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## Global Production Networks and Local Capabilities: New Opportunities and Challenges for Taiwan

Tain-Jy Chen and Shin-Horng Chen

**Tain-Jy Chen is a Professor** at the National Taiwan University, Taiwan, China.

**Shin-Horng Chen is a Professor** at the Chung-Hua Institution for Economic Research, Taiwan, China.

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## **1. Introduction**

Since the 1980s the information industry has increasingly become the engine of economic growth in Taiwan. Although progressive development in the information sector is widely seen throughout the world, in Taiwan the industry has outgrown the majority of its international counterparts. Currently Taiwan ranks as the third largest producer of information products worldwide. Well-documented is the Taiwan industry's characteristic feature of local industrial clustering (Hobday, 1995; Kim and Tunzelmann, 1998; Kraemer et al., 1996). However, it is increasingly evident that globalization is reshaping the way in which the information industry is organized globally, consequently, local agglomeration now cannot adequately account for the dynamics of Taiwan's information industry. Instead, it is the global production network that has come to the fore. This has something to do with the change in strategies of the brand marketers, in the US in particular. In response to this, Taiwanese information product producers have gone global to deploy production and more recently logistics networks in order to remain cost efficient to serve their customers. Similarly, from the onset, the development of Taiwan's semiconductor industry has been driven by the strategy of vertical disintegration, which in turn has facilitated the formation of local and cross-border linkages as the momentum for industrial expansion. In addition, on the horizon is the emerging post-PC era, leading to the proliferation of a variety of information appliances (IAs). Since IAs are related to a cluster of industries and are inherently technical systems (Windrum, 1999), Taiwan, with its dynamic information industry, is cooperating with the international forerunners to develop its IA industry. Taking all these into account, Taiwan's achievements in the IT (information technology) area may be better understood by the ability of local firms to leverage and align local and international networks.

This paper explores this issue in the context of globalization and its effects on inter-firm relationships. Globalization has been driven by multinationals' outreach of capital, production (Michalet, 1991) and more recently technology (Patel, 2000; Sigurdson, 1990). As a result, boundaries between firms have become blurred on the international scale (Delapierre and Mytelka, 1998). This has eroded the basis for the formation of traditional oligopolies. Instead, industrial rivalry now tends to occur among industrial

networks that comprise of a multiplicity of firms linked up with different knowledge bases. With regard to this, in the driver's seat are mostly firms in advanced countries, but firms in countries like Taiwan also have their role to play. In that spirit of inquiry, the paper analyzes the way in which the information technology industry is restructuring on the global scale, with a special focus on the changing role of Taiwanese (IT) firms.

The analysis proceeds in four stages. First of all, taking into account the features of certain technologies and globalization, Section 2 discusses the importance of inter-firm linkages and the emergence of global production and knowledge networks. This is followed by analysis of the way in which Taiwan's IT firms are integrated within global networks, including an examination of the personal computer, semiconductor and information appliance industries, presented in Sections 3, 4 and 5 respectively. Finally, Section 6 concludes the paper by looking at the potential implications.

## **2. Globalization and the Development of Global Production Networks**

Unlike the standard economic theory, which tends to portray firms as vertical integration, industries across countries are increasingly linked up along the value chain and across industrial boundaries. On the one hand, the standard economic theory, to a certain extent, has failed to capture the complexity of industrial organization, and on the other hand the cross-border linkage of firms has increasingly arisen thanks to globalization. To elaborate on our first point, it is useful to refer to Schumpeter's discussion on the relationship between technological innovation and industrial organization. Widely publicized is Schumpeter's concept of "creative destruction", which tends to champion the cause of small technological firms or innovative entrepreneurs, in challenging both large established firms and existing technologies, based on their radical technological breakthroughs. In contrast to the above Mark I scenario, Schumpeter (1942) also recognizes that established firms may be in a better position to appropriate new knowledge by means of devices such as patents, secrecy, lead times, and superior sales efforts. As a result, there is a Mark II scenario that is characterized by high market concentration and continued existence of large established firms.

However, the Mark I/Mark II analysis fails to capture the complexity of technology and its effects on industrial structure, particularly in the IT (information technology) area. As argued by Windrum (1999), innovations such as E-commerce are inherently large technical systems, comprising of a set of interdependent products that are jointly consumed. Because of network effects and product compatibility, successful innovations for technical systems entail intensive interfaces between multiple actors with different knowledge and skills bases, termed as "innovation networks". By implication, not only do innovations often result from the collective efforts of inter-related firms, but also the value chain needs not to be completely internalized within individual firms. Therefore, in many cases, industrial competition takes place between rival technological and production networks that contain a multiplicity of differentiated firms rather than between vertically integrated oligopolists. However, the relevant literature tends to focus mainly on innovation networks woven by firms in advanced countries (for example Delapierre and Mytelka, 1998), downplaying the role played by firms in countries like Taiwan.

In addition, the trend of globalization is reshaping the landscape of industrial competition. One aspect of globalization over the last few decades has been the increasing disintegration of production and even innovation capabilities across nations (Freenstra, 1998). When West Europe regained its economic momentum after World War II, international economic relationships were featured by a South-North divide; the industrialized economies in the developed world versus agriculture-based production in the developing countries. The resurgence of Japan and the rise of Newly Industrializing Countries (NICs) between the 1960s and the 1990s has brought about the new era of "triad" (in Kenichi Ohmae's terms) plus NICs, leading to the trend of global manufacturing capabilities being increasingly diffused from the developed countries to the developing world. Among NICs, the four Asian Tigers, driven by their export-oriented strategy, accounted for about 83% of Third World manufactured exports in 1990. Nonetheless, as the Latin American NICs have adjusted their developmental strategy toward an outward one, and as developing countries in East Asia such as Malaysia, Thailand, China have followed the footsteps of the four Asian Tigers to pursue export-oriented industrialization, not only have manufacturing capabilities been further disintegrated globally but also the

pressure of industrial competition from the developing world has intensified.

Against this background, firms in developed countries and even NICs have to re-orientate their competitive strategies. For one thing, offshore sourcing has been increasingly adopted by many American firms and more recently by Japanese firms to come to terms with the new global industrial dynamics (Chen and Ku, 2000; Kotabe, 1996; Swamidass and Kotabe, 1993; Venkatesan, 1992). In this regard, many brand marketers tend to concentrate their core competencies on brand name resources and R&D while outsource the rest of the value chain. As a result, they, traditionally considered as vertically integrated multinationals, have increasingly become hollowing-out corporations (Kotabe, 1989). On the other hand, there has been a new breed of multinationals, such as Contract Electronics Manufacturers (CEMs). Unlike traditional manufacturers and multinationals, CEM companies don't make their own brand name products. Instead, they deploy global networks with fast-response capabilities to provide production and other (mainly logistics) services to brand marketers.

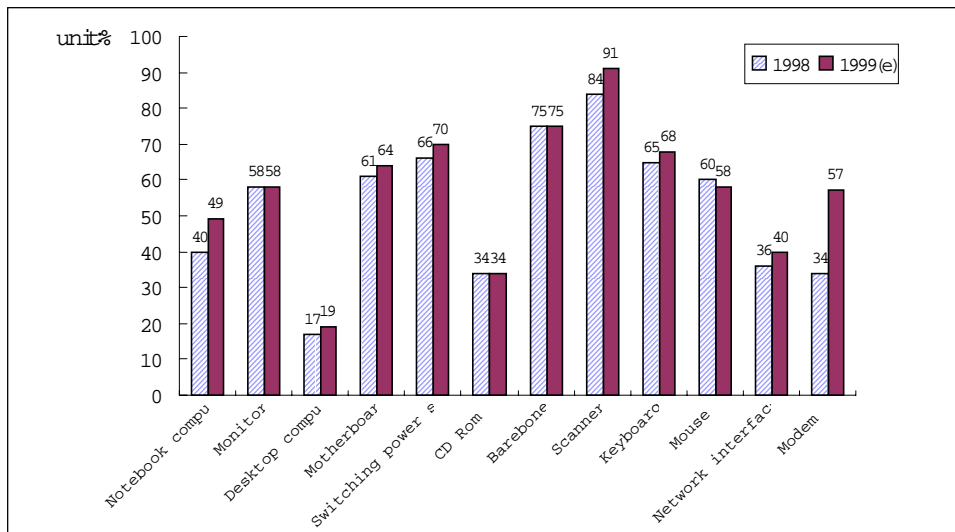
By the same token, firm in Taiwan, whose core business has mostly been OEM (Original Equipment Manufacturing) have also faced the challenge of being "bypassed" by brand marketers because of escalating low-cost competition pressure from some of developing countries. On the one hand, they may upgrade their product portfolios to avoid confrontation with firms in other developing countries. On the other hand, they may opt to extend their production capacities abroad so that they can remain cost efficient to serve their brand name customers. It is in the latter case that Taiwan's information industry has evolved from a local production network towards a global production network.

### **3. Taiwan's Information Industry: Industrial Upgrading by Going Global and Forging International Linkages**

Taiwan is widely regarded as one of the major players in the information industry, currently ranking the third largest producer of information products worldwide. This outstanding performance received its momentum mainly from the production of PCs, peripheral equipment and sub-sectors, and quite a number of Taiwanese-made products within these sectors, such as motherboards, scanners, monitors, and notebook computers,

enjoy significant global market shares (see Figure 1).



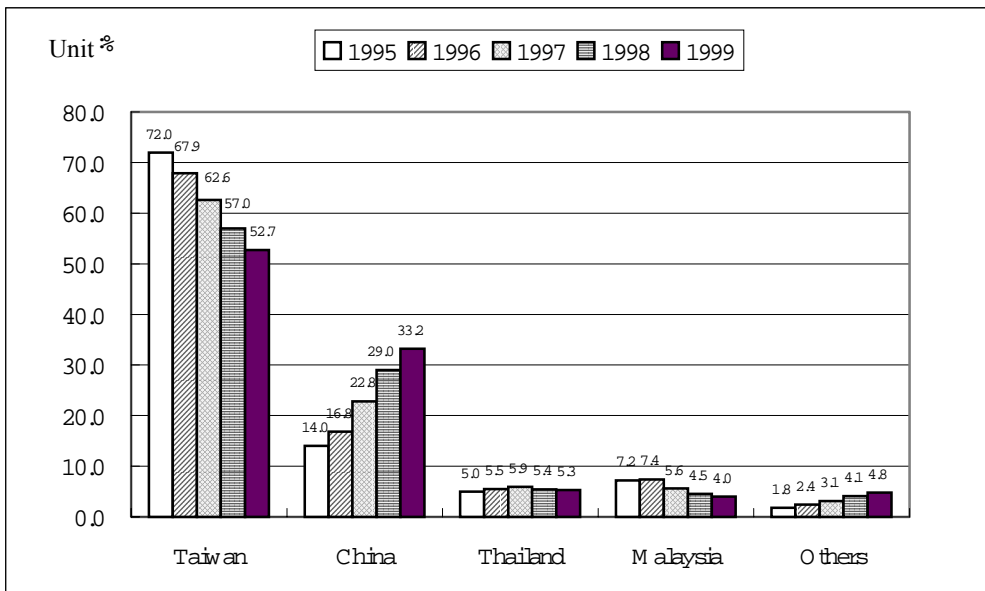


Source: Institute for Information Industry.

Figure 1 Taiwanese firms' world market share in PC-related products

An important milestone in the development of Taiwan's information industry is the outreach of its constituent firms starting from the late 1980s, with their outward investment initially being directed towards Southeast Asia, and more recently towards China and elsewhere in the world. As a result, the offshore production of Taiwan-based IT firms grew from US\$973 million in 1992 to US\$18.86 billion in 1999, accounting for 47.29% of all production by the Taiwan-based firms (Figure 2). It then follows that there has been an increasing divergence between the volume of export orders received by local IT firms, and that of their actual exports (Figure 3). It seems from observation, that 1997 was the turning point when this divergence became much greater, and this has something to do with current global restructuring in the industry, as discussed below.

As the ability to manufacture PCs has become widely diffused throughout the world, as price competition has intensified, and as profit margins have narrowed for most mature computer technologies, the PC industry has witnessed a profound change in inter-firm competition and its manufacturing systems. Within this process of change, PC firms in the US have sought to establish new sources of competitive advantage by accelerating the pace of new technological developments and by the increasing use of external subcontractors. As a result, components are now sourced from a global network of suppliers, whereas the final assembly of PCs tends to be done in each of the major market areas of North America,



Europe, and Asia (Angel and Engstrom, 1995; Borrus and Borrus, 1997).

Source: MIC Institute for Information Industry

Figure 2 Geographical distribution of IT production by Taiwan-based firms

Unit:US\$ Million



Figure 3 The divergent trend between export orders and exports in Taiwan's IT industry

More specifically, recent developments have led to the emergence of a variant of global production networks - global logistics (Chen and Liu, 1999). In their efforts to withstand market encroachment by low-cost clone suppliers, brand marketers in the US, led by Compaq, Hewlett Packard and IBM, now tend to concentrate on R&D and

marketing whilst obtaining their outsourcing production and logistics operations from, amongst others, Taiwan-based firms. Specifically speaking, Compaq pioneered the so-called optimized distribution model (ODM), which, in essence, aimed to provide customers with options as to what, when, and how they wanted, at the lowest prices.

This operational model has three facets. Firstly, in order to narrow the gap between supply and demand, production is required to meet orders (build-to-order) rather than forecasts (build-to-forecast). Secondly, in order to meet the variety of customer demands, build-to-order practices are extended to configuration-to-order practices, under which customized products are produced in specific quantities. Thirdly, Compaq's vendors are required to undertake final assembly, bringing together a set of modular subassemblies produced and delivered by Compaq's subcontractors. From Compaq's perspective the adoption of ODM enables it to concentrate on its own core competencies of R&D and marketing whilst leaving the rest of the value chain to its subcontractors in Taiwan and to vendors. Meanwhile, the latter two types of firms have come to resemble members of Compaq's 'virtual business', providing the requisite ammunition for Compaq to compete effectively in the global market.

But what does such a new model of contracting mean when it comes to the development of Taiwan's PC industry? Underlying the new contractual relationships is the drive to reduce production costs, lead time to market and inventory costs; it is therefore imperative for Taiwanese firms to establish international production and logistics networks to serve their customers. For example, by implementing ODM, Compaq has completely handed its inventory costs over to its subcontractors, whilst the latter are also required to produce and deliver subsystem products in line with tight schedules and the variety of market demand. A "983" operation formula is also imposed by Compaq, which requires its subcontractors to collect 98% of the components and parts needed for production within 3 days of the order, and to ship the products within 6 days. Therefore, they have to ensure that everything is synchronized up and down the supply chain. In order to do so, these subcontractors, such as those based in Taiwan, have had to establish a well-structured, fast-response global production and logistics network by means of internalization, or through the formation of strategic alliances. They often also ask their components and

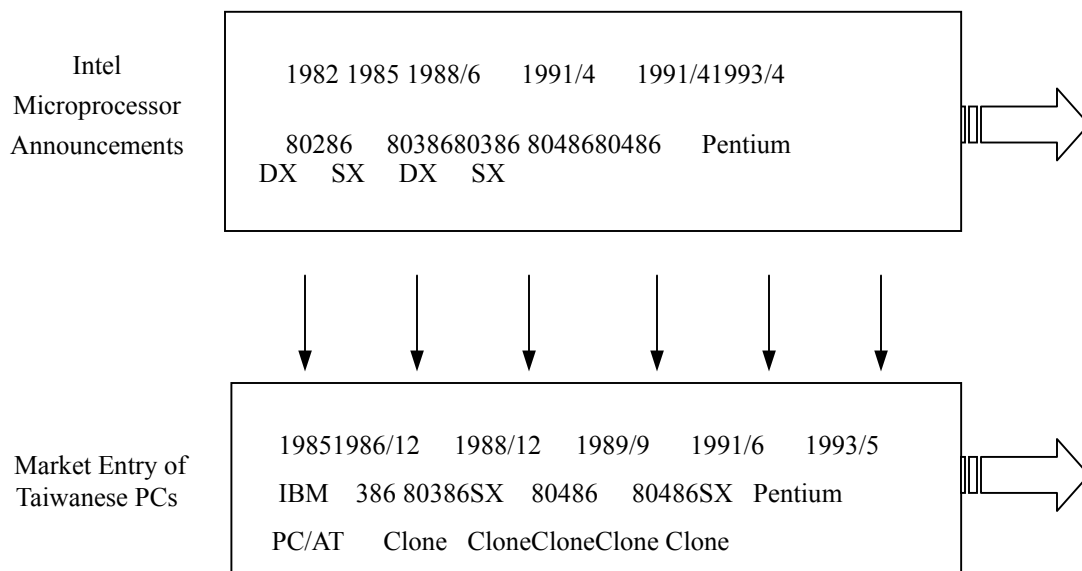
parts suppliers to follow suit, in order to smoothly link up the whole supply chain. As a result, the totality of PC production systems has increasingly come to resemble a 'just-in-time' system on a global scale, weaving together the cross-national constituent elements of the value chain into competitively effective production systems.

Therefore, the relationship between Taiwanese IT firms and their customers - owners of world-class PC brand names - has gone beyond that of the traditional original equipment manufacturing (OEM) model. Under OEM contracting, Taiwanese IT firms acted merely as providers of finished products to their customers. In contrast, emergent global logistics contracting requires Taiwanese subcontractors to take on much greater responsibility by participating in supply-chain management, logistics operations and after-sale services. In addition, both sides of the contractual relationship now have to work closely together and link themselves up electronically in order to create 'across-the-board' competitive advantages in all mainstream activities in the industry, engendering escalating interdependence between them and hence a 'locked-in' effect. Aided by such relationships, Taiwanese firms may be able to broaden the scope of their value chains, upstream to R&D and downstream to distribution and logistics, in a way that involves much less risk. Moreover, with a global production and logistics network at their disposal that will satisfactorily meet the needs of their customers, Taiwan-based IT firms may preempt the entry into the network of their counterparts in many countries. As a result, from a Taiwanese perspective, owners of world-class PC brand names, which are international core firms in the industry, can be 'anchored' to Taiwan's economy (Chen and Liu, 2000).

Looking back to their developmental roots, Taiwanese firms were previously able to rely heavily on local firms and networks, stretching from Keelung to Hsinchu, in their production of PCs (Kawakami, 1996; Kraemer, 1996). However, under the global logistics systems, they now have to mobilize resources from their global networks to undertake their production. In other words, PCs delivered by Taiwan-based firms will be the result of the productive and innovative efforts of a variety of firms and economies around the world. Admittedly, the PC firms in the US are in the driving seat, but Taiwan-based IT firms may act as an essential node of the global production and logistics network.

Taiwan-based firms have earned such advantages because of their outreach, as well as

their ability to climb up the value chain ladder. As PCs have become a modularized product, it is producers of key components and software rather than those of PC systems who set the momentum for innovations in the industry. Therefore, when Taiwan's PC industry has established the full range of operations locally it has evolved from a distant-follower to become an immediate follower in the field of IBM-compatible PCs based on Intel microprocessors. As Figure 4 shows, this has indeed happened long before the Taiwanese industry going global. Back in 1982, it took 3 years for Taiwan's PC industry to offer a new motherboard with Intel's 80286 CPU inside. In 1983, this lag had shrunk to just one month, implying a much closer working relationship with Intel, as well as a stronger technological capability to follow-up Intel's innovations. Since Taiwanese firms are, in general, short of marketing capacity and brand names, there has been a serious concern that their outreach might become footloose, engendering the hollowing-out of industrial activities back in Taiwan. However, the IT story has proved not to be the case; by going global, Taiwanese IT firms have been able to position themselves as an active coordinator of the global production network. A study by the Central Bank in Taiwan has even revealed that global logistics contracting contributed to Taiwan's GDP growth in 1999, by 0.85%.



Source: Information Industry Institute, Taiwan.

Figure 3. The Developmental Process of the PC Industry in Taiwan

#### **4. Taiwan's IC Industry: Growth through Flexible Specialization**

The IC (semiconductor) industry presents another example of Taiwan's impressive performance in the IT arena. The industry in Taiwan currently ranks the fourth largest in the world, subordinate only to the US, Japan and Korea. Of particular interest are the differences between Taiwan and its forerunners in a couple of aspects. Unlike Korea, which tends to specialize in the production of dynamic random access memory (DRAM), Taiwan provides IC design houses and IDM firms with foundry services, which have captured around 70% of the global market share, and produce a much wider variety of chips. In addition, Taiwan's IC industry consists of many small firms specializing within a narrow range of the value chain, such as IC design, mask production, foundry service, packing and testing, in contrast to the dominance of vertically integrated conglomerates in Korea and Japan. In a sense, Taiwan's IC industry is organized by an industrial network system with a strong connection to Silicon Valley, the globally prominent IC market and technology center.

For one thing, the development of Taiwan's IC industry has been driven by organizational innovation, creating foundry services as a market niche to specialize in production for external customers. This was a deliberate choice made by local entrepreneurs to avoid the risks associated with the market fluctuations of DRAM, and whilst there are currently some DRAM manufacturers in Taiwan, foundry services still accounted for 53% of local IC production in 1999. By disintegrating the IC value chain, the emergence of foundry services in Taiwan has facilitated the proliferation of small- and medium-sized firms engaged in other market segments, such as IC design, testing and packaging. In 1999, there were 127 firms in Taiwan engaged in IC design; 5 in mask production; 21 in wafer fabrication, 42 in packaging; and 33 in testing. This flock of constituent firms demonstrates a balanced and vertically disintegrated industrial structure.

However, despite the vertically disintegrated structure, there is arguably a trend towards 'virtual' vertical integration amongst local firms in a number of ways. Firstly, the domestic sales ratio in Taiwan's IC industry increased from 39.5% in 1996, to 54.7% in 1999 (see Table 1), higher than in other major countries or regions, such as North America

(44.8%), Japan (51.8%) and Europe (43.6%). Secondly, the subcontracting relationships that exist in the value chain range tend to be localized. For example, local contracts accounted for 91.2% of revenue in Taiwan's IC design houses in 1999, as compared to 72.3% in 1998. Likewise, around 98% of the products of Taiwan's fabless designers were packaged locally in 1999. Thirdly, almost 70% of the ICs designed by local fabless designers are for the information industry, indicating a strong connection between Taiwan's IC and information sectors.

*Table 1 Taiwanese IC industry statistics*

	1996	1997	1998	1999
	Unit: NT\$ Billion			
Global IC output Value (US\$ Billion)	114.9	119.5	109	126.6
Growth Rate(%)	-8.9	4.0	-8.8	16.0
Output Value (US\$ Billion)	6.85	7.60	8.80	13.49
Market Share (%)	5.96	6.36	8.07	10.66
Output Value	188.2	247.9	283.4	423.5
Growth Rate(%)	9.5	31.7	14.3	49.4
IC Design	21.8	36.3	46.9	74.2
IC Fabrication	125.6	153.2	169.4	264.9
Foundry Service	56.0	84.2	93.8	140.4
IC Packaging	35.8	47.8	54.0	65.9
IC Testing	5.0	10.6	13.1	18.5
Product Revenue	91.4	105.3	122.5	198.7
Domestic Sale Ratio(%)	39.5	47.0	49.7	54.7
Domestic Market	203.6	235.5	274.4	345.7
The NT\$/US\$ Exchange Rate	27.49	32.64	32.22	31.40

*Source:* Data taken from ERSO ITIS Project (May 2000) and Taiwan Statistical Data Book, 2000.

In essence, the development of Taiwan's IC industry has, to a large extent, come to resemble the scenario of the flexible specialization thesis (Piore and Sable, 1984). Fabless IC design houses have proliferated in Taiwan partly because their access to external fabrication capacity has lowered the entry barriers of the IC design market. In addition, the geographical concentration of Taiwan's IC and computer-related firms in the Hsin-Chu Science-Based Industrial Park has generated agglomeration effects, allowing those firms to explore the benefits associated with geographical proximity and outsourcing. Therefore, whilst specializing in one segment of the value chain or another, IC firms in Taiwan are networked by social and business connections.

What's more, it is arguable that the IC industries in Taiwan and Silicon Valley are closely connected. Table 2 presents data on the R&D intensity and capital expenditure intensity of the IC industries in the US, Japan, Korea and Taiwan during the period 1995 to 1999. It is evident that with regard to R&D intensity, the US is the highest amongst the four largest IC producing countries, whereas in contrast, with regard to capital expenditure intensity, Taiwan comes top, whilst the US ranks fourth. By implication, there seems to be an interesting pattern emerging in the international division of labor in the IC industry between Taiwan and the US. On the one hand, Taiwan's strength lies in foundry services for which development requires substantial investment in fabrication capacities, whilst on the other hand, the US IC firms tend to devote themselves to R&D, design and marketing, which is backed up by their access to Taiwan's foundry service capacities.

*Table 2 R&D intensity<sup>1</sup> and capital expenditure intensity<sup>2</sup> of the IC industry in the US, Japan, Korea and Taiwan*

		Unit: %				
		1995	1996	1997	1998	1999
US	R&D Intensity	9.7	11.6	12.1	13.9	-
	Capital Expenditure Intensity	20.7	22.8	17.5	18.0	14.0
Japan	R&D Intensity <sup>3</sup>	6.6	6.5	6.6	6.5	-
	Capital Expenditure Intensity	16.1	20.8	20.2	18.0	16.0
Korea	R&D Intensity	-	7.9	11.6	12.9	-
	Capital Expenditure Intensity	25.7	40.1	51.0	26.0	26.0
Taiwan	R&D Intensity	7.0	6.9	8.8	9.1	-
	Capital Expenditure Intensity	31.9	63.4	63.4	73.0	68.0

Notes:

- <sup>1</sup>. the ratio of R&D expenditure to sales at percentage.
- <sup>2</sup>. the ratio of capital expenditure to sales at percentage
- <sup>3</sup>. fiscal year

Source: ITIS (1999) and IC Insight (2000)

This argument is more directly supported by the data in Table 3, which presents the geographical distribution of the clients of Taiwanese foundry services over the past five years. In 1998, over half of Taiwan's foundry capacities served customers in the US, whilst local contracts amounted to only around 35%. In fact, most of the top ten fabless designers



in the US have been clients of Taiwanese foundry companies.

Considering customers as their partners, TSMC, the largest foundry service provider in the world, shares its resources and information with its customers imitatively. Each year, TSMC makes known to its customers its plans for the development of its process technology for the next five years. The exposure of this information is useful for TSMC's customers, since it helps to ensure that the proposed process technologies of TSMC can support the future development of their products. As a result, the sharing of resources and information not only facilitates the development of a close relationship in the long run, but also helps to reduce the uncertainty associated with technology development on both sides.

*Table 3 Geographical breakdown of Taiwan's foundry services clients*

Unit: %

	Taiwan	North America	West Europe	Others
1994	30.5	55.1	5.1	9.3
1995	36.6	55.5	4.0	3.9
1996	40.8	42.8	11.7	4.7
1997	47.5	31.2	6.3	15.0
1998	34.9	51.4	7.2	6.5

Source: Data taken from ITIS (1999).

The connection between Taiwan and the US in the IC industry also takes the form of an intensive interface between the specialists of both countries. Underlying this interface are Taiwanese and Chinese expatriates living abroad, who have played important roles in bridging the overseas social networks and those returning to Taiwan, crucial for tightly connecting Taiwanese production systems with advanced market knowledge and technology (Saxenian 1997; Kim and Tunzelmann 1998). According to Saxenian (1997), in the 1990s, one out of three specialists in Silicon Valley were from overseas, and there are over 1,300 firms (or 17% of the total) under the directorship of overseas Chinese, who mainly emigrated from Taiwan.

Such an ethnic social network of engineers helps to create the IC industrial linkage between Silicon Valley and Taiwan, both of which have production networks that are organized by specialist firms. Firstly, industries with production networks in both regions are able to flexibly adapt themselves to the changes in technology and markets. This type

of industrial system encourages the pursuit of multiple technical opportunities and heavy reliance on outsourcing because the industrial systems in both regions are decentralized (Saxenian, 1997). Secondly, the ethnic social network assists the trade in differentiated chips. As Rauch (1999) argued, proximity and common language/colonial ties are more important for differentiated products than for products traded on organized exchanges in matching international buyers and sellers. In dimensions of both characteristics and quality, the ‘uninformativeness’ of prices on organized exchanges cannot perfectly match international buyers and sellers of these differentiated products, which thus leads to higher costs in the search process, but as Rauch argues, ethnic social networks, resulting in trading networks rather than ‘markets,’ can effectively reduce the costs incurred in the search process.

It is instructive here to refer to Saxenian’s (1994) explanation as to why high technology industries in Silicon Valley tend to enjoy greater capacity for adaptation than their counterparts on Route 128. She suggests that firms in Silicon Valley, regarded as being network-based, are smaller in size, with each firm specializing in narrow stages of the production process. A close personal relationship exists between specialists who work for different firms, helping to diffuse market and technology information and resulting in low transaction costs in product markets. As a result, the social-institutional conditions of Silicon Valley enrich various organizational trials. Thanks to the intensive information sharing and variety of organizational trials, firms in Silicon Valley are able to respond swiftly to the changes in technologies and markets. Along similar lines, Hsin-Chu Science-Based Park, the center of Taiwan’s IC industry, shares something in common with Silicon Valley, making networking across both localities much easier.

It is worthwhile mentioning that such industrial networking as exists in Taiwan’s IC industry has benefited from recent innovations in information technology. Firstly, information technology reduces the uncertainty and the transaction costs involved in purchasing from the best outsiders, offsetting the advantage of large firms’ centralized purchasing or in-house suppliers. Secondly, technological changes have led to the production of small runs, making changes in products more feasible, providing more room for small, specializing firms to exploit the fragmented product markets with their flexible

response.

## **5. The Emergence of Internet Appliances: Taiwan's New Opportunities and Challenges**

It is important to notice that the emerging post-PC era will present both threats and opportunities to Taiwan's IT industry. The Post-PC era has resulted from the trend of 'digital convergence' and 4Cs (computers, communications, consumer electronics, and contents) integration, and it is about to lead to the proliferation of a variety of Information Appliances (IAs). The development of IAs is currently still in its infancy, hence it is characterized by diverse points of innovation, particularly with regard to product architectures and industrial standards. As a result, there are no well-established industrial standards (such as the 'Wintel' for PCs) for Taiwanese IT firms to follow, and the extent to which such technological discontinuity will undermine the fortunes of Taiwanese IT firms is still an open question.

In order to confront the challenge, Taiwan has formed the IA Consortium, which comprises of more than 180 local information hardware, software and content firms. In addition, some of the leading international firms, such as Sony, Microsoft, TI and NS are amongst its members. This reflects the view that at the dawn of the post-PC era, the forging of international linkages and industrial clusters, is essential to the development of Taiwan's IA industry since IAs are characterized by technical systems that entail innovation networks (Windrum, 1999).

(To be completed)

## **6. Conclusions and Implications**

Taiwan's achievements in high-tech production can be better understood by the ability of local firms to leverage and align local and international networks. The industrial structures of Taiwan's PC and semiconductor sectors are both characterized by vertical disintegration but with strong linkages amongst local firms and across national borders. The agglomeration effect of industrial clusters helps to create the momentum for the development of the local industries in Taiwan, and, to the extent that the local networks

become part of the global network, the local industries are given additional ammunition for development. However, there is a downside to such local and global networking because of their 'lock-in' effects (Hakansson, 1987, p.92). It is therefore imperative for Taiwanese firms to align themselves in terms of their position within the global network, and for the global network to re-configure. In this way, Taiwanese IT firms are endeavoring to become important players in coordinating the supply chain of the global network.

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