "Partners Health Care System" with neighboring universities and hospital. By cooperating with the Taipei City Hospital and National Yang-Ming University, it aspires to establish a model of cooperation that associates general education and biotechnological management.[14]

Another major theme of these programs is to advance the teaching and research

[13] Official website of the Ministry of Education, Republic of China. http://english.moe.gov.tw/ct.asp?xItem=10164&ctNode=784&mp=1

[14] Official website of the National Chengchi University: http://www.nccu.edu.tw/about/

excellence of universities. For example, the **Program for Promoting Academic Excellence of Universities** was launched by the MOE together with the National Science Council in 2000, aimed to encourage large-scale intra- and inter-university cooperation with a budget of NT$13 billion. A group of prominent local and international scholars would host the review panel to safeguard the research standard. Moreover, this screening process would favor proposals that are innovative, international, and have the potential to meet the needs of national development (Song & Tai, 2007: 328-329). It is thus shown that at the moment, establishing hallmark universities and research centers has become the top agenda of higher educational reform in Taiwan lately.

South Korea

The higher education sector of South Korea develops at a stable pace in recent years. In terms of resource allocation, Table 35 shows that the shares of Ministry of Education in the government budget varied between 16.1% and 18.0% from 2001 to 2005. In regard to higher education, Table 36 indicates that there is no significant rise of universities in recent years. As a whole, the enrolment rate of South Korean HEIs increases modestly since 2005 (see Table 37).

Table 35. Central Government Budget vs. Ministry of Education Budget, South Korea (2006)

Year	Central Government Budget (US$ million)	MOE Budget (US$ million)	Share of MOE Budget (%)
2001	110,534.3	17,792.5	16.1
2002	121,330.5	19,785.4	16.3
2003	126,944.9	21,673.5	17.1
2004	130,437.5	23,445.5	18.0
2005	142,225.0	24,850.8	17.5
2006	147,322.1	25,867.9	17.6
2007	153,676.0	27,570.8	17.9

Source: MEST website. http://english.mest.go.kr/main.jsp?idx=0401050201

Table 36. Number of Universities, South Korea (2002-2007)

Year	2002	2003	2004	2005	2006	2007
Number of Universities	163	169	171	173	175	175

Source: MEST website. http://english.mest.go.kr/main.jsp?idx=0401030101

Table 37. Enrolment Rate of Higher Educational Institutions, South Korea

	1980s	1990s	2000s	2005	2006	2007	2008
Enrolment Rate (%)	11.4	23.6	52.5	65.2	67.8	69.4	70.5

Source: MEST, 2009.

Table 38. Number of University & college Students and Graduate School Students by Field of Study, South Korea (2004)

	University & College Students (%)	Graduate School Students (%)
Arts & physical education	11.2	7.5
Education	6.1	22.0
Engineering	26.8	15.3
Humanities	11.9	13.0
Medicine & pharmacy	5.4	8.8
Natural science	10.4	8.1
Social science	28.2	25.3

Source: MEST website. http://english.mest.go.kr/main.jsp?idx=0401030201

Like many East and Southeast Asian countries, higher educational reform in South Korea was introduced since the mid-1990s, with particular emphasis on R&D. The landmark reform is the 1.4 trillion won **Brain Korea 21 Project** (BK21), which was initiated in the late 1990s to upgrade Korean universities. Again, as in the case of some other East Asian countries, selected South Korean universities are highly subsidized to develop themselves into world-class HEIs. “Natural/Applied S&T” and “Humanities & Social Sciences” were chosen as the two key academic areas (Moon & Kim, 2001).

Table 39. The First & Second Phase of Brain Korea 21 Project, South Korea

	First Phase Brain Korea 21	Second Phase Brain Korea 21
Period	1999-2005	2006-2012
Budget	US$1.34 billion	US$2.3 billion
Participation	564 centers/teams and 89,366 students over the 7-year period	74 universities, 244 centers, 325 project teams, 20,000 graduate

		students per year
Support	$400 per month for master's, $600 for doctoral, $1,250 for post-doc researchers, $2,500 for contract professors	$500 per month for master's, $900 for doctoral, $2,000 for post-doc researchers, $2,500 for contract professors

Source: MEST website, 2007.
http://english.mest.go.kr/main.jsp?idx=0301020101&brd_no=52&cp=1&pageSize=10&srchSel=&srchVal=&brd_mainno=528&mode=v

The major contributions of the project have been the nurturing of research talents, building up of research institutes and increase in research outputs (Shin, 2009). The official statistics shows that, under the first phase of this project, 6,602 doctors in S&T were produced; the numbers of S&T SCI-level papers rose from 3,765 in 1998 to 7,281 in 2005; and the nation's ranking in SCI-S&T papers improved from 16th in 1998 to 12th in 2005. Moreover, the quality of these papers has also improved as the Impact Factor per article increased from 1.9 in 1999 to 2.43 in 2005. With these achievements, the MEST subsequently set more ambitious goals for the second-phase project: to develop 10 top research-oriented universities in the key fields; to become one of the top-ten countries in SCI-paper publication; and also to become one of the top-ten advanced countries in university-industry technology transfer, with the goal of increasing the transfer rate from 10% in 2004 to 20% in 2012 (MEST, 2007).

Another significant and latest reform was the restructuring of the Ministry of Education. Similar to Japan, the Korean government has combined the Ministry of Science & Technology and the Ministry of Education into a new Ministry of Education, Science & Technology (MEST) in 2008, for it has foreseen the essential role education can play in S&T development in the future.

Singapore

As a small city-state with little endowment of natural resources, Singapore faces immense pressure in tackling challenges posed by globalization and knowledge economy. Since the 1990s, it began to develop its higher education as a globally tradable export service, with the ambition to forge itself a regional hub of education which could also contribute to its economic growth. Accordingly, the Ministry of Education not only created the third national university — Singapore Management University (SMU) in 2000 with a new and innovative governance & funding styles, but also corporatized the two existing public universities — the National University of Singapore (NUS) and the Nanyang Technology University (NTU) as non-for-profit companies in 2005 to make their governance more autonomous. Incorporation of public universities makes them more self-conscious and accountable for their operation, thus enhances competition among these three universities not only on educational quality but also on recruitment of local and international students and faculties.

Table 40. Overview of the Top-Two Universities in Singapore (Enrollment)

Univ.	Year	Graduate Student	International Grad. Student	Science (Grad.)	Eng. (Grad.)	Academic Faculty	Research Faculty
NUS	2006	6,031	3,462	937	1,876	1,820	1,218
	2007	6,309	3,696	967	1,925	1,944	1,464
	2008	7,020	4,024	1,049	1,947	2,103	1,710
NTU	2006	6072	---	---	---	1,466	850
	2007	6,871	---	---	---	1,515	998
	2008	7,238	---	284	3,532	1,580	1,057

Source: NUS Annual Report (various years); NTU Annual Report (various years).

Learning from international world-class universities, these universities have extended their operation by increasing effort on S&T-related research activities, and have continuously expanded the scale of their postgraduate education (see Table 40). In addition, the future landscape of higher education in Singapore will become far more diversified with the contribution from its reputable private universities[15] and polytechnics[16] which have also been strengthened recently.

Japan

The Japanese HE sector mainly comprised of national, public and private universities. It is expanding steadily in recent years with increasing number of national, public and private universities as well as their student population (see Table 41). A growing trend can also be observed in the annual university student intake and the corresponding entry rate (see Table 42).

Table 41. Number of Japanese Universities, 1999-2005

Year	Total		National		Public		Private	
	No. of Institution	No. of Student	No. of Institution	No. of Student	No. of Institution	No. of Student	No. of Institution	No. of Student
1999	622	2,701,104	99	621,126	66	101,062	457	1,978,916
2000	649	2,740,023	99	624,082	72	107,198	478	2,008,753
2001	669	2,765,705	99	622,679	74	112,523	496	2,030,503
2002	686	2,786,032	99	621,487	75	116,705	512	2,047,840

15 There are 8 private-comprehensive and/or private-specialized universities in Singapore.
16 There are 5 polytechnics which also engage in R&D activities in Singapore.

2003	702	2,803,980	100	622,404	76	120,463	526	2,061,113
2004	709	2,809,295	87	624,389	80	122,864	542	2,062,042
2005	726	2,865,051	87	627,850	86	124,910	553	2,112,291

Source: Ministry of Education, Culture, Sports, Science and Technology, Japan, 2006.

Table 42. Annual Intake of Japanese Universities, 1999-2005

	Student Enrollment	Entry Rate (%)
1999	221,480	29.4
2000	232,501	31.5
2001	241,249	32.7
2002	248,653	33.8
2003	242,514	34.4
2004	242,514	35.2
2005	245,525	36.8

Source: Ministry of Education, Culture, Sports, Science and Technology, Japan, 2006.

More specifically, we can also observe the increasing number of S&T university students over the last few decades. However, as shown in Table 43, although the total number of S&T students has increased significantly from 1970 to 2005, the share of S&T undergraduate, master's and doctoral students saw no significant rises, and some of them even indicated a decline. For example, the share of undergraduate engineering students had dropped from 21.1% in 1970 to 17.3% in 2005, and the share of doctoral science students from 17.1% to 8.6%.

Table 43. Percentage Distribution of Undergraduate, Master's and Doctoral Students by Selected Major Field of Study in Japanese Universities, 1970 & 2005

	Undergraduate		Master's		Doctoral	
	1970	2005	1970	2005	1970	2005
Total number of students	1,344,358	2,508,088	27,714	164,550	13,243	74,907
Share of social sciences (%)	41.8	37.7	16.6	12.5	13.0	10.1
Share of engineering (%)	21.1	17.3	37.0	39.9	17.8	18.6
Share of humanities (%)	12.7	16.2	18.6	8.2	14.2	10.2
Share of science (%)	3.1	3.5	10.8	8.5	17.1	8.6

Source: Ministry of Education, Culture, Sports, Science and Technology, Japan, 2006. *Japan's Education at a Glance 2006*

Similarly, the Japanese HE expenditure also maintains at a stable rate in recent years. As shown in Table 44, the share of HE in the total school education expenditure and in the GDP observe no significant changes.

Table 44. Expenditures on Higher Education (in US$ Million), 1999-2003

Year	Total Expenditure on School Education	Expenditure on Higher Education	Gross Domestic Product	Share of Higher Education Expenditure (%)	
				In Total Expenditure on School Education	In GDP
1999	285,549.4	87,258.4	5,573,593.7	30.6	1.57
2000	281,655.7	85,037.8	5,630,261.7	30.2	1.51
2001	283,206.7	85,772.7	5,496,380.5	30.3	1.56
2002	284,834.7	88,113.0	5,455,078.2	30.9	1.62
2003	279,787.8	87,386.5	5,499,517.3	31.2	1.59

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/170.pdf; http://www.mext.go.jp/english/statist/06060808/pdf/172.pdf

In sum, comparing with other selected cases in East Asia, the Japanese universities suffer no huge ups and downs in terms of the quantity of expenditure and student enrollment. Yet in fact, they have gradually adapted their roles and missions as well as their operating modes qualitatively in response to the rising competition both at home and from abroad.

Recent Higher Education Reforms: Major Development Trends and Challenges

The Quest for Entrepreneurial University and Changing University Governance

Being unsatisfied with the conventional model along the lines of "state-oriented" and "highly centralized" approaches in higher education, Asian governments have recently tried to "incorporate" or introduced "corporatization" and "privatisation" measures to run their state / national universities, believing that the transformations of which could make national universities more flexible and responsive to rapid socio-economic changes (Mok, 2006a; Oba, 2007). Instead of being closely directed by the Ministry of Education or equivalent government administrative bodies, state universities in Asia are now required to become more proactive and dynamic in looking for their own financial resources. Similar to their Australian and British counterparts, universities in Asia are now under constant pressures to become more "entrepreneurial" to look for alternative funding sources from the market, strengthening their partnerships with the industry and the business (Marginson and Considine, 2000; Mok, 2008; Olsen and Gornitzka, 2006).

Adhering more towards the market and corporate principles and practices, universities in Hong Kong are now run on a market-oriented and business corporation model. Universities of the city-state have experienced corporatization and privatisation processes, whereby higher education institutions in Hong Kong have proactively engaged in fostering entrepreneurship to search for additional revenue sources from the market (Lee and Gopinathan, 2005; Mok, 2005a). In order to enhance efficiency of university governance, the University Grant Committee (UGC), the organization which shapes the directions of higher education development in Hong Kong, has recently subscribed to the notion of "deep collaboration" among universities, believing that synergy could be pulled together if universities in the city-state could better integrate. The UGC even supports university merging or other forms of restructuring to further establish Hong Kong as a regional centre for excellence in research and scholarship (Chan and Lo, 2007; Lee, 2005).

Similarly, the Ministry of Education in Taiwan has decided to change the statutory position of state universities into independent judicial entity by adopting principles and practices of corporatization. In order to reduce the state burden in higher education financing, all state universities in Taiwan have to generate additional funds from non-state sectors such as the market and enterprises. In order to generate sufficient funds to finance their institutions, various kinds of market driven strategies have been adopted. More recently, the Taiwan Government has attempted to restructure its state universities by passing a new *University Bill* to make state universities independent legal entities. Influenced by the Japan model, state universities in Taiwan have to establish new governance structures; while they are under immense pressures for searching additional financial support from the non-state channels especially when the Taiwan government has reduced significantly its funding to them (Lo and Weng, 2005; Mok and Chan, 2008; Tien, 2006).

Japan is not immune from the impact of neo-liberalism, managerialism and economic rationalism, three major ideologies underlying the tidal wave of public sector reforms and reinventing government projects across the world. With the intentions to make its state university system more responsive and flexible in coping with intensified pressures generated from the growing impacts of globalization, the Japanese government has incorporated all state universities since 2004. Central to the transformation of the existing national universities into "National University Corporations" are three major reform aspects: increased competitiveness in research and education; enhanced accountability together with introduction of competition; and strategic and functional management of national universities (Oba, 2007).

Higher education restructuring is popular not only among East Asian states but also in Southeast Asian societies. Having reflected upon the changing university governance models and evaluated the recent experiences of Singapore Management University (SMU), the Ministry of Education in Singapore has decided to change the governance models of the existing state universities, namely, National University of Singapore and Nanyang Technological University by making them independent legal entity through the process of "corporatization" (Mok, 2005, 2006a). By incorporatizing these state universities, the Singapore government hopes that universities on the island state could become more entrepreneurial. Putting the above governance / management reforms taking place in the Asian higher education systems into perspective, it is clear that the recent higher education transformations and restructuring are part of the wider reinventing state projects or the reengineering of the public sector exercises launched in Asia.

Growing Privateness in Higher Education

The four East Asian Tigers (Hong Kong, Taiwan, South Korea and Singapore) have devoted a considerable amount of public money to education. Total public expenditure on education now ranges between 3.5 and 4.5 percent of GDP. Although the GDP ratio in the four East Asian Tigers is relatively low when compared with Western countries, education is one of the most important and high-spending policy areas (see table 45). Public education is about 20 percent of the total budget in the four Tigers. The state is still the dominant funder of education in these societies. Table 46 further shows the public expenditure per student in tertiary education as % of GDP per capita of the selected five Asian societies.

Table 45: A Comparative Perspective of Tertiary Education in East Asia

	Gross enrolment ratio (%)	Public expenditures per student (% of GDP per capita)
East Asia & Pacific[1]	22.5 (2007)	/
China	23.0 (2007)	/
Hong Kong	33.8 (2007)	47.3 (2007)
Japan	58.1 (2007)	19.6 (2005)
Korea	94.7 (2007)	9.3 (2005)
Malaysia	32.0 (2005)	93.7 (2005)
Singapore	/	/
Taiwan	83.2 (2008)	/

Source: Ministry of Education, Taiwan (2009); World Bank (2007a, 2008)

Note:

1. East Asia & Pacific includes: American Samoa, Cambodia, China, Fiji, Indonesia, Kiribati, Korea, Dem. Rep., Lao PDR, Malaysia, Marshall Islands, Micronesia, Fed. Sts., Mongolia, Myanmar, N. Mariana Islands, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Thailand, Timor-Leste, Tonga, Vanuatu, Vietnam.

Table 46: Public Expenditure per Student in Tertiary Education as % of GDP per Capita

	GDP average annual % growth		Public expenditure per student in tertiary education as % of GDP per capita	
	1990-2000	2000-2007	1999	2007
Hong Kong	3.6	5.2	--	47.3
Japan	1.1	1.7	15.1	19.2
Singapore	7.6	6.1	--	--
South Korea	5.8	4.7	8.4	9.3
Taiwan	6.5	3.8	36.6*	30.9*

Source: Council for Economic Planning and Development, Executive Yuan, R.O.C. (Taiwan) (2009) *Taiwan Statistical Data Book 2009*; World Bank (2009) *World Development Indicators*, Washington (D.C.): World Bank; Statistics Singapore (2009) *Time Series on GDP at 2000 Market Prices and Real Economic Growth*, http://www.singstat.gov.sg/stats/themes/economy/hist/gdp1.html.

Note: * The data are calculated by the author. GNP per capita is used instead of GDP per capita due to unavailability of data.

Despite the state's financial commitment in higher education, we have noticed that higher education funding sources have been diversified in South Korea, Taiwan, Japan and Hong Kong in the last decade. Table 47 clearly demonstrates private funding sources have played a more important role in higher education financing in Japan, Taiwan and South Korea, especially when the higher education systems in these countries are far more private dominance when compared to Singapore and Hong Kong with a public dominance. Thus, the revitalization of the private sector and the liberalization of the market have contributed to the rapid expansion of higher education enrolments in these countries.

When comparing higher education provision among the four East Asian Tigers, it is noted that the major differences related to the roles that the public and private sectors play. While the majority of universities / higher education institutions in Hong Kong and Singapore are either run by the government or heavily state financed, there is a clearer private-public mix in South Korea, Taiwan and even Japan with private dominance. But one point which deserves attention is that the conventional public-private distinction is no longer appropriate especially when private financial contributions and fee-paying practices are becoming increasingly popular in East Asia. In order to increase the higher education enrolment rate, we have also witnessed the growing prominence of the privateness in the higher education of Singapore and Hong

Kong since these Asian states have attempted to make use of the market to fulfill the policy goals of massification of higher education. Table 47 clearly indicates a growing numbers of private higher education institutions in selected Asian countries, suggesting also the proportion of student enrolment in private higher education institutions has increased steadily in the region (Tilak, 2006: 115). Therefore, private higher education sector has paid for much of the higher education sector expansion, leading to revolutionary changes and imparting a growing "privateness" to Asian higher education systems as what Altbach and Levy (2005) have argued.

Table 47: Private Higher Education in Selected Asian Countries

Country	Private higher education institutions as % of all higher education institutions	Year	Enrolment in private higher education institutions as % of total enrolment	Year	Private universities as % of all universities	Year	Enrolment in private universities as % of enrolment in all universities	Year
Predominantly private (private higher education institutions as % of all higher education institutions: 50)								
Malaysia	92.2	2000	39.1	2000	41.7	2000	7.5	2000
Japan	86.3	2000	77.1	2000	73.7	2000	73.3	2000
Philippines	81.0	1999	76.0	1999	/	/	/	/
Thailand	68.0	2001	19.0	2001	48.9	2001	16.8	2001
Moderately private (private higher education institutions as % of all higher education institutions: 25)								
China	39.1	2002	8.9	2002	0.6	2002	/	/
Russia	37.1	2001	10.0	2001	/	/	/	/

Source: Tilak (2006, 115)

The growing privateness of higher education in East Asia has intensified the inequality in education, leading to the growing divide between the rich and the poor whose educational experiences would be very different. The growing trends of privatization, marketization and commodification in higher education have suggested a clear tendency of state withdrawal from being the primary provider and financial supporter for higher education. Our discussions in the first part in reviewing the national innovation systems have clearly indicated a paradigm shift from state / government-led model towards a more market-driven and firm led approach in innovation promotion. Putting the retreat of the state in higher education financing and provision in these Asian societies, it is not difficult to anticipate more reliance will be placed upon the industry, the market and the university or even the individuals in supporting higher education development and innovation advancement. Such a development may favour those disciplines which are more sensitive and responsive to the market forces, while the same process would undermine disciplines which are less market-valued. What makes the situation worse is when the global economic market is becoming less vibrant, the unstable economic environment would considerably undermine research and development in general and innovation advancement in particular. A critical examination of the most recent higher education reforms in these Asian societies has clearly suggested students in these societies nowadays experience more difficulty for social mobility but suffer more from intensified social inequality and growing uncertainty in career development and economic prospects.

Our above analysis has clearly indicated higher education development in East Asia has moved towards market-orientation. There are two major reasons accounting for this trend: first is related to financial reason especially when the Asian governments realize depending upon the state funding would not be sufficient to finance the pressing demand for higher education; second is to make use of the market force for driving the higher education institutions to compete and perform better in increasing accountability. But after implementing the 'marketization' policy, some Asian governments find the interactions between the higher education institutions and the industry / business has proved to be productive and conductive for enhancing innovation, such synergy is hence positively encouraged as evident in Taiwan, South Korea and Japan.

The Role of Higher Education in Promoting Innovation

As discussed earlier, industry-HEIs relationship is found to be the core of national innovation system in many developed countries, allowing a two-way exchange between academic sophistication and market-oriented innovation to create win-win situation for both partners. In order to develop a better understanding of the role of the university in innovation promotion, we must contextually analyze the changing role of the university in innovation advancement against the context of recent higher education reforms discussed in the above part. It is against the growing popularity of the privatization, marketization and commodification of higher education that higher education systems in the selected Asian societies have tried to move beyond their conventional boundary to engage in collaborating with the industry and business in promoting innovation. The following part critically reflects upon the changing role of higher education in promotion of innovation and technology.

Hong Kong

As shown in Table 48, among the university student population of Hong Kong, the shares of students from engineering & technology and science have been the largest and third largest cohorts in recent years. As for the postgraduates, which are more likely to engage in R&D activities after graduation, the government has accordingly planned to provide 800 additional places for postgraduate research programs (all fields, not exclusively for S&T-related programs) from 2009/10 to 2011/12, hoping that it will enhance the R&D manpower in Hong Kong. It is estimated that an additional HK$300 million will be needed each year (Hong Kong government, 2008: 36).

Table 48. Student Enrollment (Full-Time Equivalent) of UGC-Funded Undergraduate Programs by Field of Study, Hong Kong (2004/05-2008/2009)

Academic Year	2004/05	2005/06	2006/07	2007/08	2008/09
Medicine, Dentistry & Health	5,685 (8.2%)	5,772 (8.5%)	6,031 (9.1%)	6,165 (9.3%)	6,260 (9.3%)
Sciences	11,882 (17.1%)	11,667 (17.2%)	11,395 (17.1%)	11,020 (16.7%)	11,074 (16.4%)
Engineering & Technology	13,536 (19.5%)	13,471 (19.9%)	13,546 (20.4%)	13,664 (20.7%)	13,976 (20.7%)
Business & Management	13,812 (19.9%)	13,262 (19.6%)	12,876 (19.3%)	13,078 (19.8%)	13,480 (19.9%)
Social sciences	9,415 (13.6%)	9,387 (13.9%)	8,961 (13.5%)	8,853 (13.4%)	9,117 (13.5%)
Arts & Humanities	9,692 (14.0%)	9,635 (14.2%)	9,220 (13.9%)	8,623 (13.0%)	8,946 (13.2%)
Education	5,291 (7.6%)	4,521 (6.7%)	4,529 (6.8%)	4,685 (7.0%)	4,814 (7.1%)
Total	69,313	67,715	66,558	66,088	67,659

Source: UGC, Hong Kong, 2009. http://www.ugc.edu.hk/eng/doc/ugc/stat/apcfte_series.pdf

In terms of research, which is also closely related to innovation, Table 48 shows that the total amount of departmental expenditure on research is expanding, and this phenomenon is coupled with a mild improvement of research in Hong Kong's HEIs recently (see Table 49 & 50).

Table 49. Expenditure of UGC-Funded Institutions as a Whole, Hong Kong (2001/02-2007/08)

Academic Year	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Gross Domestic Product (US$ Billion)	164.2	160.4	162.3	170.0	183.3	196.2	215.0
Expenditure of UGC-Funded Institutions (HK$ million)							
Total Expenditure	2,374.2	2,374.4	2,326.8	2,258.2	2,312.3	2,449.7	2,727.4
Departmental Expenditure on Research	621.4	615.5	614.9	603.5	651.9	693.7	776.5
Ratio of Expenditure of UGC-Funded Institutions to GDP							
Total Expenditure	1.45%	1.48%	1.43%	1.33%	1.26%	1.25%	1.27%

Departmental Expenditure on Research	0.38%	0.38%	0.38%	0.36%	0.36%	0.35%	0.36%

Source: UGC, Hong Kong, 2009. http://www.ugc.edu.hk/eng/doc/ugc/stat/expend.pdf

Table 50. Research Outputs in S&T Fields, Hong Kong's HEIs (2006/07 & 2007/08)

	Total Research Outputs		Refereed Research Outputs		Prizes & Awards	
	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08
Biology & Medicine	6,434	6,450	5,338	5,399	120	200
Physical Science	2,581	2,579	1,772	1,786	35	46
Engineering	5,996	5,830	4,690	4,320	134	163

Source: UGC, Hong Kong, 2009. http://www.ugc.edu.hk/eng/doc/ugc/stat/outputbsa.pdf.

Apart from conducting their own research, another role played by Hong Kong universities regarding innovation is to join with the government in operating **research centers**. In June 2004, the Innovation and Technology Commission issued a Consultation Paper entitled *New Strategy of Innovation and Technology Development*, which put forward a new direction for Hong Kong's innovation system, emphasized a focus on selected strong industries, market relevance, industry participation, leverage on the Mainland China, as well as a better coordination among stakeholders. Two proposals in the Consultation Paper are worth highlighting. First, the Paper proposed 13 technology focus areas[17] that Hong Kong should direct enough resources to develop. Secondly, the Paper proposed to set up five research centers under the Hong Kong R&D Centers Program;[18] some of which are hosted by leading universities in Hong Kong (see Table 51). Together with the Hong Kong Jockey Club Institute of Chinese Medicine, these six government-university-industry cooperated centers are among the leading research centers in Hong Kong.

The setting up of these research centers in 2006 was a breakthrough of R&D in Hong Kong, especially demonstrating the fact that the Hong Kong was willing to set aside its conventional "non-interventionist" industrial policy and to take up a more proactive role. The government explains that the state-led initiative has "…the aim to harness Hong Kong's advantages in applied research, intellectual property protection, business-friendly environment, and proximity to the manufacturing based in the Pearl River Delta (PRD), to thrive as a regional technology service hub."[19] It is still

[17] The 13 technology focus areas include: (1) advanced manufacturing technologies; (2) automotive parts & accessory systems; (3) Chinese medicine; (4) communications technologies; (5) consumer electronics; (6) digital entertainment; (7) display technologies; (8) integrated circuit design; (9) logistics / supply chain management enabling technologies; (10) medical diagnostics & devices; (11) nanotechnology and advanced materials; (12) opto-electronics; and (13) textile and clothing.

[18] http://www.itc.gov.hk/en/rdcentre/rdcentre.htm

[19] http://www.itc.gov.hk/en/rdcentre/rdcentre.htm

premature to assess their results because they have operated for only four years, but the establishment of the R&D centers, *per se*, is a significant step forward for closer R&D co-operations among the government, industry and university.

Table 51. Research Centers under the Hong Kong R&D Centers Program

Research centers	Universities involved
Automotive Parts & Accessory Systems (APAS)	✷ No university involved
Information & Communication Technologies (ICT)	✷ No university involved
Logistics & Supply Chain Management Enabling Technologies (LSCM)	✷ University of Hong Kong ✷ Chinese University of Hong Kong ✷ Hong Kong University of Science & Technology
Nano & Advanced Materials (NAMI)	✷ Hong Kong University of Science & Technology
Textiles & Apparel (RITA)	✷ Hong Kong Polytechnic University

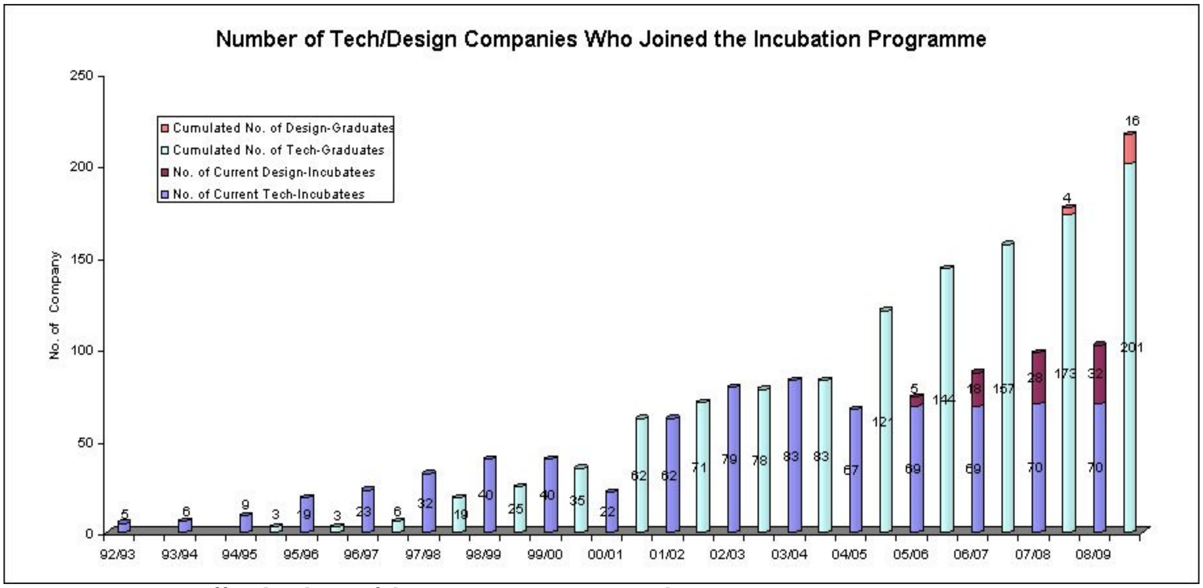
Source: Innovation and Technology Commission, HKSAR, 2004. *New Strategy of Innovation and Technology Development*.

Apart from research centers, inspired by the success of Singapore, South Korea and Taiwan, Hong Kong government also began to study the formation of **science park** in 1992 (Parayil & Sreekumar, 2004), and it was eventually established in 2001. Like any other science parks across the world, the Hong Kong Science Park, located next to the Chinese University of Hong Kong, also emphasizes on “industry-university collaboration” that aims at building up network to facilitate partnership among enterprises, strengthening talent pool, bringing expertise together into university and industry, organizing training and seminar, as well as promoting successful research outputs and developing products.[20]

As shown in Figure 4, the number of tech/design companies which have joined incubation programs in the Science Park keeps increasing over the past decade or so. However, an evaluation study has found that firms in Science Park lack sharing technical resources since every firm has its own specific needs and resources. The interaction among the firms may not be so complementary and synergistic. University-technology start-ups relationship is more useful than science park-technology start-ups relationship in the product development process, since universities can provide firms with hardware resources like laboratory and workshop facilities, as well as software support such as consulting services (Chan & Lau, 2005).

[20] http://www.hkstp.org/HKSTPC/en_html/en_full18_1.jsp

Figure 4. Number of Tech/Design Companies Joining the Incubation Program in the Hong Kong Science Park, 1992-2009



Source: Official website of the Hong Kong Science Park.

From the standpoint of universities, except for waiting to be invited or motivated by the government to engage in R&D activities with the industry, since the 1990s, they have actively sought ways to explore the potential of university-industry partnership, mainly through setting up spin-off companies and technology transfer office (Sharif & Baark, 2008). For instance, the Hong Kong University of Science and Technology has established its HKUST R&D Corporation both in Shenzhen and Hong Kong; as well as a Technology Transfer Center in January 2007. Likewise, the Hong Kong Polytechnic University established its Institute for Enterprise, which consists of several operating units that help to facilitate R&D commercialization and technology transfer.[21] Moreover, the International Strategic Technology Alliance and the Shenzhen Research Institute were formed to foster research collaboration and technology transfer with international community and the Mainland China respectively.[22] As for the University of Hong Kong (HKU), a company called Versitech and the Technology Transfer Office has also been set up. In fact, HKU revisited its vision and mission in 1998, placing more emphasis thereafter on applied research.[23]

Finally, another noteworthy development concerned is the role of Hong Kong

[21] These units are: Technology and Product Development Group; Management and Executive Development Centre; Partnership Development Office; PolyU Technology & Consultancy Company Limited; PolyU Outpost Centre.

[22] In face of the expanding bureaucratic structure and increasing importance of these R&D activities, the university has even arranged one of its Vice President to oversee partnership development.

[23] HKU however stresses that paying more attention to applied research is by no means to sacrifice the quality of research, "the goal is to produce results of 'relevance' to the community, through 'excellence'..." (http://www.hku.hk/rss/direction.htm).

universities in RIS. Many people in 1990s have already envisioned that Hong Kong's innovation system would be increasingly integrated with Mainland China's in face of the handover.[24] Aiming to develop Hong Kong into an innovation hub, since the 2000s, the government has tried to position Hong Kong as a regional service hub for the Pearl River Delta (Baark & So, 2006). This vision became reality when Shenzhen and Hong Kong signed the **Shenzhen-Hong Kong Innovation Circle** cooperation agreement in May 2007. The newly-developed Innovation Circle aims to establish innovation bases, service platforms and initiate major research and development projects. One of the goals is to set up a Shenzhen-Hong Kong Industry-University-Research Base for Hong Kong's Universities.[25] In the 2007 Budget, the Financial Secretary pledged to relax restrictions imposed on the University-Industry Collaboration Program to further its development. Meanwhile, the Innovation and Technology Fund also put forward a consultation paper, suggesting that the government relaxed geographical restrictions on the Program and allow the industry to choose non-local universities as partners, as well as conducting their R&D activities outside Hong Kong (Innovation and Technology Commission, 2007).

While in general, these proposed relaxation measures were welcomed by trade associations and professional bodies, local universities expressed a more reserved support, fearing that such a proposal will move R&D activities out of Hong Kong.[26] Nevertheless, in 2008, the government has successfully made a deal on the first mega-project under the concept of the Innovation Circle. The U.S. firm DuPont has agreed to establish the Global Thin Film Photovoltaic Business/R&D Center in the Hong Kong Science Park, while setting up its production line in Shenzhen (Hong Kong SAR Government, 2008).

Taiwan

The ambition of Taiwan in R&D activities is best indicated by the far-reaching policies it has put forward, especially in regard to higher education. For example, the

[24] According to a consultant report on Hong Kong Science Park conducted in the early 1990s, out of the 560 tech-based firms interviewed in 17 countries, 63 of them (mainly from Mainland China, west coast USA and the strongest European economies) expressed interest in establishing firms in the Park. One of their main reasons is the possibility of exploring the market, manpower and technological potential of China (Yeh & Ng, 1994).

[25] The Secretary for Commerce & Economic Development of HKSAR, Rita Lau, explained the design of the Circle that: "the action plan comprises 24 cooperation projects under three categories: Innovation Foundation (provision of laboratories or facilities), Service Platform (sharing of technological resources and provision of technological services platform); and Major research and development (R&D) Projects (cooperation in particular technological areas, such as solar battery)" (Hong Kong Information Services Department, 2009).

[26] For example, the University of Hong Kong suggested that priority should be given to local R&D organizations and institutions. Similarly, the Hong Kong Polytechnic University proposed that the government should set a ceiling on the amount of R&D activities eligible outside Hong Kong, and only allow non-local R&D work if there is no relevant local expertise and capability in Hong Kong (Legislative Council Panel on Commerce and Industry, 2008).

National S&T Development Plan (2001-2004) outlines the proposal of "strengthening the training, recruiting, and utilization of technological manpower" as one of the S&T development strategies (National Science Council [NSC], 2001). The mid-term goal of this strategy was to increase the number of research personnel with a bachelor degree to 80,000, and at least 60% of the overall personnel with an MS or PhD degree by 2004. The long-term goal towards 2010 is to increase the number of the former to 100,000, and the proportion for the latter to at least 65% (ibid.).

Intending to strengthen the quality of S&T manpower in universities, the second **National S&T Development Plan (2005-2008)** vowed to (1) implement "macro planning of higher education"; (2) encourage "the development of interdisciplinary courses, shrinking the gap between university education and industrial S&T manpower needs"; and (3) strengthen "cooperative work-study programs involving industry, academia, and research organizations in order to boost S&T manpower development" (NSC, 2005: 14).

Against this policy backdrop, as shown in Table 52, the total number of S&T students has increased over the past decade from 593,419 in 2000/01 to 635,709 in 2008/09, though the share of S&T students to the whole student population continues to decline.

Table 52. Enrollment of S&T students in Taiwanese Tertiary Educational Institutions

Academic Year	Total Enrollment	Enrollment in S&T Fields	
		Number	As Share of Total (%)
2000-2001	1,092,102	573,419	52.51
2001-2002	1,187,225	611,793	51.53
2002-2003	1,240,292	625,468	50.43
2003-2004	1,270,194	632,273	49.78
2004-2005	1,285,867	631,862	49.14
2005-2006	1,296,558	634,255	48.92
2006-2007	1,313,993	638,789	48.61
2007-2008	1,326,029	639,391	48.22
2008-2009	1,337,455	635,709	47.53

Source: Ministry of Education, Republic of China, 2009. Enrollment in Tertiary-by program, http://english.moe.gov.tw/lp.asp?CtNode=1184&CtUnit=415&BaseDSD=7&mp=1.

In terms of industry-academia collaboration, *Chanxie hezuo* is indeed a buzzword in Tawian's HE sector. As shown in Table 53, the government has continued to pour a large amount of money to achieve the goal, accounting for over 80% of the total funding for higher education's R&D activities in the past few years.

Table 53. Higher Education R&D Expenditure (in US$ Million) by Source of Fund,

Taiwan (2003-2007)

	Business Enterprise	Government	Higher Education	Private Non-Profit	Abroad
2003	156.0 (4.2%)	3,150.4 (85.1%)	353.1 (9.5%)	38.6 (1.0%)	5.8 (0.2%)
2004	200.6 (5.2%)	3,245.6 (83.4%)	393.3 (10.1%)	48.7 (1.3%)	2.6 (0.1%)
2005	237.7 (5.8%)	3,427.9 (83.3%)	397.8 (9.7%)	48.6 (1.2%)	2.3 (0.1%)
2006	267.7 (5.6%)	4,079.1 (84.7%)	413.8 (8.6%)	51.9 (1.1%)	3.5 (0.1%)
2007	275.1 (5.3%)	4,449.5 (85.9%)	401.7 (7.8%)	50.3 (1.0%)	2.9 (0.1%)

Source: National Science Council, Republic of China, 2008.

Regarding research incentives for R&D personnel in HEIs, the National S&T Development Plan (2005-2008) suggests revising regulations, so that instructors could participate in industry-academic cooperation incentive mechanisms (NSC, 2005: 21). Also, it suggests the expansion of pre-employment courses to train industry-needed manpower, allowing industry personnel to participate in course planning (ibid.: 22). In 2007, rules were also passed by the Ministry of Education to include the performance of HEIs' industry-academia collaboration as one of the criteria for evaluation, as well as awarding faculty members and students who have performed well in the collaboration (Ministry of Education, ROC, 2007b).

As for the forms of industry-academia collaboration in Taiwan, the two mainstream formats are as follows:

(1) **Technology Transfer Office**. For instance, the National Taiwan University and National Tsinghua University, selected by the Ministry to be the potentially world-class universities, have formed the Technology Transfer Bureau and the Office of Technology Licensing respectively. Another example that worth mentioning is the case of National Chiao Tung University. As one of the oldest and most renowned research universities in Taiwan, it continues to supply much of the R&D personnel for ITRI and the Hsinchu Science Park since the 1970s. In order to build upon its previous success, the University established the Office of Research and Development in 1995-96 to orchestrate all related activities, such as the commercialization and

licensing of its R&D outputs, as well as building the portfolio of intellectual property rights of the university (Mathews & Hu, 2007, 1012).

(2) **Incubation Center**. This is a common form of industry-academia collaboration in Taiwan since the government finds it hard for SMEs to establish their own research departments. Seen in this light, support from the government and academic institutions is significant and pivotal to their growth and competitiveness. In 1997, SMEA launched the Innovation Incubation Program. As of 2008, there were already 104 incubation centers with more than 3,380 incubated enterprises in Taiwan. Overall, an amount of NT$51.9 billion have been invested, and 45 incubated companies listed as OTC (Over-the-Counter) or on the Taiwan Stock Exchange (Ministry of Economic Affairs, ROC, 2008).

Table 54. Number of Incubation Centers by Type, Taiwan (2008)

	No. of Incubation Centers
Universities	84 (80.8%)
Government Agencies	10 (9.6%)
Foundations	9 (8.7%)
Private Enterprises	1 (1.0%)
Total	104 (100%)

Source: SME Administration, Ministry of Economic Affairs, Taiwan, 2008

As shown in Table 54, universities-based incubation centers constitute over 80% of the total 104 incubation centers, followed by government agencies (9.6%) and foundations (8.7%). The share of private enterprises is below 1%. The importance of Taiwanese universities to SMEs' R&D development is very obvious in this vein. As a recent statistical study indicates, SMEs in Taiwan are deeply involved in university-industry linkages, and have transformed their innovation activities from process innovation to product innovation through these linkages. The study also shows that SEMs tend to cooperate with the public rather private universities, since the resourceful former are more capable to help SEMs in the emerging industries like biotechnology and nanotechnology (Hu & Mathews, 2009).

Table 55. Top Ten Categories of Incubation Center in Taiwan

Category	Distribution	Category	Distribution
IT & Electronics	30.02%	Environmental Protection Industry	3.86%
Machinery & Electric Machinery	18.05%	Multimedia & Broadcasting	3.63%
Biotechnology	14.52%	Medical Industry	3.60%
Raw Material	4.21%	Education & Cultural Art	3.26%
Livelihood Industry	3.93%	Petrifaction & Chemical	1.90%

Source: SME Administration, Ministry of Economic Affairs, ROC, 2008.

The National Tsing Hua University's Innovation Incubator (THII) is a successful example that worth noting in this regard. THII implemented a "feedback system" since 2000, which requires the incubated companies to contribute certain profits back to THII for the maintenance and expansion of its operation.[27] However, due to insufficient funding from the government, some less resourceful universities have to form their own alliance of innovation incubators. For example, the Chou Shui River League of Incubation Centers has been formed by a group of universities along the River, including the Dayeh University, National Changhua University of Education, Mingdao University, Chienkuo Technology University, National Yunlin University of Science & Technology, National Formosa University, Transworld Institute of Technology, Nan Kai Institute of Technology, and the National Chiayi University. The league organizes a business alliance conference each year to attract companies (Yang, 2007).

South Korea

In South Korea, most R&D expenditures were used for development research (over 60%), followed by applied (about 20%) and basic research (about or less than 15%) (see Table 56). Notably, it is not universities which perform basic research the most; rather this leading role is taken up by companies, particularly large companies (see Table 57). Andersson & Dahlman (2001) explain that the reason why South Korean universities do not focus on basic research is the lack of government funding as compared to governmental research institutes. Therefore, they have to turn to private enterprises for funding through conducting applied and development research (cited in Shapiro, 2007: 176).

Table 56. Trend of R&D Expenditure by Research Stage, South Korea,2000-2005 (in US$ Million)

	2000	2001	2002	2003	2004	2005
Total	12298.8	14307.7	15,386.4	16,934.9	19,702.8	21,452.4
Basic (%)	12.6	12.6	13.7	14.5	15.3	15.3
Applied (%)	24.3	25.3	21.7	20.8	21.2	20.8
Development (%)	63.1	62.1	64.6	64.7	63.5	63.8

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402010601

[27] By 2007, "about NT$2 million, contributed products worth NT$15 million and 336,281 stock shares have been received" (Fan, 2007).

Table 57. Basic Research Expenditure by Sector, South Korea (in US$ Million)

	2004	2005
Total	3,019.0	3,292.0
Public Research Institutes	547.2 (18.1%)	607.9 (18.5%)
Universities	654.4 (21.7%)	740.5 (22.5%)
Companies	1,817.5 (60.2%)	1,943.6 (59.0%)
- Large	1,579.6	1,778.5
- Small & Medium Sized	159.0	93.7
- Venture	79.0	71.4

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402010601

In this regard, universities usually team up with SMEs for applied and development research. As mentioned earlier, *Chaebols* (big corporations) in South Korea have their own resources to conduct in-house research. Since SMEs lack the research capacity and expertise, they are the frequent partners in university-industry collaboration. Kim's (2001) analysis shows that after the 1997/98 Asian Financial Crisis where *Chaebols* started to cut their R&D expenditures, SMEs seized on the opportunity to jumpstart innovation. The number of venture firms increased exponentially from 100 before the Crisis to more than 7,000 in the mid 2000s (cited in Shapiro, 2007: 176). A study taken by the Korean Research Foundation in 2007 found that in 2006, 51.6% of the university-industry research collaborations by the 12 leading universities were conducted with SMEs with a size of less than 300 employees (Hemmert et al., 2008: 167).

Among the leading universities, different situations have been encountered in dealing with the university-industry research collaborations. For the Seoul National University, it consists of 17 government-funded research centers. In 2007, the university conducted 4,473 research projects. The total amount of research fund was 356,000 million won. The government's funding constituted about 84.4% of the total pool of research resources, while that of private sector and college only accounted for about 12.8% and 2.6% respectively. There are 44 "Brain Korea 21" research groups, with about 70% of staff participating. With all these resources, the Seoul National University has improved its research output. For example, the number of SCI paper publications has increased from 3,062 in 2003 to 3,946 in 2005, and even to 4,219 in 2007.[28] As for the Korean Advanced Institute of Science and Technology, in 2007, it

[28] SNU website, http://www.useoul.edu/research/res0201.jsp

has devoted nearly 32% of its US$397 million budget to research activities, while 31% was allocated for education. As a whole, US$124 million of its budget came from government subsidy, US$128 million from research grants, and US$145 million from donation and other income.[29]

Compared to other selected cases, the South Korean universities, similar to their Japanese counterparts, are involved in the development of regional innovation systems[30] within the country, playing a role of knowledge provider to local industries. The **New University for Regional Innovation Project** was launched by MEST from 2004 to 2008 with the intention to make university graduates more readily to work in local industry.[31] Secondly, the South Korean universities participate in the building and development of regional science parks. In fact, this push for the development of RISs has implication on public management. The emphasis on RISs was regarded as a shift of governance from centralization to decentralization (e.g. local states have more power over local affairs) through which innovation efficiency can be bolstered, and that the dynamic balance between advanced and not-so-advanced regions achieved (Kim, 2007).

Over the years, the South Korean government has launched various programs to advance the development of university-industry collaborations and RISs, including the Leading Technology Development Program, the Science Research Center Program, the Engineering Research Center Program, and the 21st Century Frontier R&D Project (Ministry of Science & Technology, 2008, cited in Sohn et al, 2009). These programs and other related polices are intended to balance the innovation systems between capital regions and non-capital regions. For example, during the Rho administration in the late 80s and early 90s, the government initiated the Regional Industry Support Program to support the development of RISs in 13 non-capital regions (Korean Institute for Industrial Economics & Trade et al., 2007, cited in Sohn et al., 2009). However, despite the successive launch of different programs, South Korea's regional innovation system, as compared to that of the European Union, is far from genuinely regionally in nature, for the central government is still adopting a top-down approach on regional innovation policies (Kim, 2007).

Singapore

Observing increasing emphasis on research in 1990s at Singapore's HEIs, especially at the three autonomous universities, their linkages with technology

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[29] KAIST website, http://www.kaist.edu/english/01_about/02_glance_04.php?pt=10

[30] "Regional innovation" here refers to co-operation of cross-city's R&D activities, not cross-country's.

[31] The government had devoted around US$1.3 billion into the project, and a total of 109 local universities, 130 project units and 170,000 students have participated. As a result, the graduate employment rate has increased from 60.2% in 2004 to 68.1% in 2006 (MEST, 2007).

commercialization and industrial production became closer and closer, illustrating an overall shift towards an entrepreneurial university model. As shown in Table 59, the total number of patent application and patent granted from the HE sector increase substantially, although there is a sharp decease in 2007. S&T revenue from licensing and commercialization tend to varies over the years depending on technology breakthrough, but they are found to be a significant contributor to NIS, especially licensing revenue from patent and new technology development.

Table 59. S&T Patenting and Revenue in the Higher Education Sector (2001 – 2007)

Year	S&T Patenting				S&T Revenue (in US$ Million)			
	Patent Applied		Patent Awarded		Licensing		Commercialization	
	HE	% of TN	HE	% of TN	HE	% of TN	HE	% of TN
2001	126	11.50	29	6.29	0.51	1.31	0.83	0.007
2002	129	13.78	42	9.31	0.61	0.98	0.04	0.001
2003	98	9.79	44	9.57	0.67	0.71	0.04	0.000
2004	245	19.49	59	9.85	0.36	0.24	0.05	0.000
2005	201	0.13	57	0.06	0.17	0.26	0.19	0.002
2006	200	9.82	79	0.08	0.76	0.76	0.02	0.000
2007	100	5.75	67	7.12	0.40	0.43	0.80	0.007

Source: A*STAR, Singapore National Science and Technology Survey (various years).

Positioning as the Singapore's premier university in S&T, NUS began to establish a technology licensing office in mid-1990s. A significant move of NUS toward an entrepreneurial university is the creation of NUS Enterprise, a new division at the university to formulate policies with respect to governance of technology commercialization and to reform university education with entrepreneurial spirits (NUS, 2009). The NUS Enterprise Incubator Ecosystem (NEI), on the other hand, provides infrastructural support for technology start-ups that are directly or indirectly linked to NUS, including spin-offs by NUS professors and students that seek to commercialize NUS IP, and other non-NUS start-ups (both local and foreign) that want to utilize NUS research resources, such as researchers and lab facilities, or that have partnership with NUS start-ups. Various types of financial assistances are available to eligible start-ups through the NUS Start-up Fund, which provides seed funding of up to S$200,000. Although the shift toward an entrepreneurial university in NUS is still in its early stage, it has shown obvious improvement in various aspects concerned.[32]

[32] According to its 2007/08 Annual Report, NTU hosted a total of 55 start-ups by its Enterprise Incubation in 2008, comparing with 12 start-ups in 2005/06. Among the 70 NUS enterprise portfolio

The Singapore Management University (SMU) and Nanyang Technology University (NTU) have also developed similar agencies at campus to promote technology transfer and foster entrepreneurship. The Institute of Innovation & Entrepreneurship at SMU was formed to collectively organize university-industrial affiliated activities through the IP Management Office, Joint R&D Programs, and affiliation with SMEs and enterprises (SMU, 2009). In addition, there are promotional and training programs to develop specific interest in innovation and entrepreneurial activities among SMU stakeholders. At the NTU, an Innovation & Technology Transfer Office (ITTO) was established in 2000 to manage innovation and entrepreneurship through facilitating the transfer of leading-edge technologies developed in the University to companies in the industrial sector (NTU, 2009). Research collaborations with NTU are undertaken in two forms: joint research programs or engaging NTU's research expertise to undertake the research projects. To ensure its research and technology innovation in line with public interest, ITTO formulated a set of policies on intellectual property, technology transfer and research collaboration to govern university intellectual property. Adding to this, ITTO provides relevant services to help university researchers to evaluate, protect, and commercialize their technological inventions, in the form of licensing or forming spin-off companies.[33]

On the other hand, since the implementation of its National S&T Plans in the early 1990s, the government has shifted the emphasis of R&D research to the private sector, reflected by the over-proportionate R&D funding to the private sector. As shown in Table 60 & Figure 5, from 1997-2007, the private sector consistently occupied over 60% of the total national R&D funding, while the HE sector only accounts for 10%-13% of these amounts, and shown a slight decline since 2003:

Table 60. Singapore National R&D Expenditure by Sector (1997-2007)

Year	R&D Expenditure by Sector (in US$ Million)									
	Total National (TNE)		Government Sector		Public Research Institutes		HE Sector		Private Sector	
	S$	% of GDP	S$	% of TNE	S$	% of TNE	S$	% of TNE	S$	% of TNE
1997	1,501	1.5	154	10.27	211	14.07	198	13.21	938	62.5
1998	1,778	1.81	214	12.04	250	14.09	218	12.28	1,096	61.64
1999	1,895	1.9	218	11.48	265	13.97	221	11.67	1,192	62.91
2000	2,147	1.88	302	14.09	272	12.66	241	11.23	1,331	61.99

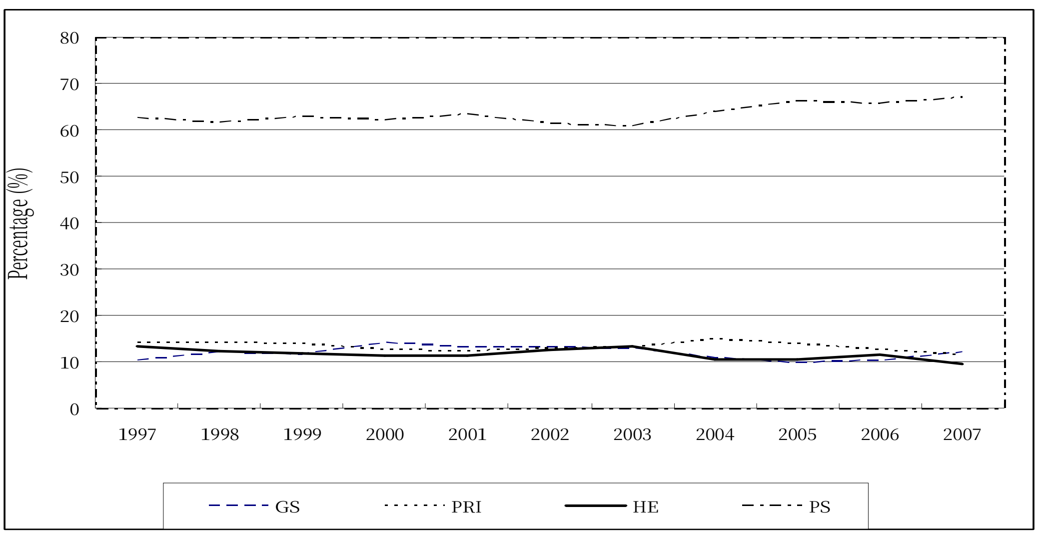
companies, 30 of them were spun out of the University using NUS intellectual properties.

[33] The Innovation Center is a sub-division of ITTO to provide space for NTU members to start up affiliated companies.

2001	2,306	2.11	303	13.15	283	12.25	262	11.35	1,459	63.25
2002	2,429	2.15	320	13.19	310	12.75	307	12.63	1,492	61.41
2003	2,443	2.11	311	12.73	321	13.14	327	13.37	1,485	60.76
2004	2,897	2.2	315	10.88	432	14.9	303	10.47	1,848	63.78
2005	3,269	2.3	316	9.67	449	13.75	341	10.43	2,162	66.15
2006	3,574	2.31	370	10.34	444	12.44	411	11.5	2,349	65.73
2007	4,522	2.61	550	12.16	521	11.52	430	9.51	3,021	66.81

Source: A*STAR, Singapore National Science and Technology Survey (various years).
Note: Taking the currency exchange rate of 25th Jan for analysis, which was about US$ 1 to S$ 1.4017.

Figure 5. Sector R&D Expenditure as a Percentage of Gross R&D Expenditure (1997-2007)

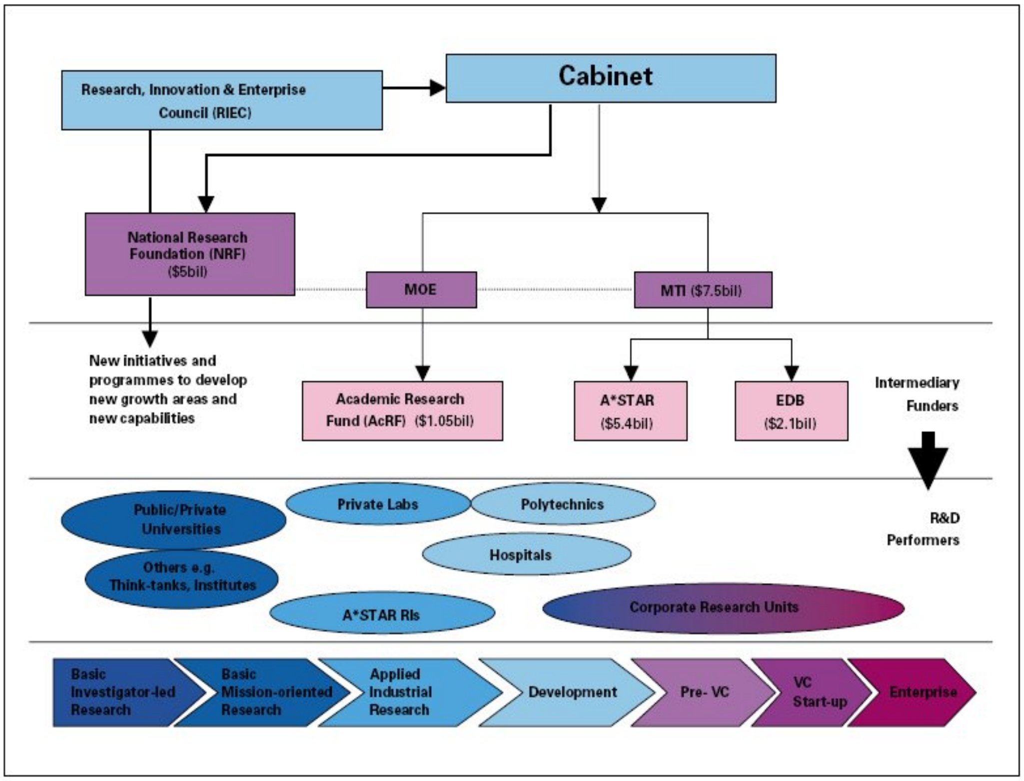


Source: A*STAR, Singapore National Science and Technology Survey (various years).

In the STP2010, it has been emphasized that the national innovation system (excluding national defense) is organized and led mainly by two governmental agencies — the MTI and the Ministry of Education (MOE) (Figure 6). While MTI is responsible for driving mission-oriented R&D through coordinating efforts of its key agencies, EDB, A*STAR, and SPRING, MOE is accountable to supervise academic S&T researches by organizing purpose-built funding schemes and investigator-led researches through expanding the function of Academic Research Fund (AcRF) on top of funding university basic research. These investigator-led researches are attached with an ensured level of funding from AcRF over a reasonable period in order to attract world-class researchers to work in Singapore, generating a fertile environment for seeding new ideas and achieving breakthroughs in innovation. The universities are expected to continue supporting faculty-led internal or externally collaborative researches, especially on the selected scientific areas that have medium- to long-term strategic interests of Singapore.

From 2000 to 2007, Singapore has successfully awarded with 3200 US patents. A considerable portion of this achievement comes from HEIs and public research institutes. To further promote research engagement of academic faculty, NRF launched the **National Framework for Innovation and Enterprise** to provide proof-of-concept grants of up to S$250,000 to HEIs (Vedam et al., 2009). Other HEIs like the polytechnics are assigned to focus on researches with more developmental nature that could strengthen the nexus between R&D and business through joint projects with industry and local enterprises. There are also translational R&D grants designated to support translational research performed by polytechnics to bring research breakthroughs to the market place. In addition, NRF provides innovation vouchers to SMEs as incentives for collaboration with HEIs' R&D. Under the STP2010, universities with enhanced research capacities would become the lead partners of public research projects; on the other hand, polytechnics will play a significant role in strengthening R&D more likely in the private sector and uplifting technological and manpower capabilities in Singapore.

Figure 6: Singapore National R&D Framework



The **Research, Innovation and Enterprise Council** will lead the national drive to promote knowledge creation and innovation.

Source: MTI, Singapore Science and Technology 2010 Plan (STP2010).

Japan

The first Japanese white paper on S&T, *The State of Our Country's Industrial Technology*, was issued in 1949 right after the World War II, yet at that time, university-industry research collaboration was very much limited because universities were national in nature and therefore professors were civil servants, who could not receive much private benefits out of the collaboration with the industrial sector. While Japan has continuously trying to steer university-industry collaborations since then, it was until the 1990s that this effort became forceful and consistent, concomitant with the trend of changing university governance.

Like other selected cases in this study, Japan is also aspiring to create top-tier universities. In 2002, the Center of Excellence (COE) programs were launched, including specific programs such as the 21st Century COE Program, Global COE Program and Super COE Program. In 2007, the **World Premier International Research Center Initiative** was launched, which has chosen four former imperial universities, namely the Tohuku, Tokyo, Kyoto and Osaka Universities, as well as the National Institute for Materials Science, as the key research centers that are worth nurturing (Kitagawa, 2009: 6-7). These universities are given more resources for research development that help boost Japan’s competitiveness.

To remove barriers and build up platform for university-industry collaborations, a number of legislations were passed since 1990s. The Technology Licensing Offices Act was passed in 1998 to authorize the establishment of technology licensing offices in universities. In 1999, the Law of Special Measures for Industrial Revitalization was introduced to facilitate the issue of intellectual property rights. In 2000, the Law to Strengthen Industrial Technology Capability was passed to legalize compensated consulting of university faculty. The National Public Service Law was also passed in 2000 to allow university research staff to take up management positions in university start-ups. All these policies were aimed to relaxing the restrictions and providing incentives for universities and their staffs to participate in research ties with the industry. Moreover, in 2003, MEXT began to establish Intellectual Property Centers at universities to facilitate the use of intellectual properties.

Apart from these, another major push factor was the passing of the National University Corporation Law in 2004 to incorporate national university into a semi-independent entity, offering universities autonomy in the commercialization of research outputs and the recruitment of S&T research talents (Yamamoto, 2004). As a result, “the number of research collaboration between national universities and industries has risen from 1,139 in 1990 to 4,029 in 2000 and to 6,767 in 2002. Besides, the number of starts-ups based on university-invented technologies increased from 11 in 1995 to 135 in 2000” (Odagiri, 2006). Also, in 2006, the government decided to reduce the operating grants of all the National University Corporation by 1% each year, propelling universities to search for more external resources.

The Japanese government actively seeks ways to promote university-industry collaboration with the coordination among different governmental departments, e.g. between MEXT and METI (Ministry of Economy, Trade and Industry).[34] Moreover, intending to explore emerging fields of innovation apart from natural science and engineering, MEXT set up the “Program for Practical Human Resource Development by Industry-Academia Cooperation-Service Innovation Human Resource Development” to promote “service science”, which studies the ways to innovate and better the service sector (White paper 2008: 81-82). A number of leading universities have participated in the program (see Table 61).

[34] For example, the METI launched the **Hiranuma Plan** in 2001 to advance university-industry research collaborations with the goal of establishing about a thousand university-based start-ups in the following three years.

Table 61. List of Participant Universities in the Program for Practical Human Resource Development

University	Project
Tohuku University	Development of service innovation manager-Human resource developments for controlling productivity in service sector
University of Tsukuba	Development of advanced professional fostering program based on service science for customer-oriented business innovation
Tokyo Institute of Technology	Program for fostering social service value designing innovators
Kyoto University	Development of education program **Service Value Creation Management**
Bunri University for Hospitality	Formulation of program for fostering middle managers with the simulation mind to produce high value-added development and operation of Service Management 100 (three-stage case method)
Meiji University	Human resource development project for grasping and utilizing quintessence of service innovation

Source: MEXT (2008: 82).

In fact, Japan does not have a long tradition of university-industry research collaboration. During the 1980s, its large corporations have chosen to conduct basic research in American universities rather than in local ones. In face of this situation, the Ministry of Education set up four mechanisms to encourage university-industry partnership: joint research, contract research, secondment of industry researchers to universities, and donations. A handful of university-industry joint research centers were also established. It were estimated then that national university-industry joint projects rose from 56 in 1983 to 396 in 1987. By that time, Japanese corporations decided to shift back their research bases from America to Japan (Low, 1997: 135-136). Nevertheless, these collaborations are becoming more prevalent nowadays. As of 2005, the number of joint research projects exceeded 13,000 for national, public, and private universities altogether; while national universities alone accounted for more than 10,000 projects. For contract research projects at national, public, and private universities, the number was 16,960. Also, the fees for these projects had reached 126.5 billion yen (White paper, 2007: 42).

The number of university start-ups has increased significantly from 287 in 1999 to 1,112 in 2004 (METI, 2005). While big corporations still choose to conduct their in-house research, studies find that small and new firms are gaining momentum in promoting university-industry collaboration (Motohashi, 2005). The *White Paper on Small and Medium Enterprises in Japan* in 2003 issued by the Japan Small Business Research Institute states that small firms benefit more than large corporations in university-industry research collaboration in terms of sales growth (Fukugawa, 2005:

380). It is also worth noting that national universities play a major role in university-industry collaborations despite that they constitute the smallest portion of the HE sector.[35]

Universities in Japan are taking the leading role in basic research. Table 62 shows the distribution of R&D expenditures by research type. Overall speaking, the most resources-devoted research type is development research, followed by applied research and basic research. This pattern applies to the industry and private research institutions. For governmental research organizations, though development research has acquired the largest share of expenditure, the distribution of expenditures among these three kinds of research is more even. The only exception is universities & colleges, which put most emphasis on basic research, followed by applied research and developmental research.

Table 62. R&D Expenditure by Type of Research, Japan (2002-2005, %)

	Basic Research				Applied Research				Developmental Research			
	2002	2003	2004	2005	2002	2003	2004	2005	2002	2003	2004	2005
Total	15.0	15.0	14.4	14.3	22.8	23.0	23.0	22.8	62.2	62.0	62.6	62.9
Industry	5.9	6.0	6.0	6.3	19.5	19.4	19.4	19.6	74.6	74.7	74.6	74.1
Government Research Organizations	31.0	30.9	25.5	24.4	26.9	30.5	30.3	29.6	42.1	38.6	44.2	46.0
Universities & Colleges	54.0	55.0	54.3	55.1	36.4	36.5	36.9	35.8	9.6	8.5	8.7	9.1
Private Research Institutions	20.1	18.7	19.9	20.3	38.9	39.3	38.8	35.8	41.1	42.0	41.3	43.9

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/148.pdf

Another striking characteristic of the Japanese university-industry research collaborations is the close ties between universities and RISs. Since the implementation of the S&T Basic Law in 1995, the successive three S&T Basic Plans have mentioned the strategies for RIS development. The First S&T Basic Plan (1996-2000) proposed an increase in budget for S&T developments and encouraged university-industry linkages; the Second Basic Plan (2001-2005) highlighted the importance of regional S&T policies; the Third Basic Plan (2006-2010) went further to propose the establishment of RISs by forging academia-industry-government linkages at the regional level (Kitagawa, 2008: 15-16).

Against these policy backgrounds, a number of regional innovation initiatives were launched. For instance, the METI implemented the **Industrial Cluster Initiative** in

[35] By 2008, there were 589 private universities, 86 national universities and 90 local public (municipal & prefectural) universities (Kitagawa, 2009).

2001. Based on a business approach, this Initiative "aims at revitalizing regional economies and promoting industrial accumulation through promoting networks between industry, university and public research institutes…" (Kitagawa and Woolgar, 2008: 59). Under the Industrial Cluster Initiative, the "Technology Advanced Metropolitan Area" (TAMA) in the Tokyo Metropolitan Area is a successful example of using university-industry linkages as an intermediary player in product development and patent application of SMEs (Kodama, 2008). Similarly, the MEXT launched the **Knowledge Cluster Initiative** in 2002. Adopting an "academic approach", this Initiative "aims to construct a 'regional system of technological innovation', based on industry–university–government collaboration by forming networks of Center of Excellence in regions" (Kitagawa & Woolgar, 2008: 59). These programs reflect not only a growing trend of university–industry collaborations at the regional level, but also a shift of governance on research from centralization towards decentralization.

Assessing the Role of Higher Education in Innovation Promotion

Comparing and contrasting the role of the university in innovation promotion between the Asian universities with their counterparts in Europe and North America, we have noted that the university sector in Asia has not played a very important role (refer to Figure 3). As discussed earlier, the relatively late participation of the university in Asia in innovation promotion is closely related to the unique socio-political and socio-economic contexts, especially due to being late comers in joining the enterprise in developing higher education, research and development, and promotion of technology and innovation. As we have highlighted in the previous section, Asian universities are now under far more pressure to move beyond their comfort zone in questing for becoming entrepreneurial universities. Such a development has been clearly revealed by the increasing involvement of the university sector in collaboration with the industry in innovation promotion and technological advancement. But it would take a while for Asian universities to establish themselves as enterprise universities to engage in the third mission of university by playing a more active role in economic and social development.

As for the case of Hong Kong, as Baark & Sharif (2006) rightly point out, the past mistake of its innovation policy was that it had wrongly envisaged technological development in a linear process: from upstream scientific research by universities to downstream commercialization process by enterprises. In this vein, the Hong Kong government asserted its role simply as infrastructure builder and funding provider, hoping that once these needs are satisfied, technological development could be achieved by research institutions and product firms. Nevertheless, since the 1990s, Hong Kong's NIS has become "a more interactive and dynamic trilateral government-industry-academia NIS mode" (ibid: 383). More government's participation has been devoted throughout the whole process rather than just jumpstarting the process at the very outset. Recent development of its innovation system also highlights that in future, Hong Kong may needs to pay more attention to its regional integration with China.

In Taiwan's innovation system, the government, universities and the industry are interacting very closely and dynamically. As Mathews & Hu (2007: 1017-1018) rightly note that "while university R&D in the advanced countries plays a role of linking a country's innovation infrastructure and industrial cluster, the impact of academic R&D in the latecomer country like Taiwan is shifting from building the national innovation infrastructure (i.e. training the well-educated manpower or help targeting on high-tech industrial clusters) in the earlier years to now acting as a knowledge platform to link innovation infrastructure and industrial clusters (through technology licensing and incubation centers) beginning in the 2000s". Overall, Taiwan has transformed itself from a "fast followership" in the 1970s to an "innovation-led fast followership". Yet from all the related activities and efforts, we can still find the very visible hands of the government.

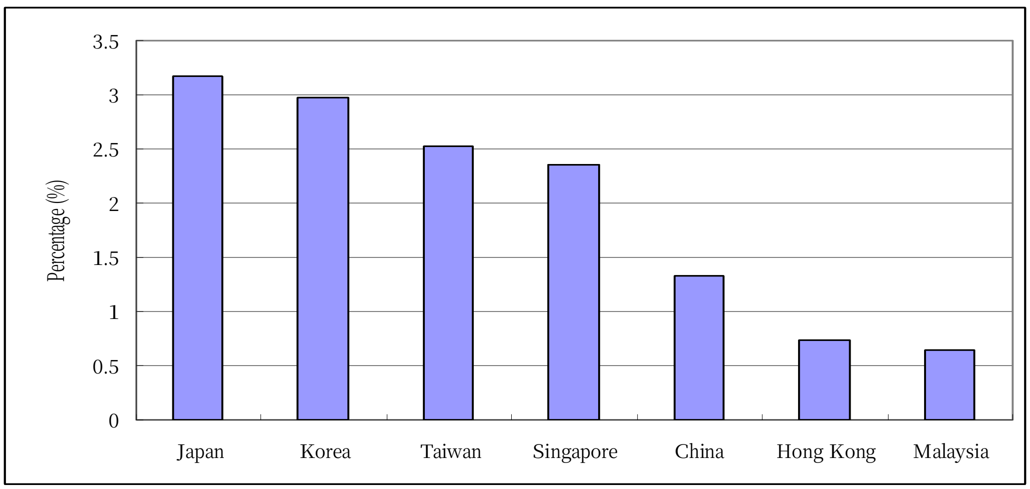
The bipolar economic structure of the Korean economy — strong large firms on the one end and weak small firms on the other (Lim, 2008: 149) — is clearly reflected in its innovation system. Industrial enterprises, especially the *Chaebols*, are the driving force of innovation, followed by government-funded research institutes. While universities are gaining momentum in R&D by partnering with SMEs and are exerting their impacts in building up regional innovation systems, the university-industry research collaborations are limited with the lack of government funding for universities. It is then anticipated that the future development of South Korean NIS depends on whether the government will increase its support for universities and SMEs as well as the cooperation between them.

Singapore may well be the most proactive case to present in terms of innovation system reform. To maintain its attractiveness as a place for business of the future, Singapore has determinedly switched its developmental focus from a large manufacturing base for MNCs to a dynamic innovation hub that supports high-tech manufacturing and R&D. During this process, the HE sector has been turned to perform a more meaningful role in improving its NIS, particularly through fostering entrepreneurial mindset among young Singaporeans and increasing technology transfer to the industrial sector. As a result, Singapore has demonstrated progress in innovative activities such as patenting, and the revenue from commercializing high technology increased since the 1990s. As shown in the above Table 62, its university-industry R&D collaboration has been remarkably ranked as the fourth in the world recently. By far, the reward from S&T development in Singapore is really impressive.

And finally, in Japan, there are also plenty of rooms for its HE sector to involve further in scientific and technological R&D activities, since over the years, as in the case of South Korea, these activities were mainly carried out by industrial enterprises. However, triggered by the trend of incorporation and the government's strong encouragement, Japanese HEIs, especially those national universities, have increasingly engaged in industrial innovation by forging research ties with private enterprises, mostly with the SMEs. Through which, they have also involved deeper in the RISs. Nevertheless, Japanese private enterprises, particularly those resourceful industrial conglomerates, may still be the major driving force of innovation in the near future.

Figure 6 compares and contrasts the GERD / GDP for selected Asian societies, it clearly shows Hong Kong has spent the least in innovation, while Singapore has tried to catch up and Japan, South Korea and Taiwan have a similar level of GERD / GDP in innovation advancement.

Figure 6. Comparison of GERD/GDP for Selected Asia Countries (2005)



Source: Malaysia National R&D Survey, 2008.

Experiences of the five selected East Asian economies in managing the development of their innovation systems seem to suggest a commonality of stronger state intervention when compared to their OECD counterparts, though with varied degrees. This may well be regarded as a modified Triple Helix Model, characterized generally by the proactive and leading role of the government acting through infrastructural support and policy incentives on the one hand, while a relatively insufficient involvement of HEIs in R&D activities on the other. In most cases, private enterprises, which represent market forces to a great extent, are also comparatively weak, yet they could be mobilized to serve the purpose if the state acting as a "market accelerationist" rather than a heavy-handed "interventionist" in this regard. The prevalence of science parks/high-tech parks throughout these East Asian economies could well be a good example to illustrate this modified and featured government-industry-academia collaboration.

Thus paradoxically, a strong ingredient of state intervention seems to be part of the success formula in developing a NIS which is supposed to foster innovation in a free environment with least intervention. As hinted in the above Tables 26 and 27, albeit it is too early to draw any conclusion, the more proactive and effective (in terms of the state's muscle), Taiwan and Singapore governments have managed to secure a better progress in the ranking of the Knowledge Economy Index from 1995 to 2009; whereas the less aggressive Hong Kong, South Korean and Japanese governments could barely maintain their previous rankings. The above comparative study has clearly shown the strengths and weaknesses of the existing NIS, especially after a critical analysis of the role of the university in innovation promotion. The strengths of the existing model are related to the positive role of the state in steering innovation promotion, research and development. The recent ranking among these selected Asian societies again shows the determination of their governments in promoting innovation. The success of Singapore and Taiwan in maintaining their global ranking is closely related to the continual support of the state in promoting university-industry collaborations, especially these two Asian states have made additional efforts in investing in firms or universities for promoting innovation and entrepreneurial approach in research and development.

All the systems under review have indicated that the role of the state is extremely important for strategic development of the NIS. But equally important, the reduction of the state role in the context of the growing influence of neo-liberalism and the drive to make universities more entrepreneurial has considerably weakened the significant role of the state in driving the agenda for innovation advancement. Although the role of the firms / industries are becoming more important in directing innovation and research development, the capacity of firms in sustaining innovation and research development is rendered problematic especially when the global economic environment is getting unstable and being difficult for prediction. The fluctuation in the global market place would certainly affect the financial ability of the industry in investing in research and development and promotion of innovation. Our above comparison has clearly shown the innovation promotion in South Korea, Taiwan, Japan and Hong Kong are more firm-led, with the exception of Singapore having a more state-led model. The uncertainty in the global economic environment would certainly affect the way that the industry could perform in innovation advancement.

After examining the role of the university in advancing innovation of the selected societies, it is clear that the university sector is getting more involved in promoting innovation and they now become more engaged with the industry in research development and innovation advancement. Nonetheless, the university in Asia could play an even more important role in engaging with the industry or the business in research development and innovation advancement. Despite the fact that the Asian governments have tried to reduce their role in financing the university sector to engage in collaboration the industry, they should have invested more in universities to set out a more encouraging environment / productive framework for inducing universities for moving beyond their 'comfort zone' to work with the industry / firms / NGOs.

Overall speaking, what is revealed in this study is that, despite the different starting points and different formation processes of NISs of the five selected countries / cities, they all intend to move toward a more complete and balanced Triple-Helix mechanism, hoping that each stakeholder can perform to its greatest strength and that the three stakeholders can be more integrated and connected. Yet the government remains a very important role in the process, if not dominant. It needs to be an initiator at the outset and a facilitator and collaborator in-between and the promoter and regulatory in the end.

Policy Recommendations and Good Practices Identified

Our above comparative analysis of national innovation systems and the examination of the role of the university in promoting innovation has clearly indicated that policy challenges and responses may differ significantly among countries / societies, depending on their histories, size and level of development, their industrial, scientific and technological specialization, as well as their institutional structure, which affects domestic patterns of knowledge interactions and innovation advancement. Traditionally, governments have intervened in the technology arena to address market failures, such practices are common in the OECD countries especially when firms under-invest in R & D because of the existence of spillovers that limit their ability to fully appropriate returns or due to the uncertainty associated with innovation.

1) Important Role of the Government

Being relatively 'late-comers' in developing innovation and R & D related work, governments in Asia have taken more interventionist role in promoting innovation, technology and development. But once the infrastructure has been set up with more involvement of the industrial and business sectors, the role of the government is beginning to reduce. But we must be aware that the global economic environment is highly unstable, the governments in Asia should play a more active role to address systemic failures which may block the functioning of the innovation system, hinder the flow of knowledge and technology and, subsequently, reduce the overall efficiency of national R & D efforts. In this connection, governments need to play an integrating role in managing knowledge on an economy-wide basis by making technology and innovation policy an integral part of overall economic policy.

Identifying good practices from the OECD countries in terms of their policy and strategy in promoting innovation, Asian governments need to refocus specific objectives and adapt the instruments of technology and innovation. In addition, they should also secure framework conditions that are conducive to innovation. Reform measures must be introduced to reform the existing regulatory frameworks which would help lessen administrative burdens and institutional rigidities, developing sound financial and fiscal policies to ease the flow of capital to small firms in engage them in innovation advancement.

2) Fostering New Partnerships, Networking and Clustering

In response to the rise of diversified sectors / stakeholders in innovation advancement, there is a strong need to search for new approaches or institutional arrangements to facilitate the partnerships between the various sectors like the government, university, industry and business, as well as other forms of organizations in promoting innovation, technology and development. Since many science and technology policies in the selected Asian societies are still developing, with insufficient attention given to fostering interactions and spillovers at national and international levels, the governments in Asia would need to devote more attention to develop policies / frameworks which would foster closer partnerships between the various sectors in promoting innovation. International comparisons show the growing importance of interactions within networks of firms and knowledge-based organizations in advancing innovation. The experiences of our OECD counterparts have clearly suggested the importance to promote networking and clustering because of the growing trends of more networked business and innovation interactions. These networks also reflect the increasing interdisciplinarity that is at the core of today's technical change. In view of the success story of the OECD countries, Asian societies should take strategic research and technology development alliances among firms and universities very seriously since such deep collaborations would further advance innovation, research and development. In order to promote these strategic alliances, governments in Asia should remove unnecessary barriers to cooperation and alliances, as well as formation of networks.

3) Building an Innovation Culture

Despite the fact that more awareness of the importance of innovation and creativity has been found among the selected Asian societies / countries in recent years, the education systems still place much emphasis on public examination and academic results rather than rewarding people with innovation and creativity systematically. There is a strong need for Asian societies to create favourable framework conditions for business, research and education to encourage innovation and creativity. Governments in Asia can extend the scope of technology diffusion programmes to include elements that promote firm-level capabilities for identifying, accessing and incorporating new knowledge and techniques, while universities would reform their admissions and rewards systems in encouraging talents of different kinds to be admitted / rewarded by their performance in advancing innovation.

4) Reforming Education and Promoting Knowledge Transfer

With a strong conviction to promote innovation, governments in Asia must encourage human as well as institutional linkages through reforming the university curricula by emphasizing multidisciplinary research, teaching and learning and promoting lifelong learning. Education reforms should focus on new skill requirements such as working in teams, maintaining interpersonal relationships, communicating effectively, networking and adapting to change. Universities also need to promote knowledge transfer by encouraging their faculty members to move beyond their conventional missions focused on research and teaching to service, advancing innovation and technology.

5) New Policy for Leveraging Research and Development

In order to sustain the efforts in promoting innovation, new approaches are needed which provide private initiative greater scope and more incentives and which are less dependent on direct government financial support. Since the stagnation of research spending may have implications for long-term innovative capacity in some economies, government must respond by preventing under-investment in research and innovation. Market-led innovative processes should rest on a sound knowledge base, which is found primarily in the science system, which is the scientific research performed in academic and public research institutions that are largely supported by the state. In order to stabilize the 'infrastructure of research', governments in Asia need to provide sufficient funding to sustain research activities conducted by universities and public research institutions on the one hand. On the other hand, governments in Asia should also encourage commercialization since innovators and society will also gain from greater commercialization of research, including through patents, licenses and spin-off firms. Experiences elsewhere like the USA and other European countries show that royalties and licensing fees from patents and technology can yield significant income. An emphasis on commercialization also helps move technology into the marketplace. Governments in Asia should develop policy frameworks which could foster commercialization and high-technology start-ups require institutional flexibility and appropriate intellectual property rights rules and other regulations.

In addition to the policy recommendations outlined above, the present comparative study has identified a few good practices that other developing countries may find useful when developing their research and development, and advancing innovation and technology.

1. *Investment in Higher Education*: all the five selected Asian economies under review has clearly suggested the significant role of higher education in nurturing talents for further research and development and the advancement of innovation. The access to higher education and the assurance of higher education quality has laid a very solid foundation for the promotion of innovation in these Asian economies.

2. *The Steering Role of the State*: the developmental state role that the Asian states have adopted in driving their economic growth still functions well in the promotion of research and development and advancement of innovation. Unlike their US counterparts, these Asian states have made serious attempts to steer the development of R & D, such a strategic role has proved to be very effective in shaping the policies and measures in promotion of innovation in these economies.

3. *The Interactions between the Industry and the University*: the present comparative study has clearly indicated an emerging trend of more interactions between the industry and the business in promoting innovation, research and development. Despite the fact that the government does perform a very important role during the inception phase of R & D, the inter university and industry collaborations would become increasingly important especially beyond the inception stage. But the government should act as a facilitator or enabler to drive the university and the industry to engage in deep collaborations.

4. *Preferential Policies and Incentives in Innovation Promotion*: the present comparative study has also discovered the important function that preferential policies and incentive schemes in promoting innovation, especially when the industry / business is given tax exemption or special loan schemes in fostering a culture of research and development. More importantly, these Asian governments have to regularly review their policies and regulatory frameworks to ensure their systems / measures are conductive to sustain the deep collaborations between the industry and the university sector.

Conclusion

This report has reviewed the most recent developments of innovation, research and development in seven Asian societies through a critical review of the government policies in relation to promotion of innovation. Against a highly competitive world, a growing number of Asian countries have started promoting innovation by strengthening the collaborations between the business, industry and university sectors. This report has indicated that the selected Asian societies under review have engaged more proactively in the promotion of innovation, research and development in order to enhance their global competitiveness. This report also critically examines recent strategies adopted by the selected Asian societies in reforming their higher education systems in fostering closer links with the industry and business sector in promotion of innovation. Our comparative study has shown the selected Asian societies have experienced different stages of development and different models in terms of promotion of innovation, research and development. But one area common to all selected Asian countries is that all these societies under review have taken the promotion of creativity and innovation more serious and the relationship between higher education institutions, the business and the industrial sectors is becoming increasingly closer in the promotion of innovation in the globalizing economy context.

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