THE EVOLVING INSTITUTIONAL EMBEDDEDNESS OF A LATE-INDUSTRIAL DISTRICT IN TAIWAN

JINN-YUH HSU

Department of Geography, National Taiwan University, 1, Roosevelt Road, Sec. 4, Taipei 106, Taiwan. E-mail: jinnyuh@ntu.edu.tw

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ABSTRACT

The high-technology industrial system in Taiwan is noted by its decentralisation and geographical agglomeration. It demonstrates varieties of features of industrial district: spin-offs, collaborations, networking, and most importantly, institutional presences. At the initial stage, Taiwan's Government did lead in the technology transfer, rendered new firms formation and pushed the private sector hard to bring the industry into being. However, as the industry became global, new redundant and complementary institutions, including dense social and professional connections and associations, joined the monotonic role of the state to make network learning in the decentralised industrial system effective. It represented a developmental paradox: if the developmental state is argued to be a top-down bureaucratic rationality based governance mechanism, how could it build up and articulate with the supposedly bottom-up trust-based social networks? How could the potential tension between the top-down and the bottom-up be settled? The research will explore the process of institutional embeddedness, de-embeddedness, and re-embeddedness in Taiwan's high-technology region, and provide a lesson for the late-industrialising countries in the globalisation era.

Key words: Hsinchu, Silicon Valley, institutional embeddedness, developmental state, transnational technical community, industrial district

INTRODUCTION

A number of East Asian countries – Japan, Taiwan, South Korea, Hong Kong and Singapore – have been home to the world's most dynamic and successful economies for a long time before 1997, drawing the attention of scholars from contradictory theoretical positions (e.g., Henderson 1993). The East Asian experience has constituted an empirical field for the testing of rival theories and spawned debates over the reasons for the rise of this area.

While neo-liberals argue that the market mechanism will naturally lead to the efficient exploitation of comparative advantage, the statists believe that government policies will influence the behaviour of firms and market allocation in such a way as to create competitive advantage. In fact, both arguments are partially accurate in their descriptions of the interaction between the market mechanism and state activity in the East Asian experiences. Even if it is widely accepted that the developmental states responsible for the success of East Asian high technology development (Mathews & Cho 2000), it still remains unclear how the industrial policies in different countries, such as Taiwan and Korea, have led to different industrial organisations and consequently the divergent market structures and economic trajectories. As Korean information technology (IT) industries are dominated by few key *Chaebols* (diversified business groups), Taiwan boasts high rates of entrepreneurship and thousands of small and medium-sized enterprises (SMEs) alongside

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larger technology companies with multiple backward and forward linkages.

One concern is raised here: how could the bureaucratic states create and command the contrasting industrial structures, and correspondently meet the uncertainty of the volatile global market? Evans (1995), based on the study of Korean and Brazilian IT sectors, argued that the developmental states assist in the birth and growth of domestic, national firms through their role as 'midwife' of new firms and sectors and by tending to the 'husbandry' of these growing industries.[1] The states do not achieve the goal by themselves, but embed their policies in local capital through the close ties between state bureaucrats and domestic businesspeople. Although Evans, as well as Amsden (1989), illustrates the critical role played by the developmental state and its embeddedness in big capital (*chaebol*) in Korea, it is doubtful that the regime of governance will demonstrate the nature of the alliance between big state-big capital in Taiwan, which is noted by its SMEs dominance in high technology development. As Lundvall and Maskell (2000) point out, the main reason for difference in performance between national systems may be that the degree of matching between economic structure and institutions differs among countries. Evan's concept of 'embedded autonomy' leaves two critical issues moot. First, in the process of 'midwifery', how could the state bureaucrats evaluate and select the prospective high technology industries, as they were short of experiences and talents in the new sectors? Second, more importantly, as local firms compete in the global markets, how could the *dirigisme* from the domestic developmental states meet the spontaneity of the transnational business networks? This is particularly perplexing for Taiwan's development of high technology, which is characterised by decentralised industrial systems and close global connection, and is usually contradictory to the rigidity of state bureaucracy (O'Riain 2000).

But the existence of transnational and decentralised industrial systems does not mean the lack of market tyranny from state dominance (Bourdieu 1999). Instead of retreating from institutional de-embedded, the local industrial system encounters the challenge of the co-evolution of organisational forms and governance regimes in the global space of flow. How the state mediates in the globalisation process will be the critical issue for the late-industrialising countries to compete in the rise of network social economy. By and large, engaging in global production and competition aligns local capitals with the interest of their international partners, and undermines their embeddedness in domestic state policies. Consequently, it adds ceilings on the state's leadership in intervening firm's activities, and forces the state to restructure itself to be better positioned in handling global connection. In other words, the key to the politics of the late-industrialising economies in globalisation era resides on the tension and solution in the articulation process, as the top-down domestic developmental state meet the bottom-up transnational socio-economic networks.

The Hsinchu region, the Hsinchu Science-based Industrial Park (HSIP) and its neighbouring corridor extended to Taipei, was praised as one of the most successful technopoles around the world (Hall & Castells 1994; Mathews 1997), and was conceived as a paradigmatic example of late development to meet global industrialisation (Hsu 1997), and thus allowed the investigating of the changing institutional infrastructures of a late-industrial district in the globalisation process. The area is the home to Taiwan's most rapidly growing microelectronics industries such as integrated circuit (IC) and personal computer (PC). These firms, mostly small and medium sized, collectively build up a vertically disintegrated industrial system. Local companies dominate the markets for a large and growing range of computer-related products, from notebook computers, motherboards and monitors to optical scanners, keyboards and power supplies. In addition, Taiwan's state-of-the-art semiconductor foundries account for two-thirds of global output. Not surprisingly, the industry has grown dramatically in the past two decades. Taiwan's IT sector now ranks third in the world, with total output of US$34 billion in 1998, ahead of larger nations like South Korea, and behind only the US and Japan.

In an industrial agglomeration such as the Hsinchu region, it is important to avoid underestimating the roles played by institutions such as the state by assuming a *laissez-faire* economic system. Instead, institutions are the bases in which capitalist relations of production and exchange are embedded (Dosi *et al.* 1994; Amin & Thrift 1994; Hollingsworth & Boyer 1997). Institutional thickness is critical if an economic system, particularly the industrial district, which targets collective learning, is to reduce the dynamic uncertainty involved in the innovative process. Furthermore, the roles played by certain institutions may change as the structure and technological level of industrial systems change (Nelson 1994; Nelson & Nelson 2002). Institutions that perform well in certain situations may become obsolete in other contexts such as rapid globalisation process (Pempel 1999). For example, from a learning perspective, government subsidies are enough to encourage and discipline private firms to engage in production efficiency improvements, as Amsden (1989) argues. Nevertheless, as the industry grew global, the source of learning should be broad to include purposive learning networks, and it is dubious whether the government is the best candidate to coordinate nearly self-spontaneous learning networks (Bell & Albu 1999). The technological strategies pursued by the industrial system should result in different forms of institutional embeddedness. In the following sections, the process of dynamic institutionalism in Taiwan's IC industry will be scrutinised, and focus on the transformation of institutions that played mediating roles in the development by tackling the nature of the divergent institutional players, their power relations, structural constraints, and evolution as the organisational fields reshuffled in the globalisation process. Key issues will be explored such as: what roles are played by the developmental state agencies, such as the government, the public laboratory, and even the technology park at the initial stage? To what extent were the relations between the institutional infrastructures and the business 'developmental' and fit with the developmental statist arguments? How would the institutional roots transform themselves in the process of industrial development, as firms competed globally and became estranged from the national regulatory agencies? And finally, as the globalisation process meant the reshuffling of organisational and geographical orders, how would the cross-border business transactions be governed by the corresponding institutions?

INSTITUTIONAL EMBEDDEDNESS IN DEVELOPMENTAL STATE

Without doubt, the state is one of the most outstanding institutions to foster late development in the East Asian Miracle (Amsden 1989; Wade 1990; Evans 1995). According to these theorists, the state is administrated by a group of high-calibre technocrats who exploit their own autonomies and are dedicated to economic development. It is the state, not the market, which leads the industrialisation process. Wade (1990), for example, raised Taiwan's government as an example of the developmental state, which possessed the capabilities to direct a continuous upgrading of the technical level of industry, and thereby avoid the low-wage trap. Two direct actions taken by Taiwan's government to promote the IC industry: the establishment of the Electronic Research Service Organisation (ERSO) as the bridging mechanism to transfer foreign technology, and the construction of the HSIP to host the high-technology firms by subsidies.

The Electronic Research Service Organisation (ERSO): the bridging mechanism – As early as the mid 1970s, the government embarked on a plan to upgrade Taiwan's economic structure, transforming its orientation from labour-intensive to skill and knowledge intensive (Li 1980). This was the basic reason behind the establishment of the Industrial Technology Research Institute (ITRI) in 1973. When the government decided to enter the IC industry, ERSO (an electronics arm of ITRI) was chosen to be the vehicle. Originally, the government had invited private capital to help with the task, but the latter thought the IC business too risky and refused. Under such conditions, ERSO had to shoulder the burden solely of developing the IC industry. Through a series of projects, the state successfully promoted the local IC industry to take roots (see Table 1).

The Government decided to use ERSO as a bridge for selecting and acquiring foreign technology, assimilating it, training people in it, and then diffusing it to the private sector. In other words, the state took advantage of late development, dedicated itself to technological learning, and then served as a bridge between foreign technology and new local firms. The spin-off of

Table 1. *Public R&D projects for IC industry.*

	EIDP-I	EIDP-II	Very large scale IC (VLSI) Project	ULSI Project
Timeframe	1976–79	1979–83	1983–88	1990–94
Expenditure (US$ million)	12.23	20	97.37	196.43
Objectives	IC design and mfg tech acquisition Establish pilot operation	Improve pilot CMOS facility Acquire mask tech	Establish VLSI process tech Acquire CAD for VLSI ICs	Acquire submicron process tech Establish ULSI pilot plant
Major features	Pilot plant Tech acquisition and transfer Personnel training	Pilot plant improved LSI chips Mask shop	VLSI chips VLSI pilot plant	ULSI chips ULSI pilot plant
Tech capability	7.0 micron CMOS	3.5 micron CMOS	1.0 micron CMOS	0.5 micron CMOS
Spin-offs		UMC, Syntek, Holtek	TSMC, TMC, Winbond	VISC

Source: adapted from Liu (1993, p. 303).

UMC, the first local IC firm, illustrates the 'midwife' role of the developmental state.

Why was ERSO competent to play the role of midwife? This had more to do with the state's ability than with its desire. Substantial funds and manpower were controlled by ERSO in the late 1970s. From 1976 to 1980, ERSO invested approximately US$120 million in the acquisition of IC design and manufacturing technologies, as well as the establishment of a pilot operation. This showed the Government's dedication to the new industry (Chang *et al.* 1994). The amount was relatively small in comparison with the investments of US or Japanese companies, but the financial resources possessed by ERSO were enough to engage in the initial task of technology transfer.

More important than financial resources, capable manpower was the key for the late-industrialising state to start up a new industry. This was especially challenging for a developing country like Taiwan, which faced a serious brain drain.[2] A special feature of IC technology is its tacit side, which is people-embodied. Thus, to incubate the industry and allow it to take root, overcoming the qualified manpower barrier was critical. In the 1970s, few people outside a small group of professors and students at Chiaotung University had learned semiconductor-related technologies. Later on, one of these professors, Dr Ding-hua Hu, joined ERSO and was put in charge of the project for technology transfer from RCA.

Besides local sources of manpower, ERSO recruited several key people from overseas. Among them, three skilled engineers, Dr Ding-yuan Yang, Dr Chin-tay Shih and Dr Ching-chu Chang, were particularly influential. All of them had earned Ph.D. degrees in electric engineering at Princeton University. They took the RCA project as an opportunity to contribute their knowledge to their home country. Each of them took responsibility for leading a team to RCA and other firms to learn IC fabrication, mask making, and design skills, as well as factory management practices. After that, they engaged in the construction of a pilot factory in ERSO and planned the spin-off. To sum up, ERSO overcame its manpower constraint problem by relying not only on already existing talent, but also on reversing the brain drain.

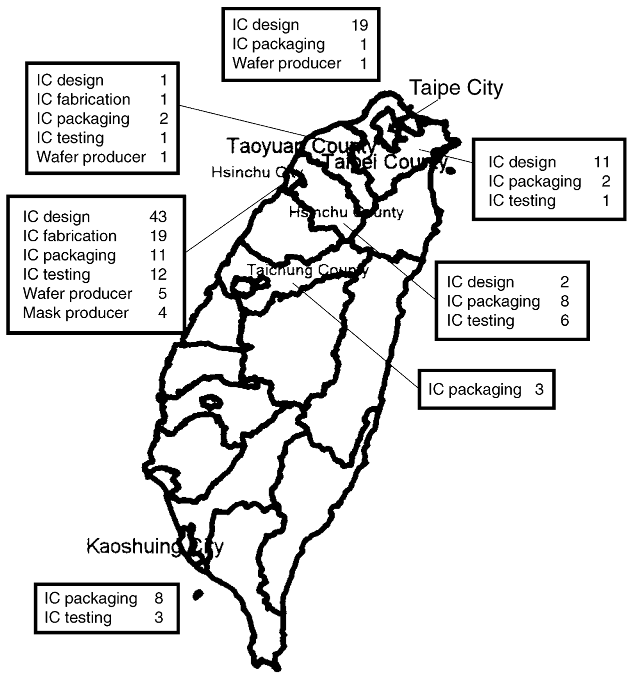
Nevertheless, to succeed in the leadership build up, the state needs not only strong capabilities, but also relative embeddedness in the industrial sectors. Building up linkages with business will help the bureaucrats to collect and analyse information about the industries, and finally make the strategic decision. Without the input from business, strong state capability leads to catastrophe in some cases, as the supply from the effective bureaucracy will not guarantee matching with the demand from new industry (Evans 1995). But this requirement raised a difficulty for governments in developing countries such as Taiwan, which had little experience in high technology areas, in the late 1970s. A number of studies point out that Taiwan's Government has played a critical and leading role in the development of an IC industry (Liu 1993; Mathews 1997; Chu 1995; Hong 1992). However, they do not provide enough evidence to demonstrate how the Government could achieve the goal without connecting with the insider's knowledge of the challenging industry. In fact, Taiwan's developmental state did not base the IC industrial policy on its own bureaucratic apparatus, but on the advice of experienced overseas Chinese engineers. As a newcomer to the IC industry, Taiwan had to search for some form of technology outsourcing. In other words, it had to transfer technologies from foreign companies. This point was confirmed by high-ranking officials and their overseas consulting groups. Under the leadership of Yunsuan Sun, the Minister of Economic Affairs, a group of senior overseas Taiwanese electronics engineers was organised to provide advice and guidance in the nurturing of high-technology industries in Taiwan.[3] The advisor's role was key to the information collection, evaluation, selection, and implementation of the technology transfer deal with the leading foreign firm (RCA) in the initial stage. It is not sure that Taiwan's Government could foster the new technology-intensive industry without the overseas advisor's recommendations. In other words, the state benefited from the social embeddedness with the overseas technical community, not from the high-calibre bureaucrats assumed by developmental statists such as Wade (1990) and Amsden (1989).

After transferring technology from RCA, ERSO founded a new private IC company, UMC. As shown above, ERSO transferred technology, machinery, personnel, and products to UMC. Given private capital's reluctance to invest in a risky venture, the government had to assign the state-run Bank of Communications and China Development Fund to invest in the new company. Thus, the government, through its agents such as ERSO, TAC, and the banks, allowed UMC to get an early start in building scale and scope economies, and promoting learning effects. This first mover advantage could not have been realised without a big push from the government, since private capital hesitated to enter the new technological area.

The Hsinchu Science-based Industrial Park (HSIP): A government-subsidised industrial location – Another supporting institution initiated by the state is the HSIP. It was not established exclusively for the IC industry, but as of 1995, the IC industry is the most successful one in the park, in terms of the number of companies, sale revenues, and growth rate. Over 85 per cent of Taiwan's IC firms concentrated in the park (see Figure 1).

From the beginning, the HSIP has been well administrated and financed by the Government. According to the administration of the HSIP, by 1998 the Government had spent more than US$670 million on the development of the park. The Government uses the HSIP as a vehicle to provide financial and infrastructure supports to emerging industries. In the HSIP, plants, utilities, residential housing, schools and the like are all built according to high standards. All an investor needs to do is move in and start a business.

HSIP is especially attractive now that it is so difficult for investors to find a piece of land where they can build their new plants, due to skyrocketing land prices in Taiwan. This benefits the small and medium-sized high technology firms, because they are able to save money on the fixed capital investment and spend more on product R&D. Besides the public infrastructure, the Government provides tax incentives for firms located in the HSIP. Such tax breaks allow firms to dedicate their funds to equipment and technology acquisition. A third benefit accruing to tenant companies is that the HSIP is near to ERSO and the universities. The Government expects this to produce cross-fertilisation between the HSIP, public research institutes, and higher education. The HSIP hosted most of Taiwan's IC companies, and engendered substantial agglomeration economies for its tenant firms.



Source: MOEA 1999.

Figure 1. *The map of IC industry in Taiwan, 1999.*

The neighbouring universities are common goods for the HSIP. Universities are usually recognised as a repository of public scientific and technological knowledge. Some privileged universities like Stanford and Cambridge are said to be the powerhouses of their neighbouring industrial parks (Hall & Castells 1994). In the Government's original plan, the selection of Hsinchu as the site of the science park aimed to take advantage of geographic proximity with two of Taiwan's leading science and engineering universities, Tsinghua and Chiaotung.

The universities have two distinct kinds of contributions to the IC industry. The first is that academics can teach engineers and scientists in industrial laboratories the basic principles relevant to the industry. Sometimes the relationship between academic principles and industrial applications are not clear and direct. Most IC companies will therefore combine on-the-job training with school education for their employees. School education supplies the basic knowledge and logical thinking for entry-level engineers, and on-the-job training allows them to get real-time practical knowledge and experiences.

Another, maybe more critical, possible contribution made by universities to the industry comes from co-operation in R&D, and enhanced firms' capabilities (Massey *et al.* 1992). The HSIP was planned to take advantage of proximity to the universities by providing a focus for university-industry links, technology transfer, and the commercialisation of academic research (Li 1980). Getting access to the academic resources of the host universities is one of the major goals of the HSIP. Particularly for small to medium-sized firms, external academic support is supposed to help them overcome the size barrier in R&D.

However, as a latecomer, Taiwan's IC firms sourced key technologies from remote providers, rather than the near by universities. Before the early 1990s, formal research links were nearly non-existent. Most funding for university research came from the Government, and supported academic research, which did not necessarily have any connection with the industry's commercial practices. According to Dr Chiatung Lee, the former dean of academic affairs at Tsinghua University, there was no significant advantage for the universities and the HSIP to be in the same area, because 'Taiwan's industrial production had not involved any "real" R&D activity; so the companies did not need help from the universities' (quoted in Castells & Hall (1994, p. 106)). This view was echoed by Miin Wu, the president of MXIC, who believes Taiwan's IC companies only practise the adoption and modification of foreign technologies, and do not engage in any serious research. 'The real situation in Taiwan was a small r, and a big D.' For such 'shortsighted' firms, the basic scientific research undertaken in the universities is of little use. Even during the period 1995–99, the revenues of the HSIP firms grow at 116 per cent, the contribution of the HSIP firm-sponsored collaborative projects accounts for only 8 per cent to 15 per cent of the college's research grants (Chiaotung University 2001).

To sum up, the state tried to build up a special zone to attract high-technology investments by providing financial incentives and general infrastructure. To some extent, the state attained its goals, given that most firms identified tax breaks, a good investment climate, and infrastructure as the priorities in their location decisions, according to a report by the Chung-Hua Institute for Economic Research (1991).

De-embeddedness from the developmental state – After the setting up of UMC, ERSO maintained its leading role in promoting the new industry. It still controlled huge budgetary resources and recruited experienced engineers from overseas. The VLSI (Very Large Scale IC) project represents another effort by ERSO to push Taiwan's IC technology onto a new level. UMC argued that it was the proper vehicle for the VLSI project, but ERSO (as well as other government advisers) did not believe UMC was yet qualified for the task. This time ERSO co-developed technology with Vitelic Technology, a DRAM specialist design house founded by a Silicon Valley returnee. The co-operative effort with Vitelic proved successful in developing DRAM chips. But ERSO did not have the fabrication capability to manufacture them and forced Vitelic to sell the design to Korean IC firms. This led ERSO to build a VLSI foundry, which it later spun off as TSMC. This demonstrates that UMC, the child of ERSO, began to constitute a separate voice to ERSO and that private firms began to help shape IC policy.

Several new IC companies emerged after the mid 1980s spin-off from TSMC. Most of the wave of start-ups such as Winbond, HMC, SIS and Holtek, were founded by senior ERSO engineers, who took with them hundreds of people and their technical know-how. Some of the key personalities behind ERSO's early development, such as Dr Ding-yuan Yang, Dr Ding-hua Hu, and Dr Ching-chu Chang, were among the exodus. The exodus of senior engineers from ERSO represented a paradox for ERSO. As Dr Chang, the head of ERSO when he left, said, 'I always feel sad about the tragic role played by ERSO. If ERSO succeeds in promoting the IC industry for the private sector, they will grow strong and do their own R&D, thus they won't need us. But if we fail, they certainly won't need us either. The road before ERSO is a deadlock. This is why I have to leave ERSO. I don't want to be trapped in the impasse' (ERSO 1994). At the same time, more Silicon Valley returnees were joining new companies such as MXIC and Mosel. More importantly, private capital started to view IC investments as profitable, after the successes of UMC and TSMC. Thus, while the IC companies received new financial and manpower resources, ERSO was leaking both. In addition, ERSO also faced the possibility of budget cuts in the late 1980s because of various political economic reasons. The loss of people and money caused ERSO to lose its leading role *vis-à-vis* private IC firms.

The submicron project represented an effort by ERSO to manage these new developments. In the project, ERSO expected to upgrade Taiwan's IC technology to the submicron level and, at the same time, build up new cooperative relationships with private companies. ERSO initiated a working alliance with UMC and TSMC, and asked them to contribute a percentage of the R&D fees for the project. Another six IC firms were invited to form a user alliance, and to gain access to the developed technology by paying fees. But the private firms were lukewarm toward ERSO's idea. Most of these firms started their own submicron projects through technology co-operation with foreign companies. They no longer had to rely on ERSO.

The tension between ERSO and the private companies increased when ERSO planned to spin off a new company embodying the fruits of the submicron project. UMC and other companies contended that the new company would hurt them since it had benefited from government grants.

The confrontation between ERSO and the private IC firms exploded during the budget review in Parliament in 1993. UMC, TSMC, and other IC companies protested that ERSO's research projects monopolised the government grants and human resources needed by private companies to engage in R&D. These companies complained that ERSO was so inefficient in its projects that it should not be allowed to monopolise huge government grants. They asked lawmakers to cut ITRI's budget, and force ERSO to become a better partner with the industry. As a result, US$2 million was cut from ITRI's US$11 million budget. Robert Tsao, ex-vice head of ERSO and now the chair of UMC, declared that ERSO should never engage in technology projects again. He even rejected any roles ERSO might play in the future development of Taiwan's IC industry, as he claimed 'the only thing the government has to do for the semiconductor industry is just leave us alone' (*Common Wealth*, September 1993). Ironically, the same private companies that were once cradled by ERSO became its gravediggers.

In fact, the confrontation between the IC firms and ERSO represented a new developmental pattern in the HSIP. Learning from partners has become a key strategy for Taiwan's latecomer firms since the early 1990s (Jou & Chen 2001). For example, the interactions between equipment suppliers and Taiwan's IC manufacturing firms are crucial to the latter's competitiveness in production capacity. As the technological lag between Taiwan's IC manufacturing firms and the most advanced firms decreased from more than five years in the late 1980s to less than two years in 1994, the technological progress these firms made partially derived from the advantage of backwardness. Taiwan's IC firms took advantage of learning economies, and absorbed the experiences of advanced firms. As Mosel's vice-president said, 'We are not on a high enough level to compete on the technological frontier. Thus we do not have to rush to get the most state-of-the-art machinery. What we have to do is evaluate the performance of machinery employed by advanced firms, and then choose the best ones.'[4] Taiwan's IC engineers consulted with equipment manufacturers when yields were not as high as expected, according to Japanese equipment vendors (*Nikkei Electronics Asia*, November 1995). Equipment firms readily provided information to IC makers, such as whether a problem was in the lithography or etching, and built up a pool of knowledge, which could be used to resolve other production problems. In most cases, once a problem was identified, equipment vendors would send a team of specialists to work closely with the production engineers of the IC manufacturer. Both parties accumulated a stock of knowledge, which was important for the improvement of yields in wafer fabrication.

Under such conditions, ERSO lost its advantage as the only local supplier of technology, and became at best a partner in the new technology networks. As Dr Chih-tein Hsing, the ex-head of ERSO, argues, 'A new situation arose: the private firms invested huge amounts of capital in R&D, international co-operation prevailed recently, and rapidly growing (Taiwanese) IC firms possessed the capabilities to negotiate with foreign partners. All these resulted in a fact: ERSO was no longer the unique local technology supplier for the IC industry. What the private sector now requested from us had changed to auxiliary research and industry services which were not suitable to be individually provided' (ERSO 1994, p. 156).

As technological learning strategies became more complex, and close interaction between vertically disintegrated firms were enhanced, the characteristics of the HSIP changed from being a haven of tax breaks. In a sense, the meaning of the HSIP for IC firms has shifted from a cost-cutting industrial location towards dynamic industrial district that emphasises collective learning process, skilled labour moves within the local labour market (Hsu 1999), customers and suppliers interact technically and organisationally, technical exchange occurs formally and casually, and, finally, above all, the supporting institutions provide complementary information and specialised services.

The declining of state involvement did not mean an institutional vacuum, but an institutional restructuring, in the IC industry. New actors played more important roles in supporting the vertical disintegrated industrial system to grow. Trade associations, for instance, can be established independently of any one company, and have the power to represent, aid, and guide participating firms. They represent the industry to the Government, educate members about the effects of government policies, and encourage collective action (Sayer & Walker 1992). They are an important mechanism of integration for most industries.

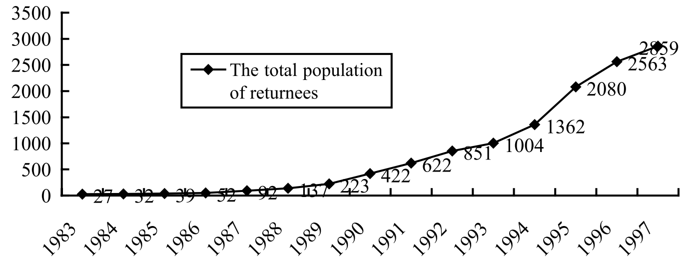
In the HSIP, the Association of Allied Industries in the HSIP (AAI) was organised by most of the high-technology firms in the HSIP, and thus contains IC firms but also PC, communication, and other companies. AAI was established to serve as the counterpart of the official Science Park administration, and tries to work together with the administration to solve problems occurring in the HSIP. In particular, ameliorating the diseconomies accruing to agglomeration has required collaborative efforts by the administration and the industries. For example, the AAI actively engaged in developing solutions to the environmental pollution being caused by the HSIP. The AAI is also involved in lobbying at the national level. One subcommittee was set up to study the legal problems surrounding intellectual property rights (IPR), business secrets, IC layout protection and the like.

A new organisation, the Taiwan Semiconductor Association (TSA), was established in 1998. It was formed from AII, and is to act as a counterpart to the Semiconductor Industry Association of America. According to Huey-lin Chen, the deputy director of planning & exploratory research division at ERSO, who is in charge of the co-ordination of the IC firms, 'Sometimes, when foreign organisations like American semiconductor association have technology co-operation deals to negotiate with us, we do not have an organisation to serve as its counterpart. Such deals occur more frequently as our IC industry grows more global. At the same time, we need an organisation, which is able to co-ordinate firms to lobby the Government for favourable policies, and to serve as a neutral third party to co-ordinate firms in the formation of research consortia. Under such conditions, we need to set up an exclusive IC association.' In 1999, the TSA acted as the co-ordinator to organise Taiwan's IC manufacturing firms to fight against the tort indictment by Micron Technology, a US DRAM specialist.

Re-embeddedness in cross-border technical community – A fundamental fact of life in high-technology industries is a technological system so complex that it requires companies to co-operate in some areas of technology development and, at the same time, compete in areas such as marketing. As they upgrade their technological level, Taiwan's IC firms have to increase, not decrease, the number of collaborative schemes with technology leaders, so that these firms will be able to stay on top of the development of advanced technologies and increase their opportunities to learn from outside sources (Freeman 1994).

However, engaging in global technology learning was not an easy task for Taiwan's IC latecomers. While it might be not that difficult to collaborate with other local firms in the HSIP with ERSO's intervention, it is hard to imagine the governing mechanisms existing within the cross-border connection. As Lundavall (1996) argued, learning process involved more than technology purchasing, and included the social dimensions such as the absorption of tacit knowledge, which is embodied in the technical people. Therefore, building up capabilities in identifying know-who in the cross-border technology learning will be the primary issue for a late-industrial district such as the Hsinchu region to meet the challenge of global competition. To a certain extent, the transnational sociotechnical communities provided the networks for Hsinchu to tap into the high technology hub in Silicon Valley as the solution (Saxenian & Hsu 2001; Hsu & Saxenian 2000).

In the mid 1980s, Taiwan's PC industry was emerging and entering a phase of rapid growth (Hwang 1995, p. 11, Ill 1991, p. 15). The sales revenues of local PC manufacturers reached US$ one billion in 1985. At the same time, the skyrocketing stock market after the mid 1980s created financial incentives for swarms of overseas engineers to come back and set up their own enterprises. Some small IC companies founded by Taiwanese-Americans moved their base to Taiwan in order to tap into the huge reservoir of capital on the island.[5] As observed by



Source: HSIP (1998).

Figure 2. *The total population of returnees in the HSIP. Returning entrepreneurs have started 97 companies in the Park, or 40% of the total.*

Chin-tay Shih, president of ITRI and the former head of ERSO, 'When the current overseas technology and talent met the current of local capital and Taiwan's industrial base, it would create multiplier effects. The two forces were complementary, and reinforced each other' (*Common Wealth*, September 1994, p. 39). Almost half of the companies in the Science Park (97 companies) in 1997 were started by US-educated engineers, many of whom had considerable managerial or entrepreneurial experience in Silicon Valley (HSIP 1998). The number of returnees increased rapidly after mid 1990s, as shown in Figure 2.

The returnees have created the links for the high-technology firms in both regions to collaborate. More frequently the cross-regional collaborations involve partnerships between specialist producers at different stages in the supply chain. The relationship between Taiwan-based semiconductor foundries and their Silicon Valley equipment manufacturers is a classic example. Steve Tso, a senior vice-president in charge of manufacturing technology and services at Taiwan Semiconductor Manufacturing Corporation (TSMC) worked at semiconductor equipment vendor Applied Materials in Silicon Valley for many years before returning to Taiwan. He claims that his close personal ties with senior executives at Applied Materials provide TSMC with an invaluable competitive advantage by improving the quality of communication between the technical teams at the two firms, in spite of the distance separating them.[6]

How to govern the connection in the supposed stateless transnational playground? – Taiwan's global links with the Californian technology hub unfold in several ways: Taiwan's companies recruit overseas engineers, they set up listening posts in Silicon Valley to tap into the innovations there, or successful overseas engineers return to Taiwan to start up their own businesses. All of these possible links are established smoothly not on an individualistic base, but with the mediation of overseas organisations, since the experienced engineers such as Steve Tso need to be able to integrate into local social networks to ensure access to technology and market information and absorb them effectively (Hsu & Saxenian 2000).

One of the most important overseas organisations for high-technology industries is the Monte Jade Science & Technology Association. It was initiated by a group of overseas Taiwanese engineers and professionals in high-technology firms in Silicon Valley. It was formed to promote co-operation and mutual flow of technology and investment between Taiwan and Silicon Valley. This association opens up opportunities for professionals and corporations at both ends of the Pacific to network and share their experiences, according to Monte Jade's documents. The activities of the Monte Jade include monthly dinner meetings, which encourage and promote networking among members, special topic seminars that are put on in co-operation with other professional organisations, and social events and entertainment. For example, in September 1996, Monte Jade sponsored a seminar on venture capital and investments. It invited 24 venture capital companies from Silicon Valley and Taiwan, and a number of new start-ups in Silicon Valley to conduct face-to-face communication. This helped Taiwan's capital to meet Silicon Valley's technologies. Through Monte

Jade's efforts, many networking opportunities are created and proliferated. Besides Monte Jade, other professional associations for overseas Taiwanese provide channels for the exchange of information about technology and employment. More than 10 professional associations organised and steered by overseas Chinese engineers in Silicon Valley to enhance the cross border collaboration between Taiwan and the US (Saxenian 1999).

These transnational associations allow intensive interactions between technology and capital in different regions, and render new cross-border investments possible. All of these supporting institutions not only attack the problems of market failure (the lack of public goods), but also enhance networking between the constituent parts of the industrial system. Through networking, institutions maintain and promote the possibilities for collective learning for the disintegrated industrial system. As Taiwan's IC vertically disintegrated industrial system become more coherent, the process of technology learning becomes more interactive, and the underlying institutions become thicker in content, broader in scope, and more diversified in variety. It goes beyond the state-led industrialisation argument.

LATE INDUSTRIALISATION BEYOND STATE LEADERSHIP

The story of Taiwan's IC industry demonstrated several key figures that could not be granted full explanations from the late-industrialisation paradigm raised by Evans (1995) and Amsden (1989), who based their assessment on Korean case studies. The key difference lies in the presence of associational embeddedness and transnational social networks within Taiwan's SME-based high technology development. However, here is a developmental paradox: if the developmental state is argued to be a top-down bureaucratic rationality-based governance mechanism, how could it build up and articulate with the supposedly bottom-up trust-based social networks? How could the potential tension between the top-down and the bottom-up be settled?

Although Taiwan's state did foster the IC industry at the initial stage, as its Korean counterpart did (Mathews & Cho 2000), it took different strategies to get the job done. In Korea, the state targeted the *chaebol*, the big industrial giant, to enter the risky industry, with the generous banking loans and market protection. Taiwan's developmental state, as shown above, did not choose specific big firms, but provided infrastructures (the ERSO and the HSIP) and subsidies (tax breaks and cheap land), to encourage the formation of spin-offs. In this sense, the state played the role of demonstrator to show private capital the profitability of the seemingly risky business, and lowered the entry barrier for the IC start-ups by subsidies, rather than the role of powerful planner in the Korean case.[7] The different strategies led to the different industrial landscape: while Korean IC industry was dominated by a few key giants like Samsung, Taiwan's IC industry was composed of many more (256 firms in 2001) small to medium-sized enterprises who benefited from the demonstration effect. As shown in Saxenian & Hsu (2001), transnational communities are not unique to Taiwan, but the best environments for breeding such specialist firms are the decentralised industrial systems of places like Silicon Valley and Hsinchu. Just as the social structures and institutions *within* these regions encourage entrepreneurship and learning at the regional level, so the creation of a transnational technical community facilitates collaborations between individuals and producers in the two regions and supports a process of reciprocal industrial upgrading.[8]

The research argued that the success of Taiwan's high technology SMEs comes from the combination of local vertically disintegrated district and the close co-operation with the global hub, Silicon Valley. The late-industrialising firms could have benefited from the institutional embeddedness on the domestic developmental state as developmental statists vividly illustrated, but also from tapping into the transnational connection with the overseas Chinese technical community. It was well recognised that social and institutional embeddedness existed on the local level (Granovetter 1985; Scott 1988). The story of Taiwan's high technology SMEs system explored the possibilities of the transnational embeddedness in the evolution of the late-industrial district.

The late-industrial district lying on the Hsinchu-Taipei Corridor also practised contracting features with the non-Western new industrial district proposed by Park and Markusen (1995). They introduced the notion of the satellite industrial district, comprised of branch operations of non-locally based corporations, and argued this type of state-led and non-place embeddedness would predominate in not just Korea, but also the non-Western late-industrialising countries in general. In the sense, it was the agglomeration economies, rather than the dynamic learning effect, that provided the *raison d'etre* of the creation of the late-industrial district.[9] It was true that the state effort is critical to the creation of new high technology district in the beginning, as the Hsinchu case has shown. It is also correct to point out that the local embeddedness was not enough to support the development of the late-industrial district. However, reflecting on Taiwan's story would lead to starkly divergent conclusions. Taiwan's late-industrial district allowed the state to foster a vertically disintegrated industrial system, in which the networks between the indigenous high technology SMEs (not the branch plants of non-local big oligopolistic firms) facilitate collective learning. More importantly, the existences of complementary regional industrial systems and the cross-border overseas Chinese technical communities infused the late-industrial district with the entrepreneurs and technologies from the technology hub, and led to the transformation of the dynamic institutional embeddedness of the district from the domestic developmental state to social associations. The key lesson here was that, in spite of the state playing a central role at the first stage, it was the transformation from agglomeration economies for cost saving into learning district that drove the process of the late-industrialisation.

In brief, Taiwan's late-industrial district is similar to its Korean counterpart in the state leadership, but different from each other in that Taiwan's state adopted spin-off strategies to encourage entrepreneurism, and render the formation of a decentralised industrial system, which allowed the complementary connection with Silicon Valley. In other words, while Park & Markusen (1995) painted the governance mechanisms of geographical scales in the satellite industrial district as the local market-type and nonlocal hierarchy-type, we argued that Taiwan's late-industrial district was embedded on both local and global networks.

CONCLUSION

The development of the Hsinchu late-industrial district demonstrated the possibilities and limits of developmental state and the evolution of embedded institutions in the globalisation process. As the public research arm of the developmental state, ERSO promoted and fostered the IC industry with its uniquely-possessed talents and resources. The state also encouraged the risky investment by subsidies such as the construction of the HSIP, as well as the labour training offered by the neighbouring universities. Organisations like ERSO and the universities create and upgrade labour skills, and they serve as external R&D sources for the vertically disintegrated industrial system. In a sense, it agreed with the argument proposed by Park & Markusen (1995) that the state helped in creating an industrial district, but disagreed with them in that the district was not necessarily dominated by a small number of conglomerates.

While the sociopolitical context changed and the firm's learning strategy altered corres-pondingly, the state lost its hegemony in industrial development. The role of ERSO has therefore shifted from that of midwife to that of coordinator, and the HSIP has transformed its role from a state-subsidised industrial zone to an endogenous-growth industrial district. As for the universities, they are also changing from suppliers of entry-level engineers to research partners with industry. In the transformation process, the global links with the technology hubs, particularly Silicon Valley, were conceived as the primary dynamics behind the evolution of the Hsinchu late-industrial district.

As Hsinchu's high-technology firms grew technologically sophisticated, and accompanied new firms set up by the Silicon Valley returnees, learning by networking became dominant for the decentralised system. In the learning process, it took close social ties to identify the 'right' people, and thus the 'right' technologies, and ensure the transfer of the embodied tacit knowledge. Transnational connection is not a social and institutional vacuum field, but a divergent governing environment for the local industrial system to renew the embeddedness. New redundant and complementary institutions, including dense social and professional connections and associations, replaced the monotonic role of the state to make network learning in the decentralised industrial system effective. The development of Taiwan's IC industry witnessed a process in which the decentralised industrial system fostered by the developmental state at first, and decoupled with the state leadership at the mature stage, and re-embedded in the transnational sociotechnical communities as the global learning networks became dominant. It is the dynamic process as the top-down developmental state meets the bottom-up social networks that create and sustain the development of Taiwan's high technology industries.

Notes

1. Peter Evans (1995, pp. 77–81) defines four patterns of state involvement in terms of 'roles'. The midwife state means that instead of substituting itself for private producers, the state tries to assist new entrepreneurial groups to take on more challenging endeavours.
2. According to an informal report (*Common Wealth*, June 1983), from the mid 1950s until the early 1980s, more than 50,000 Taiwanese students studied and worked overseas, mostly in the US. Less than 10% returned to Taiwan.
3. According to Dr Pan, the head of the TAC, the mission of TAC was as follows:

    1. TAC offered a draft of the request for proposal used by ITRI to invite foreign companies to bid for technology transfer deals. Proposals should contain the requirements for facilities planning, laboratory establishment, process technology, CAD programming, quality control, IC design and mask making, and personnel training.
    2. TAC would help ITRI in evaluating the qualifications of foreign bidders, and be involved in the bargaining process.
    3. TAC would cooperate with other consulting companies to set up Taiwan's IC laboratory.
    4. TAC would participate in the engineer training programmes.
    5. TAC would find IC experts to help ITRI in the early stages of Taiwan's IC development.

4. Interview with Nasa Tsai, Mosel. 9 September 1995.
5. In the late 1980s, 'US and Taiwan universities flooded the island with 180,000 graduates in computer and related fields, giving Taiwan a substantial pool of engineering talent' (*Electronic Business*, 4 September 1989).
6. Steve Tso interview, in Hsinchu, 15 March 1999.
7. The difference in industrial policies comes from the difference ruling regimes and state-business relationships in Taiwan and Korea respectively. Korean government, even the dictator administrations, had to rely on big business (the Four *chaebols*) to run and win the elections and embedded economic development in their support, thus adopted 'pick the winner' policy to favour the *chaebols*. However, in Taiwan, the then ruling party (KMT) possessed its own party assets, which were believed to be the richest party in non-communist systems, and thus it was not necessary to get campaign donations from business to run their election campaigns. At the same time, KMT administration, a Leninist party, was controlled by Mainlanders, kept the local Taiwanese groups from influence after they retreated from China in 1949. Thus in terms of decision-making in industrial policy, the government appeared to play an impartial role by providing subsidies to those who are qualified to apply. In consequence, it led to the proliferation of small and medium-sized enterprises. See Cheng (1990) for details. Here we echo Douglass's assertion that much of the recent literature tends to crowd the NIC states into an undifferentiated model of the 'developmental state', however, a closer examination reveals significant differences among them in terms of the state's relations to capital, labour, and the external economy that not only defy reduction to a single model but also show that options for moving away from labour intensive segments of production for world markets vary considerably (Douglass 1994).
8. This is not arguing that Korean *chaebols* are not innovative enough. However, it is hard to imagine that such a SME-friendly environment exists in Korea, and would attract Korean returnees to start up companies and engender cross-Pacific co-operation with Silicon Valley.
9. According to Park & Markusen (1995), the satellite industrial district was painted as a collection of subsidiaries of non-local oligopolistic firms and inter-regional, rather than intra-regional, labour market, which engaged in unskilful processing under the auspice of developmental state. In this sense, the district lost its theoretic particularities, and went back to Hooverian agglomeration economies.

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