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# Revisiting the Silicon Island? The Geographically Varied 'Strategic Coupling' in the Development of High-technology Parks in Taiwan

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YANG Y.-R., HSU J.-Y. and CHING C.-H. Revisiting the silicon island? The geographically varied 'strategic coupling' in the development of high-technology parks in Taiwan, *Regional Studies*. High-technology parks have been instrumental for propelling regional development and acclaimed as the panacea for curing regional decline since industrial restructuring after the 1980s in Taiwan. This paper aims to explore the divergent dynamics of different technology park projects in Taiwan as well as their impacts on local development. Inspired by the global production networks (GPNs) perspective, a triangular framework is proposed – the interaction between state intervention, economic competence, and societal forces – to highlight and explain the geographically varied patterns of 'strategic coupling' between the global production networks and local institutional embeddedness that shape the divergent patterns of regional development in Taiwan.

Global production networks Strategic coupling Developmental state Technical community Regional development

YANG Y.-R., HSU J.-Y. and CHING C.-H. 重访硅岛？台湾高科技园区发展中地理差异的 '战略性耦合'，区域研究。高科技园区已经成为促进区域发展的工具，同时也被认为是80年代以来台湾进行产业重构后治愈区域衰退的万能药。本文旨在探讨台湾高技术园区不同工程所具有的多种活力及其对地方发展的影响。受全球生产网络研究视角的启迪，我们提出了一个三角框架-国家干预、经济竞争以及社会力量之间的互动-以强调并说明 '战略性耦合'的地理性差异模式。

全球生产网络 战略性耦合 发展国家 技术性社区 区域发展

YANG Y.-R., HSU J.-Y. et CHING C.-H. L'île d'industries électroniques vue sous un nouveau jour? La diversité géographique de 'l'accouplement stratégique' dans le développement des technopôles au Taiwan, *Regional Studies*. Les technopôles ont été une force motrice quant à l'impulsion donnée à l'aménagement du territoire, acclamées comme la panacée du déclin régional depuis la restructuration industrielle après les années 1980 au Taiwan. Cet article cherche à examiner la dynamique différente de divers projets de construction de technopôles au Taiwan aussi bien que leurs impacts sur le développement local. En s'inspirant des réseaux de production mondiaux, on propose un cadre triangulaire – l'interaction entre l'intervention de l'Etat, la compétence économique et les forces sociales – afin de souligner et expliquer la diversité géographique de la distribution de 'l'accouplement stratégique' entre les réseaux de production mondiaux et l'ancrage insitutionnel local qui influent sur la distribution divergente de l'aménagement du territoire au Taiwan.

Réseaux de production mondiaux Accouplement stratégique Etat du développement Communauté technique Aménagement du territoire

YANG Y.-R., HSU J.-Y. und CHING C.-H. Eine neue Sicht von Silicon Island? Die geografisch unterschiedliche 'strategische Kopplung' in der Entwicklung von Hochtechnologieparks in Taiwan, *Regional Studies*. Seit der industriellen Umstrukturierung in Taiwan nach den achtziger Jahren haben Hochtechnologieparks bei der Förderung der Regionalentwicklung eine wesentliche Rolle gespielt und wurden als Allheilmittel zur Abwendung eines regionalen Niedergangs gepriesen. In diesem Beitrag untersuchen wir die divergente Dynamik verschiedener Technologiepark-Projekte in Taiwan sowie ihre Auswirkungen auf die lokale Entwicklung. In Anlehnung an die Perspektive der globalen Produktionsnetze (GPN) schlagen wir zur Darstellung und Erläuterung der geografisch unterschiedlichen Muster einer 'strategischen Kopplung' zwischen den globalen Produktionsnetzen und der

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lokalen institutionellen Einbettung, die die divergenten Muster der Regionalentwicklung in Taiwan prägen, einen dreieckigen Rahmen vor: das Wechselspiel zwischen staatlicher Intervention, wirtschaftlicher Kompetenz und gesellschaftlichen Kräften.

Globale Produktionsnetze Strategische Kopplung Entwicklungsstaat Technische Gemeinschaft Regionalentwicklung

YANG Y.-R., HSU J.-Y. y CHING C.-H. ¿Revisión de Silicon Island? Diferencias geográficas de la 'conexión estratégica' en el desarrollo de parques de alta tecnología en Taiwán, *Regional Studies*. Desde la reestructuración industrial tras la década de los ochenta en Taiwán los parques de alta tecnología han sido fundamentales para impulsar el desarrollo regional y han sido alabados como la panacea para solucionar el declive regional. El objetivo de este artículo es analizar las dinámicas divergentes de los diferentes proyectos de parques tecnológicos en Taiwán así como sus efectos en el desarrollo local. Inspirados por la perspectiva de las redes de producción global, proponemos una estructura triangular –la interacción entre la intervención estatal, la competencia económica y las fuerzas sociales– para resaltar y explicar las diferentes variaciones geográficas de 'conexión estratégica' entre las redes de producción global y la integración institucional a nivel local que forman los modelos divergentes del desarrollo regional en Taiwán.

Redes de producción global Conexión estratégica Estado desarrollista Comunidad técnica Desarrollo regional

JEL classifications: L63, O18, R11, R58

## INTRODUCTION

High-technology parks have been instrumental for propelling regional development and acclaimed as the panacea for curing regional declines since industrial restructuring after the 1980s in Taiwan. Regarding the issue of regional development, for example, the complex interactions between transnational corporations and nation-states had attracted the attentions of economic geographers (DICKEN, 1994). Furthermore, as YEUNG (2009) points out, the variable of a developmental state's policy should be taken into special account in East Asia's regional development. Thus, it is without doubt that the firm and the state are the relevant elements in exploring the regional economic development in East Asia as well as in Taiwan. Is it enough to understand the regional development in Taiwan by *only* investigating the global leading firms and the developmental state's policy? What is the role of other institutional agents in shaping the patterns of Taiwan's regional development, understood as a dynamic outcome of the complex interaction between territorialized relational networks and global production networks within the context of changing regional governance structures (COE *et al.*, 2004)?

For instance, the 'global production networks (GPNs)' thesis highlights the 'strategic coupling' between GPNs and local institutional thickness (COE *et al.*, 2004, 2008; HENDERSON *et al.*, 2002; YEUNG, 2009). Departing from the singular focus on the endogenous institutional structures and their capacity to 'hold down' global networks, the processes of regional development were revisited as a relational process occurring through the intersection of local assets with the strategic requirements of GPNs, an interface that is heavily mediated by a 'variety of institutional forces'. Echoing with such perspective, the authors believe that a further exploration of the processes of strategic coupling, understood as a dynamic and a geographically varied process, is relevant to understand the multi-scalar process of regional development in Taiwan. Therefore, this paper seeks to demonstrate the roles played by a variety of institutional forces, including the 'non-firm' actors in influencing the patterns of strategic coupling. It tries to illustrate an actor/practice-sensitive triangular framework to unpack the seemingly simple but indeed complicated processes for the region to articulate the GPNs.

Taiwan is often regarded as a representative for the advocates of the developmental state thesis (AMSDEN and CHU, 2003; EVANS, 1995; HAGGARD, 2004; WADE, 1990; WU, 2004). However, most of these empirical studies were conducted in the 1980s. Nowadays, Taiwan seems to be undergoing a 'neo-liberalist turn' after the 1990s (HSU, 2006). It is not the intention here to involve in such debate (that is, whether developmental state?). For the authors, it might be required to go beyond the 'state-centred' perspective of the 'institution' to understand further the recent dynamics of regional development in Taiwan. In Michael Storper's terms (STORPER, 2005), the societal and communitarian forces that shape the ways individuals participate and interact in the economic development might be relevant in such historical context.

In this paper, the theoretical concern is about how the capitalist geographical industrialization discloses itself among the divergent institutional embeddedness, structural coherence, geographical organizations, and especially scalar connections. The GPNs' perspective will be adopted as the starting point to tackle this broader issue. The so-called 'Silicon Island Project' pattern of 'siliconization' in Taiwan's regional development, that is, high-technology parks that are constructed in different historical contexts, provides the empirical cases (Fig. 1). It was observed that there exist different development patterns in these parks, including the industrial type, trans-border production networks' connections, local institutions, and spatial–organizational

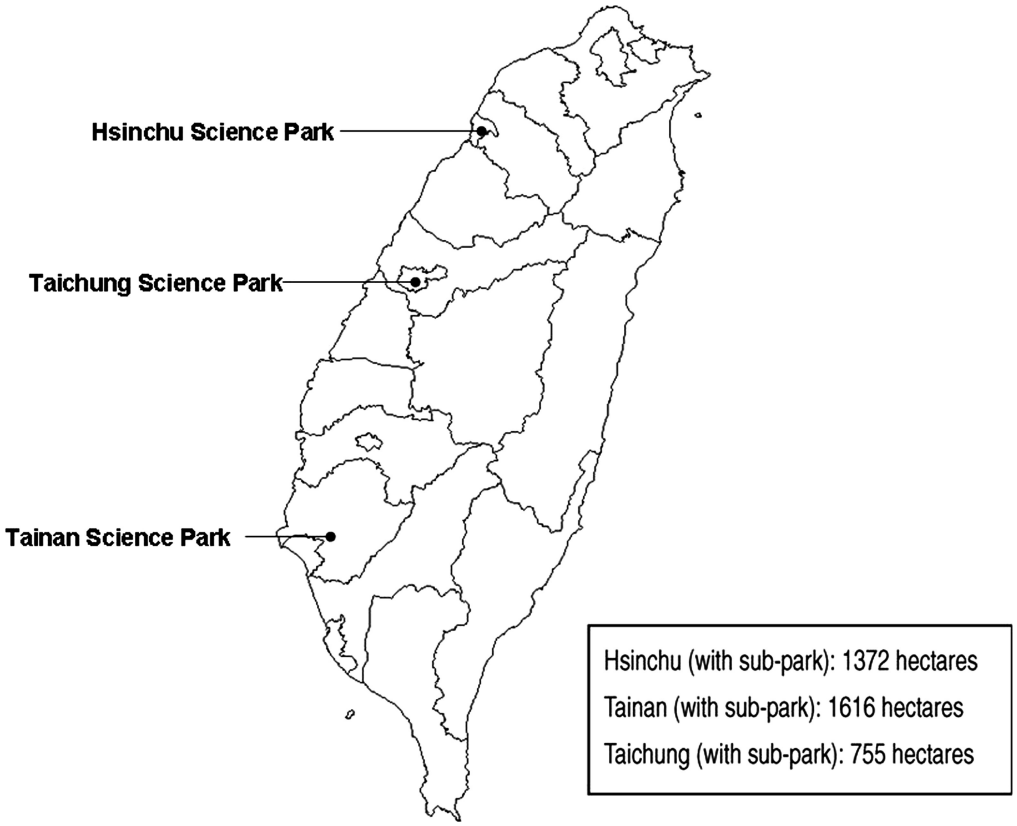


*Fig.* 1. *The 'Silicon Island Project', Taiwan*
*Source:* National Science Council, ROC

formation. For example, Hsinchu Science Park built an intensive connection with Silicon Valley in California, United States, and shaped the semi-conductor industrial cluster in northern Taiwan. Tainan Science Park transferred the thin-film transistor-liquid crystal display (TFT-LCD) technology from Japan and shaped another high-technology industrial cluster in southern Taiwan. Recently, Taichung Science Park has been booming in hosting domestic and overseas high-technology firms. These three parks shaped the landscape of high-technology industries in Taiwan and occupied a significant share of in Taiwan's domestic manufacturing.

Inspired by the GPN perspective, the research question is how the interplay between the GPNs and the evolutionary (post-)developmental state's institutions as well as the societal/communitarian forces contribute to shape the pattern of 'siliconization' in Taiwan's regional development? Taking the development of these three high-technology parks as examples, the paper investigates the divergent patterns of 'siliconized' regional development – the process of strategic coupling, industrial clusters' social–geographic formation, local spillover, and the evolutionary role of state intervention. Most importantly, the aim is to illustrate the *geographically varied strategic coupling* in the development of these three high-technology parks in Taiwan, and to provide an analytical framework to explain such variation.

Theoretically, the authors will try to highlight the practices of some relevant institutional forces that mediate the strategic coupling by proposing a triangular framework, that is, the interaction between state intervention, economic competence, and trans-border community. In other words, based on an understanding of the strategic coupling as a dynamic and geographically variable process, the aim is to incorporate the dimension of societal and communitarian forces into the framework to analyse such process. Therefore, this paper seeks to exemplify the evolutionary interplay of different institutional forces in contributing to the divergent trajectories of 'siliconized regional development' in Taiwan, as well as to provide a theoretical complement that might contribute to an explanation to the differentiated social–spatial patterns of globalizing regional development.

## THEORETICAL REVIEW: UNPACKING THE GEOGRAPHICALLY VARIED STRATEGIC COUPLING

Inspired by the GPN perspective, regions and GPNs could be understood as relational constructions and social formations that are constituted through ongoing actor-specific practices and processes (YEUNG, 2009). The process of strategic coupling between local institutional thickness and GPNs is not automatic.

The intervention by some intentional actors is required. The structural–institutional condition as well as the agency of intervention to achieve the coupling could be geographically varied. As a result, the coupling is not always successful, and some regions fail to articulate with the GPNs. Thus, to identify and explain the successful coupling patterns further is meaningful in terms of regional policy. Furthermore, the strategic coupling could be conducted by some actors through multiple 'networks of association' (Cox, 1998). During the process, the trans-scalar 'spaces of engagement' (Cox, 1998) were constructed.

Under such a conceptualization, to unpack those successful cases of dynamic 'geographically varied strategic coupling', it is proposed that attention should be paid to the 'actor-specific practices'. Situating within Levy's (2008) interpretation of the GPNs, it is argued that the process actors struggling over the construction of political economic relationships, governance structures, institutional rules and norms should be the nexus of analysing the dynamic strategic coupling process. These actors not only behave in an 'economically rational' way, but also are embedded in a series of social–spatial relationships. As Martin Hess illustrated, different dimensions of embeddedness refer to different relations between the social agents and other socio-spatial actors. Among them, network embeddedness and territorial embeddedness are particularly relevant here. While the former refers to a process of trust building between network agents, the latter means that economic actors absorb, and in some cases become constrained by, the economic activities and social dynamics that already exists in those places (Hess, 2004). Furthermore, these actors are subjected to complex power relationships and evolve in a relational way such that their differential practices unleash multiple forms of emergent power.

In Taiwan's case, the 'siliconization' in regional development might be understood from the broader view of 'interface' – between advanced countries (the United States, Japan) and a latecomer (China) (Hsu, 2005; Yang and Hsia, 2007). That is, the coupling of trans-border resources through a variety of networks of association is relevant for explaining Taiwan's regional development. Thus, under such an actor/practice-sensitive perspective, a further investigation on the relevant actor-specific practices during the various processes of network articulating could offer the key to decode the varied regional patterns of strategic coupling.

Moreover, departing from the 'lead firm-driven' perspective of regional upgrading in the global value chains (Gereffi, 1999; Humphrey and Schmitz, 2002), the GPNs' perspective inspires one about the importance of the broader institutional environments within which production networks operate, but also within which they are formed and shaped. Echoing with the GPNs' attempt to rectify the deficits of the 'firm-centred' perspective on global economic activities that form the global value chains (GVCs)/global community chains (GCCs) theses (Coe *et al.*, 2008), the present paper pays special attention to the specific 'non-firm' institutional forces in influencing the extra-regional articulation in Taiwan's regional development, that is, the role played by the 'technical communities'. Situating it in Taiwan's context, a triangular framework is proposed that highlights the interplay of three institutional forces in mediating the globalizing regional development as well as contributing to the dynamic and geographically varied strategic coupling: industrial firms, technical communities, and state policy (Fig. 2).[1]

Firms, through the intra-firm and inter-firm division of labour, shape the geographical industrialization of the host economies (Hudson, 2001). Linkages, both backward and forward, are the key drivers to draw impacts to the situated regions. Leading firms in the GPNs were often regarded as the resources to boost regional development. In fact, a firm's regionalization process could be conceived as one of firm territory decoupling and recoupling (Jessop, 2000). It is understood as being embedded in multiple and overlapping processes, linking intra- and inter-organizational networks, and occurring in different spatial and temporal contexts. The attention thus should focus on how the firms respond strategically to the divergent territorial institutional environment, and the corresponding organizational reshuffling (Taylor and Asheim, 2001;

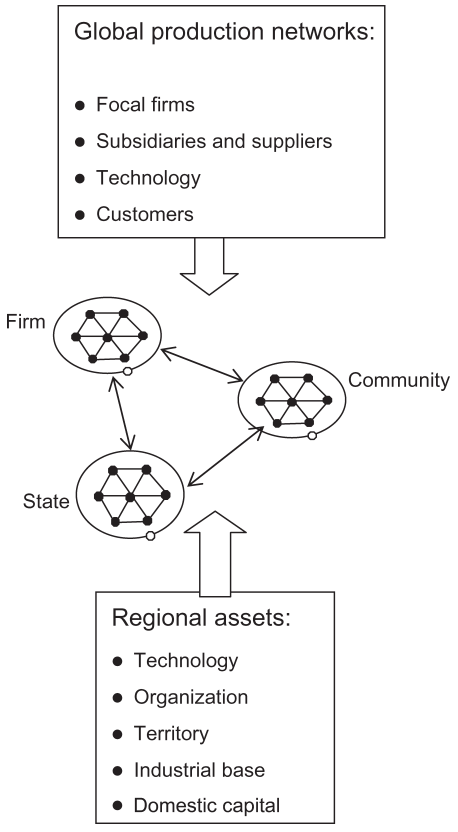


*Fig.* 2. *The triangular framework of strategic coupling*

YEUNG, 2005). As demonstrated by SCHOENBERGER (1997), firms can exploit different strategies, particularly spatial and organizational decoupling and recoupling, in the governance of the industrial system. Firms could take different degrees of territorial linkages with their host regions in different periods of economic activities, and take advantage of the latter in accord with their evolving competences in mobilizing the local resources. Overall, in analysing the firm as an agent in mediating the strategic coupling, attention is focused on the specific match-making pattern through which the assets of the territorial embedded firms (such as capital) articulate with the resources (such as technology) and the strategic requirement of the focal firms in the GPNs.

The second major player in the framework is the technical communities that are bound by relations of common interest, purpose, or passion, and held together by routines and varying degrees of mutuality in specific technology development. The communities can be seen as a means to enhance individual technical and business competences, and are oriented towards their members (BROWN and DUGUID, 1991). In the old industrial model, the technical community was primarily inside the corporation. The firm was seen as the privileged organizational form for the creation and internal transfer of knowledge, particularly technological know-how that is difficult to codify (KOGUT and ZANDER, 1993). In other cases, communities can cut across functional divisions, spill over into project-based teams, and straddle networks of inter-firm and professional ties (AMIN and COHENDET, 2004). In regions such as Silicon Valley, where the technical community transcends firm boundaries, however, such tacit knowledge is often transferred through informal communications or the inter-firm movement of individuals (SAXENIAN, 1994). Moreover, communities operate across different scales, from local, regional, national, and global. The social structure of a technical community thus appears essential to the organization of production at the global as well as at the local level. This suggests that the multinational corporation might no longer be the advantaged or preferred organizational vehicle for transferring knowledge or personnel across national borders. An international technological community provides an alternative and potentially more flexible and responsive mechanism for long-distance transfers of skill and know-how – particularly between very different business cultures or environments.[2]

Finally, the government policies will influence the behaviour of firms and market allocation in such a way as to create competitive advantage. EVANS (1995), based on the study of Korean and Brazilian information technology sectors, argued that the developmental states assist in the birth and growth of domestic, national firms through their role as the 'midwife' of new firms and sectors and by tending to the 'husbandry' of these growing industries.[3] 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 a state's leadership in intervening with firm's activities, and forces the state to restructure itself to be better positioned in handling global connection. As LUNDVALL and MASKELL (2000) pointed out, the main reason for differences in performance between national systems might be that the degree of matching between economic structure and institutions differs among countries. In other words, the key to the politics of the late-industrializing economies in the globalization era resides on the tension and solution in the articulation process, as the top-down domestic developmental state meets the bottom-up transnational socio-economic communities.

Inspired by the GPN thesis, this paper will focus on the practices of these agents – firms, communities and states – in globalizing regional development by tackling the nature and characteristics of the divergent institutional players, their power relations, structural constraints, and evolution as the organizational fields reshuffle in the regional transformation process. In other words, the key to decode the divergent patterns of strategic coupling as well as globalizing regional development hinges not only on the presence of the agents themselves, but also on the ongoing coalition, dissension, struggle, and even decoupling among the relevant institutional forces. It is argued that further investigating these varied patterns in the divergent regions will illustrate the rich varieties of production worlds in the geographical industrialization process. This point needs highlighting since the recent 'institutional turn' in economic geography is wont to give the impression that institutional thickness matters as much, if not more than, as the firms at the heart of the regional development (HUDSON, 1999; MORGAN, 2004).

The following sections will investigate the regionalization of high-technology development in Taiwan. The first science park (the Hsinchu case) will be dealt with first. Then follows a case study of Tainan park, which leads to a different developmental trajectory from Hsinchu's. In the next section, a new siliconization project, Taichung park, will be added to flesh out the impacts of divergent networking on regional transformation. After the three case studies, a comparative discussion will follow to echo the argument of 'geographically varied strategic coupling' of the three key agents in the geographical industrialization process. Finally, a short conclusion wraps up the paper.

With regard to the research methodology that allows a comparison to be made among these three cases, the authors lever the roles of industrial/governmental consultants (that is, observable participants) to conduct over 100 interviews with key personnel in government departments, firms, and industrial associations from 1997 to 2007 to collect first-hand information. The authors also reviewed news, reports, academic studies, and statistical data to support the analysis. Although

the three clusters developed in different time periods, based on the solid empirical material, the authors believe they have observed the major as well as the clear development patterns of these three clusters. Thus, it is suitable to make the comparison. Finally, the research method is multiple, including the 'extended case method' (BURAWOY, 1998) in the analysis of Tainan high-technology park.

## HSINCHU: THE INTERPLAY OF A DEVELOPMENTAL STATE AND A CROSS-BORDER TECHNICAL COMMUNITY

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 industrialization 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 integrated circuit (IC) industry: the establishment of the Electronic Research Service Organization (ERSO) as the bridging mechanism to transfer foreign technology, and the construction of the Hsinchu Science-based Industrial Park (HSIP) to host the high-technology firms by subsidies (HSU, 2004).

The government used the HSIP as a vehicle to provide financial and infrastructure supports to emerging industries. In a sense, it echoed the argument proposed by PARK and MARKUSEN (1995) that the state helped to create an industrial district.

Nevertheless, 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? By and large, engaging in GPN aligns local capitals with the interest of their international partners, and undermines their embeddedness in domestic state policies. Consequently, it adds ceilings on a state's leadership in intervening a firm's activities, and forces the state to restructure itself to be better positioned in handling global connection. 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-subsidized industrial zone to an endogenous-growth industrial district (HSU, 2004).

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 the mid-1990s. 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 its brain power, 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 basis, but with the mediation of overseas organizations, since the experienced engineers need to be able to integrate into local social networks to ensure gaining access to technology and market information and absorb them effectively (HSU and SAXENIAN, 2000).

More frequently, the cross-regional collaborations involve partnerships between specialist producers at different stages in the trans-border production network. While Silicon Valley and Hsinchu remain at different levels of development and are differently specialized, the interactions between the two regions are increasingly complementary and mutually beneficial. As long as the United States remains the largest and most sophisticated market for technology products, which seems likely for the foreseeable future, new product definition and leading-edge innovation will remain in Silicon Valley. However, Taiwanese companies continue to enhance their ability to design, modify, and adapt as well as rapidly commercialize technologies developed elsewhere. As local design and product development capabilities improve, Taiwanese companies are increasingly well positioned to take new product ideas and technologies from Silicon Valley and quickly integrate and produce them in high volume at relatively low cost.

The connection between Taiwan and Silicon Valley through the mediation of the transnational ethnic–technical community is not unique.[4] As China promotes high-technology sectors, such as computer and semiconductor industries, the extension of Silicon Valley–Taiwan connections to China through attracting Taiwanese high-technology investments becomes possible. Most Taiwanese personal computer firms chose the Pearl River Delta and the Yangtze River Delta as their destination. In fact, the locale of Taiwanese investments, particularly those high-technology investments such as notebook computers and IC industries, has concentrated in the Yangtze River Delta region (YANG and HSIA, 2007). It constituted a triangular manufacturing network between the buyers (in the United States), the middleman firms (in the Hsinchu region), and the subcontracting firms (in the Yangtze River Delta region).

In GEREFFI's (1995) analysis of triangle manufacturing, Gereffi proposed a role for the semi-peripheral manufacturers to transit from direct suppliers for the US market to 'middlemen' in the production chains. The essence of triangle manufacturing is that the first-tier subcontractors and their located regions take their orders from the global buyers, and then shift part of the requested production to affiliated offshore factories in other peripheral countries. By doing so,

the intermediary manufacturers could upgrade their position in the ladder of global value chains.

In the triangular manufacturing networks, the middleman firms in Hsinchu exploited the advantage of dense technical communities and complementary industrial structures with Silicon Valley and accumulated a knowledge base in more than two decades of technological learning (HSU and SAXENIAN, 2000). In addition, the ethnic ties and cultural affinity between Taiwan and China enabled cross-border investment and made exploring the market in China relatively easy (HSU, 2005).

The case of Hsinchu Park demonstrated very well the interplay between the top-down developmental state and the bottom-up technical community in the governing of the GPNs. It was the demonstration effect made by the state to initiate the high-technology industries to fill the manufacturer role at the early stage. However, the midwifery role became outdated as the innovative imperative from the changing GPNs which a flexible technical community, grown from the trans-border industrial development, was more productive to persuade.

## TAINAN: FIRM-CENTRED TECHNICAL TRANSFER FROM JAPAN

After the successful experience in Hsinchu, the state decided to launch another high-technology park project in Tainan in the mid-1990s. However, the growth dynamics of the second park are beyond the state's initial proposal. As Table 1 and Fig. 3 show, the main industry in Tainan high-technology park is a new one in Taiwan – advanced optoelectronics, especially thin-film transistor-liquid crystal display (TFT-LCD). The TFT-LCD industry had overgrown the IC industry in Tainan high-technology park recently and became the mainstream of the park. Furthermore, as Table 2 shows, the average firm size of Tainan high-technology park is larger than Hsinchu's. That is, the growth of the TFT-LCD firms had shaped another high-technology landscape in southern Taiwan. This section will adopt an 'extended case method'

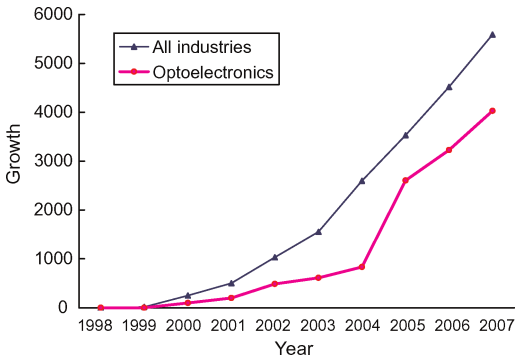


*Fig. 3. The growth of optoelectronics industry in Tainan high-technology park*

*Source:* Values are calculated from the official annual report of Tainan high-technology park (available at: http://www.stsipa.gov.tw/web/indexGroups?frontTarget=ENGLISH)

(BURAWOY, 1998) to analyse the development of Tainan high-technology park's TFT-LCD industry.

Japan has been engaging in the research and development of TFT-LCD panels since the 1980s. Mass productions began in 1991, and the production output was once the highest in the world. Taiwan did not enter the manufacturing of TFT-LCD panels until 1999. The technologies of the so-called 'five Taiwanese tiger' TFT-LCD companies (the five key producers, as shown in Table 3) all came from Japan. But it only took four years for Taiwan to outperform Japan. The global market share and output values exceeded 40% in 2005, which puts Taiwan in the fight with South Korea for champion of the world.

How did the TFT-LCD industry transfer and grow in Taiwan so quickly? It is hard to explain the trans-regional technical interaction of the TFT-LCD industry between Japan and Taiwan from the thesis of 'state intervention' or 'transnational ethnic–technical community'. On the one hand, the state played a minor role in the industrial transfer. As mentioned above, the role of ERSO has shifted from that of 'midwife' to that of coordinator. The state's original conception was to provide more cheap land for the increasing

*Table 1. Sales figures for Tainan high-technology park, 1998–2007*

| Industries | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|
| All industries | 1.1 | 15.9 | 247.3 | 501.8 | 1031.0 | 1553.2 | 2594.3 | 3527.8 | 4516.1 | 5588.7 |
| Optoelectronics | 0.0 | 0.5 | 98.4 | 199.6 | 485.4 | 609.0 | 831.5 | 2604.6 | 3224.0 | 4026.7 |
| Integrated circuits | 0.7 | 11.4 | 139.1 | 287.4 | 523.4 | 897.3 | 1685.8 | 831.7 | 1102.2 | 1302.1 |
| Precision machinery | 0.0 | 0.8 | 2.5 | 7.8 | 16.1 | 32.7 | 46.0 | 50.7 | 137.1 | 186.5 |
| Biotechnology | 0.0 | 0.1 | 0.6 | 1.5 | 2.4 | 5.3 | 11.6 | 15.4 | 20.0 | 30.9 |
| Telecom | 0.4 | 3.1 | 6.7 | 5.5 | 3.7 | 6.6 | 8.7 | 10.6 | 14.2 | 15.4 |
| Computer and peripherals | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 9.0 | 11.3 | 9.2 | 8.8 |
| Other industry | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 1.7 | 1.8 | 2.4 | 2.9 |

*Note:* Units = 100 million NT dollars.
*Source:* Values are calculated from the official annual report of Tainan high-technology park (available at: http://www.stsipa.gov.tw/web/indexGroups?frontTarget=ENGLISH).

*Table 2. Firm sizes at Tainan high-technology park, 2007*

| | Numbers of firms | Number of sales[a] | Number of employees[b] | Number of sales per company[a] | Number of employees per company[b] |
|---|---|---|---|---|---|
| All industries | 107 | 5588.7 | 54 115 | 52.2 | 505.7 |
| Optoelectronics | 31 | 4026.7 | 35 098 | 129.9 | 1132.2 |
| Integrated circuits | 11 | 1302.1 | 11 955 | 118.4 | 1086.8 |
| Precision machinery | 32 | 186.5 | 3122 | 5.8 | 97.6 |
| Biotechnology | 18 | 30.9 | 950 | 1.7 | 52.8 |
| Telecommunications | 8 | 15.4 | 819 | 1.9 | 102.4 |
| Computer and peripherals | 3 | 8.8 | 263 | 2.9 | 87.7 |
| Other industry | 1 | 2.9 | 1539 | 2.9 | 1539.0 |

*Notes:* [a]Units = 100 millions NT dollars.
[b]Migrant labour is not included.
*Source:* Values are calculated from the official annual report of Tainan high-technology park (available at: http://www.stsipa.gov.tw/web/indexGroups?frontTarget=ENGLISH).

demand from the IC industry. No industrial policy was launched to introduce the TFT-LCD industry. The outgrowth of the TFT-LCD industry in Tainan high-technology park is not part of the state's plan. On the other hand, it is through the mechanism of firm-centred technical transfer that occurred between large Taiwanese enterprise groups and Japanese '*keiretsu*'.

The flagship corporation in Tainan high-technology park – Chimei Chimei Corporation – will illustrate the story perfectly. Chimei is now ranked the fourth largest TFT-LCD panel manufacturer in the world, and ranks first in LCD television panels. Most of the optoelectronics companies in Tainan park have business relationships with Chimei. In other words, a large portion of the growth in Tainan park is related to Chimei. The authors believe it is suitable to explore the development of Tainan park by deeply investigating the corporate strategy of Chimei, the most representative company in the park.

The story started at the stage of technology transfer. The key agent in Chimei's trans-border technological cooperation is a technical team led by Mr Ting-Shen Hsu. Hsu is an engineer at Primeview, a manufacturer of small-size panels in northern Taiwan. He left Primeview and prepared a proposal for the initial development of large-sized TFT-LCD panel plants. Hsu tried to persuade the related state apparatus and many business groups to adopt the proposal. After many failures, Hsu finally won the support from Chairman Wen-Long Hsu of Chimei Corporation, a company that originally manufactured petrochemicals. Chairman Hsu made a decision to invest in this new industry and began working on this project by purchasing equipment and building factories.

T.-S. Hsu once worked for Motorola and Applied Material, and thus was familiar with the information technology market in Japan. After Chimei decided to implement the larger-side TFT-LCD panel factory building and product manufacturing project, Hsu determined that a front-end array production process (Fig. 3) would be required. In that time, this technology was only available in Japan. Therefore, Hsu began negotiations with Japanese vendors on technology sourcing. After many attempts, Hsu finally decided to work with Fujitsu.

The TFT-LCD panel industry is a capital-intensive industry. Why were the leading Japanese corporations willing to transfer the technology to Taiwanese companies without the state's support? Since the leading *keiretsu* of TFT-LCD panels in Japan were fiercely hit by the Asian financial crisis in 1997, they were short of capital to conduct a new round of investments. Furthermore, Chimei had began purchasing equipment and building its 3.5-generation (14-inch) plants. Fujitsu

*Table 3. Profile of the 'five Tigers'*

| Vendor | AU Optronics | Chimei | CPT | Hanstar | Quanta Display |
|---|---|---|---|---|---|
| Source of technology | IBM Japan, Panasonic | Fujitsu | Mitsubishi (ADI), Sharp | Toshiba | Sharp |
| Parent group | BenQ | Chimei | Tatung | Walsin Lihwa | Quanta Display |
| Main business of the parent group | Information technology | Chemical, ABS | Commercial, electronics, cathode ray tube (CRT) television, information technology | Information technology, semiconductors | Information technology |
| Vertical integration of the upper and down streams in the group | LCD televisions, LCD monitors, mobiles, key components | LCD televisions, mobiles, key components, equipment | LCD televisions, LCD monitors | LCD televisions, key components | LCD televisions, mobiles |

*Note:* ABS, acrylonitrile butadiene styrene; LCD, liquid crystal display.
*Source:* Data were collected and arranged by the authors.

then realized that all hardware equipment was already in place, What was missing was only the software technology. Moreover, if Chimei had not worked with Fujitsu, other rivals in Japan would have had the chance to become the source of technology transfers for Chimei. Finally, Fujitsu adopted the strategy of 'using the technology in exchange of production capacity'. By doing this, Chimei was then like one of the overseas factories for Fujitsu, and Fujitsu consigned the technology to the plant in Taiwan in exchange for the 14-inch panels it needed.

Under such commercial negotiation, the Fujitsu–Chimei technology transfer took place. Technology transfers were not just about providing written technology manuals. The more important part was face-to-face experience sharing and transfer between senior engineers. The content of the technology transfers was the concrete and specific on-site training and team work. Fujitsu sent its people to Taiwan to perform technology instructions. Instruction was undertaken by tutorials. The Fujitsu engineers taught the first-generation technology team of Chimei, which consisted of about five people. The key Array production process was a tacit know-how, including the production process and the design layout, and equipment adjustment/tuning, which were not easy to disclose. Since the acquisition of technology involves not only written information (for example, blueprints and operating instructions), but also embodied skills and know-how and the adaptation of techniques to local operating conditions, the movement of people guarantees the effectiveness of the transfer process. Although equipment suppliers would teach the Chimei team about the methods of operation, the most crucial production process did require people-embodied know-how. It took Fujitsu's engineers about a year travelling back and forth between Taiwan and Japan before Chimei's first-generation technical team finally mastered the production technology. The instruction ended around 2001.

After Chimei began commercial production, it became Fujitsu's major panel supplier. However, Chimei did not completely depend on Fujitsu's original technological resources to grow itself. There existed special patterns of further innovation and the improvement of borrowed technologies.

The production process for TFT-LCD panels was not the same as that of wafers (semiconductor manufacturing). In general, there would be no particular changes regarding the production process between different generations. The major two production processes – multi-domain vertical alignment (MVA) and in-plane switching (IPS) – could be used continuously. The most important change took place when the size of the panel became larger. In cases such as this, some work had to be done such as fine-tuning evenness at the edges. In other words, the technological upgrade of TFT-LCD panels meant an increase in the panel's size and the consequent improvement of the production process. Unlike the production of wafers, no intellectual property fees need to be paid. For the production of panels, the vendor only needs to fine-tune dominant research and development activities on the technologies transferred from the vendor between generations, especially when the size of the panel becomes larger.

The first 3.5-generation of Chimei's plant produced the 14-inch panel at first, and gradually moved up to 42-inch, the mainstream product of the 5.5-generation plant. During the process of such upgrading, technical interaction with Fujitsu was little. In fact, Chimei turned its attention to technical collaboration with other companies, especially the intensive cooperation with the upstream components and parts (such as glass-master) suppliers, and downstream application-end vendors (such as LCD televisions) with respect to information/technology to ensure the production capacity for future products and their specifications. Most of these companies were large in size, and even monopolized in several key components and parts technologies, such as the making of liquid molecules and large-size glassmasters, as shown in Fig. 4.

In other words, such inter-firm collaboration with suppliers and customers was a must in the interactive learning phase. It led to the cluster of these companies in Tainan high-technology park, and rendered such communications easy. Unlike the Hsinchu case, cross-border technical community between Japan and Taiwan did not play a relevant role in such a process. The main human capital was trained by the domestic corporations. The TFT-LCD-related companies in Tainan's cluster were mainly shaped by the advanced components companies' branch plants, the large downstream Taiwanese system manufacturers' subsidiaries (such as Wistron, the information technology system manufacturer that began to produce LCD televisions), as well as the panel manufacturers' expansion to upstream fields.

In brief, Tainan's story demonstrates that in contrast with semiconductor industry, the giant corporation had replaced the state's role in launching the new technological transfer in the early stage of TFT-LCD development. It took advantage of the shifting GPNs in which the Japanese companies are willing to transfer technology, and mobilized the regional assets, the locally embedded company, Chimei, to collaborate with the former. Frequent inter-firm learning with the key suppliers and customers becomes the main channel of technology diffusion in Tainan park. Instead of relying on the state's initiative, the key local corporation plays an active role in the fostering of regional development in the Tainan case.

## TAICHUNG: ENDOGENOUS GROWTH POTENTIAL?

Divergent from the policies in Hsinchu and Tainan that highlighted the introduction of new industry (especially

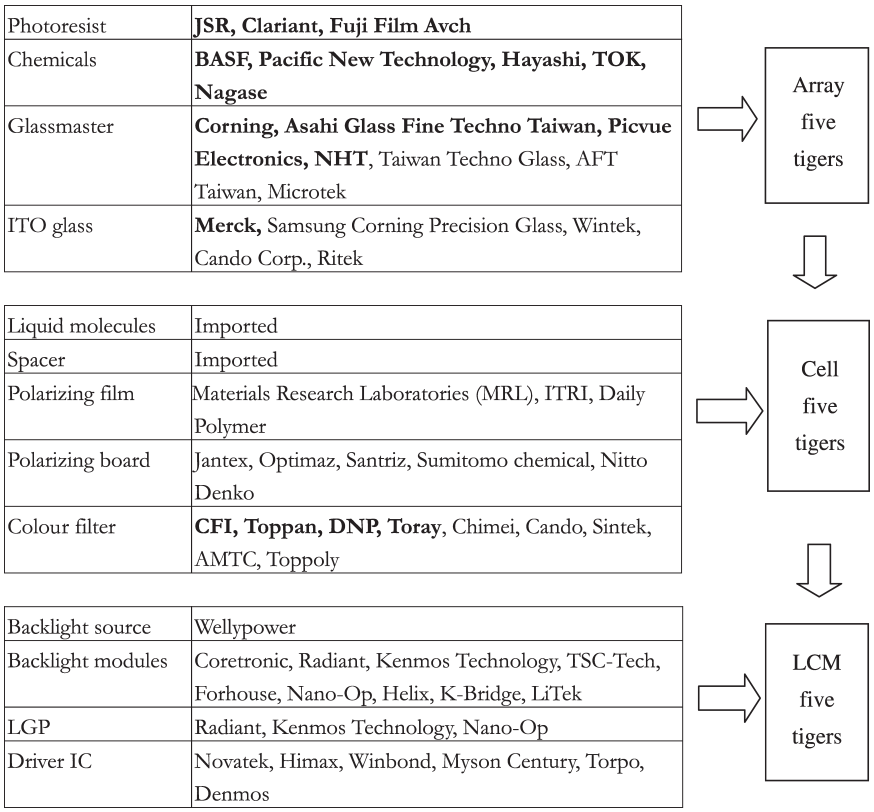


*Fig.* 4. *Industrial structure of thin-film transistor-liquid crystal display (TFT-LCD) panel and related companies in Taiwan*
*Note:* Bold type = *foreign direct investment*

semiconductors and TFT-LCDs), the one in Taichung high-technology park aimed to promote and revive a traditional industrial base in the central Taiwan region, especially the machinery industry. In other words, the specialty of Taichung park's policy lay in leveraging the 'endogenous growth potential' (MARTIN and SUNLEY, 2003). However, the outcomes or achievements of this policy are shaped by the nature of the interactions between firms, state, and community, as well as the structural constraints.

This section begins with a brief introduction of the industrial structure and development of this region. Several industrial sectors, belonging to the so-called traditional industries, such as plastic products and chemical products manufacturing, apparel, clothing accessories and other textile product manufacturing, metal industries, machinery and equipment, have agglomerated in the central Taiwan region since the stage of rapid industrialization in the 1960s. In particular, the precision machinery and instrument industry constituted the most dynamic industry in the region. Currently, due to lower cost competition from other latecomer countries, this region faced a challenge of constant decline while firms extensively shifted their production lines to the low-cost areas, especially on Mainland China.

In spite of extensive investments in China, the machinery and equipment manufacturing industry still developed well in this region. Taiwan stood as one of the most important export countries in machine tool products, accounting for 9.1% of the total global share in 2004. And it is still growing, with the value of production increasing by 33%, 13%, and 14% in 2004, 2005 and 2006, respectively, and the value of exports increasing by 31%, 13% and 13% in the same periods.[5]

In terms of industrial organization, the machinery and equipment manufacturing industry is mainly composed of family workshops and small to medium-sized enterprises. Intensive interactions between firms were overwhelmingly characterized by a flexible and efficient production networks in the region. The long-term corporation relationships existed extensively among firms and helped to establish mutual trust between firms within this area. For example, VICTOR Taichung Machinery connected with more than 400 local cooperative firms to form a factory fraternity with regular meetings to share information about the provisions of raw materials, market information, and technological issues in product development.

Local associations also played a role in promoting industrial development. The Precision Machinery Development Association of Taiwan (CMD) was established in 1983 in Taichung. It performed as a social and institutional platform for the industry to upgrade advanced precision machinery. The Association has set up a research and development centre (PMC) since

1983 to undertake research and development into the technologies of precision machinery and to help upgrade the Taiwanese machine tool industry. It also made efforts to link with international technological sources and the global market, especially connecting with the Japan Machine Tool Builders' Association (JMTBA), while promoting interactions between local firms, universities, and governmental institutions. It also introduced the testing technology for machinery products from Japan (JMI and JQA; Japan Quality Assurance Organization) to expedite excellent machine's confirmations. It functioned as an institutional platform to absorb the advanced technologies and diffuse them to the local firms. Technical and commercial opportunities penetrated through the activities of industrial exhibitions, conferences, lectures, workshops, seminars, and a training curriculum. In other words, through the local institutions, the region developed with technological absorption from extra-regional connections, knowledge spillovers, and proliferation to the local firms.

The state decided to establish this park in early 2001. At that time, the state was facing complicated political and economic circumstances. Firstly, many Taiwanese firms have shifted their manufacturing facilities to the areas of lower production costs, particular to China. The state was forced to make efforts to keep economic growth and attract inward investments. Secondly, it needs to reduce the regional disparity between north Taiwan and other regions in response to the domestic political situations under recent democratic development. However, the state also faced the predicament of lacking fiscal resources to support a large industrial development project. Therefore, the central Taiwan region was chosen as the location of the third high-technology park in Taiwan; while the policy instrument for promoting the park's development was mainly focused on cheap industrial land and the infrastructure provision, in addition to a small amount of budget to support CMD's projects and connections between industries and universities.

By the end of 2004, the first company began commercial production. In 2007, nearly 100 firms had their plants built and they started operations by setting up their manufacturing establishments. Generally speaking, an industrial cluster is forming. Currently, the industrial or firm types within the park mainly include IC and dynamic random access memory (DRAM), optoelectronics and precision machinery, and biotechnology (Table 4).

Till now, the growth dynamics are mainly from the spillover effect of the Taipei–Hsinchu technological corridor. The major firms in IC and optoelectronics industries are branches of their mother companies in Hsinchu and Taipei. They are the giant companies in Taiwan and have well-developed connections with the global technologies or knowledge sources. Another kind of newcomer is foreign direct investments, such as LG Micron, and PKL from South Korea, Synthetic Rubber and Nitto Denko from Japan, and Corning from the United States.

In addition to attracting new investments, the initial expectation of the state for this park's development is to establish linkages between the indigenous industrial dynamics (equipment manufacturing and precision machinery) and the high-technology industries (for example, IC and TFT-LCD). Some policy initiatives have been announced with regards to the promotion of local industrial restructuring, and to help firms in the research and development stage and production process improvement. The state-led research institution, the Mechanical Industry Research Laboratories (MIRL),[6] has set up a branch in this region to help local firms upgrade their technologies and international competitiveness. However, the state's capacity has shrunk compared with the 1980s, while Hsinchu has developed. Fewer resources have been pumped into research and development. What the state could provide is mostly cheap public land and infrastructure, accompanied by tax preferences. The same as in Tainan, the role of the state is acting as a 'coordinator'. There is little sign

*Table* 4. *Industrial types and numbers of firms within Taichung high-technology park*

| Industrial types | Number of firms | Sample large firms |
|---|---|---|
| Integrated circuits and dynamic random access memory (DRAM) | 6 | Winbond, TSMC, ProMOS Technologies, Powerchip |
| Precision machinery | 27 | KINIK, Kao Fong machinery, HOTA, Gallant Precision Machining, Aquest Systems, EUMA-SPINNER, Awea |
| Optoelectronics | 24 | Taiwan Corning, Taiwan Nitto, CPT, LG Micron (Taiwan), Genius Electronic Optical, Taiwan PKL, Taiwan ShinAn SNP, Japan Synthetic Rubber(JSR), DENKO, Taiwan Fiber Optics, Sintek, Polaray Optoelectronics, Largan Precision, CHUNGHWA Picture Tubes, AU Optronics |
| Biotechnology | 12 | Yusheng Biotechnology, Yung Thin Pharmaceutical, Sunder Biomedical Technology, PharmaEssentia |
| Others | 18 | |

*Source:* Central Taiwan Science Park website (available at: http://www.ctsp.gov.tw/english/00home/home.aspx?v=20) (accessed February 2007).

that these newcomers have developed their connections or cooperated with the local industrial base so far.

For example, AU Optronics (AUO) set up its largest and most advanced fabrication facilities in this park, and Powerchip Semiconductor Corporation (PSC) set up its fourth 12-inch DRAM fabrication in 2006. The equipment for advanced technologies of 70 nanometre processes are imported from overseas. PSC also signed a memorandum of understanding with Elpida (Japan) at the end of 2006 to set up a new joint venture to operate the world's largest 12-inch DRAM fabrication facility in the park with a total planned capacity of 240 000 12-inch wafers per month, making this site the largest concentration of 12-inch DRAM fabrication facilities in the world. Their new plants use the products or equipment from Japanese firms, such as Renesas and Mitsubishi Electric, rather than from local firms. According to the interview conducted in November 2006, the local machinery firms still lacked business relationships with those giant IC and optoelectronics enterprises. The reason lies in that most of these local firms are small to medium-sized enterprises, and that many of their technological and production capabilities cannot meet the requirements of these enterprises in setting up their most advanced production facilities.

Thus, the high-technology firms in this park are strong in 'global pipeline' but weak in 'local buzz' (BATHELT *et al.*, 2004). For example, ProMOS Technologies cooperates with Hynix Semiconductor; Winbond Electronics connects with NCR, Hewlett-Packard, Toshiba, Fujitsu, Sharp, Qimonda, and Infineon. A number of optoelectronics firms also connect strongly with firms in South Korea, Japan, and other countries – Sintek connects with IBM Japan and DNP; and Chunghwa Picture Tubes with Toshiba and Fujitsu ADI, and RDI (USA). There are relatively few policy instruments for the state to promote and help local firms' abilities in innovation in order to meet these high-technology firms' requirements.

In brief, Taichung park is initially designed as a subsidy to keep Taiwanese high-technology firms from investing in China. Rather than playing a midwifery role in fostering new industries, the state acts as a husbandry role in providing necessary inputs, such as land, for industrial development. In contrast, the thickness of the locally embedded machinery cluster potentially offers an endogenous regional asset for Taichung park to connect with the GPNs which might search for local partners to develop new products. In the meantime, local industrial associations more than likely persuade local machinery firms to join in with the maintenance and parts supplying chain of these giant high-technology companies. Strategic coupling between the GPNs and regional assets is still a key issue for the newly constructed park to handle.

## DISCUSSION: VARIED PATTERNS OF GLOBALIZING REGIONAL DEVELOPMENT

After the empirical review of the development of the three high-technology parks in this section, the authors would like to point out the geographically varied patterns of 'strategic coupling' in these three industrial clusters, as well as to interpret such variation from the viewpoint of the evolutionary interplay between state, firm, and societal–communitarian forces. The characteristic of strategic coupling in Hsinchu high-technology park could be categorized as 'from developmental state to ethnic–technical community', while in Tainan, it is categorized as 'firm-centred technology transfer'. These two different coupling patterns reflect the transforming dynamics of the state capacity and enterprise competence behind the temporary 'spatial fix'. Furthermore, the cross-border technical staves' association with Japan in the Tainan case was much 'thinner' compared with the Hsinchu–Silicon Valley interaction. It shows the divergent industrial cultures between the United States (Silicon Valley) and Japan that these technical communities embedded socially. In other words, the structural constraint of the technical community did exist.

The interaction between firms, state, and communitarian–societal forces in Taichung's case is more complicated than the other two parks. The state has fewer resources and abilities in directing the development of industries. The development of the park is not dominated by the state or only a giant corporation. Several companies in IC and optoelectronics with global reach abilities play a significant role. Besides, under the state's support, the technological associations are making their efforts in connecting the endogenous industrial base with the newcomer industries. Probably, the importance of these associations played in promoting endogenous growth potential is more significant. Thus, owing to its combination of a traditional localized machinery industrial system and new flagship investment, the pattern of strategic coupling in Taichung high-technology park was categorized as 'firm-centred plus trade association-mediated technical collaboration' (for the summary, see Table 5).

One finds the evolutionary interplay between these institutional forces that characterize the varied patterns of strategic coupling in these three cases. In Hsinchu's case, although the developmental state plays a critical role in transferring new technology, this alone could not explain the whole story of 'the connection of global technology and local capability'; the ethnic–technical community also contributed to the development of new industries. Furthermore, in the process of production networks' outward extension to Mainland China after the 2000s, the role of the technical community is much more relevant than that of the state, and it even runs against the state's policy which was confined by the inter-strait political issue. In

*Table* 5. *A comparison of three high-technology parks in Taiwan*

| | Patterns of strategic coupling | Cluster typology | Local spill over | State's role typology |
|---|---|---|---|---|
| Hsinchu | From developmental state to ethnic–technical community: Silicon Valley and China | Marshallian, flexible specialization | Decentralized | Demiurge, midwifery |
| Tainan | Firm-centred technical transfer: Japan | Non-Marshallian, vertical integration | Centralized | Husbandry |
| Taichung | Firm-centred plus trade association-mediated technical collaboration | In between | In between | Husbandry |

*Source:* Date are organized by the authors.

Tainan's case, in contrast to the semiconductor industry, the new technology was introduced by the large corporations rather than by the developmental state. Furthermore, the regional industrial networks were mainly shaped by equipment suppliers' foreign direct investment, as well as by large customer manufacturers' subsidiaries. The large firms not only launched the initial technology transfer, but also played the critical role in building up the regional industrial networks. Moreover, owing to the flagship inward investments that result from the booming high-technology industrial development in Taiwan after the 2000s, Taichung high-technology park has strong non-local connections, or a 'global pipeline'. However, it is weak in 'local buzz'. Thus, the key issue of strategic coupling in Taichung high-technology park is how to lever the resources of these large TFT-LCD and DRAM companies to revive the regional economy. Currently, the authors do not find any signs of the market mechanism playing the role of the broker; instead, it is the associations that try to connect the endogenous industrial base with the newcomer industries.

Furthermore, the spatial–organizational formations of these three high-technology parks are also varied. Using MARKUSEN's (1996) typology, the cluster in Hsinchu could be categorized as 'Marshallian'. In Tainan, a trend of 'vertical integration' had emerged that made it quite different from the Marshallian district in Hsinchu. The characteristics of competitive strategy in the TFT-LCD industry might explain the phenomenon to a certain extent. It can be seen from Table 3 and Fig. 3 that all of the 'five tigers' are involved in vertical integration and they extend their investments to cover the fields of colour filter, driver IC, and, most importantly, LCD televisions, and so on. Under such a circumstance, could the 'satellite platform industrial district' (MARKUSEN, 1996) characterize Tainan high-technology park? Although the member firms of Tainan Park do establish connections with firms in other places, it is argued that those non-local firms do not dominate over technologies and research and development activities. Thus, Tainan is defined as a 'non-Marshallian' cluster in a broader sense. However, in Taichung's case the spatial–organizational formation of the park is shaped by the endogenous machinery production networks accompanying new rounds of inward investment. On the one hand, complicated production networks and intense interactions between machinery companies still exist in the district. On the other hand, as in Tainan's case, many large enterprises with the character of vertical integration (including TFT-LCD and DRAM) are setting branch plants in the same district. Thus, the Taichung cluster is categorized as 'in-between' that of the 'Marshallian' and 'non-Marshallian' prototypes.

Moreover, attention is also paid to the local connection/spillover effect of these three high-technology parks. An interesting comparison of the phenomenon of small and medium-sized enterprise spin-offs could be found between Hsinchu and Tainan. In Hsinchu, a lot of small companies are spun off in the region, especially the IC design house, and these small and medium-sized enterprises become an important element of the regional production/innovation system. But Tainan shows few signs of small and medium-sized enterprises spin-off. Instead, what becomes phenomenal is the flagship firms' vertical integration. Although both parks contribute to local development in terms of job creation, population immigration, luxurious consumption, and land development, their geographic organizational patterns are divergent. Such divergence might be interpreted as the varied geographical formations shaped by different actors' interplay – community and firm – to some extent. In addition, although the Taichung region has an existing cluster with dense local, social and production networks in the equipment manufacturing and precision machinery industries before the establishment of Taichung park, the cluster's firms currently have not developed a strong connection with the newcomer investments of IC and optoelectronics firms. It not only requires a longer time for them to know each other and thus to establish mutual trust, but also needs institutional support to enhance the capabilities of local firms.

Last, but not least, the issue of the transforming developmental state's role is particularly relevant to the Siliconization project. As shown above, the state's capability has been shrinking in launching new technology and industry since the Hsinchu park started in the 1980s. After the early stage of the HSIP's development, the state could not play the role of the 'Demiurge' that 'created' a new industry as it did for the semiconductor sector. As illustrated by the Tainan case, the TFT-LCD

industry was set up by Taiwan's giant corporation with technology transfer from Japan. It seems obvious that the leading industrial corporations in Taiwan now carry the capability of launching new technology transfer/cooperation projects globally with little state support. Finally, as the Taichung case demonstrated, the state is mobilizing its limited capability to lever both the private and association's resources and transform the science park policy from industrial policy to an instrument for regional revival. As a result, the 'Silicon Island Project' became a challenge for the post-developmental state. How to avoid such policy initiative falling into some kind of 'development zone fever' in China (YANG and WANG, 2008) without real industrial/innovative dynamics had become a critical issue for the state.

## CONCLUSION: THE EVOLUTIONARY INTERPLAY IN ARTICULATING THE GLOBAL PRODUCTION NETWORKS

How will capitalist geographical industrialization disclose itself among the divergent institutional embeddedness, structural coherence, geographical organizations, and scalar connections? The global production networks (GPNs) thesis provides an impressive analytic framework by exploring the interface organizational fields between the GPNs and local institutional embeddedness. In other words, the dynamic '*GPNs–territory nexus*' could be the relevant research agenda for decoding the process of uneven geographical composition (YANG and COE, 2009). Inspired by the GPNs thesis, the present authors propose an actor/practice-sensitive triangular framework to catch the dynamic actor-specific practices as well as power geometry in the process of strategic coupling. As demonstrated in the Siliconization project in Taiwan, the present approach summarizes and explains the divergent 'science park-driven' regional development patterns as well as geographically varied patterns of strategic coupling. The authors could find the evolutionary interplay between three agents – firm, state, and societal/communitarian forces – in shaping the regional development patterns. On the one hand, such an approach illustrates that the process of strategic coupling could occur through the intervention of state-led policies, leading firms' initiation, trans-border technical communities' connections, as well as endogenous associations' networking. On the other hand, it shows the evolutionary interplay, transforming roles, and structural constraints of these institutional forces in coupling the regions with the GPNs. Under such a GPNs' inspired approach, the paper initially reveals and analyses the rich varieties of production worlds in the geographical industrialization process.

The findings not only show the multiple modes of temporary 'spatial fix' in the geographical industrialization empirically (HSU and CHENG, 2002), but also suggest the various potentials as well as limitations of different theoretical approaches in explaining the globalizing regional development, including the theses of trans-border community, developmental state, and firm–territory nexus. All these theses provide insights to investigate the institutional embeddedness, structural coherence, and regulative mechanisms of the capitalist geographical accumulation. However, they seem to have explanatory limits in different aspects regarding the dynamic and geographically varied process of strategic coupling, which is the key to decode the globalizing regional development. For example, the firm's role in strategic coupling could be irrelevant when the local industry is in the infant stage, the developmental state's intervention could couple the extra-local resources at this stage, while the broader political–economic circumstance could weaken the state's capacity in such an intervention. Furthermore, the roles of trans-border technical communities in bridging the regional development could be varied according to the differentiated conditions of societal and territorial embeddedness (HESS, 2004), as the divergent roles they played in the Hsinchu and Tainan high-technology parks revealed in the present paper.

With a view to a broader theoretical incorporation that goes beyond the firm-centred perspective as well as the firm–state dichotomy to capture the evolutionary coupling, decoupling, and recoupling of a variety of institutional forces (such as communities, standards, labour, consumers, civil society forces, and so on), the approach proposed herein highlights the structurally embedded social practices of these institutional forces as well as their contingent interplay in the relational geometry in understanding the dynamic process of geographically varied strategic coupling.

As demonstrated above, such a perspective could have some implications for exploring the globalizing regional development as well as the complicated modes of temporary 'spatial fix'. As the need for alternative development strategies for regions has been emphasised by regional researchers such as PIKE *et al.* (2006) to meet the demand of reconciliating top-down policies with bottom-up approaches in the multi-scalar governance model, the Siliconization project in Taiwan leaves a lesson that a region's sensitivity to take advantage of the windows of opportunity offered by the GPNs will be critical for regional development. Moreover, the GPNs are dynamic and engender divergent regional trajectories in different regions. Regional policies should be adjustable to the dynamic local–global nexus. Finally, as geographical industrialization is shaped by multi-scalar agents, the design of regional governance will be an issue of finding a collective order in which they are allowed mutually to interact and adjust in an equitable, rather than an hierarchical, manner.

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## NOTES

1. For a further discussion on the governance context, community, and trust, see ADLER (2001) and BOWLES and GINTIS (2002).
2. Critics have pointed out a number of flaws in the transnational economic network model which presumes that shared language, culture, and history facilitate the construction of shared identities among ethnic diaspora (SMART and HSU, 2004). Among others, it tends to assume both the continuation of cultural commonalities and the power of shared identity to facilitate trustworthy business networks which can then operate efficiently with lower transaction costs.
3. 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.
4. As well noted by SAXENIAN (2006), the overseas Indians have a software business connection with their motherland, despite being less entrepreneurial than their Taiwanese counterparts.
5. *Source:* Taiwan Association of Machinery Industry, statistic data on the Association's website (available at: http://www.tami.org/st/week2_2006.htm) (accessed on 19 February 2008).
6. MIRL was founded in 1969 by the Metal Industrial Research Institute. It was subordinated to the Industrial Technology Research Institute (ITRI) in 1973, and changed to its current name in 1983.

## REFERENCES

ADLER P. (2001) Market, hierarchy, and trust: the knowledge economy and the future of capitalism, *Organization Science* **12**, 215–234.

AMIN A. and COHENDET P. (2004) *Architectures of Knowledge: Firms, Capabilities, and Communities*. Oxford University Press, Oxford.

AMSDEN A. and CHU W. W. (2003) *Beyond Late Development: Taiwan's Upgrading Policies*. MIT Press, Cambridge, MA.

AMSDEN A. H. (1989) *Asia's Next Giant: South Korea and Late Industrialzation*. Oxford University Press, Oxford.

BATHELT H., MALMBERG A. and MASKELL P. (2004) Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation, *Progress in Human Geography* **28**, 31–56.

BOWELS S. and GINITS H. (2002) Social capital and community governance, *Economic Journal* **112**, F419–F436.

BROWN J. S. and DUGUID P. (1991) Organisational learning and communities of practice, *Organisational Science* **2**, 40–57.

BURAWOY M. (1998) The extended case method, *Sociological Theory* **16**, 4–33.

COE N. M., DICKEN P. and HESS M. (2008) Global production networks: realizing the potential, *Journal of Economic Geography* **8**, 271–295.

COE N. M., HESS M., YEUNG H. W.-C., DICKEN P. and HENDERSON J. (2004) 'Globalizing' regional development: a global production networks perspective, *Transactions of the Institute of British Geographers*, n.s. 29, 468–484.

COX K. R. (1998) Spaces of dependence, spaces of engagement and the politics of scale, or looking for local politics, *Political Geography* **17**, 1–23.

DICKEN P. (1994) Geography global–local tensions: firms and states in the global space-economy, *Economic Geography* **70**, 101–128.

EVANS P. (1995) *Embedded Autonomy: States and Industrial Transformation*. Princeton University Press, Princeton, NJ.

GEREFFI G. (1995) ?Global production systems and third world development, in STALLINGS B. (Ed.) *Global Change, Regional Response: The New International Context of Development*, pp. 100–142. Cambridge University Press, Cambridge, MA.

GEREFFI G. (1999) International trade and industrial upgrading in the apparel commodity chain, *Journal of International Economics* **48**, 37–70.

HAGGARD S. (2004) On govern the market, *Issues and Studies* **40**, 14–45.

HENDERSON J., DICKEN P., HESS M., COE N. and YEUNG H. W.-C. (2002) Global production networks and the analysis of economic development, *Review of International Political Economy* **9**, 436–464.

HESS M. (2004) 'Spatial' relationship? Towards a reconceptualization of embeddedness, *Progress in Human Geography* **28**, 165–186.

HSINCHU SCIENCE-BASED INDUSTRIAL PARK (HSIP) (1998) *1998 Yearly Report of the HSIP*. The Administration of the HSIP, Hsinchu.

HSU J. Y. (2004) The evolving institutional embeddedness of a late-industrial district in Taiwan, *Tijdschrift voor Economische en Sociale Geografie* **95**, 218–232.

HSU J. Y. (2005) A site of transnationalism in the 'Ungrounded Empire': Taipei as an interface city in the cross-border business networks, *Geoforum* **36**, 654–666.

Hsu J. Y. (2006) From regional collaboration to regional fragmentation: neo-liberalization, state transformation, and scale politics in Taiwan. Paper presented at the 102nd Annual Meeting of the Association of American Geographers, Chicago, Illinois, USA, 7–11 March 2006.

Hsu J. Y. and Cheng L. L. (2002) Revisiting economic development in post-war Taiwan: the dynamic process of geographical industrialization, *Regional Studies* **36**, 897–908.

Hsu J. Y. and Saxenian A. (2000) The limits of *guanxi* capitalism: transnational collaboration between Taiwan and the USA, *Environment and Planning A* **32**, 1991–2005.

Hudson R. (1999) The learning economy, the learning firm and the learning regio: a sympathetic critique of the limits to learning, *European Urban and Regional Studies* **6**, 59–72.

Hudson R. (2001) *Producing Places*. Guilford, New York, NY.

Humphrey J. and Schmitz H. (2002) How does insertion in global value chains affect upgrading in industrial clusters?, *Regional Studies* **36**, 1017–1027.

Jessop B. (2000) The crisis of the national spatio-temporal fix and the tendential ecological dominance of globalizing capitalism, *International Journal of Urban and Regional Research* **24**, 323–360.

Kogut B. and Zander U. (1993) Knowledge of the firm and the evolutionary theory of the multinational enterprise, *Journal of International Business Studies* **24**, 625–645.

Levy D. L. (2008) Political contestation in global production networks, *Academy of Management Review* **33**, 943–963.

Lundvall B.-A. and Maskell P. (2000) Nation states and economic development – from national systems of production to national systems of knowledge creation and learning, in Clark G. L., Feldman M. P. and Gertler M. S. (Eds) *The Oxford Handbook of Economic Geography*, pp. 353–372. Oxford University Press, Oxford.

Markusen A. (1996) Sticky places in slippery space: a typology of industrial districts, *Economic Geography* **72**, 293–313.

Martin R. and Sunley P. (2003) Deconstructing clusters: chaotic concept or policy panacea?, *Journal of Economic Geography* **3**, 5–35.

Morgan K. (2004) The exaggerated death of geography: learning, proximity and territorial innovation systems, *Journal of Economic Geography* **4**, 3–21.

Park S. O. and Markusen A. (1995) Generalizing new industrial districts: a theoretical agenda and an application from a non-Western economy, *Environment and Planning A* **27**, 81–104.

Pike A., Rodriguez-Pose A. and Tomaney J. (2006) *Local and Regional Development*. Routledge, London.

Saxenian A. (1994) *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Harvard University Press, Cambridge, MA.

Saxenian A. (2006) *The New Argonauts: Regional Advantage in a Global Economy*. Harvard University Press, Cambridge, MA.

Schoenberger E. (1997) *The Cultural Crisis of the Firm*. Blackwell, Cambridge, MA.

Smart A. and Hsu J.-Y. (2004) The Chinese diaspora, foreign investment, and economic development in China, *Review of International Affairs* **3**, 544–566.

Storper M. (2005) Society, community, and economic development, *Studies in Comparative International Development* **39**, 30–57.

Taylor M. and Asheim B. (2001) The concept of the firm in economic geography, *Economic Geography* **77**, 315–328.

Wade R. (1990) *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*. Princeton University Press, Princeton, NJ.

Wu Y. P. (2004) Rethinking the Taiwanese developmental state, *China Quarterly* **177**, 91–114.

Yang D. Y. R. and Coe N. M. (2009) The governance of global production networks and regional development: a case study of Taiwanese PC production networks, *Growth and Change* **40**, 30–53.

Yang D. Y. R. and Hsia C. J. (2007) Local clustering and organizational governance of trans-border production networks: a case study of Taiwanese IT companies in the Greater Suzhou Area, China, *Environment and Planning A* **39**, 1346–1363.

Yang D. Y. R. and Wang H. K. (2008) Dilemmas of local governance under development zone fever in China: a case study of Suzhou region, *Urban Studies* **45**, 1037–1054.

Yeung H. W.-C. (2005) Rethinking relational economic geography, *Transactions of the Institute of British Geographers*, n.s **30**, 37–51.

Yeung H. W. C. (2009) Situating regional development in the competitive dynamics of global production networks: an East Asian perspective, *Regional Studies*, **43**, 325–351.