From Technological Catch-Up to Innovation-based Economic Growth: South Korea and Taiwan Compared

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ABSTRACT *This paper sets out to analyse the divergent models pursued by South Korea and Taiwan in regard to technological catching-up and their ongoing transition towards innovation-based economies. It is found that South Korea's former high-debt and chaebol-dominated model inclined it to pursue a Schumpeterian scale-based technological development, while Taiwan's former pro-stability, small- and medium-sized-enterprise (SME)-based model tended to favour its emphasis on a neo-Marshallian network-based technological development. It will be argued that the state's approach to economic liberalisation and firms' demand for capital for technological upgrading are the major factors that have underpinned the adjustment efforts of these two countries.*

I. Introduction

Pair comparisons between Taiwan and South Korea in terms of developmental models, business systems, technological learning and financial systems are among the major topics of interest in developmental studies of East Asia (Haggard, 1990; Mody, 1990; Whitley, 1992; Hobday, 1995; Fields, 1995; Weiss and Hobson, 1995; Mathews and Cho, 2000; Thurbon, 2001). Most of them focus on institutional setups for advancing economic catch-up, as well as on the ways in which these two countries differ in terms of managing their respective financial and industrial systems. Few studies, however, have tackled the issue of how both economies have been transitioning from catch-up-based to innovation-based economies, especially in the post-1997 financial crisis era. Partly based on the findings of the above studies, this paper uses the development of the information technology (IT) industry with a view to taking the pair comparison process a step further. It does so by analysing the divergent routes of South Korea's and Taiwan's technological transitions.

Taiwan and South Korea have emerged as important players in the world IT industry since the late 1980s. In 2002, Taiwan produced over 60 per cent of the world market's notebook personal computers (PCs), and many other important electronics components (MIC, 2004a). Likewise, South Korea dominated the production of many essential components in the IT industry (KISDI, 2003), especially in regard to products such as dynamic random memory (DRAM) chips and thin-film-transistor liquid crystal displays (TFT-LCDs). In many areas of electronics, both South Korea and Taiwan have not only been quick learners but also innovators. Indeed, both South Korea and

Taiwan have rapidly improved their technological capabilities towards innovation since the early 1990s. This can be indicated with reference to the number of US patents granted to foreign nationals. Taiwan became the fourth (5,298 cases) and South Korea the fifth (3,944 cases) largest recipient countries in 2003, being surpassed by only the US, Japan and Germany and overtaking the UK, France, Canada and Italy (Figure 1). Among these patents, the IT industry accounted for the majority. Moreover, a comparison between South Korean and Taiwanese patterns of patents is illuminating. The top innovator in South Korea during 1999–2003 was Samsung Electronics, which accounted for 37 per cent of total patents. Taiwanese innovators, by contrast, were largely individuals (36 per cent) rather than organisations. Since Taiwanese small and medium-sized enterprises (SMEs) have a high turnover rate, innovators tend to apply for patents as individuals rather than on behalf of organisations, so as to be assured of ownership (Choung, 1998: 364). Thus while Korean patents are concentrated in a few chaebol (business conglomerates), Taiwanese patents are more decentralised among SMEs and public R&D institutes (Table 1).

The central questions of this paper therefore include the following: why have both countries caught up so rapidly in terms of technological development, while also exhibiting such different patterns of transition towards an innovation-based economy? What are the institutional arrangements underpinning such rapid development? By following the comparative institutional advantage approach, which maintains that any economy is governed by a configuration of institutions that coordinates economic behaviour (Hollingsworth and Boyer, 1997; Hollingsworth, 2000; Hall and Soskice, 2001), this paper analyses and compares technological development in South Korea and Taiwan in terms of the relationships among the state, the financial system and the industrial structure both before and after the early 1990s, when both economies began to experience pressures of liberalisation and technological upgrading. The basic arguments are that South Korea and Taiwan developed different competitive strengths in their technological catching-up, and that this was due to their different institutional arrangements before the 1990s. The South Korean state's high-debt model nurtured a chaebol-dominated industrial structure during the former stage that led it to pursue scale-based technological development; the Taiwanese pro-stability model gave rise to an SME-based and networked industrial structure that tended to blend in with integration into global production networks. It will be argued that the state's approach to economic liberalisation and the firms' demand for capital for technological upgrading are the major factors that have underpinned these two processes of economic adjustment and pursuit of technological innovation.

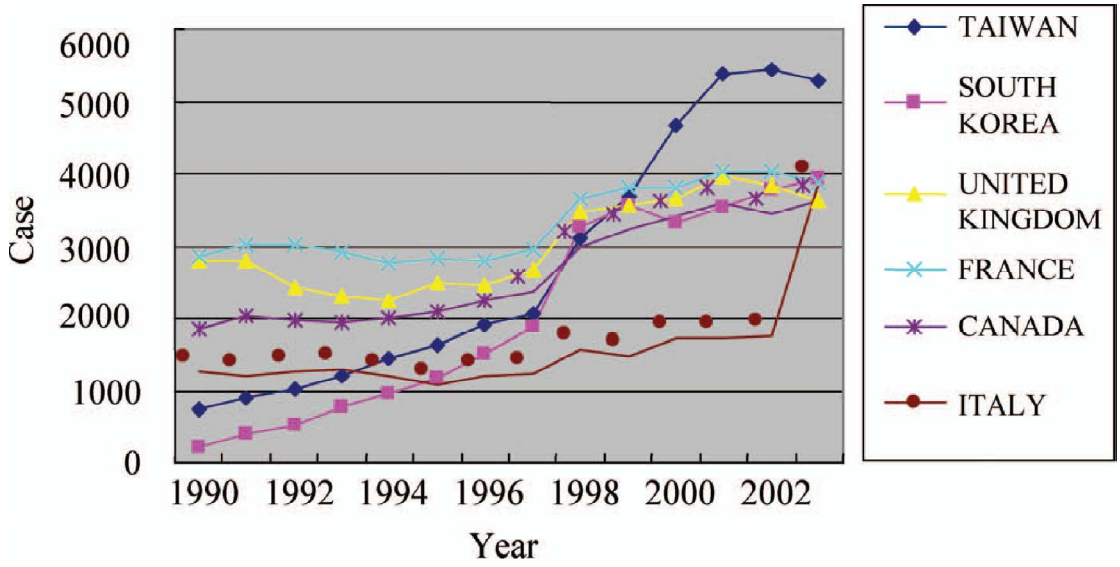

Figure 1. US Patents by foreign countries (excluding the US, Japan and Germany). Source: United States Patent and Trademark Office (2005)

Table 1. Distribution of patents by ownership

Rank	South Korea			Taiwan		
	First-named assignee	1999-2003 total	Ratio of total	First-named assignee	1999-2003 total	Ratio of total
1	SAMSUNG ELECT.	6731	0.37	Individually owned	9125	0.36
2	HYUNDAI ELECT.	1636	0.09	TSMC	2070	0.08
3	LG ELECT.INC.	1424	0.08	UMC	1710	0.07
4	Individually owned patent	1138	0.06	ITRI	1037	0.04
5	LG SEMICON	640	0.04	HONG HAI PRECISION	1035	0.04
6	ELEC. TELECOM. RESEARCH INST.	517	0.03	WINBOND	477	0.02
7	HYUNDAI MOTOR	502	0.03	VANGUARD	419	0.02
8	DAEWOO ELEC.	465	0.03	MACRONIX	393	0.02
9	LG. PHILIPS LCD	417	0.02	NATIONAL SCI. COUNCIL	292	0.01
	Total	18144		Total	25528	

Source: United States Patent and Trademark Office (2005).

II. From Technological Catching Up to Innovation

Technological learning and innovation are crucial for economic development but the way in which a society engages in these activities is deeply rooted in its institutional arrangements. In a stylised manner, there are two paradigms regarding technological development. One is the catch-up paradigm, which takes into consideration the technological learning of the late-industrialising country; the other is the innovation paradigm that is mainly applied to advanced economies.

The major characteristic of a catch-up economy is that its industrialisation is based on acquiring and improving existing technologies developed in advanced industrial economies (Hobday, 1995; Kim, 1997). A catch-up economy has a clear objective to pursue, namely, to close the technological gap between itself and more technologically advanced countries. The state in this paradigm is potentially competent in terms of leading the economy. For most of the time, state bureaucrats are able to gather and analyse existing information in order to nurture domestic industries by means of various policies. Since capital is in short supply in late industrialising economies in their initial stages of development, the state tends to adopt a restrictive policy in terms of controlling capital flows and mobilizing domestic savings for the promotion of industrialisation. In most of the East Asian countries, the state has promoted economic development through the 'financial repression' approach. This placed a heavy burden on the financial sector, and especially the state-owned banking system, in order to secure the development of the manufacturing sector (Wade, 1990; Woo, 1991; Fields, 1995). The state's policies and its ways of allocating financial resources vary in each political economy, which in turn largely shapes the constitution of its industrial structure. If the state adopts an aggressive 'choosing the national champions' approach to allocating scarce resources among its few domestic enterprises, it may nurture an industrial structure that is more centralised and whose competitiveness is dependent upon economies of scale.

By contrast, if the state has not pursued a 'national champions approach' in promoting industrialisation, the industrial structure will be more decentralised. In this case, domestic firms will tend to become smaller and their technological competitiveness will need to depend on external resources, such as the state's R&D support or foreign firms.

In contrast to the catch-up paradigm, the innovation-based economy aims at creating and searching for frontier technologies that do not yet exist in the market (Lundvall, 1992; ADB, 2003). Because state bureaucrats do not necessarily have all the relevant knowledge needed, the state cannot play the leading role that it does in the catch-up paradigm. However, it can play the role of a regulator that builds up an infrastructure that is conducive towards creating new knowledge and technologies.

In the same vein, neither is the state-controlled banking system directed to the pursuit of innovation (Eichengreen, 2002). Financial systems that may be favourable to technological innovation are either the Japanese keiretsu or German hausebank systems, in each of which private banks establish long-term relationships with specific firms and provide them with the needed resources to

explore new technologies, or the Anglo-Saxon financial market system, in which the securities market plays the major role in allocating capital resources so that firms in need can explore new and sometimes radical kinds of technological development (cf. Zysman, 1983).[1]

The industrial structure also affects the way in which technological innovation is pursued. There are two conflicting views in this regard. The first stresses the importance of economies of scale for technological innovation. In Schumpeter's (1950) view, large firms have a superior ability to generate technological and organisational innovation, due to their abundant resources. This view was amplified in Chandler's (1991) work so as to demonstrate the central role of the large oligopolistic firm in technical progress since the 1880s.[2] Secondly, there is a neo-Marshallian view that highlights the importance of dense interactions among a large number of competing and co-operating firms: these interactions create an external economy favouring technological innovation and learning (Amin and Thrift, 1993).

This view especially stresses the importance of 'collective efficiency' (Schmitz, 1995) as a means of mitigating the resource weakness of SMEs. Various studies of 'flexible specialisation' regions (Piore and Sable, 1984), and further research on 'industrial clusters' (Saxenian, 1994), suggest that dense production networks among small firms may create an environment that can facilitate the flow of knowledge, ideas, learning and innovation.

The interactions among the state, the financial system and the industrial structure over time constitute and define the 'national model', in which different institutions are complementary and reinforce each other in defining a coherent growth pattern (Amable, 2000). It is also for the same reason that socially-embedded institutional arrangements create enabling and constraining conditions for the economy based on the extent to which it adjusts to new environments. There are two essential and interrelated factors that will largely influence the way in which a political economy evolves from being catch-up-based to being innovation-based. The first factor is the state's approach to economic liberalisation. This is a political choice that results from a domestic power struggle mediated by globalisation pressures, and through which the political process of the state's transformation proceeds. In the East Asian context, it is reasonable to assume that the discretionary power of the developmental state will be largely subsumed to the political and economic influences of the private sector in the process of democratisation. The larger the scale of private firms in the industrial structure, the more they are able to make their presence felt in the state's transition.

The second factor is the need for firms to continue to engage in capital investment in order to keep up with technological innovation (Weiss, 2003; Pirie, 2005). Headto-head competition among firms in the world market has forced enterprises to maintain high levels of spending on capital investments, including purchasing expensive state-of-the-art production equipment and continuing to raise the R&D budget in order to stay at the forefront of technological competition. This inevitably creates pressure for the state to liberalise its financial controls so that companies can use the available financial resources beyond what the domestic market can afford. As a corollary, the larger the scale of private firms, the more likely it is that the state will liberalise its economy.

Based upon the above propositions, this paper will present two arguments in analysing South Korea's and Taiwan's transition from catching up towards becoming innovation economies. First, the more a state adopts an interventionist approach in supporting domestic firms in the catching up stage, the more likely it is that the state will adopt the neoliberal approach in its transition. This type of transition tends to follow the Schumpeterian model, in which a highly centralized industrial structure will be favourable to big firms seeking to pursue innovation that is based on scale economies. This pattern can explain the Korean case. Second, the less aggressive that the state's leadership is in the catching-up stage, the less likely it is that it will create a powerful private sector that is able to influence the state's decision-making. The state will thus tend to create a decentralised industrial structure and will retain the capability to manoeuvre the processes of financial liberalisation and economic transition. In this case, the resource-poor SME-based decentralised industrial structure has to be supplemented by production networks and close linkages with external resources, such as MNCs and public R&D institutes, in order to generate technological learning and upgrading. This model is exemplified by the Taiwanese case and tends to evolve into a neo-Marshallian innovation-based economy.

III. Different Catching-up Models Before the 1990s

South Korea and Taiwan have followed divergent routes in economic catching up. These different routes originated from the configuration of institutional arrangements of the respective states' development strategies, financial systems and industrial structures.

South Korea's High-debt and High-volume Model

As one of the exemplars of the East Asian developmental state model, South Korea's economic development was characterised by three major elements before the 1990s: the state's strong leadership; the state-owned banking system; and the dominance of the chaebol in the industrial structure (Amsden, 1989; Woo, 1991; Fields, 1995; Kim, 1998; Kong, 2000). These elements were also regarded as essential ingredients that helped to constitute Korea Inc. (Kong, 2000).

It is widely believed that the Korean developmental state model was created by the Park Chong-Hee regime beginning in 1961, and that it matured in the early 1970s. The Korean state was overwhelmed by the economic nationalism that intended to build a strong economy based on domestic ownership (Woo, 1991; Kong, 2000). In order to promote 'big push' industrialisation, the Korean state mobilised financial resources through domestic and foreign savings to nurture the chaebol through the mediation of state-owned banks. Policy loans that carried exceedingly low interest rates were granted to the chaebols. The rise of the chaebol was therefore a logical outcome of the Korean state's big push strategy, and the result was that the economy became dominated by a small number of chaebols (Fields, 1995; Woo, 1991).

According to Hamilton et al. (2000: 293), the top 43 chaebols accounted for nearly 41 per cent of all manufacturing sales in 1989 and contributed considerably more than 50 per cent of all export

sales. The heavy support provided by the state to the chaebols led the latter to develop the mentality of being 'too big to fail', and this laid the groundwork for the chaebols' well-known high-debt-high-growth business model (Woo, 1991: 170). The chaebols tended to develop components in-house, and to merge good SMEs into their vertically integrated organisations. Weak SMEs led to the chaebols having to import or produce parts themselves, without creating organic production networks that connected chaebol with SMEs (Kong, 2000: 55). Nevertheless, due to the state's 'unlimited supply of capital', the South Korean chaebol had the ability to assimilate existing technologies rapidly. Although the Korean state played an important role in promoting the IT industry in the mid-1970s, including setting up public R&D institutes, the chaebol gradually replaced the state as the major engine for assimilating and improving technologies (Kim, 1997). The best example involves the development of the semiconductor industry.

Bolstered by the state's financial support, Samsung, Hyundai and Goldstar in 1982 announced major involvements in the mass-production of chips. The four major players at the time, Samsung, Goldstar, Hyundai and Daewoo, committed more than $1.2 billion to this task between 1983 and 1986, or 10 times the scale of investment in Taiwan's semiconductor industry over the same period (Mathews and Cho, 2000: 126). The business strategy of these companies was to emulate Japanese production methods in relation to standardised commodity products such as memory chips but at a lower cost. Although some of the sources of Korea's technological capability had included the purchase of equipment from a variety of vendors, both American and Japanese, the chaebols' own efforts in terms of their devotion to R&D and learning activities were a major strength in their subsequent development. Through their own efforts, Samsung, Daewoo, Hyundai and Goldstar all developed their DRAM technologies independently. By the late 1980s they had shown their capacity to develop their own new products, such as 4M DRAM, with little (Goldstar) or no reliance (Samsung, Hyundai) on imported designs or technology, and they began engaging in mass production from the late 1980s onwards. Samsung subsequently became a major global player in the international market for semiconductors and by 1993 was the world's largest supplier of DRAM chips.

Taiwan's Pro-stability and Flexible Production Network Model

The Taiwanese economy before 1990 was characterised by the leadership of the developmental state, the state-owned banking system and an SME-based industrial structure (Wade, 1990; Weiss and Hobson, 1995). In a way that differed from its South Korean counterpart, the Taiwanese state did not support large privatelyowned enterprises, and the state's financial tools were mainly used to facilitate the development of state-owned enterprises (SOEs) (Wade, 1990; Haggard, 1990). Again, when compared to its South Korean counterpart, the Taiwanese state was seemingly very conservative in terms of financial controls and foreign borrowings. The Kuomintang (KMT) regime made controlling inflation and maintaining stability its overriding objective (Cheng, 1993).

Because of the state's 'anti-big private firm' policy, and its tight control of the financial sector, the industrial structure became decentralised and enterprises largely followed the low-debt model

(Fields, 1995: 108). Taiwan's industrial structure was dominated by SMEs, which were also the main exporters. The competitiveness of Taiwan's SMEs relied largely on personal networks and trust relationships that resulted in the sharing of orders, production facilities and personnel. This network type of industrial structure enhanced the SMEs' organisational flexibility and competitiveness in the world market (Fields, 1995; Hamilton, 1996). Until the early 1980s, the SMEs accounted for nearly half of the sale values and more than 76.7 per cent of Taiwan's exports (Chou and Lin, 1999: 45). Nevertheless, due to the weakness of the SMEs' R&D capability, Taiwan's technological development depended much more on external resources, such as state-sponsored R&D institutes and transnational resources, as well as on flexible production networks. These features are best shown in the development of the PC industry.

While Taiwan's PC industry was initiated by SMEs such as Acer and Mitac, the state nevertheless helped the PC industry to develop in terms of technological learning and knowledge diffusion. Support was provided mainly by the statesponsored research institute, the Industrial Technology Research Institute (ITRI), which developed new technologies and later transferred them to SMEs (Dedrick and Kraemer, 1998; Mathews and Cho, 2000). Taiwanese PC firms also acquired their technologies by means of other methods. One was by recruiting returnees who worked for global leaders in the US, while the other was by working closely with these leading firms through the original equipment manufacturing (OEM) channel, a method involving firms manufacturing industrial goods for others without having their own brand (Wu and Hsu, 2001). Because of the increase in OEM orders in the mid-1980s, the leading Taiwanese PC firms began to establish production networks that involved huge numbers of SMEs in the electronics industry, thereby establishing a pattern that was similar to that which had already existed in the garment and shoe industries.

Nevertheless, the success of Taiwan's PC industry benefited greatly from the achievements of Taiwan's semiconductor industry. The most significant feature of Taiwan's semiconductor industry was its business orientation – to become integrated circuit (IC) foundries rather than integrated device manufacturers, as exemplified by the Taiwan Semiconductor Manufacturing Corp (TSMC) and United Manufacturing Corp (UMC). Foundry companies in the semiconductor industry do not design chips, but only manufacture the chips designed by other companies. The establishment of TSMC became a catalyst that enabled many domestic fabless IC design houses to emerge and take advantage of existing fabrication facilities. The emergence of a vast number of small IC design houses led Taiwan to become one of the major IC design countries in the world and eventually caused Taiwan's semiconductor industry to concentrate on the area of application-specific integrated circuits (ASIC) that could be used in various areas of the PC system (Kanatsu, 2002). This in turn largely enhanced the competitiveness of Taiwan's PC industry.

The success of Taiwanese PC firms and the IC design industry share similar characteristics, namely, dense networking and flexibility. Neither of them needs huge capital investment but they do need intensive interaction and flexible production methods to respond to the market's fluctuations (Fuller et al., 2003).

A brief comparison

The development models of South Korea and Taiwan represent two different ways of catching up. The South Korean state's high-debt model nurtured the chaebol, which were mediated by the state-owned banks that supported their high-debt and highvolume production methods. By mass-producing a less diversified product, the Korean chaebol excelled at taking advantage of the economies of scale in dealing with large volume orders and devoting resources to the technological improvement of single products. By contrast, the Taiwanese state adopted a pro-stability and low-debt approach through which an SME-based economy was created. In the process, the SMEs' technological upgrading depended much more on networked collectivities and external resources, such as the state and transnational linkages (Hamilton, 1996; Hamilton et al., 2000). These two types of catching up continue to exist and to be transformed on a global scale as these two economies march into the liberalisation era.

IV. Divergent Routes in the Transition Towards Innovation

Both South Korea and Taiwan have experienced rapid economic transitions since the early 1990s. In a way similar to the former stage, the Korean state has pursued a more ambitious liberalisation project, while the Taiwanese state has been more cautious in adapting to the new global environment. These different routes have largely related to the character of their political transitions and to the demand for capital for the industrial upgrading that has underpinned the progress of financial liberalisation.

South Korea: An Emerging Neoliberal Regime with Economies of Scale

During the mid-1980s and early 1990s, the South Korean political economy had been oscillating between the traditional state-led development model and the neoliberal approach. On the one hand, it was widely believed in the policy community that further liberalisation was a way for South Korea to reach the goal of becoming an advanced country (Kong, 2000: 15). On the other hand, the state still wielded its discretionary power over chaebols so as to lead the economy. Nevertheless, the political democratisation process that had been taking place in the 1980s favoured the chaebols by enabling them to pursue an ambitious globalisation project and make their presence felt.

The *chaebols'* emphasis on globalisation was mainly due to their pursuit of scale economies. For the Korean firms, because their voluminous production was based on few products (mostly electronic products and cars), the requirements for capital investment and R&D spending were enormous in order to remain competitive in the global market. As technological development was becoming more expensive,[3] the Korean economy needed to invest on a massive scale to remain competitive, and this was to a certain extent beyond what the Korean domestic market could afford (Pirie, 2005). The Korean chaebol needed access to global capital and the equity market in order to fund new investments as well as tap into transnational technological networks to further develop its frontier

technologies.

The double transition of political democratisation and economic liberalization materialised in the early 1990s after PresidentKim Young-Sam came to power in 1993. Korean Inc. then began to be transformed and increasingly became based on a neoliberal approach that promoted Korea's economic development. Kim's 'New-Economic Plan' (1993–97) was aimed at liberalising the economy to levels approximating those of the advanced industrialised economies, the purpose being to create a 'NewKoreawith a New Economy' (Kim, 2000; Kong, 2000). Behind the new national programme was the increasing political power of the chaebol due to the democratisation of Korean politics and the chaebols' ambitious global expansion that regarded the state's intervention as a hindrance (Kang, 2000). In his reformprogramme,Kimthus explicitly sought to end the government's provision of guidance since the early 1960s, including ending the policy loan strategy, the implementation of the five-year plan and the existence of the Economic Plan Board (Weiss, 2000; Kong, 2000; Kang, 2000). All of this was done in order to enhance the freedom of the market for the chaebol.

This neoliberal approach consequently created conditions for the chaebols' expansion and exacerbated their debt-to-equity ratios. Indeed, the globalization project taken on by the chaebol generated a large demand for capital, which was later borrowed mostly from abroad. In mid-1997, South Korea's short-term foreign borrowing even rose to 67 per cent of all foreign debt and to as high as 300 per cent of Korea's foreign reserves (Noble and Ravenhill, 2000: 5), and the top 10 chaebols' debt-to-equity ratio reached as high as 622 per cent on average just before the crisis (Chung and Wang, 2001: 75–76).

It is widely believed that Kim's liberalisation policy brought South Korea into the 1997 financial crisis, due to the lack of corresponding structural and regulatory reforms (Weiss, 2000; Wade and Veneroso, 1998; Chang et al., 1998). The Kim Dae-Jung regime's post-crisis reforms implemented after 1998, under the supervision of the International Monetary Fund, continued along the lines of President Kim Young-Sam's neoliberal programs (Hundt, 2005), which included the completion of trade and financial liberalisation, privatisation and corporate governance reform and labour-market deregulation. However, the state's authority increased while the chaebols' power decreased in the reform process, due to the widespread blame for the latter's reckless borrowing and expansionary behaviour that had brought the whole nation into a crisis (Woo-Cumings, 2001; Hundt, 2005). Kim Dae-Jung established a number of ad hoc organisations, such as the Planning and Budget Commission, the Financial Supervisory Commission and the Korean Asset Management Corporation, to deal with the economic emergency and carry out the reforms.

In terms of corporate governance reform, the Kim Dae-Jung government broke the myth of 'too big to fail': it allowed many chaebols to go bankrupt and requested that they restructure to focus on their core businesses.[4] In terms of financial reform, many banks went bankrupt and were purchased by foreigners. Most importantly, the stock market became heavily penetrated by foreign capital from 1998 onwards. The ratio of stock owned by foreigners, in terms of market capitalisation, increased rapidly from 12.3 per cent in 1997 to 21.9 per cent in 1999 and to 40.1 per cent at the end of 2003

(SERI, 2004: 59).Many top blue-chip companies on the list had foreign equity of over 50 per cent, such as LG Electronics (64.96 per cent), Samsung Electronics (54.68 per cent) and Hyundai Motor (55.59 per cent) at the end of 2004 (KOSCOM, 2005). The importation of a large amount of foreign capital into the securities market helped the chaebols finance their ambitious domestic and global expansion.

In addition, the financial liberalisation significantly opened up the Korean market to FDI. Before the crisis, the Korean development model was preoccupied with economic nationalism, which favoured foreign borrowing over foreign investment. However, this situation changed radically following the crisis. The total amount of inward FDI during 1998–2003 accumulated to around $62 billion on a notification basis. This figure was far more than double the US$25 billion posted during the previous 35 years of economic development, reaching about 8.0 per cent and 7.7 per cent of GDP in 2002 and 2003, respectively (UNCTAD, 2004: 407). The liberalisation policy transformed the Korean economy from placing its priorities on economic nationalism to putting emphasis on economic globalism, and from stressing the chaebol's outward globalisation to focusing on the transnationalisation of the domestic economy (Dent, 2003: 264). Through these economic liberalization policies, the role of the securities market gradually increased in terms of supplying Korean firms' financial needs, ranging from only 4 per cent in 2002 to 36 per cent in 2004 (Bank of Korea, 2005). Along with this globalisation within its internal market, South Korea also became very active in participating in the international capital market in order to access funds for its enterprises' global expansion. In 2002 and 2003 it collected US$54.6 and US$63.5 billion, respectively, of which the corporate sector accounted for US$21.3 billion alone in 2003. These figures were the highest among the Asian countries (ADB, 2004: 16).[5]

Along with the Korean state's liberalisation policy, the chaebols' technological development continued ambitiously as they pursued a high-volume production path. First, they continued to invest huge amounts of funds into high-volume production in order to maintain their leadership in a few products. For example, the capital investment of Samsung alone in the DRAM industry exceeded that of all five Taiwanese DRAM firms among the top 10 listed firms combined from the year 2000 onwards (Table 2). In 2004, Samsung spent US$4.3 billion purchasing equipment, and it also invested 47 per cent more in terms of capital than all five Taiwanese DRAM firms combined (US$2.3 billion). In 2003, South Korea accounted for over 43 per cent of world sales of DRAM, followed by Taiwan (13.4 per cent), with Samsung taking the lead with 28.6 per cent of world sales (KISDI, 2003: 97).

Second, the Korean chaebols' success in the IT industry has not only been based on their volume of production but also on their intensive R&D activities, which have facilitated continuous product innovation. Since the early 1990s, the Korean state has placed more emphasis on increasing R&D expenditure so as to transform the economy from being in a catching-up mode towards facilitating innovation. R&D expenditure as a proportion of GNP in South Korea in 2002 was 2.91 per cent, which was also one of the highest such proportions in the world. As in other parts of the world, the importance of the government in R&D activities has declined when firms become mature, in that they can take responsibility for their own technological development. In 2002, the government's

share of R&D expenditure was 13.4 per cent, that of higher education was 10.4 per cent, and that of the private sector was 75 per cent of the total (NSC, 2004). The South Korean government's role in technological development was to engage in key R&D projects such as CDMA cell phones. In 2001, it supported approximately 12.3 per cent of the total R&D expenditure in the IT industry (KISDI, 2003). These projects were mainly channeled to supporting R&D activities proposed and engaged in by major chaebols. Indeed, the increase in R&D expenditure has continuously been concentrated in the top few chaebols (MOST, 2004). The highest concentration was in 1999 when the top five chaebols accounted for 42.6 per cent and the top 20 chaebols for 61.9 per cent of all R&D expenditure (see Table 3).

To sum up, the Korean chaebols have transformed themselves from technological followers to technological leaders by taking advantage of scale economies and receiving heavy support from the state for their own R&D and for public R&D that they have included with their own. Although the Korean state has expressed its intention to reduce the chaebols' influence by promoting IT start-ups and venture capital in the post-crisis era, it has not changed the tendency for the chaebol to dominate the industrial structure (KISDI, 2003: 35). Schumpeterian scale economies have steadily become the dominant production norm in the Korean model.

Table 2. Capital investment of top DRAM manufacturers (in US$ million)

	2000	2001	2002	2003	2004
amsung (K)	4,170	2,170	1,800	3,633	4,328
Hynix (K)	1,583	250	400	583	1,050
Micron (US)	1,475	1,164	904	756	1,400
Infineon (G)	2,100	124	653	1,000	1,400
NanYa (T)	616	327	124	140	260
Inotera (T)	–	–	–	413	812
ProMos (T)	400	506	223	230	310
Winbond (T)	410	173	150	140	121
Power Chip (T)	243	186	702	441	800
Elpida (J)	–	240	345	912	1,091
Sum	10,997	5,140	5,301	8,248	11,572

Source: Liu 2005: 19.

Table 3. Concentration rates of R&D expenditure in South Korea (%)

	1996	1997	1998	1999	2000	2001	2002
Top 5 companies	32.3	36	40.2	42.6	34.8	35.6	37.5
Top 10 companies	44.5	48	49.7	53.3	45.9	43.4	43.2
Top 20 companies	56.5	59.4	60.8	61.9	55.4	49.8	49.6

Source: MOST, 2004.

Taiwan's Precautionary Transition and Global Production Networks Similar to the South Korean case, Taiwan's political community in the 1980s also recognised that economic liberalisation was a strategy to upgrade its economy and to link its firms more closely to transnational technological networks. However, in a way that was different from its South Korean counterpart, Taiwanese private capital was not so powerful as to be able to transform the state (Wang, 1996). Due to its smaller scale and its related weakness in terms of political power, the private capitalist in Taiwan in the process of democratisation at most transformed himself from being the son to becoming the elder brother of the state in the new form of a democratic alliance (Wang, 1996; see also Weiss and Hobson, 1995). Moreover, because of the increase in tensions across the Taiwan Strait, the Taiwanese state became even more concerned with the security issue, and to this end brought the economic liberalisation process under its control, proceeding in a very cautious way.

In these circumstances, several features have distinguished Taiwan from its South Korean counterpart in terms of its economic transition. First, in contrast to the postcrisis South Korean neoliberal state, the Taiwanese route towards financial liberalisation is a type of 'managed opening' (Weiss, 2003). Due to security concerns, even when under pressure from the United States, the Ministry of Finance liberalised the banking sector in a very restricted way and privatised the state-owned banks on a gradual basis. The state only gradually raised the capital ceiling for individual foreign institutional investors in any listed company in order to maintain financial stability. The central bank also intervened in the market if it considered that foreign investors were engaging in speculative activities (Thurbon, 2001: 253). The state also limited financial and technological flows to China, which as a consequence resulted in restrictions being imposed on many industrial sectors. As a corollary, although Taiwan opened its market to 100 per cent foreign stock ownership in any single firm listed on the stock market in 2000, foreign portfolio investment accounted in total for only 12.5 per cent of the market value in 2004 (Securities and Futures Bureau, 2004), a far smaller share than that in the case of Korea. The state's control of the financial sector prevented Taipei from becoming a financial centre along the lines of Hong Kong or even Seoul (Wang, 2004). Therefore, although the securities market has become more open than before, the business debt mainly came from the banks rather than from the financial market just as it did before, with the former accounting for 71.8 per cent of the debt and the latter for the remaining 28.2 per cent in 2004 (CBC, 2005).

Second, similar to the South Korean case, where further technological development needs new sources of financial input to remain on the technological frontier, Taiwanese firms, especially the leading PC, semiconductor and TFT-LCD firms, have also demanded new financial resources in order to pursue technological development based on economies of scale. Nevertheless, the fragmented nature of Taiwan's industrial structure has also laid down the parameters for Taiwanese firms in their pursuit of economies of scale. In a way that differs from the South Korean firms' vertically integrated industrial structure, the Taiwanese firms' approach to the IT industry has been to externalise different parts of the production process into different segments. The enlargement of the scale of operations is therefore achieved by collective co-ordination, in which one segment's capital investment will

necessarily result in other segments adjusting with it. Hence, the enlargement of the scale of Taiwan's IT industry has not been achieved by a few firms, but has been accomplished by the networking that has taken place among firms.

The state's precautionary policy and the fragmented nature of the industrial structure have resulted in Taiwanese firms' smaller scale of operations as compared with the Korean chaebol. For example, the largest privately-owned enterprise in the electronics industry in 2003 was Hong Hai Precision Corporation, whose net asset value was US$3.82 billion and annual turnover approximately US$7.45 billion. By contrast, the respective figures for its counterpart in South Korea, Samsung Electronics, were US$51.92 billion and US$47.61 billion; and for its counterpart in Japan, Sony, US$66.76 billion and US$59.60 respectively. Samsung Electronics had thus 13.6 times the net asset value and 6.4 times the annual turnover of Hong Hai Precision Corporation (Table 4).

Table 4. Top five electronics companies in Taiwan, South Korea and Japan, 2003

	Taiwan	South Korea	Japan
1	Hong Hai Precision	Samsung	Electronics Sony
Asset value	3.82	51.92	66.76
Sales value	7.45	47.61	59.60
2	TSMC	LG Electronics	Matsushita
Asset value	11.29	16.04	62.48
Sales value	4.69	17.84	59.03
3	Mitac	Samsung SDI	Toshiba
Asset value	1.61	4.58	41.78
Sales value	4.62	5.30	45.11
4	Tatung	Hynix Semiconductor	NEC
Asset value	5.54	8.92	32.72
Sales value	4.38	3.75	37.44
5	Quanta Computer	Samsung Electro-Mechanics	Fujitsu
Asset value	2.89	2.87	33.69
Sales value	4.13	3.12	36.83

Source: Adopted from Yazhou Zhoukan (Asia Week), special issue on Asia top 1000. 7 Dec. 2003.

Despite the fact that Taiwanese IT firms have not developed their economies of scale in the same way as their South Korean counterparts, they are however very competitive in the areas of PCs, notebook PCs, foundry ICs and other related peripherals. In 2002, Taiwan produced 61 per cent of the world's notebook PCs, more than 75 per cent of the motherboards, 61 per cent of the liquid crystal display monitors, 23.9 per cent of the desktop PCs, 51 per cent of the tube monitors and over 75 per cent of the foundry ICs for the world market (MIC, 2004a). These achievements largely relate to the Taiwanese IT firms' strong foothold in the global production networks (GPNs) and the external

economies of the IT industry in the 1990s, which laid the foundation for innovation.

First, the Taiwanese IT industry expanded its flexible production system to encompass China and gained second-tier status in the global production networks (GPNs) (Ernst, 2000; Chen, 2002), becoming one of the major producers in the world IT industry since the early 1990s. The flexibility of the SMEs and the adaptability of the production networks prevented the Taiwanese PC industry from collapsing as a result of the continuous price wars waged by the world's leading firms, such as Compaq and IBM, in the early 1990s. Ironically, all have become even more dependent upon Taiwanese firms to provide contracted manufacturing products to compete in the world market. Because of this mutual dependence, GPNs in the PC world have been created, with the market leaders becoming the flagships supported by mini-GPNs established by the leading Taiwanese firms. The Korean chaebols' organisational rigidity, by contrast, prevented them from becoming successful in the PC world. The high-volume production method does not apply to the highly flexible PC world (Dedrick and Kraemer, 1998; Kanatsu, 2002). In the process of becoming the first-tier suppliers, the leading Taiwanese PC firms, however, did not develop the features of vertically-integrated organizations exhibited by the Korean chaebol. Instead, they became horizontally integrated with large numbers of SMEs located mainly in China and other places in the world. The proportion of offshore production value accounted for by Taiwan's IT industry increased from 37 per cent in 1997 to 79 per cent in 2003, of which China accounted for 23 per cent and 63 per cent, respectively, of the total overseas production value (MIC, 2004b). The locally-embedded production networks characteristic of the former stage have now changed into globally-nested production networks, which are coordinated and managed by the major Taiwanese PC firms. In this sense, if the Taiwanese PC firms' success can be attributed to the enlargement of their scale of operations (Amsden and Chu, 2003), it is in fact the flexible mini-GPNs that have underpinned the organisational scale and have built the basis of their competitiveness in the world market.

Second, as discussed above, the achievements of the PC and related sectors in the world market have largely been related to the success of Taiwan's semiconductor industry in which the foundry IC was the dominant segment. Unlike South Korea's vertically integrated firms that produce semiconductors for a whole value chain, Taiwanese foundries only manufacture ICs designed by others. The Taiwanese chip makers have now developed the technologies that can simultaneously handle 50 to 100 technologies (Keller and Pauly, 2001). This kind of flexibility and technological capability are not matched by any other foundries in the world. Because of the success of the foundry, many world-leading IC design firms that have worked closely with the leading foundries have emerged in Taiwan. The IC design firms share similar characteristics to the foundry and PC industries: flexibility, focus on a single product and networking.

Finally, like the South Korean case, the importance of the state in technological development has been declining due to the maturing of the domestic industry.[6] The state instead has now changed its approach by promoting R&D activities through a strategy that mixes tax incentives with partial subsidisation. The state has used ITRI as the main instrument to build public-private R&D networks so

as to promote technological upgrading, especially among the SMEs. This type of R&D network has generally been based on a 50–50 contribution from both the government and firms, through which the firms have been able to utilise the equipment and laboratories for research and experimental purposes. Various forms of R&D consortia have been formed, through which leading-edge IT technologies and innovative products have been developed and transferred to SMEs (Mathews, 2002).

The above external linkages have enhanced the SMEs' R&D activities, networking them with major leading firms and public R&D institutes that have largely reduced the resource weaknesses inherited from the firms' smaller operating scales. The smaller scale of Taiwanese IT firms has therefore not hampered their technological development. On the contrary, as shown in Figure 1, Taiwanese IT firms still exhibit a strong tendency towards innovation. This pattern is similar to the neo-Marshallian description of industrial districts that created external economies which thereby facilitated the SMEs' technological development. Indeed, as many have observed, the IT cluster built in and around the Hsinchu Science-based Industrial Park has become the major production site for Taiwan's IT industry, in which globally linked but locally embedded networks have been formed to enhance knowledge diffusion and creation which is favourable to technological innovation (Wang and Gao, 2000; Saxenian and Hsu, 2001; Chen, 2003). One may argue that Taiwan's technological development has been transformed into one that is akin to the 'flexible specialisation' type (Fields, 1998) or to the Silicon Valley-type of innovation (Keller and Pauly, 2001), and which exhibits different characteristics to those of South Korea's scale economies.

V. Discussion and Conclusion

This paper has analysed the divergent models of South Korea and Taiwan in terms of their economic catching up and their ongoing transition towards innovation-based economies. It has demonstrated that South Korea's high-debt and chaeboldominated model at the former stage inclined it to pursue scale-based technological development. In the 1990s, the South Korean state adopted a neoliberal approach in the transitional process. The financial market was opened to international capital and the chaebols were able to take the opportunity to enlarge their operating scales even further and pursue a Schumpeterian technological innovation. By contrast, the Taiwanese state's pro-stability, SME-dominated model has tended to blend in with the flexible networked production system, in which technological catching up has depended on the state's support, external dependency on foreign firms as well as the networked learning effect. In the 1990s, economic liberalisation in Taiwan proceeded in a precautionary way. While this resulted in some weakness in regard to the capacity of Taiwanese firms to expand their scale of operations, Taiwanese firms nevertheless were able to work with the state and with their own production networks, as well as with global leaders in the global production networks to keep up with a neo-Marshallian technological innovation.

The comparison between South Korea and Taiwan gives rise to some theoretical Issues that

deserve further attention. The first issue is concerned with whether or not globalisation has created a convergent effect toward neoliberalism. Our comparison shows that the Korean state and the Taiwan state have been faced with different characteristics in their state-led transitions. The South Korean state transformed itself into a neoliberal model in the 1990s while the Taiwanese state remained very cautious with regard to moving in the same direction. The irony is that the South Korean state was much stronger in shaping its economy than the Taiwanese state was in the former stage. This paradoxical development, as discussed above, is largely related to the emergence of corporate power in South Korean politics, as well as to the chaebols' enormous demand for capital inputs in the technological development process.

The second issue has to do with the problem of scale – whether taking advantage of economies of scale is a necessary condition when transitioning from a catch-up to an innovation-based economy. This perspective is partially correct when applied to both Korean chaebols and large Taiwanese firms. However, the argument needs some qualification: the Korean economies of scale are based on the chaebol's vertically-integrated organisation that is similar to that of the American firms. The Taiwanese economy, however, is strongly characterised by vertical fragmentation, which is supported by a vast number of globally-networked SMEs. The competitive strength of the Korean firms depends on the chaebol itself. For their Taiwanese counterparts, however, it is based on their networked collectivities. In this sense, the competitiveness of the Korean chaebol-based economy rests with the Schumpeterian principle of scale, while that of the Taiwanese SME-based economy is instead based on the Marshallian principle of external economies.

The third issue concerns which model is more suitable for other late industrializing countries to imitate. The South Korean case shows that its development has been based on the state's almost unlimited support of a few national champions, even at the expense of high external debt and massive foreign borrowing. This also has brought with it the chaebol's high-debt corporate governance that has cultivated the economies of scale based on producing single goods. While all these have contributed to South Korean firms' successful catching up and upgrading towards innovation, they nevertheless have also given rise to an inbuilt systemic risk that revealed itself during the 1997 financial crisis. On the contrary, the Taiwanese model is less risky and its competitiveness is based on more accountable corporate behaviour as well as on the collective effort of flexible networking firms. Even if an external crisis occurs, the risk is socially shared by a large number of firms rather than by only a few resource-concentrated firms as in the South Korean case. In this age of globalisation, few late industrialising countries are able to afford the South Korean model, because it requires the state to be heavily involved in supporting as well as subsidising the firms which may violate the regulations of free trade. It is therefore the Taiwanese model of supporting SMEs that will be more affordable for other late industrializing countries to imitate. However, as has been shown, in order to first resolve the technological and resource-related weaknesses of the SME-based economy, it is necessary for the state to create an environment that facilitates collective learning and fosters external economies.

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Notes

1. According to Hall and Soskice (2001: 39–41), the bank-based financial system tends to be favourable to incremental innovation, due to the stronger interrelationships among stakeholders that make firms more likely to secure their existing technologies and production lines and to improve upon them. The capital market-based system on the contrary tends to support radical innovation, because financial markets are composed of dispersed shareholders who favour short-term profitability, and therefore few restrictions are imposed on firms in relation to mergers or acquisitions that may enable them to access new or radical technologies.

2. Recently, this Schumpeterian view was elaborated by Amsden and Chu (2003) so as to apply to latecomer firms. They proposed 'the second mover's advantage' thesis and argued that because latecomer firms tend to enter the mature or mid-level technology industries (whose typical feature is that the return on profit has been declining), the strategy that latecomer firms have to adopt is thus to enlarge their organisational scale and improve their technological capability.

3. The cost of building a single semiconductor plant in the late 1960s was about US$2 million, which rose to US$l billion by the mid-1990s, and the cost of a state-of-the-art semiconductor plant today is around US$3 billion. Moreover, the annual R&D budgets of leading global electronics firms were well in excess of US$6 billion by the end of the 1980s (adopted from Pirie, 2005: 30).

4. It was also under state pressure that most chaebols reduced their debt-to-equity ratios, these being reduced overall from 396.3 per cent in 1998 to 130.0 per cent in 2002 and to 100 per cent at the end of 2003 (SERI, 2004: 138).

5. According to the Asian Development Bank (ADB, 2004: 16), the amounts for Taiwan's access from the international securities market in 2002 and 2003 were US$12.4 billion and US19.4 billion respectively; those for China were US$17.2 billion and US$19.9 billion; and those for Malaysia were US$23.4 billion and US23.4 billion.

6. In 2002, the shares of the public and private sectors in total R&D expenditure were 37 per cent (including 25 per cent for government and 12 per cent for higher education) and 62 per cent, respectively (NSC, 2004). The public sector's share of the total expenditure, however, accounted for over 50 per cent in both 1991 and 1992.

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