7. Trade policy and international production networks: A company-level case study of the Thai hard disk drive industry

Archanun Kohpaiboon

7.1. Related issues

International production networks (IPNs), i.e., the cross-border dispersion of component production/assembly within vertically integrated product processes, is an important feature of the deepening structural interdependence of the world economy. In the recent literature on international trade, an array of alternative terms has been used to describe IPNs including international production fragmentation, vertical specialization, slicing the value chain and outsourcing (Athukorala, 2006). IPNs open up opportunities for countries to specialize in different segments of the production process, depending on the relative cost advantage and other economic fundamentals. Consequently, parts and components are now exchanged across borders at a faster rate than final goods. In this context, the decisions on how much to produce and for which market have to be combined with decisions on where to produce and to what degree of intra-product specialization (Athukorala, 2006).

A consensus in the recent literature[1] on international trade points to the increasing importance of IPNs in East Asian economies, as opposed to North America and Europe. They become an integral part of export dynamism in the region, which thus results in a further impact on overall economic performance. In addition, IPN trade tends to be far more sensitive to cross-border barriers than is final goods trade, as goods under IPNs go through border controls several times (Yi, 2003). Hence, a low tariff rate on parts creates considerably adverse effects on the international competitiveness of final goods. Interestingly, policy initiatives and academic proposals have been made in the region on formulating FTAs with a key objective of strengthening de facto economic integration in East Asia. Specifically, Baldwin (2006) put forward a case for "multilateralizing regionalism" in Asia (a "New East Asia regional management effort" with a reinforced ASEAN+3), with a goal of ensuring smooth functioning of the process of fragmentation-based specialization (which he dubbed "Factory Asia").

Most studies[2] that examine trade flows base their analyses on trade data at the disaggregated level (e.g., 5-digit SITC) and shed light to a certain extent on the role of trade policy. Although they need to be supplemented by in-depth case studies that illustrate the

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1 See, for example: Athukorala, 2006, 2008a and 2008b; Athukorala and Kohpaiboon, 2009; Borrus, Ernst and Haggard, 2000; Dobson and Yeu, 1997; McKendrick, Doner and Haggard, 2000; Naughton, 2007; and Ng and Yeats, 2003.

2 For a recent example of this type of study see Athukorala and Kohpaiboon, 2009, and works cited therein.

nature of cross-border transactions at the industry level, such studies remain sparse. Against this backdrop, this chapter provides an in-depth examination of IPNs in the hard disk drive (HDD) industry in Thailand. Previous studies – for example, Berger (2005), Hiratsuka (2006, 2007), and McKendrick, Doner and Haggard (2000) – have provided clear evidence of the break-up of the HDD production process. Yet, a question arises over the industrial clustering in the HDD industry in Thailand that has occurred during the past decade.

The HDD industry in Thailand was first established during the early 1980s. By 2008, Thailand had become the second-largest HDD exporter in the world, accounting for about 17.4 per cent of world exports. Four out of six major HDD producers have affiliates in Thailand, including Seagate (since 1983), Hitachi GST (since 1991), Western Digital (since 2002) and Toshiba (since 2008).[3] Thus, sufficient time has passed for an assessment to be made of the development of Thailand's HDD industry.

Section 7.2 discusses the research methodology employed in the study detailed in this chapter. Section 7.3 sets out the policy environment in the HDD industry, with emphasis on the trade and investment policy regime. Section 7.4 reviews the development of the HDD industry and its current performance while section 7.5 describes the evidence gained during the company interviews. The conclusion and policy inferences are provided in Section 7.6.

7.2. Research methodology

To gain an insight into IPNs in the Thai HDD industry, purposive rather than probability sampling techniques were employed in the current study. As defined by Patton (1990), the latter technique refers to the method that obtains samples by random selection among all units of the population and permits confident generalization for a larger population. In the former method, however, samples are purposively chosen from information-rich cases for in-depth analysis related to the central issues under study. In this chapter, the main objective is a qualitative examination of IPNs of the HDD industry in Thailand. However, this cannot be achieved by probability sampling, which uses a variety of sample characteristics to draw quantitative inference. To gain a good insight, interaction with interviewees is needed.

A flexible interview guide was used that allowed the respondents to relate their experiences in their own words, based on their own sequence of the topics asked. The main advantage of this approach is that it minimizes the likelihood of missing important aspects of the story. The main disadvantage is that some respondents whose experiences might be limited to a particular interest cannot always be asked all of the questions in the interview guide (Morawetz, 1981). Second-round interviews with different interviewees could mitigate this disadvantage in several cases.

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[3] Fujitsu sold its production facilities in Thailand in early 2008 to Toshiba after ceasing HDD production worldwide.

The interview guide begins by establishing a general company profile, i.e., size, past performance, ownership, production process, product destination, product cover etc. This is followed by a series of opening probes into the process of IPNs, starting with their general perception of the industry's development. This is followed by their opinions about the development of IPNs, input procurement and recent changes. Then questions are asked concerning opinions of the usefulness of RTAs and any potential obstacles such as rules of origin (RoO) constraints and opportunity costs of applying RTA preferential tariffs. Finally, general questions concerning current problems, the role of government and future prospects for the industry are addressed. Interviews were held with top-level managerial staff from five Thai enterprises and four government officers from the public sector from November 2008 to April 2009 (table 7.1). All the interviews were conducted by the author.

Table 7.1. Characteristics of interviewed samples

Sample No.	Characteristics
1	HDD makers
2	HDD makers
3	Non-electronics parts + foreign firms
4	Electronics parts + foreign firms
5	Core parts + foreign firms
6	Ministry of Science and Technology
7	National Electronics and Computer Technology Centre

7.3. Policy environment

During the past four decades, Thailand has created an investment climate that is conducive, including domestic price stability, disciplined fiscal and monetary policies, and a stable nominal exchange rate, to foreign investors. Since 1960, the Government of Thailand has maintained a firm commitment to private sector-led industrialization combined with prudent public investment in infrastructure.[4] In addition, a "market-friendly" approach to foreign investors in manufacturing has consistently been pursued since the early 1960s. Foreign businesses can operate without any significant discrimination between local and foreign entrepreneurs. Foreign investors have been able to get involved in almost any business. There are legal restrictions on foreign ownership of commercial banks, insurance companies, commercial fishing, aviation businesses, commercial transportation, commodity exports, mining and other enterprises. However, these restrictions are not generally applied to foreign investors alone. Even local investors frequently require permission from government authorities to pursue these activities.

[4] Government involvement has shifted from direct production via state enterprises to investment in public infrastructure required for economic development, such as electricity and water supply, and transportation facilities. It virtually prohibited state participation in those commercial and industrial activities that might compete directly with private enterprises (Akira, 1989).

Under the Foreign Business Act, 1999 (better known as the "Alien Business Law"), which replaced the 1972 National Executive Council Announcement No. 281, the Government restricted certain types of businesses for Thai enterprises only. Nevertheless, most of the listed activities are related to non-manufacturing, such as newspaper publishing, radio and television station operation, lowland and upland farming or horticulture, and raising animals.

Foreign investors are usually guaranteed the same rights as domestic investors, including guarantees against expropriation and nationalization. The Government permits freedom to export and to remit investment capital, profits and other revenue in foreign currency. Despite the presence of capital control measures during the pre-1990 period, in practice repatriation of foreign capital related to direct investment (e.g., investment capital, profit or dividends, interest and principal of foreign loans, royalties and payments on other obligations) has not been restricted (Akira, 1989).

Some restrictions exist on land ownership and hiring of foreign migrants by foreign investors. In general, according to the Land Code (1954), foreign-owned firms are generally not allowed to own land in Thailand.[5] According to the Alien Occupation Law, passed in 1973 and amended in 1978, foreigners require a work permit for any type of employment. However, such restrictions have not been prohibitive and have not been applied to foreign investors who receive investment privileges from Thailand's Board of Investment (BOI). Thus, this has encouraged foreign investors to apply for BOI promotion privileges.[6]

To ensure fair domestic competition, the Competition Act, 1999 (which replaced the Anti-Monopoly Act of 1979) applies to all types of business operations except: (a) those of central, provincial and local administrations; (b) state enterprises under the law on budgetary procedure; (c) farmers' groups, co-operatives or co-operative societies recognized by law as businesses being operated for the benefit of the farmers; and (d) businesses prescribed under the Ministerial Regulations. Under the Competition Act, 1999 a criterion for justifying anti-competition action is based on industrial conduct such as setting unfair prices for goods and services, setting unfair trading conditions, limiting supplies of goods and services, and intervening in other businesses without proper reasons. Nevertheless, anti-competition cases that have been tried so far have involved conflicts between Thai conglomerates such as tie-in sales of whisky and beer, and the merger of two cable television companies (Kohpaiboon, Chantasakda and Tanasritunyakul 2010).

Trade policy and investment promotion policies have been used as a main instrument to influence resource allocation in the private sector including the HDD industry.

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5 Under the Thai-United States of America Treaty of Amity and Economic Relations signed in 1966, United States companies in Thailand are granted equal treatment to Thai companies. This permits 100 per cent United States-owned companies to operate in sectors where other foreign companies are generally allowed a maximum ownership level of 49 per cent. In addition, United States companies are allowed to own land up to 10 *rai* (0.16 hectares) with approval from the Ministry of Interior. The Land Code (1954) was amended in 1999 to relax this restriction. Since 1999, qualifying foreign investors, regardless of nationality, have been able to own up to 4 *rai* of land for residential purposes.

6 For more details, see Kohpaiboon, 2006.

Where trade policy is concerned, Thailand – like other developing countries – implements both tariff and quantitative restrictions as trade policy instruments. However, historically, there has been greater reliance on tariffs rather than quantitative restrictions (World Bank, 1988). This is especially true for the manufacturing sector where tariffs were the main trade policy instrument for influencing the country's resource allocation, with a few exceptions. One exception has been the automotive industry for which the Government has used both tariff and non-tariff measures, i.e., local content requirements to encourage auto component localization (see Kohpaiboon, 2006 and 2009).

A significant reduction and rationalization of the tariff structure and the dismantling of most non-tariff barriers took place in Thailand in the second half of the 1980s. As part of Thailand's commitments under WTO, a comprehensive plan for tariff reduction and rationalization was proposed in 1990 and implemented between 1995 and 1997. In mid-1997, the reform process was temporarily interrupted by the Asian economic crisis of 1997-1998. Tariff restructuring has received renewed emphasis as an essential part of overall economic reforms aimed at strengthening efficiency and competitiveness (Warr, 2000; and WTO, 1999). The Government of Thailand introduced tariff cuts in June 2003 (with implementation in October 2003), followed by a four-year period of tariff reductions from 2004 to 2008. Overall, during the past three decades, there have been significant reductions in nominal tariff rates. The simple average applied tariff rate declined sharply from 40 per cent between 1985 and 1994 to 23 per cent from 1995 to 1996 and 17 per cent in 1997 (table 7.2). The downward trend in the average tariff was temporarily reversed during the onset of the 1997-1998 economic crisis. The average tariff rate was again reduced to 13.3 per cent in 2003, and then to 12 per cent in 2004. Since then, the rate has been more or less stable at around 11 per cent.

By regional standards, Thailand remained a high-tariff country until the mid-1990s (table 7.2). During that period, Thailand's simple average tariff rate continued to exceed levels in Indonesia, Malaysia, the Philippines and even China by a wide margin. Nevertheless, the utilization of non-tariff measures, represented by the coverage ratio of non-tariff barriers, in Thailand has been low compared with most other East Asian countries (table 7.3). This makes tariffs virtually the sole means of border protection in Thailand.

Table 7.2. Simple average tariff rates in selected Asian countries, 1985-2005

(Unit: Per cent)

	China	Indonesia	Rep. of Korea	Malaysia	Philippines	Taiwan Province of China	Thailand	Viet Nam
1985	n.a.	27.0	n.a.	n.a.	27.6	26.5	41.2	n.a.
1986	38.1	31.5	n.a.	15.8	27.9	22.8	n.a.	n.a.
1987	39.5	n.a.	22.9	13.6	27.9	19.4	n.a.	n.a.
1988	n.a.	n.a.	18.9	13	27.9	12.6	n.a.	n.a.
1989	n.a.	25.2	14.9	17	27.6	9.7	40.8	n.a.
1990	40.3	20.6	13.3	n.a.	27.8	9.7	39.8	n.a.

Table 7.2 *(continued)*

(Unit: Per cent)

	China	Indonesia	Rep. of Korea	Malaysia	Philippines	Taiwan Province of China	Thailand	Viet Nam
1991	n.a.	20.3	11.4	16.9	26	n.a.	38.7	n.a.
1992	42.9	20.0	10.1	12.8	24.3	n.a.	n.a.	n.a.
1993	39.9	19.4	8.9	14.3	22.6	n.a.	45.6	n.a.
1994	36.3	n.a.	n.a.	13	21.7	n.a.	23.3	n.a.
1995	n.a.	n.a.	n.a.	n.a.	20	11.2	23.1	12.8
1996	23.6	13.2	13.4	8.7	14.3	9.7	n.a.	n.a.
1997	17.6	n.a.	13.3	9.1	13.4	n.a.	17	13.4
1998	16.8	9.5	11.1	7.1	10.7	n.a.	20.1	n.a.
1999	n.a.	10.9	8.7	9.7	10.1	8.8	17.1	n.a.
2000	17.5	8.4	12.6	n.a.	7.5	7.8	18.4	16.5
2001	17.5	8.4	12.4	10.2	7.6	7.8	18.5	15.7
2005	9.95	6.9	11.2	7.2	6.2	5.8	11.1	16.8

Source: Jongwanich and Kohpaiboon, 2007. Data for 2005 calculated by the author from official data sources.

n.a. = not available.

Table 7.3. Coverage ratio of NTBs in import trade

(Unit: Unweighted, Per cent)

Country	1984-1987	1988-1990	1991-1993	1997-2000
China	10.6	23.2	11.3	5.7
Indonesia	94.7	9.4	2.7	3.1
Republic of Korea	8.8	4.0	2.6	1.5
Malaysia	3.7	2.8	2.1	2.3
Philippines	44.9	n.a.	n.a.	1.8
Thailand	12.4	8.5	5.5	2.1

Source: Jongwanich and Kohpaiboon, 2007.

n.a. = not available.

Note: Calculated as a percentage of the import value of HS 6 tariff lines affected by NTBs in total imports. NTBs include quantitative restrictions in the form of all types of licences and import authorization, quotas, import prohibitions, advanced import deposits, foreign exchange restrictions, fixed customs valuations and state trading monopolies. Figures reported under a given sub-period relate to a single year within that sub-period.

In recent years, there has been a trade policy shift towards preferential trade liberalization through formal trade agreements. So far, there have been 14 FTAs agreements involving Thailand (table 7.4), seven of which have come into force. This number is relatively high, compared with the Asian standard of around 10 FTAs per country.[7]

Table 7.4. Free trade agreements involving Thailand

FTAs	Signed
ASEAN Free Trade Area (AFTA)	2003
ASEAN-India	2003
Thailand Australia FTA	2005
Thailand-New Zealand FTA	2005
ASEAN-China FTA	2006
Japan-Thailand Economic Partnership Agreement (JTEPA)	2007
Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)	2009
Thailand India FTA	2005
ASEAN-Republic of Korea FTA	2010
ASEAN-Australia-New Zealand Free Trade Area (AANZFTA)	2010
East Asia Free Trade Area: EAFTA (ASEAN plus 3)	UN
ASEAN-EU FTA	UN
Thailand-Peru Closer Economic Partnership	UN
Thailand-Mexico FTA	UN

Source: Compiled from the official website of the Department of Trade Negotiation at www.thaifta.com/ThaiFTA/?sub=3.

Note: Bold type indicates FTAs involving Thailand that have come into force. UN = under negotiation

Table 7.5 shows the tariff structure in Thailand's HDD industry from 1995 to 2010. The 1995 structure reflected the overall structure in the 1980s, whereas the 2002 structure was a consequence of the major tariff restructuring implemented in 1997. The 2003 and 2010 figures illustrate the current status of the tariff structure.

Two key inferences can be drawn from table 7.5. First, the HDD industry is relatively less restrictive compared to other industries. Tariffs related to the HDD industry (for intermediate and final goods) are generally lower than the average rates during 1995-2006. Second, there is distortion in the tariff structure, in which tariffs on intermediate goods are always higher than those on final goods. For example, hard disk drives were tariff-free during 2002-2006, whereas tariffs on inputs such as motors, bearings and aluminium plates were not zero.

[7] This is based on the author's calculations from data collected by Asia Regional Integration Centre, Asian Development Bank (table 6), available at http://aric.adb.org/10.php.

Table 7.5. Tariff structure in the Thai HDD industry, 1995-2010

Component	1995*	2002	2003	2010
Hard disk drive (HS 847170)	9.8	0	0	0
Inputs:				
Wafers (HS 3818)	11	0	0	0
Printed circuit boards (HS 8534)	14	8	4	0
Integrated circuits (HS 8542)	14	0	0	0
Semi-conductors (HS 8541)	14	1	1	0
Motors	14	9	8	8
Finished motors (HS 8501)	14	8	7	7
Parts for motors (HS 8503)	14	10	10	2.8
Ball bearings (HS 848210)	10	10	10	1
Aluminium plate (HS 7601)	19	1	1	0
Media (HS 852390)	14	9	7.4	0
Average tariffs	21	114.3	114.3	111.3

Source: Office of Fiscal Economics, Ministry of Finance.

* Represented by 2-digit HS 847170, e.g., HDD tariff in 1995 is represented by the average tariff of HS 84.

Nonetheless, the distorted effect caused by such a tariff structure is offset by investment promotion measures. Since most HDD makers and their component suppliers are foreign-owned and export-oriented (McKendrick, Doner and Haggard, 2000), they are eligible for BOI investment privileges. One investment privilege was tariff exemptions that were introduced in 1983. This was very important during the mid-1980s for export-oriented foreign investors as tariffs in Thailand remained high (tables 7.2 and 7.5). In addition, the timing of the introduction of such privileges was more or less in line with changes in the global environment when many East Asian manufacturers began to lose their international competitiveness in labour-intensive products. This was instrumental in making Thailand an attractive location for export-oriented, labour-intensive FDI from East Asian investors (Kohpaiboon, 2006).

Most HDDs and components are subject to a zero tariff rate (table 7.5), so there is no incentive for firms to use RTA preferential schemes. The exception in table 7.5 is for motors (HS 8501 and HS 8503), which are subject to an 8 per cent to 10 per cent tariff. Therefore, to illustrate the relative importance of RTA trade preferential schemes as opposed to tariff exemptions, the pattern of motor imports is examined. Clearly, most motor imports applied for tariff exemptions. For example, in 2009, 63.4 per cent of motor imports applied for available tariff exemptions. Motor imports under RTA trade preferential schemes accounted for about 2 per cent in 2009.

Table 7.6. Motor imports in Thailand under tariff exemptions and RTA preferential schemes, 2003-2009

	2003	2004	2005	2009
Total import value (millions of United States dollars)	475.0	536.6	597.6	1 009.2
Composition (%)				
Tariff exemption schemes	54.2	54.5	49.0	63.4
FTAs	0.8	3.1	4.3	2.0
ASEAN Free Trade Area	0.8	3.1	4.3	1.5
Thailand-Australia FTA	n.a.	n.a.	0	0
Thailand-New Zealand FTA	n.a.	n.a.	0	0
Japan-Thailand Economic Partnership Agreement	n.a.	n.a.	n.a.	0.43

It is useful to clarify the difference between tariff exemptions granted by BOI and alternative schemes. While tariff exemptions and tax rebate schemes are administered by the Department of Customs, the BOI offers a prior exemption scheme that is less cumbersome than the two existing schemes. After receiving approval from BOI, export-oriented BOI-promoted firms are automatically allowed to access their imports without a delay to calculate and pay levies. This reduces custom procedures that, prior to 1997, were considered unusually cumbersome and imposed costs on importers (Warr, 2000).

Since the early 2000s there has been a policy shift in Thailand towards strengthening the supply-side capability of firms, e.g., promotion of human capital development, financial support for R&D projects and strengthening linkages from MNEs to indigenous enterprises. Several government agencies are involved, such as the National Electronics and Computer Technology Centre, Ministry of Science, Office of Industrial Economics, Ministry of Industry, and BOI. Most of policy measures are a result of close consultations with the private sector. For example, many R&D projects initiated by the private sector are being co-financed by the Government. The portion of the Government's financial contribution depends on the nature of each project's outcome, i.e., whether it is proprietary or common knowledge. The more common the knowledge created by a project, the larger the government contribution.

In addition, BOI extends investment privileges if foreign firms upgrade their existing production. For example, to be eligible for one additional year of the tax holiday, three criteria must be met. First, firms eligible for an additional year of the tax holiday must have had average R&D or design expenditures for the first three years of not less than per cent to per cent of annual total sales; or not less than Baht 50 million for HDD manufacturing, or not less than Baht 15 million for HDD parts manufacturing. Second, at least 5 per cent of the total workforce in the first three years should have comprised science and technology personnel with a minimum of a Bachelor's Degree in science, engineering or other fields

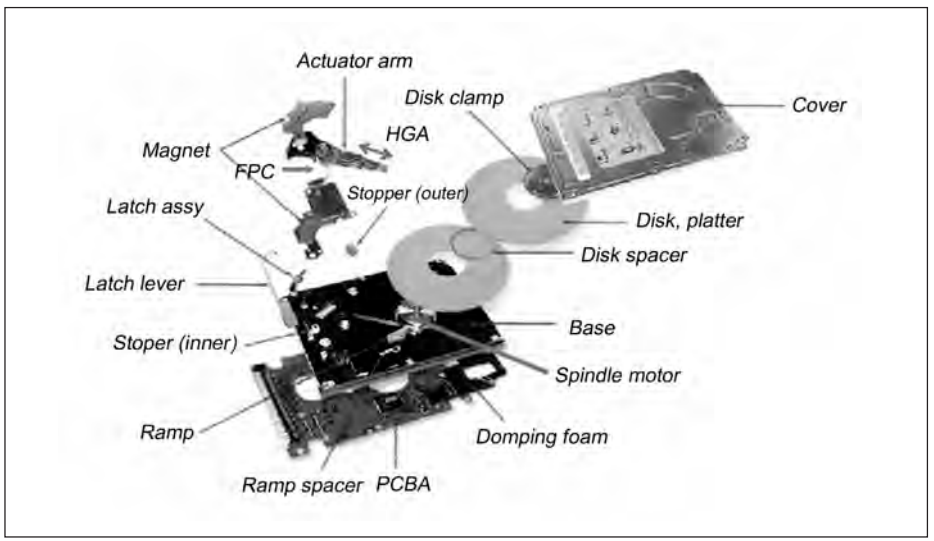
related to technology, R&D or design. Finally, the average cost of training Thai staff for the first three years must have been at least 1 per cent of the total payroll costs.

7.4. Features of the HDD industry in Thailand

7.4.1. Fragmentation in HDD production

The HDD is by far the most complex component in a personal computer in terms of moving parts, and its value chain is extremely differentiated. Figure 7.1 illustrates the HDD composition. Generally, there are five main parts: head sub-assemblies; media; motors; electronics; and other accessories.[8] Each has its own type of production process. For example, read/write heads, the single most costly component that has a direct impact on drive performance, are manufactured in stages, beginning with highly automated and technically complex wafer fabrication. Wafers are then machined into sliders, which are the tiny read/write elements. Each slider is then attached to a suspension, a small arm that holds the head in position above or beneath the disk. This process is called head-gimbal assembly (HGA). Sets of HGAs stacked together for installation in a disk drive are called a head-stack assembly (HSA), Modular units that include the required circuitry and actuators; this process is also highly labour intensive.

Figure 7.1 Product fragmentation of a hard disk drive



Source: National Electronics and Computer Technology Centre, 2007.

8 McKendrick, Doner and Haggard, 2000.

Electronic parts in HDD include semiconductors and discrete components (including those designed specifically for disk drives), printed circuit boards (PCBs), and the flexible circuits or flex circuits that connect PCBs to the rest of the HDD. The semi-conductors include a read channel to store and retrieve data bits, and a read/write preamplifier (preamp) that amplifies the strength of the signals so that chips on PCBs can convert electrical impulses to a digital signal. Spindle and actuator motor controller electronics ensure that the platters spin at the correct speed. The actuator arms place the read/write heads over the precise spot on the platter. Interface electronics communicate with the system's central processing unit in the proper format. A microprocessor and associated memory chips oversee drive operations. For high-performance drivers, an additional digital signal processor is required. All of these electronic components are typically mounted ("stuffed") on to PCBs in highly automated procedures.

Each part is brought together for final assembly in clean-rooms. They are brought in a base casting or base plate – a single piece of aluminium that also provides a mounting for a PCB – which houses the electronics. A gasket between the base casting and the top cover acts as a seal to provide a contamination-free operating environment for the read/write heads. Once the HDD is assembled, it moves to a station for servo writing, an electromechanical technique to control the positioning of the head. The finished HDD then undergoes functional testing, which is automated, and manual reworking if necessary.

7.4.2. Integration and industrial clustering

Hard disk drive production in Thailand began in 1983 after Seagate Technology moved its HSA, the most labour intensive segment in HDD production process, out of Singapore. The import content of HSA exports was about 80 per cent. Despite high tariffs, HDD makers were eligible for input tariff exemption schemes as their products were for export.

From then on, Seagate Technology expanded its production capacity and added new activities, and since then numerous newcomers have set up production in Thailand, including part suppliers and other HDD makers. In 1987, Seagate Technology expanded its existing capacity as well as started high-volume production of head-drive assembly in Thailand. This demonstrated net gains from HDD production in Thailand to other HDD firms. In addition, Seagate Technology provided training for numerous technical workers and enhanced the availability of skilled labour (McKendrick, Doner and Haggard, 2000). This, in turn, had a positive effect on attracting other key players in the HDD industry to Thailand. This process is in line with what the MNE literature postulates as the general tendency for MNE affiliates to become increasingly entrenched in host countries the longer they are present there, and the more conducive the overall investment climate of the host country becomes over time (Rangan and Lawrence, 1999).

In 1991, IBM formed a joint venture with the Thai conglomerate, Saha Union, and started manufacturing HDDs in Thailand, followed by the launch of its own production facility in 1997. By the end of the 1990s, IBM affiliates in Thailand accounted for approximately two-thirds of the company's global output. Other companies that have set up facilities in

Thailand include Fujitsu, which began producing desktop disk drives in 1991, and Western Digital, which took over 3.5-inch HDDs from Fujitsu in 2001 and purchased the shares of Read-Rite Corporation in 2003. In 2004, Hitachi Global Storage Technologies shifted its production base from the Philippines to Thailand. In 2008, Toshiba started producing HDDs in Thailand, using the production facilities of Fujitsu as a joint investment in manufacturing HDDs by both companies.[9]

A number of parts suppliers also began production Thailand. In 1988, NMB, a large Japanese producer of bearings and other metal products in Thailand for several years, began motor production for HDDs. Nidec, a major Japanese motor producer, set up its first Thai plant in 1989 and a second one in 1991. K.R. Precision and Magnetric began their operations in 1988 and 1992, respectively, to service Seagate Technology's requirement for suspension parts. T.P.W., a precision-machining firm based in Singapore, shifted its operations to Thailand in 1989 to manufacture actuators and base plates for motors.

The expansion of the Thai HDD industry continued in the 1990s when industrial clustering was observed. While HDD makers introduced several new production activities, many other parts suppliers started manufacturing in Thailand. Seagate Technology expanded its spindle motor capacity in 1994. Expansion induced parts suppliers such as Eiwa, Habiro, Nippon Super, Thai Okoku Rubber and Shin-Ei Daido, whose main products are motor hubs and related parts for spindle motors, set up affiliates nearby. Each of the three largest HDD assemblers manufactured HDD head sub-assemblies for internal use during that period. Magnetric and Read-Rite, two independent HGA and HSA firms, also set up Thai operations in 1990 and 1991, respectively. A few producers of PCB and PCBA, and flex circuits established Thai operations in the mid-1990s. The trend continued with the number of firms in the Thai HDD industry increasing from five during 1981-1985 to 74 between 2001 and 2006 (table 7.7).

[9] Interview with Bloomberg, 14 January 2009. See www.bloomberg.com/apps/news?pid=20601204&sid=adfHko5e4yk4#.

Table 7.7. Number of enterprises in Thailand's hard disk drive industry, 1981-2006

1981-1985	1986-1990	1991-1995	1996-2000	2001-2006
5	18 (13)	36 (18)	51 (15)	74 (23)
1. Seagate (1983)-HSA	1. Seagate (1987)-disk assembly	1. Fujitsu (1991)-disk assembly	1. IBM-SPT (1997)-disk assembly	1. Benchmark Electronics (2007)-flex suspension
2. GSS arrays (1985)-HSA	2. KR Precision (1988)-suspension	2. Avatar Peripherals (1995)-disk assembly	2. Fujitsu (1999)-HGA	2. Comp Part Precision (2003)-arm coils
3. Fujikara (1985)-actuators	3. Seagate (1989)-HGA	3. IBM/Saha Union (1991)-HGA	3. Maxtor (1996)-HAS	3. Innoven (2002)-printer flex
4. NMB (1985)-bearings and spindle motors	4. Micropolis (1988)-HSA	4. Read-rite (1991)-HGA	4. IBM-SPT (1997)-HAS	4. Innoven (2005)-PCB
5. GSS (1985)-PCBs	5. IBM/Saha Union (1989)-HSA	5. Minibear (1994)-HGA	5. Boron (2000)-flex suspension	5. LCET (2006)-coil assembly
	6. Read-rite (1989)-HSA	6. Fujitsu (1991)-HSA	6. Eng Precision (1999)-Actuators	6. LCET (2005)-membrane switch circuit assembly
	7. Seagate (1986)-spindle motors	7. Magneccomp (1992)-suspension	7. Fujitsu (1994)-actuators	7. LCET (2004)-write-read heads
	8. NMB (1988)-spindle motors	8. Fujitsu (1994)-actuators	8. Measuren (1998)-actuators	8. LCET (2004)-coil assembly
	9. Nidec (1989)-spindle motors	9. TDK (1992)-voice coil magnets	9. Habiro (1995)-hubs and O-rings, sleeves, brackets	9. PCTT (2007)-PCBA
	10. Elec & Eltek (1988)-PCB	10. Hana (1993)-voice coil magnets	10. Nippon Super (1996)-hubs and O-rings, sleeves, brackets	10. PCTT (2006)-FPCB
	11. SCI (1988)-PCB	11. NHK (1994)-bearings		11. PCTT (2003)-FPCB multi-layer
	12. TPW (1989)-base plates			12. Intreflex (2006)-metallic parts
				13. Cal Comp electronics (2007)-semi-PCBAs
				14. Star microelectronics (2005)-PCBAs

Table 7.7 *(continued)*

1981-1985	1986-1990	1991-1995	1996-2000	2001-2006
5	**18 (13)**	**36 (18)**	**51 (15)**	**74 (23)**
	13. Magnetric (1990)-HGA	12. Seagate (1994)-magnets 13. Daido (1995)-magnets 14 Seagate (1994)-PCBs 15. Hana (1993)-PCBs 16. Boron (1995)-flex circuits 17. Wearnes Precision (1994)-housing and base plates 18. NHK Precision (1993)-housings/ base plates	11. Advanced Magnetic Materials (1998)-magnetic powder 12. Ad Flex (1996)-flex circuits and suspension assembly 13. Asahi Komag (1996)-polished substrates 14. Arrow Mizutani (1998)-heat sinks 15. G.D.P. (1998)-general machining	15. Beyonic Technology (2002)-base plates 16. Single point parts (2006)-ring motors, sleeves, shafts 17. Chin-ed Su Magnetic (2006)-voice coil motors 18. MPN technology (2005)-base plates 19. World Precision (2004)-base plates 20. Altum Precision (2006)-base plates 21. Silatic (2004)-PCBAs 22. Prem Star (2006)-PCBAs 23. Prem Star (2006)-electronic micro assembly

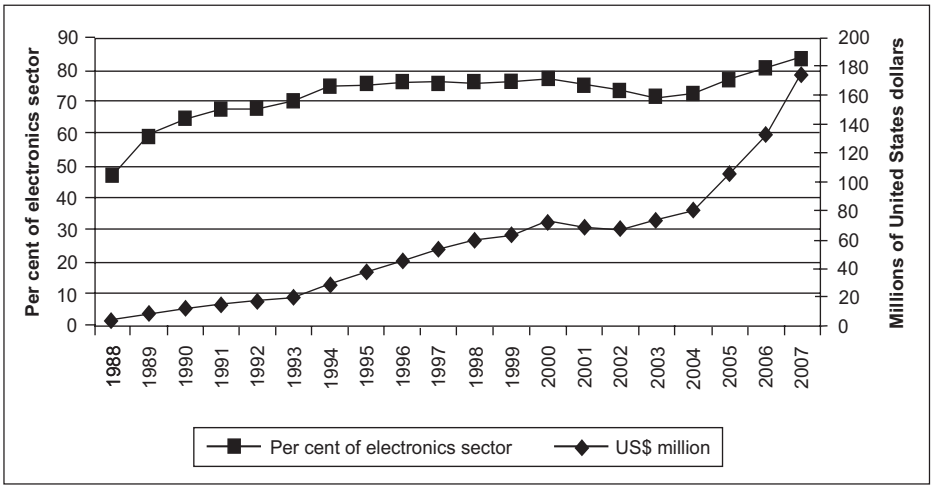
Sources: Data between 1981 and 2000 from McKendrick, Doner and Haggard, 2000; data for 2001-2006 compiled from the BOI database by the author.

Note: Numbers in parentheses indicate additional establishments per period, other numbers are cumulative.

7.4.3. Economic performance

The HDD industry is the most important industry in the electronics sector of Thailand, accounting for more than 70 per cent between 1988 and 2006, and experiencing rapid growth in the past two decades. Its annual (real) growth rate averaged about 16 per cent from 1988 to 2006. This outperformed the growth of other industries and its share in manufacturing value-added increased from about 1 per cent in 1988 to more than 10 per cent in 2006 (figure 7.2).

Figure 7.2. (Real) value-added of Thai HDD industry, 1988-2007

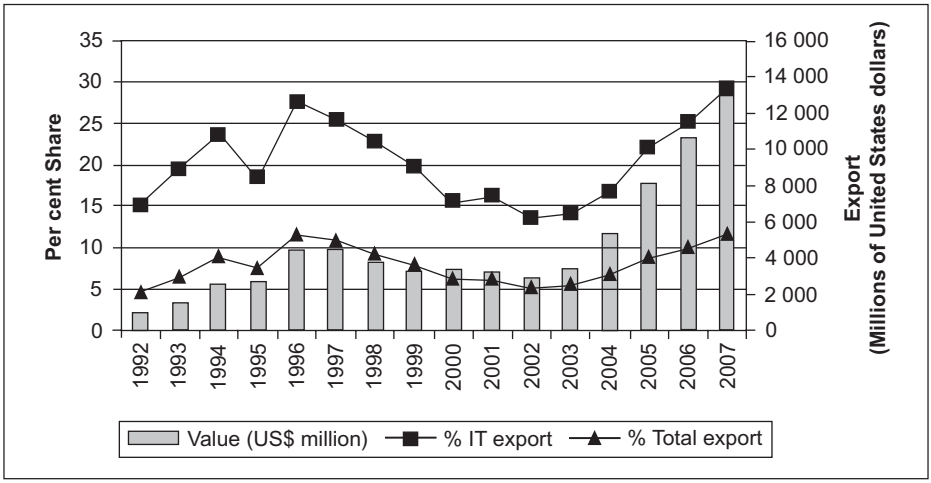


Source: National Economics and Social Development Board.

HDDs comprise one of the most important electronic exports by Thailand. Figure 7.3 illustrates export value and its relative importance in information technology (IT) exports during 1988-2008. Between 1999 and 2003, there was a slight downward trend in export value because of the crisis in the global IT industry. The export value dropped to an average figure of US$ 3,400 million during 1999-2003. From then on, HDD exports grew at a phenomenal rate, reaching US$ 8,214 million in 2005 and US$ 15,493 million in 2008. As a result, HDD exports by Thailand accounted for 45 per cent of total IT exports and a 15 per cent share of total exports in 2008 (figure 7.3).

Note that the export value reported in this chapter is far lower than that reported in official documents such as the Annual Report of the Hard Disk Drive Institute. Specifically, in 2003-2005, the export value shown in this chapter is, on average, about 55 per cent of what is reported in the official document. This is due to the different sources of data. Here, exports of HDDs are based on actual trade data (SITC 75270, equivalent to HS 847170) whereas the figure in the official document is extrapolated from annual reports of BOI-promoted firms. The latter approach appears to be problematic as it is likely to be subject to double-counting. Export value consists of two parts, HDDs and components, the

Figure 7.3. HDD exports from Thailand, 1992-2008



Source: Author's calculation based on data from United Nations Comtrade database.

Notes: Information technology (IT) includes categories of SITC 75-77, manufacturing is SITC 5-8 net of 68 and HDD is HS 847170.

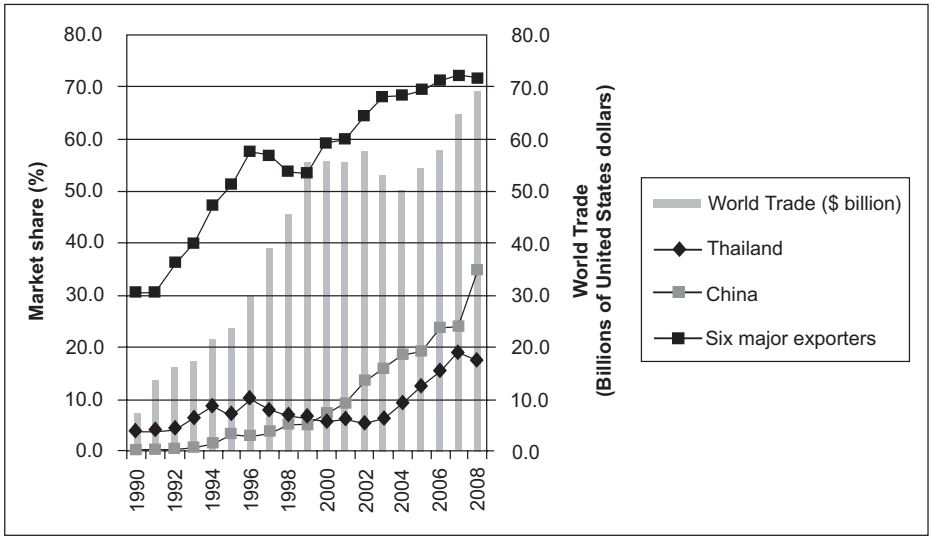
export value of which is reported by HDD makers and related components suppliers, respectively. The first part is regarded as finished HDDs whereas the second part is components.[10] In fact, the second part comprises indirect exports as these components are assembled as finished HDDs and then exported. Hence, adding them together is simply double-counting.

Figure 7.4 presents the market shares of major HDD exporters. Three inferences can be drawn from this figure. First, these six major exporters, which include Thailand, accounted 70 per cent of global trade in 2007, reflecting the international division of labour and the relative importance of East Asia in supplying HDDs to the rest of the world. Second, according to the export shares, Thailand is the second-largest HDD exporter, accounting for 17 per cent in 2008, behind only China at 35 per cent. Interestingly, Thailand's market share increased continuously from the start of the new millennium, except in 2008. The country's market share went hand–in-hand with that of China. In other words, there was no crowding-out effect on Thai HDD exports from the increasing importance of China's share.

In order to gain a better understanding of the market positioning of these major exporters, the export unit values of four East Asian countries are shown in figure 7.5. The downward trend of export unit values during various periods simply reflects price deflation in HDDs because of technological advances. In addition to the deflation trend, the clear pattern is that HDD exports from Singapore always have the highest export unit value whereas China recorded the lowest figure between 1996 and 2008. The export unit values

[10] Both are regarded as parts and components in the literature on IPNs, as most HDDs are for personal computers.

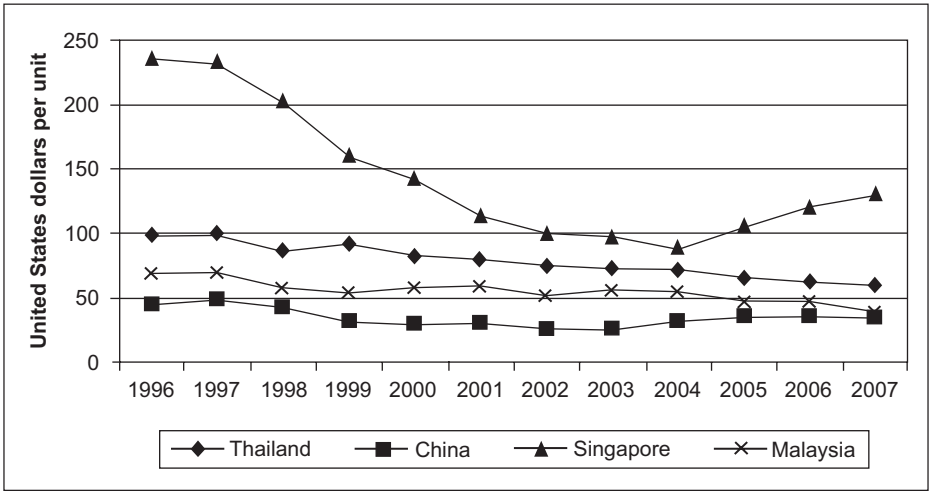
Figure 7.4. Market shares of major HDD exporters, 1990-2008



Sources: Author's compilation from the United Nations Comtrade database.

Notes: HDD refers to HS 847170; the six major exporters are China, Thailand, Malaysia, Singapore, Ireland and the Philippines.

Figure 7.5. Export unit value of major HDD exporters in East Asia



Source: Author's compilation from the United Nations Comtrade database.

Note: HDD – HS 847170.

of Thailand and Malaysia are between those of Singapore and China. This is consistent with resource endowment dispersion in these four countries. That is, HDD MNCs have located relatively high-tech HDD production in Singapore, which is relatively capital-intensive, whereas they use China as a production base for simple HDDs. The HDDs manufactured in Thailand and Malaysia are, to a certain extent, similar in their quality range, although the export unit value of Malaysia is slightly higher than that of Thailand.

Table 7.8 illustrates HDD trade flows and their major components from 2001 to 2007. Export destinations and import sources are grouped into three main regions, i.e., East Asia, North America and the European Union-15. This has been done in order to contribute to the fallacy of the "decoupling thesis", the notion that the East Asian region has become a self-contained economic entity with the potential for maintaining its own growth dynamism independent of the economic outlook for the traditional developed market economies.[11]

In addition, the East Asian region has been disaggregated further into ASEAN-10 and China for the debate on regional economic integration, i.e., ASEAN plus 3. It is clear that international trade involving the HDD industry is intraregional. For example, East Asia accounted for nearly 61 per cent of total HDD exports by Thailand between 2005 and 2007, increasing from 51 per cent during 2001-2003. North America and the European Union-15 accounted for only 22.1 per cent and 13.1 per cent, respectively, of Thailand's HDD exports during 2005-2007. Interestingly, half of the HDD exports (34.4 per cent) were to China during 2005-2007. This was a sharp increase from 12.5 per cent between 2001 and 2003.

In contrast, ASEAN-10 has become less important as an export destination for HDDs from Thailand. This reflects the role of China in IPNs in East Asia, which relies heavily on inputs from other countries in the region for extra-regional exports. The degree of regional dependence is even larger where sources of inputs are concerned. More than 70 per cent of PCBs, ICs, semi-conductors, transistors, resistors, media and wafers were sourced in the region.[12]

7.5. Company-level case studies: IPNs versus industrial clustering in Thailand

HDD makers (e.g., Seagate Technology, Western Digital, Fujitsu and Hitachi Global Storage Technology) utilize international production networking to enhance their international competitiveness. This reflects the corporate strategy evolved during the past three decades. Currently, the fragmentation goes beyond the manufacturing process as many companies have set up testing facilities abroad, particularly in East Asia. In addition, a few companies have established R&D centres outside their home countries.[13] HDD

[11] This theory was popular in Asian policy circles in the 2000s until the onset of the recent financial crisis. See Yoshitomi, 2007, and Park and Shin, 2009 as well as the works cited therein.

[12] The import value of these electronics products is an aggregate one, and not exclusive to HDDs. Of course, the value might exceed what is actually used in the HDD industry. Unfortunately, disaggregated data are not available. Since the purpose here is to illustrate the broad picture of trade flows in Thailand's HDD industry, the import share based on the aggregate value would not create a major problem.

Table 7.8. Trade flows of the hard disk drive industry in Thailand, 2001-2007

	East Asia, incl. Taiwan Province of China		China		ASEAN-10		NAFTA		European Union-15	
	2001-2003	2005-2007	2001-2003	2005-2007	2001-2003	2005-2007	2001-2003	2005-2007	2001-2003	2005-2007
I. Export destination of HDDs (per cent of total exports)	50.8	60.7	12.5	34.4	18.0	7.3	27.3	22.1	19.3	13.1
II. Import sources (per cent of total imports)										
1. Printed circuit boards (HS 8534)	79.8	87.0	2.1	5.8	45.1	41.1	10.7	4.8	5.1	6.5
2. Integrated circuits (HS 8542)	72.9	73.4	0.8	1.7	35.0	38.0	22.2	18.9	4.7	7.2
3. Semi-conductors (HS 8541)	78.3	76.0	1.5	2.9	32.4	26.4	18.3	20.3	2.1	2.1
4. Aluminium plates (HS 7601)	8.1	12.7	1.6	3.1	4.2	7.9	0.5	2.1	0.5	0.2
5. Diode transistors (HS 854110 + 854121 + 854129)	71.4	64.3	0.7	1.6	29.1	25.2	27.0	33.9	1.6	1.7
6. Transistors and resistors (HS 8532 and 8533)	94.6	93.7	3.8	5.6	47.2	50.9	2.6	3.0	2.4	2.6
7. Wafers (HS 3818)	92.6	95.0	0.1	0.7	48.8	79.4	2.8	0.6	3.5	3.1
8. Media (HS 852390)	97.1	97.9	1.1	4.2	79.0	48.8	1.1	0.6	1.7	1.3

Source: Author's compilation from United Nations Comtrade database.

makers also outsource their peripheral activities (motors and PCBs) to third parties while concentrating on their core business activities (media, sliders, heads) (Western Digital, 2008; and Seagate Technology, 2008). Thus, both intra- and inter-company transactions are observed.

While HDD makers use IPNs to enhance their international competitiveness, this does not constrain them from also benefiting from economies obtained through agglomeration. In fact, evidence from the Thai HDD industry suggests the coexistence of IPNs and industrial clustering. Nevertheless, it began with international outsourcing. When affiliates reach a certain level of technological capability, industrial clustering begins as HDD makers and Tier 1 suppliers are located nearby to harness agglomeration economies.

Thailand was first integrated into the global production network of HDD MNEs as a result of the entry of Seagate Technology in 1983. It started with a simple assembly task, assembling HDD heads with actuator arms and read/write heads for export. Most components for assembly came from Singapore and Malaysia. The Seagate Technology entry was primarily motivated by cheap labour costs. While there was concern about developmental impact of being the so-called screwdriver assembly base of MNEs (i.e., industry footloose) at the early stage of the industry's development, the evidence in the previous section clearly suggests the opposite. The HDD industry in Thailand experienced industrial deepening during that period and Thailand became one of the major exporters.

Over the years, the affiliates in Thailand gradually acquired more technological capability as workers gained knowledge from their work experience. As Sample 7 taken in this study revealed, after receiving prototypes/blueprints developed by the parent company, several tasks must be undertaken before the manufacturing process can begin. Workers in the affiliates need to develop basic and detailed designs for the production processes. Production facilities, tools, moulds and other equipment are then designed and ordered. Task details are prepared for production line workers. Additional tasks include pilot runs, during which the production processes undergo final checks in readiness for mass production (sample 2). This is where detailed knowledge is needed.

In the early stage, Thai workers acquired such knowledge so that only mass production was undertaken by Thailand's affiliates (samples 1 and 2). This is what is referred to as the labour-intensive stage. Over the years, workers gained more experience and accumulated skills so the affiliates started undertaking more complicated tasks. It is very difficult to show from the interviews any particular examples illustrating successful movement up the quality ladder of these affiliates. However, the fact that the HDD industry has been able to grow continuously, despite increasing wage levels during the past two decades, supports the existence of such success. Currently, the affiliates in Thailand can convert prototypes/blueprints into action plans for manufacturing. At this stage, the affiliates require more engineers and scientists. This is especially true nowadays as the HDD industry has transitioned from the use of longitudinal magnetic recording (LMR) head

[13] Most R&D activities are in the United States, i.e., Colorado, Minnesota, Pennsylvania and Massachusetts (Seagate Technology, 2008).

technology for the head writer function to perpendicular magnetic recording (PMR) technology. Sample 1 revealed the presence of an increasing number of engineers and scientists in the factory to overcome engineering problems that can emerge in the production process on a daily basis. Such a developmental stage is referred to as the "engineering stage" by Takayasu and Mori (2004).

After reaching the engineering stage, industrial clustering develops since intensive cooperation between HDD makers and suppliers is needed in order to establish effective coordination and achieve "virtual integration of the entire system". Nonetheless, while the industry is clustering, it does not completely rule out making use of globalized production. It depends on what layers of the process are fragmented and what parts are under consideration.

Consider, for example, an HDD production network where HDD makers are at the centre. There are at least two layers. In the first layer, HDD makers interact with Tier 1 suppliers. The second layer is where Tier 1 suppliers participate with their suppliers, referred to as Tier 2 suppliers. Industrial clustering is observed in the first layer with few exceptions as several customized parts and components are traded in this layer. Hence, inter-personal participation is required in order to create effective and efficient coordination (samples 1 and 2).[14] Despite the continuing improvement of telecommunications technology, that still cannot substitute completely for inter-personal contact in terms of several aspects such as the speed of solving problems and the effectiveness of trial and error experiments. In other words, distance still matters when it comes to establishing effective coordination.

In the first layer, HDD makers usually request their suppliers to assign a few staff members to work with the HDD makers' staff as intercompany teamwork for exchanging information about production efficiency and cost-effectiveness as well as to make necessary changes (samples 1, 2 and 7). As revealed by sample 3, several staff members are assigned to work with each customer on a daily basis in exchanging production-related information, matching production and delivery schedules, assessing and reporting on certain performance measures. Sometimes, HDD makers request suppliers to exchange certain components (i.e., Tier 2 suppliers) in order to improve the performance of finished HDDs. This can even occur at very short notice. Sample 4 provided the same impression. Speed in responding to such requests is one of the performance indicators that HDD makers monitor, based on which they rank their Tier 1 suppliers for deciding on future order volumes.

Through such close coordination, HDD makers also benefit from overseeing their suppliers' capability and productivity. Since the former are at the network's centre and therefore has better information of all components used in assembly in the last stage, they are in a better position to provide sensible solutions for improving the performance of their suppliers. Sometimes, a problem occurs with a particular component but needs cooperation from other component suppliers in fixing it. Even though there are no restrictions requiring

[14] The proximity was also found by Kimura (2001), who studied Fujitsu's HDD production in the Philippines.

Tier 1 suppliers to serve only one HDD maker, these suppliers need to have a separate production line for each customer. Even a relatively generalized component used by all HDD makers cannot be manufactured for all customers by a single production line. For example, sample 3 supplied more than one HDD maker and has individual product lines to serve each customer. This is necessary given the extremely short product lifecycles and highly volatile market demand.

Leadership position cannot be taken for granted, and HDD makers must therefore be ready for the emergence of new and untested market opportunities. Hence, firms in such an industry usually have slightly excess capacity while their suppliers must have the capacity to respond to any immediate changes that might occur, e.g., innovations resulting from R&D. Even though HDD makers outsource peripheral parts to third parties, that relationship is far different from the arms' length transactions with a loose patchwork of stand-alone affiliates, joint ventures and suppliers. Hence, efforts are made by HDD makers to network their own operations and inter-company relationships, across both functions and locations (Borrus, Ernst and Haggard, 2000).

In contrast, it is the second layer where international fragmentation takes place. Intermediates used for supplies from Tier 2 to Tier 1 suppliers are less customized as opposed to the first layer. This is especially true for electronic components. As sample 4 revealed, intermediates traded in the second layer such as PCBs, integrated circuits, resistors and semiconductors are used not only by the HDD industry but also by other industries. This is reinforced by the digitalization phenomenon where electronic elements play an important part in determining the performance of manufacturing goods. In addition, a number of MNEs such as Celestica, Flextronics, Jabil Circuit, Sanmina and Solectron specialize in manufacturing these components and thus play an important role in global trade (Lakeman, Boyd and Frey, 2001; and Yusuf, 2004).[15] More importantly, these MNEs have their own production networks around the world. For example, Flextronics, the largest, had 87 plants in 27 countries and a turnover of US$ 146 billion in 2002 (Yusuf and Evenett, 2002). Celestica have 50 production facilities around the world, most of which are in developing countries in East Asia. The same production network is found in the case of Solectron (Sturgeon and Lester, 2004). Hence these companies make their own decisions on how to serve their clients (either by setting up another affiliate geographically close to their clients or by exporting from their existing production facilities). The longer lead time required in the second layer is another factor, possible as a result of the fact that first- and second-tier suppliers are not necessarily located nearby. As argued by Kimura (2009), from the experience of machinery industries, it can be inferred that the first layer's lead time is

[15] Sometimes they are referred to as contract equipment manufacturers (CEMs) (Lakeman, Boyd and Frey, 2001). The emergence of these manufacturers was partly related to changes in the business environment of high-tech industries, such as business consolidation strategies and an increasing number of common components across products (i.e., a certain type of chip can be used not only in computers but also in other electrical appliances). In this environment, business opportunities for CEMs are even greater. They can quote the lowest prices because of their high turnover and capability of offering a wide range of electronic items to customers. They can switch production from one category to another, and can pool their inventories for several customers, thereby reducing individual inventories.

usually a high-frequency, just-in-time system (i.e., 2.5 hours) as opposed to 1-7 days required in the second layer. In addition, since most components used in HDD production are small and have high values per weight, they can be sent by air transportation (sample 4; and Kimura, 2001). Hence, Tier 1 and Tier 2 suppliers can be located in different countries.

Sample 4 revealed experiences in internationally sourcing parts in the second layer. The company imports bare PCBs from Singapore and Taiwan Province of China, and integrated circuits from Singapore and the United States; it then customizes the PCB assembly for HDD makers. Components used for sub-assembly must be sourced from approved vendor lists provided by HDD makers; interestingly, most of these imported components usually come from East Asia. However, intermediate trade in the second layer is not necessarily done internationally. In some cases, it can be done domestically (sample 3). What is argued here is that the option of international sourcing is economically feasible.

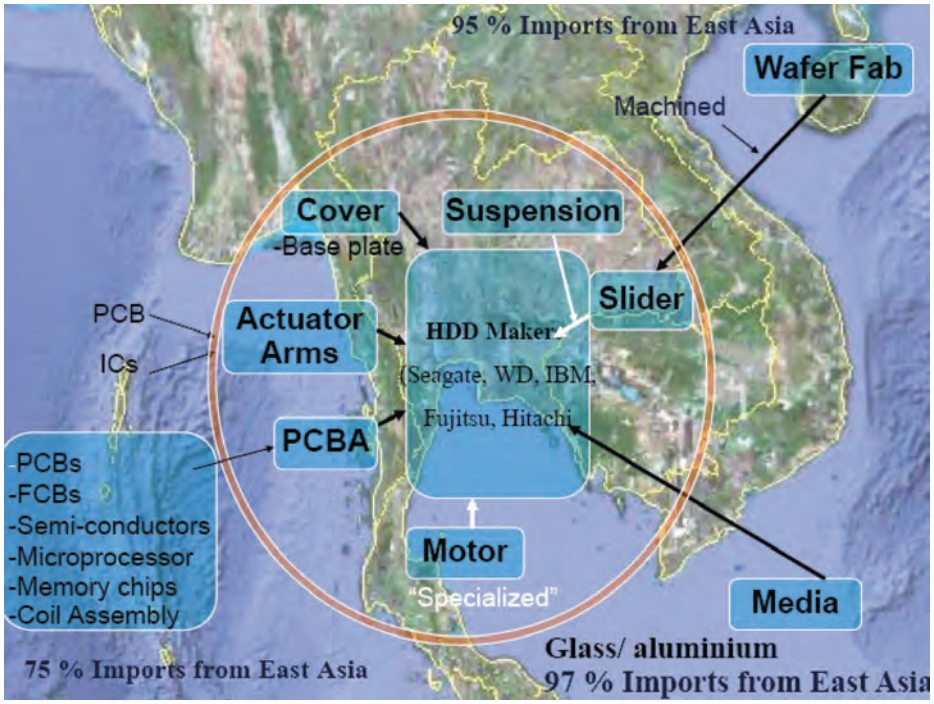
The exceptions in this layer are wafers, media, and other minor and small components, which are usually imported from the HDD makers' affiliates abroad. Their quality tends to be standardized so that geographical proximity is not a necessity. Wafers and media play a very important role in determining business competency and their production is likely to be in-house. This is especially true for media.[16] Both Seagate Technology and Western Digital import them from affiliates in Johor, Malaysia (samples 1 and 7; Seagate Technology, 2008: and Western Digital, 2008). Both these types of components are capital-intensive and huge costs are involved in their production. For example, Showa Denko set up its new plant in Singapore in 2006. The factory cost about Y 60 billion and employs about 600 workers. Hence, once a factory is located in a given location, it takes time to establish a new factory. There are numerous metallic components used in linking several major parts in HDDs, including spring wire, bottom VCs, top VCMs, TG clamps, top cover assys, top cover seals, positional seals and window clock seals. These components are physically small and economies-of-scale are important in their production processes. Hence, supplying them to a specific factory is economically worthwhile.

Overall, evidence from the HDD industry in Thailand suggests the possibility of coexistence between industrial clustering and IPNs. MNEs can complement them to enhance their competitiveness. While industrial clustering is present in the first layer, MNEs can still manage to harness benefits from the dispersion of resource endowments in the second layer (figure 7.6.).

With regard to the proliferation of FTAs, HDD makers and component suppliers have no plan to utilize such agreements. There are no problems related to tariffs in their production process. The output tariff is zero per cent in accordance with the Information and Technology Agreement under the WTO framework, so that tariff concessions under FTAs are zero. Notwithstanding the non-zero tariffs on several inputs listed in table 7.5, firms in

[16] When HDD makers employ PMR technology, media plays an important factor in determining HDD performance in terms of areal density (Western Digital, 2008).

Figure 7.6. IPNs and industrial clustering in Thailand's HDD industry



Source: Developed by the author.

the Thai HDD industry are unlikely to be negatively affected because of the presence of tariff exemption schemes, especially those offered by BOI. Such schemes cover both direct and indirect export activities. The latter means firms that import raw materials for manufacturing intermediates to be used in export-oriented activities are eligible for tariff exemptions.

7.6. Conclusion and policy inferences

This chapter examines the nature of IPNs at the industry level, using the HDD industry in Thailand as a case study. The research methodology was based on interviews of selected samples in order to reveal how firms make use of IPNs. The key finding concerns how MNEs in the HDD industry manage their IPNs, making use of both domestic and international fragmentation. Domestic fragmentation is used in the first layer of the production network between HDD makers and Tier 1 suppliers to overcome any coordination failure that might occur. At the same time, when parts are less customized as found in the second layer, enterprises in the HDD industry internationally source their intermediates to maximize benefits from the existing dispersion of resources around the world. In other words, based on the example of the Thai HDD industry, industrial clustering and IPN can coexist.

Three policy inferences can be drawn from this analysis. First, the coexistence of industrial clustering and IPNs suggests that any observed industrial clustering is not a synonym for complete localization. Local content might increase as a consequence of industrial clustering, but by how much is based purely on cost-benefits. As long as the benefits from geographical proximity exceed any possible costs of concentration, firms will prefer local sourcing.

Second, industrial clustering can be regarded as a proxy of development indicators of a given industry. It must occur naturally only after the affiliates reach a certain level of technological capability. It cannot be forced by any policy measures such as tax incentives. In fact, it largely depends on supply-side capability. Recent policy initiatives such as joint programmes between the private and public sectors in education and training would be a prudent policy for increasing the pool of qualified engineers and scientists for the HDD industry.

Third, while tariffs in the HDD industry appear to form a non-binding constraint, further trade liberalization is needed to encourage potential indigenous enterprises to learn and benefit from technological advances associated with MNEs in the HDD industry. Even though tariffs do not matter to existing firms in the HDD industry, they create a cost burden for enterprises and ever indigenous ones that are not yet ready but have the potential to participate in IPNs in the future. In addition, as electronics are commonly used in a wide range of products, tariffs on common parts could limit spillovers that might be associated with the entry of MNEs in the HDD industry.