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ISBN 957-9676-19-4

CHUNG-HUA INSTITUTION FOR ECONOMIC RESEARCH

THE EMERGING PATTERN OF DIVISION OF LABOR ACROSS THE TAIWAN STRAIT: MACRO OVERVIEW AND SECTORAL ANALYSIS OF THE ELECTRONICS INDUSTRY

CHIN CHUNG

DISCUSSION PAPER SERIES No.9611
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The Emerging Pattern of Division of Labor across the Taiwan Strait: Macro Overview and Sectoral Analysis of the Electronics Industry

by

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CHIN CHUNG*

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I. Introduction

Both Taiwan and China experienced significant structural changes during the 1980s. Taiwan, as one of the leading NIEs in the world economy, faced growing labor shortages and a rapidly appreciating currency in the mid-1980s as part of the unpleasant costs of accelerated economic growth. For Taiwan to begin a new phase of development, it was necessary to upgrade its technology and reorient its industries. China, on the other hand, awakened from decades of Maoist communism and embarked on massive economic reforms in the late 1970s. The core of these reforms lies in two strategies: "opening up to the world" and "fostering internal economic dynamism." In following these principles, China has implicitly adopted an export-oriented policy based on foreign direct investment (FDI) combined with indigenous labor resources to achieve high economic growth — a strategy similar to one that has made the Four Dragons prosperous.

This paper analyzes the emerging pattern of the division of labor

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**An earlier version of this paper was presented at the Conference on The China Circle, sponsored by the Institute for Global Conflict and Cooperation, University of California at San Diego, December 1994, Hong Kong.

between China and Taiwan, utilizing systematic data on trade, investment, and production flows to envisage a dual relationship between the two economies as both competitors in the world marketplace and cooperative partners in a wide array of manufacturing activities. In particular, recent developments in one of the key sectors in Taiwan's economy, the electronics industry, will be closely examined to gain a clearer picture of the new forms of economic interaction across the Strait. These developments may not only change the bilateral economic relationship between Taiwan and China, but may also exert a considerable impact on the reshaping of the broader economic landscape beyond the region. Current and possible future courses of government policies toward this escalating bilateral economic interchange will also be discussed.

II. The Emerging Pattern of Division of Labor: An Overview

During the three decades prior to 1986, Taiwan built up its industrial capability primarily through an export-led growth policy. The success story of Taiwan and the other Asian Dragons may well have generated a sense of marvel in the minds of the Chinese communist leaders, as they finally decided upon reviving the economy with a dose of free-market spirit and accepting the principle of international division of labor governed by comparative advantage in production. The opening of the four Special Economic Zones and subsequent extension to coastal areas proved to be a highly successful strategy in attracting foreign direct investment (FDI) and has done much to foster economic development in these labor-abundant regions. In 1987, the Taiwan government abolished martial law and lifted the ban on kinship visits to the mainland after a forty-year freeze. The foreign exchange regime was also liberalized to allow free capital movements under NT$5 million. The impact of these policy changes on the course of Taiwanese FDI toward China can be easily discerned from Table 1.

Compared with ASEAN countries, China has obviously been more successful in attracting FDI over the past decade. From 1986 to 1994, China accumulated some US$288 billion in FDI inflow, more than four times the amount Indonesia, the second largest FDI recipient in the region,

Table 1 Cumulative FDI in China and ASEAN Countries: 1986-94

Units: US$ Million, %

Recipient/ Investor		World Total	Hong Kong	Taiwan	Japan	U.S.
China	1986	2834 (100)	1449 (51.1)	- (0.0)	210 (7.4)	530 (18.6)
	1987	3709 (100)	1947 (40.4)	100 (2.7)	301 (8.1)	342 (9.2)
	1988	5297 (100)	3467 (65.5)	421 (7.9)	276 (5.2)	370 (7.0)
	1989	5599 (100)	3160 (56.4)	523 (9.3)	439 (7.8)	641 (11.4)
	1990	6597 (100)	3676 (55.7)	984 (14.9)	458 (6.9)	357 (5.4)
	1991	11977 (100)	7215 (60.2)	1358 (11.3)	812 (6.8)	548 (4.8)
	1992	58123 (100)	40044 (68.9)	5543 (9.5)	2173 (3.7)	3121 (5.4)
	1993	111436 (100)	73939 (66.4)	9965 (8.9)	2960 (2.7)	6813 (6.1)
	1994	82680 (100)	46971 (56.8)	5395 (6.5)	4440 (5.4)	6010 (7.3)
	1986~94	288252 (100)	181868 (63.1)	24289 (8.4)	12069 (4.2)	18729 (6.5)
Indonesia	1986	-	-	18 (-)	-	-
	1987	1520 (100)	129 (8.1)	8 (0.6)	554 (35.4)	80 (5.3)
	1988	4482 (100)	253 (5.6)	914 (20.4)	391 (8.7)	671 (15.0)
	1989	4719 (100)	407 (8.6)	157 (3.3)	779 (16.5)	348 (7.4)
	1990	8751 (100)	993 (11.4)	618 (7.1)	2241 (25.6)	154 (1.8)
	1991	8778 (100)	278 (3.2)	1056 (12.0)	929 (10.6)	276 (3.1)
	1992	10323 (100)	1021 (9.9)	563 (5.5)	1511 (14.6)	923 (8.9)
	1993	8144 (100)	384 (4.7)	131 (1.6)	836 (10.3)	882 (9.6)
	1994*	23092 (100)	6013 (26.1)	2480 (10.7)	1388 (6.0)	445 (1.9)
	1987~94*	69889 (100)	9475 (13.6)	4927 (7.0)	8620 (12.3)	3778 (5.4)
Malaysia	1986	654 (100)	22 (3.3)	4 (0.6)	45 (6.9)	21 (3.2)
	1987	818 (100)	35 (4.3)	96 (11.8)	284 (34.7)	65 (7.9)
	1988	1863 (100)	114 (6.1)	317 (17.0)	467 (25.1)	204 (11.0)
	1989	3194 (100)	130 (4.1)	797 (25.0)	993 (31.1)	119 (3.7)
	1990	6517 (100)	139 (2.1)	2345 (36.0)	1557 (23.9)	210 (3.2)
	1991	6202 (100)	218 (3.5)	1312 (21.1)	1348 (21.7)	654 (10.5)
	1992	6977 (100)	31 (0.4)	589 (8.4)	1504 (15.1)	1295 (18.6)
	1993	2327 (100)	36 (1.5)	347 (14.9)	608 (26.1)	674 (29.0)
	1994	3826 (100)	350 (9.1)	1150 (30.1)	706 (16.5)	501 (13.1)
	1986~94	32378 (100)	1075 (3.3)	6958 (21.5)	7512 (23.2)	3743 (11.6)
Thailand	1986	513 (100)	14 (2.8)	20 (3.9)	292 (57.0)	40 (7.8)
	1987	1055 (100)	42 (4.0)	160 (15.2)	583 (55.3)	69 (6.5)
	1988	3790 (100)	133 (3.5)	455 (12.0)	2265 (59.7)	262 (6.9)
	1989	3987 (100)	206 (5.2)	517 (13.0)	1979 (49.6)	182 (4.6)
	1990	7359 (100)	4322 (58.7)	420 (5.7)	1235 (16.8)	336 (4.6)
	1991	2447 (100)	107 (4.4)	317 (13.0)	949 (38.8)	400 (16.4)
	1992	3128 (100)	34 (1.1)	130 (4.2)	986 (31.5)	808 (25.8)
	1993	1737 (100)	194 (11.1)	49 (2.8)	307 (17.7)	287 (16.5)
	1994	1327 (100)	320 (24.1)	83 (6.3)	123 (9.3)	156 (11.8)
	1986~94	25643 (100)	5372 (20.9)	2151 (8.4)	8719 (34.0)	3061 (11.9)

* The 1994 figures for Indonesia are up to October. Figures in parentheses are percentage shares.

Sources: FDI approval data adopted from host country official statistics (BOI for Thailand, MIDA for Malaysia, BKPM for Indonesia, and MFTEC for China).

was able to induce. Taiwanese FDI toward the mainland quickly took off after 1987 and soon overshadowed its FDI toward ASEAN countries. Moreover, FDI from Japan and the United States has also gradually shifted away from ASEAN countries and toward the PRC since 1991.

Being politically and culturally intertwined with Hong Kong and Taiwan, it is only natural that China has drawn most of its inward FDI from its two cultural siblings. But other countries, including the U.S. and Japan, also have shown great interest in the Chinese market and invested quite heavily in China, albeit still with a sense of caution. The motivations for investing in mainland China are likely to be different, though, for the advanced countries and for a NIE like Taiwan. China, as a host to FDI, not only possesses the obvious *location advantage* of low-cost labor and land, but also has the additional advantage of a vast and rapidly growing internal market.[1] While the latter attribute is enticing for both advanced countries and NIEs, the first advantage is probably more important to NIEs seeking to relocate their traditional processing activities offshore. However, as a destination for Taiwanese (and, for that matter, Hong Kong) FDI, China possesses yet a third location advantage, due primarily to a similar cultural and linguistic background that effectively lowers the transaction costs of doing business there. This last feature may prove to be all the more important for FDI firms with *meager ownership advantage*. Theory suggests that the existence of an *ownership advantage* provides the ultimate basis for an FDI undertaking (Hymer 1960). The firm making FDI must be competitive enough to earn a profit in the foreign country, where transaction costs are typically higher than in the familiar home-country environment. The greater the ownership advantage a firm possesses, the more readily the higher costs of operating in a foreign country may be endured. This explains why such international giants as Coca-Cola, Nabisco, Volkswagen, Philips, Hitachi, and Mitsubishi were among the first to enter the Chinese market with FDI ventures. These firms were able to do so because they enjoyed a certain element of monopolistic power stemming from, for example, their established brand names and/or patent technologies.

During the early phases of Taiwanese investment on the mainland, however, a large number of FDI cases were carried out by small- and

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[1] In his "eclectic theory", Dunning identified three necessary conditions forming the basis of an act of FDI: an *ownership* advantage of the FDI firm, a *location* advantage of the FDI host, and an *internalization* advantage of the FDI act. See Dunning, John (1977).

medium-sized enterprises (SMEs) with standardized technology and little worldwide reputation.[2] Apart from their newly acquired financial capability, these firms seemed to possess two primary advantages: a knowledge of how to organize production efficiently and stable market access stemming from their previous OEM experience. Nevertheless, since recognized brand names and patent technologies are generally lacking at the firm level, these "ownership advantages" pertained more to a given industry as a whole than to each individual firm within the industry. This implies that their FDI undertakings might have been "strengthened" (or facilitated) in some way by other sources of advantage — and the most obvious one would seem to be the lower transaction costs that result from cultural and linguistic proximity at the FDI location.[3] The fact that the number of cases of Taiwanese FDI in China is much more numerous but the scale of projects is substantially smaller compared with Taiwanese FDI in other low-wage countries (for example, Malaysia and Thailand) seems to attest to the above hypothesis. Moreover, since the ownership advantages of Taiwanese firms are typically confined to the realm of production and rarely extend to R&D and marketing, the possibility of using other forms of transactions (for example, licensed production) are limited. As a result, the best way for these firms to recoup lost profit as domestic conditions worsen is to reorganize production in another cost-competitive location — provided entry costs are low. In other words, *internalization* provides the only viable solution for these firms to salvage their eroding value-added at home.

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[2] For a detailed account of Taiwanese SMEs' investment behavior in China, including their motivations, limitations, and trade consequences, see Chung, Chin (1995).

[3] This was compared with the Japanese case in the late 1960s and early 1970s when SMEs constituted the norm of Japanese investment. It was argued that, in the case of Japan, an equally "exogenous" strand of advantage was injected from outside the FDI carriers in the form of *keiretsu* assistance and/or government guidance — compared with that of a cultural and linguistic proximity in the case of Taiwanese SMEs operating in China. See Chung, Chin (1995), ibid.

Table 2 presents the results of a recent report on industrial distribution of Taiwanese FDI on the mainland.[4] One can clearly see that the rankings of Taiwanese investment between different sectors are significantly different from those of the average FDI in China (which are strongly influenced by FDI from more advanced countries). In particular, Taiwanese FDI in transportation equipment and nonmetallic mineral products was minimal, whereas FDI in plastic products, processed foods, machinery, and miscellaneous products ranked substantially higher than average FDI from all sources. In total, Taiwanese realized (as opposed to contracted) investment in the PRC amounted to US$4.23 billion as of early 1993.

Outward FDI, especially that of a "relocation" type, is expected to induce structural changes in the home and host countries, both in production and in trade. It is possible to estimate these impacts on the home and host economies by utilizing input-output analysis (Chung 1991a). A simplified version of such an analysis is summarized in equations 1 to 4 below, which display the main relationships among outward FDI, the generation of host-country output and exports, the derived demand for intermediate inputs, and the FDI-induced "reverse imports" from the host to the home economy.[5] Equation 1 shows the increase in output in the PRC (ΔY_i^*) as a function of the amount of FDI (ΔK_i) and the overseas output-capital ratio or capital productivity ($(Y_i/K_i)^*$). This corresponds to that part of the output which is redeployed from home.[6] Equation 2 shows the FDI-induced increase in exports from China (ΔX_i^*) to the rest of the world, where α_i is the export propensity of the FDI firms in the ith industry. Equation 3 shows the

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[4] The figures are obtained from an official survey of all FDI operations in China as of February 1993. See Kao, Charng and Shih-Ing Wu (1994).

[5] For details of the set-up of this model and a discussion of the underlying assumptions, see Chung, Chin (1991a), ibid., pp.226-230.

[6] All things considered, the net effect on home production is given by the equation $\Delta Y = D\Delta T - D[\Delta K_i(Y_i/K_i)]$, where Y_i/K_i is the domestic output-capital ratio (which may or may not be the same as $(Y_i/K_i)^*$. The first part of this equation shows the increase in home production induced by an increased demand for its exports (in the form of intermediate inputs) by FDI operations overseas, while the second part shows the decline in home production due to a relocation of its capital stock and production activity.

Table 2 Industrial Distribution of Taiwanese FDI: 1979～92
Cumulative Realized Investment

	Total Foreign Direct Investment		Taiwan's Direct Investment	
Manufacturing sector	US$ Million (Rank)	% Share	US$ Million (Rank)	% Share
1. Processed foods	2494. 17 (7)	6. 11	395. 02 (3)	9. 33
2. Beverages and tobacco	693. 74	1. 70	46. 65	1. 10
3. Textiles	3522. 23 (3)	8. 63	263. 51 (7)	6. 23
4. Wearing apparel	4198. 74 (2)	10. 28	299. 82 (5)	7. 08
5. Leather, fur, and articles thereof	1501. 98	3. 68	153. 72	3. 63
6. Wood, bamboo, and rattan products	18. 33	2. 98	223. 11	5. 27
7. Pulp, paper products, and printed matter	2372. 43 (8)	5. 81	228. 74 (10)	5. 40
8. Chemicals	3152. 37 (4)	7. 72	344. 49 (4)	8. 14
9. Chemical products	562. 72	1. 38	26. 53	0. 63
10. Oil and coal products	663. 10	1. 62	3. 62	0. 09
11. Rubber products	698. 19	1. 71	90. 84	2. 15
12. Plastic products	2802. 42 (5)	6. 86	417. 04 (2)	9. 85
13. Non-metallic mineral products	2752. 43 (6)	6. 74	191. 53	4. 52
14. Basic metals	649. 66	1. 59	22. 87	0. 54
15. Metal products	1983. 21 (9)	4. 86	242. 89 (8)	5. 74
16. Machinery	1700. 08	4. 16	265. 22 (6)	6. 27
17. Electronic apparatus	6172. 12 (1)	15. 12	555. 51 (1)	13. 12
18. Transportation equipment	1817. 85 (10)	4. 45	164. 79	3. 89
19. Precision Instruments	649. 59	1. 59	56. 44	1. 33
20. Miscellaneous products	1228. 01	3. 01	240. 38 (9)	5. 68
All Manufactures	40833. 38	100. 00	4232. 73	100. 00

Source: Kao, Charng and Shih-ying Wu (1994), *An Investigation of Foreign Direct Investment in Mainland China* (in Chinese), project report commissioned by the Investment Commission, Ministry of Economic Affairs, ROC.

derived demand for intermediate goods from Taiwan (ΔT, a 29x1 vector) created by FDI-related production in China (ΔY^*, a 29x1 vector), where D is the 29x29 domestic input coefficient matrix derived from the 1989 input-output table for Taiwan, and δ_i is a sector-specific scaler representing the propensity to acquire these inputs from original sources by the ith-sector FDI firms.[7] Equation 4 shows the "reverse imports" or "sellbacks" to the home market of the ith industry (ΔM_i), based on an estimate of γ_i, the "reverse-import propensity" of the ith-sector FDI firms operating in China.[8]

$$\Delta Y^*_i = \Delta K_i (Y/K)^*_i \qquad i=1.....29 \qquad (1)$$
$$\Delta X^*_i = \alpha_i \Delta Y^*_i \qquad i=1.....29 \qquad (2)$$
$$\Delta T = \delta_i D\Delta Y^* \qquad i=1.....29 \qquad (3)$$
$$\Delta M_i = \gamma_i Y^*_i \qquad i=1.....29 \qquad (4)$$

The results of this exercise are shown in Table 3. From a cumulative FDI of US$4.23 billion (taken from column 3 of Table 2), an estimated US$13.95 billion of overseas production was generated in 1992, roughly equal to 7.3 percent of Taiwan's domestic manufacturing output for the same year. Of this output, US$9.3 billion was exported to the world market from China, accounting for 11.6 percent of China's total exports in 1992. In order to manufacture this output, however, an estimated US$5.9 billion of intermediate goods were imported from Taiwan to China, equal to 7.2 percent of Taiwan's total exports in 1992. Finally, an estimated US$2.42 billion of imports from China to Taiwan was created in the form of FDI sellback, making up 4.2 percent of total imports to Taiwan in 1992.[9]

It has been argued that Taiwan, by relocating production to China, is duplicating the Japanese strategy (in the 1970s and 1980s) of indirectly

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[7] Operationally, the δ_is enter the equation in the form of a 29x29 diagonal matrix with the δ_is sitting on the diagonal and zeros everywhere else.

[8] The coefficients used in the estimation of this model are derived from interviews and surveys conducted by Chung-Hua Institution over the past five years. See, for example, Yen, Tsong-ta, Y. J. Lin, and C. Chung (1992).

[9] By using primarily a survey method, Kao, Lee, and Lin reached broadly similar estimates, especially in terms of Y_i^* and X_i^*, to the ones presented here.

Table 3 Estimates of Taiwanese FDI Output, Exports, and Sellbacks in 1992

Unit: US$ Million, %

Industrial Sector	Sectoral FDI (1)	Estimated FDI Output (2)	As % of Taiwan's Domestic output (2)'	Estimated FDI Exports (3)	As % of China's Total Exports (3)'	Estimated FDI Sellback (4)	As % of Taiwan's Total Imports (4)'
1. Processed foods	395.02	1090.26	6.96	745.30	27.79	4.03	0.20
2. Beverages and tobacco	46.65	150.21	2.97	105.15	13.63	0.00	0.00
3. Textiles	263.51	793.17	6.77	432.83	7.82	95.18	6.35
4. Wearing apparel	299.82	902.46	14.15	804.09	4.95	45.84	8.53
5. Leather and products	153.72	905.41	36.59	761.72	19.17	5.79	1.56
6. Wood and products	223.11	698.33	24.75	675.71	37.11	196.65	20.11
7. Paper and products	228.74	523.81	5.96	234.62	44.72	167.41	9.91
8. Chemicals	344.49	809.55	5.65	84.92	3.42	431.73	7.46
9. Chemical products	26.53	78.00	1.62	14.00	5.18	8.18	0.25
10. Oil and coal products	3.62	6.91	0.63	5.99	0.13	0.69	0.01
11. Rubber products	90.84	274.33	11.52	243.14	77.79	27.43	-
12. Plastic products	417.04	1084.30	9.41	715.86	19.68	340.90	38.52
13. Non-metallic min. prod.	191.53	296.87	4.72	158.78	5.06	9.17	1.16
14. Basic metals	22.87	36.82	0.27	12.40	0.37	0.00	0.00
15. Metal products	242.89	699.52	6.96	211.75	17.87	172.85	21.07
16. Machinery	265.22	745.27	8.97	562.75	16.71	533.39 *	7.63
17. Electronic apparatus	555.51	3044.19	9.20	1990.29	24.35	213.76	2.30
18. Transportation equip.	164.79	479.54	3.16	384.35	17.44	7.24	0.12
19. Precision Instruments	56.44	309.29	14.06	126.96	5.62	21.71	1.01
20. Miscellaneous products	240.38	1024.02	15.31	1005.38	8.93	137.94	18.26
All Manufactures	4232.73	13952.26	7.31	9275.99	11.64	2419.89	4.21

Sources: 1. The Input-Output Table of Taiwan (1989).
2. *Monthly Statistics of Import/Export Trade, Taiwan Area*, various issues.
3. *Industrial Production Statistics Monthly, Taiwan Area*, various issues.
4. *China Customs Statistics*, various issues.
5. FDI figures from Table 2 above.

exporting to the United States and other advanced-country markets.[10] More basically, however, successive waves of Taiwanese FDI toward China were, more than anything, a manifestation of the changing comparative advantages in production and trade between the two economies. In retrospect, one can easily discern this shifting comparative advantage between Taiwan and China through their respective export performance (Table 4). Utilizing what I call the Constant-Trend Growth Model, we can measure this shifting comparative advantage *ex post* as the difference between "actual export growth" and "constant-trend export growth" for each of these economies between two points in time — one immediately before the macroeconomic changes that induced the shift in comparative advantages, and the other, several years after these changes actually occurred.

We choose 1986 as the dividing year marking the beginning of macroeconomic changes in the productive environment in Taiwan. Using Taiwan's and China's 1986 exports as the basis for observation, the "constant-trend exports" for the two economies in 1992 are calculated, using the average growth rate of the period 1982 ~ 86 for each country as the constant-trend growth rate. The difference between "constant-trend exports" and actual exports in 1992 is what we call the constant-trend export gains (column 5 of Table 4). This figure represents the amount of expected export gains for Taiwan (or China) from 1986 to 1992 *if comparative advantage remained the same*. But if we subtract the 1986 actual exports from the 1992 actual exports, we obtain the 1992 actual export gains (column 6 of Table 4), which are a result of Taiwan's (or China's) true comparative advantage in 1992 following the series of changes during 1986 ~ 1992 — including domestic changes in production conditions, FDI, and perhaps also changes in the international competitive environment. Because of the latter figure's all-encompassing nature, the difference between columns 5 and 6 (or, alternatively, between columns 3 and 4) may be viewed as an *ex post* indicator of the extent of the shift in comparative advantage for each economy between 1986 and 1992.

From an *ex ante* point of view, all sectors with an asterisk in Table 4 are expected to show the clearest shift in comparative advantage.[11] These

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[10] Chung, Chin (1991a), ibid., pp.237-238.

[11] According to Taiwan's input-output table for 1989, these are all labor-intensive

include the manufacture of apparel, leather and fur products, wood an bamboo products, miscellaneous products (such as toys and sporting goods) plastic products, nonmetallic mineral products, metal products, and electrica and electronic products. These sectors all fall into the labor-intensiv category that met with difficulties in Taiwan from 1986 to 1992. These expectations are supported by our results in Table 4, where all of these sectors are shown to have a negative sign in the difference between "actual" and "trend" exports for Taiwan (Table 4 (A)). As for the other sectors, the calculated difference between actual and trend exports are all positive, indicating a shift in comparative advantage that was favorable for the production and export of these goods in Taiwan (although the magnitudes involved tend to be small). Loosely speaking, from 1986 to 1992, Taiwan's traditional labor-intensive sectors "lost" some US$35 billion worth of exports because of shifting comparative advantages, whereas the export "gains" from the other sectors amounted to only US$5.6 billion, rendering a net "loss" of US$29.4 billion in exports for Taiwan.

The situation is clearly different for China. All the labor-intensive sectors except for wearing apparel registered positive differences between actual and trend exports from 1986 to 1992 (Table 4 (B)). The magnitudes of these gains range from US$0.5 billion to US$7.1 billion, implying that, after 1986, the shift in international comparative advantage in producing these labor-intensive items has tilted in favor of China at the expense of Taiwan. According to our calculations, this change in comparative advantage had already created a cumulative gain of $32.5 billion in exports for China as of 1992. Furthermore, we observe an almost all-out positive gain across all manufacturing sectors in the case of China. This stands as a sharp contrast to the Taiwan case where some sectors have gained at the expense of others. The asymmetry in performance can have important policy implications because it suggests that the shift in comparative advantage between the two economies may be *comprehensive* rather than applying only to individual sectors.

By the mid-1990s, a decade after Taiwanese SMEs first set foot in China, both the scale and the content of Taiwanese FDI have been elevated to a new plateau. The average size of investment toward China rose sharply from US$735,000 in 1991 to US$2.78 million in 1995. Firms making investments are now publicly listed companies rather than small- and

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sectors with capital-labor ratios below 0.8.

Table 4(A) Taiwan's "Actual" and "Trend" Exports: 1986~92

Unit: US$ Million, %

Manufacturing Sector	1986 Actual Export (1)	1982-86 Avg. Growth Rate (2)	1992 Trend Export (3)=(1)*(2)	1992 Actual Export (4)	Δ in Trend Export (5)=(3)-(1)	Δ in Actual Export (6)=(4)-(1)	Difference (7)=(6)-(5)
1. Processed Foods	1,934	12.77%	3,978	2,606	2,044	672	-1,372
2. Beverages and Tobacco	14	-4.17%	11	49	-3	35	38
3. Textiles	2,636	14.24%	5,859	6,722	3,223	4,086	863
4. Wearing apparel	4,663	9.51%	8,042	4,572	3,379	-91	-3,470 *
5. Leather products	1,287	25.27%	4,973	1,081	3,686	-206	-3,892 *
6. Wood and bamboo products	1,762	12.22%	3,519	1,070	1,757	-692	-2,449 *
7. Miscellaneous products	4,287	13.25%	9,044	5,098	4,757	811	-3,946 *
Nondurables Subtotal	16,583	13.49%	35,426	21,198	18,843	4,615	-14,228
8. Paper and paper products	250	11.32%	476	827	226	577	351
9. Chemicals	782	16.21%	1,926	2,498	1,144	1,716	572
10. Chemical products	698	4.56%	912	1,448	214	750	536
11. Rubber and plastics prod.	3,943	22.26%	13,168	5,122	9,225	1,179	-8,046 *
12. Nonmetallic mineral prod.	791	13.15%	1,660	1,217	869	426	-443 *
13. Basic metals	702	1.85%	784	1,453	82	751	669
14. Metal products	2,360	23.36%	8,317	5,304	5,957	2,944	-3,013 *
Intermediates Subtotal	9,527	19.14%	27,243	17,869	17,716	8,342	-9,373
15. Machinery	1,598	17.27%	4,156	5,731	2,558	4,133	1,575
16. Electronics apparatus	8,910	22.85%	30,629	22,222	21,719	13,312	-8,407 *
17. Transportation equipment	1,749	12.49%	3,544	4,049	1,795	2,300	505
18. Precision instruments	740	11.60%	1,430	1,925	690	1,185	495
Durables & Capital Goods	12,997	20.48%	39,759	33,927	26,762	20,930	-5,832
All Manufactures	39,107	17.41%	102,428	72,995	63,321	33,888	-29,433

* Indicates sectors with significant shift in comparative advantage.

Table 4(B) China's "Actual" and "Trend" Exports: 1986~92

Unit: US$ Million, %

Manufacturing Sector	1986 Actual Export (1)	1982-86 Avg. Growth Rate (2)	1992 Trend Export (3)=(1)*(2)	1992 Actual Export (4)	Δ in Trend Export (5)=(3)-(1)	Δ in Actual Export (6)=(4)-(1)	Difference (7)=(6)-(5)
1. Processed Foods	1,907	24.15%	6,983	2,682	5,076	775	-4,301
2. Beverages and Tobacco	120	5.55%	166	771	46	651	605
3. Textiles	3,306	1.74%	3,667	5,942	361	2,636	2,275
4. Wearing apparel	5,110	27.28%	21,726	16,238	16,616	11,128	-5,488 *
5. Leather products	227	9.75%	397	3,973	170	3,746	3,576 *
6. Wood and bamboo products	168	-2.16%	147	1,821	-21	1,653	1,674 *
7. Miscellaneous products	1,398	6.85%	2,080	11,257	682	9,859	9,177 *
Nondurables Subtotal	12,236	19.24%	35,166	42,684	22,930	30,448	7,518
8. Paper and paper products	200	8.56%	327	525	127	325	198
9. Chemicals	801	3.86%	1,005	2,483	204	1,682	1,478
10. Chemical products	897	17.01%	2,302	1,640	1,405	743	-662
11. Rubber and plastics prod.	391	4.82%	519	3,950	128	3,559	3,431 *
12. Nonmetallic mineral prod.	322	-0.15%	319	3,135	-3	2,813	2,816 *
13. Basic metals	670	0.29%	682	3,366	12	2,696	2,684
14. Metal products	563	1.87%	629	1,185	66	622	556 *
Intermediates Subtotal	3,844	7.04%	5,783	16,284	1,939	12,440	10,501
15. Machinery	381	-10.24%	199	3,367	-182	2,986	3,168
16. Electronics apparatus	487	14.28%	1,085	8,175	598	7,688	7,090 *
17. Transportation equipment	255	-11.18%	125	2,208	-130	1,948	2,078
18. Precision instruments	151	-1.14%	141	2,259	-10	2,108	2,118
Durables & Capital Goods	1,274	3.32%	1,550	16,004	276	14,730	14,454
All Manufactures	17,353	16.10%	42,499	74,971	25,145	57,618	32,473

* Indicates sectors with significant shift in comparative advantage.

Sources: *Monthly Statistics of Import/Export Trade, Taiwan Area,* ROC; *China Customs Statistics,* various issues.

medium-sized firms. The motivation for FDI operations has turned from an export orientation toward local-market exploitation. The locale of FDI has shifted from the south farther toward the north of China, and the areas of investment are assuming ever-stronger capital- and technology-intensity.[12] Table 5 provides a glimpse of Taiwan's publicly listed companies that have established a presence in China as of mid-1996. It is impressive that FDI is being made across the board covering all industrial categories — and Taiwanese publicly listed companies were not even allowed to invest in China until as recently as 1990.[13] These developments seem to lend strong support to the hypothesis that improvement in China's comparative advantage *vis-a-vis* Taiwan may have been comprehensive rather than sporadic. This, in turn, suggests grave implications for the possible future course of the division of labor between Taiwan and China *if market forces were allowed to run free*. Here an important distinction must be drawn between what is good for a firm and what is good for an industry, in the sense that a firm is "footloose" and mobile whereas an industry must be defined in terms of a specific geographic location.[14] For Taiwanese businesses, China as a production base has three levels of advantage: low costs, big market, and minimal entry barriers. Especially when political barriers between Taiwan and China abate, large-scale migration of industrial activities will likely become rational, and even optimal, because the size of the Chinese market is many times that of Taiwan, and operation costs are several times cheaper. What kind of division of labor would then prevail within the manufacturing sector will become a critical question for policymakers in Taiwan. Is Taiwan, for example, ready for a division of labor that is given by a "corner solution" (i.e., total specialization) in which Taiwan concentrates its resources on, perhaps, providing "local"

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[12] For a detailed discussion of these recent changes, see Chung, Chin (1996).

[13] Before October 1990, FDI toward the mainland was considered illegal by the Taiwan government despite the fact that cumulative contractual investment toward China was already approaching US$2 billion by the end of 1990. In October 1990, the government legalized 3,353 manufacturing items, mostly labor-intensive products, as permissible FDI projects in China by Taiwanese firms. This "positive list" was also applicable to publicly listed companies, provided their China-bound investment did not exceed 20 percent of their registered capital.

[14] The conceptual distinction drawn here between a firm and an industry parallels that between GNP and GDP.

Table 5 Taiwan's Publicly Listed Companies Investing in China: Numbers and Weights

Industry Category	Total number of Listed Firms	Number of Listed Firms Investing in China *	% Share
Cement	9	3	33.33
Processed Foods	28	13	46.43
Plastic Materials	18	5	27.78
Textiles	46	8	17.39
Electrical Products	17	5	29.41
Electronics	48	12	25.00
Cable & Wire	12	5	41.67
Petrochemicals	19	7	36.84
Ceramics & Porcelain	6	3	50.00
Paper Products	7	1	14.29
Steel	24	1	4.17
Rubber Products	8	4	50.00
Automobiles	5	1	20.00
Transportation	14	1	7.14
Construction	36	1	2.78
Tourism	6	0	0.00
Total	358	83	23.18

* Statistics as of mid-1996; not including those conducted via individual channels.
Source: Taiwan Securities Exchange Commission, Ministry of Finance, ROC.

services? These and related questions may be among the toughest to answer by students of economic changes witnessing rapidly shifting comparative advantages across different regions with different levels of economic achievement. The process of factor-price equalization (Samuelson 1984) is now accentuated by the free mobility of capital and managerial resources, countering endeavors by governments around the world to maintain their relative positions against one another. And, beyond doubt, this process is likely to be further intensified by the emergence of China on the world's economic landscape.

III. Sectoral Analysis of the Electronics Industry

Electronics has been a major field for Taiwanese investment in the PRC since 1987. As with other lines of production, outward FDI in electronics has also engendered a substitution of production and exports between the two economies. In this section, we will take a closer look at the electronics sector in Taiwan, with particular emphasis on the personal computer (PC) industry, to shed more light on the emerging division of labor across the Taiwan Strait — as well as some of the potential problems and policy issues surrounding this trend. The choice of the PC industry is significant in two senses: first, it is the "sunrise industry" in Taiwan , one that has enjoyed continuous buoyant growth since the mid-1980s. The same experience has been shared by few other sectors (machinery may be one exception) over the past decade. Second, it is the *only* manufacturing sector in Taiwan whose growth performance has *not* been related to the emergence of the Chinese economy either as a nearby export market or as a regional production base — at least until very recently. Large quantities of Taiwan's PC-related exports were shipped to the North American markets, Europe, Latin America, and ASEAN countries, but very little went to explore the Chinese inland markets until after the 1990s. The same is true for FDI activities. However, once the process is triggered, a quick-paced division of labor between Taiwan and China emerges, as do significant inter- and intra-sectoral shifts in both the investing and the invested countries. It is therefore of particular interest, from the perspectives of both economies, to study the impact and implications of the rapidly enhanced interaction between Taiwan and China in this important sector of the Taiwan economy. .

To recap briefly, Taiwan's electronics industry was initiated in the 1960s and 1970s by an influx of foreign direct investment from Western and Japanese multinational corporations (MNCs). Firms like RCA, Zenith, Philips, Matsushita, Mitsibishi, and NEC came to Taiwan to set up wholly-owned subsidiaries or local joint ventures (JVs) for the production of transistor radios, black-and-white television sets, calculators, electrical household appliances, and electronic components and parts. Even though these investments in absolute terms seldom exceeded 25 percent of domestic capital formation (except at the very beginning), foreign-affiliated production once accounted for more than 60 percent of the island's electronics exports in the 1970s. Later on, however, domestic entrepreneurs successfully emulated the local MNCs in establishing their own assembly lines and gradually became the center of gravity of Taiwan's electronics production. The sector as a whole expanded steadily during the 1970s and overtook textiles by the early 1980s to become the biggest foreign exchange earner in the Taiwan economy.

With the advent of macroeconomic changes the electronics industry in Taiwan underwent a major restructuring of its product composition in the latter half of the 1980s. Domestic output of radio receivers, tape recorders, television sets, and electrical household appliances declined sharply as exports of these items were rapidly replaced by competing products from China and other developing countries (Table 6). Part of the domestic production has since been relocated overseas, and the rest simply faded away. Thanks to the timely and accelerated growth of the PC industry, the gap created by the decline in older products was filled, and the electronics sector as a whole grew strongly into the 1990s. By 1995, its output level was elevated to a new height of US$60 billion, accounting for 23 percent of Taiwan's manufacturing GDP and over 35 percent of itstotal exports.[15]

The PC industry, unlike the earlier consumer electronics industries, was established in Taiwan largely based on indigenous effort.[16]

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[15] *Monthly Statistics of the Import/Export Trade, Taiwan Area, ROC*, and *Statistics of Industrial Production Monthly, Taiwan Area, ROC*, Department of Statistics, Ministry of Economic Affairs, ROC, September 1996.

[16] The role of MNCs in the PC industry has been rather indirect in Taiwan. They impacted the local industry mainly through OEM/ODM procurement activities with different degrees of technological assistance. See, for example, Kawakami (1996).

Table 6 Production Index for Subsectors of the Electronics Industry in Taiwan

Year	TV sets, Video Tape Recorders & Players	Radio Tape Recorders & Record Players	Record & Stereo Equipment	Electric Fans	Lighting Fixtures	Electric Heating Appliances	Other Elec Appliances & Houseware
1984	80.83	247.65	65.11	116.16	128.72	49.11	28.02
1985	80.65	209.53	59.47	121.21	131.46	51.10	24.65
1986	119.10	225.28	77.48	144.62	128.25	65.37	29.87
1987	159.13	247.84	94.02	148.49	123.05	75.76	41.40
1988	173.91	195.44	95.78	131.74	140.10	89.13	60.61
1989	161.86	155.57	98.54	97.46	110.58	90.75	84.16
1990	93.84	113.05	95.92	85.48	98.56	83.19	76.40
1991	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1992	79.33	80.50	76.94	89.21	81.66	90.74	92.41
1993	63.76	66.94	68.36	64.26	61.84	77.76	83.37
1994	60.35	59.14	78.40	60.00	46.01	92.07	77.66
1995	65.45	58.11	76.21	52.99	39.70	84.56	79.19

Year	Data Storage Media Unit	Data Terminal Equipment	Data I/O Peripheral Equipment	Computer Components	Other Computer Equipment	Electronic Tube & Semi-Conductors	Other Electronic Parts & Components
1984	16.63	38.79	44.87	14.42	19.47	48.41	33.19
1985	20.27	41.48	42.08	20.64	23.74	39.39	32.32
1986	29.90	58.45	43.28	34.13	35.39	55.64	42.92
1987	43.38	73.61	60.31	56.21	52.44	64.97	55.54
1988	39.17	89.79	64.61	51.66	49.25	72.24	67.77
1989	48.99	87.26	62.70	70.36	61.31	78.26	71.13
1990	84.54	94.58	87.00	84.11	82.88	93.02	84.53
1991	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1992	146.82	116.31	117.92	110.81	114.44	123.80	109.30
1993	187.15	125.61	135.48	125.39	123.60	147.27	131.81
1994	205.29	136.66	147.72	179.93	120.45	146.95	166.48
1995	234.11	168.93	146.00	252.04	166.51	146.23	216.11

Source: *Industrial Production Statistics Monthly, Taiwan Area,* The Republic of China.

The preceding television and calculator industries had bestowed Taiwan with a well-rounded local component industry and a proficiency in the manufacture and assembly of audio/video equipment, thereby striking a solid basis for the subsequent development of PC products such as terminals, monitors, and other peripheral items. In the late 1970s and early 1980s, a sudden boom in the manufacture of videogame machines and Apple II clones further generated a large number of local engineers experienced in circuit design and the application of microprocessors.[17] The concurrent establishment of the Institute for Information Industry (III) in Taipei, the Electronics Research Service Organization (ERSO) and Science-based Industrial Park in Hsinchu, along with favorable investment incentives accorded by the government, attracted both local talent and a significant backflow of overseas Chinese with computer technology backgrounds to set up PC-related businesses on the island. In 1983, one year after the world's first IBM-compatible PC XT was introduced by Compaq, Acer (then already a local champion of Chinese I/O terminals and education PCs) presented Taiwan's first IBM-compatible PC XT and ignited the subsequent rapid expansion of the industry.[18] While Taiwan's total PC-related output in 1981 amounted to a mere US$200 million, in 1995 it grew to be an impressive US$15.8 billion, 90 percent of which being furnished by indigenous firms.[19] Together with an offshore production value of $5.4 billion, Taiwan surpassed Germany to become the world's third-largest PC maker in 1995, next only to the U.S. and Japan. Among Taiwan's major product items are desk-top and portable PCs, computer monitors, motherboards, keyboards, PC mice, and switch power supply units. Many of these items accounted for more than half of world supply in quantity terms (Table 7). Rapidly growing international orders and OEM/ODM (original design manufacturing) contracts from the world's leading PC producers (including IBM, Compaq, Apple, HP, NEC, and Toshiba, among others) suggest that Taiwan's manufacturing capability in

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[17] Kawakami (1996), ibid, pp.25-27.

[18] Chou, C. S. (1996), *The Computer Legend of Stan Shih* (in Chinese), Lainking Publishing Co., Taipei, pp.119-128.

[19] There were only a few important foreign-affiliated PC producers in 1994, ranging from the fourth place to the 31th in industry ranking, including Digital Equipment International, AOC International, and Logitech Far East Ltd.

Table 7 Taiwan's Top 12 PC Products: Domestic and Overseas Production (1995)

Unit: 1,000 sets

Rank	Product Item		World Market Share		Domestic Production		Growth Rate	Overseas Production		Growth Rate	Overseas/Total Production Ratio
1	Monitor		57%		16085		12%	15244		58%	49%
2	PC	Desk Top	12%	10%	6759	4167	48%	400	400	-	9%
		Portable		27%		2592	39%		-	-	-
							26%				
3	Motherboard		65%		13113		14%	7751		29%	37%
4	Switch Power Supply		35%		7756		261%	26564		12%	77%
5	Image Scanner		64%		2481		49%	-		-	-
6	Graphics Card		32%		4920		-2%	4380		17%	47%
7	Keyboard		65%		4589		-35%	28191		79%	86%
8	CD ROM Drive		11%		2825		1519%	927		927%	25%
9	Network Interface		38%		9946		63%	318		1490%	3%
10	Terminal		27%		956		-8%	-		-	-
11	Audio Card		35%		1663		-16%	-		-	-
12	Mouse		72%		31087		41%	9817		27%	24%

Note: "-" means no overseas production and/or data not available.

Source: Market Intelligence Center (MIC), Institute for Information Industry (III), ROC.

the PC area has been internationally recognized and affirmed.

Several distinctive features of the Taiwan PC industry are of interest here. First, it has a very high export propensity. In 1995, the export ratio of Taiwan's PC industry was as high as 63 percent. High export propensity implies intense pressure from international competition. As a result, optimizing productive efficiency and reducing operational costs are of primary concern to firms. Second, Taiwan has established an extensive network of vertical linkages within the industry (although not necessarily within each firm), ranging from upstream electronic components and parts (logic IC, memory IC, chipsets, smaller-sized LCDs, CRTs, and motherboards), midstream peripheral items (keyboards, monitors, image scanners, PC mice, and power supply units), to the final assembly of desk-top and portable PCs. The closely integrated local production network, together with a crucial dose of domestic design capacity (developed mainly through publicly supported institutions, such as ERSO and III, but also within private firms) helped form the OEM and ODM credibility of Taiwan, making it one of the world's leading manufacturing centers of PC products. Third, Taiwanese PC firms are renowned for their fast speed in catching up with the most recent development in the marketplace and positioning themselves accordingly as accommodating suppliers of PC-related products.[20] Thus, with the advent of network-related applications, Taiwanese PC producers are among the first to grab market niches and furnish multimedia audio and video cards, image scanners, modems, switches, bridges, and CD-ROM drives. These firms often become significant suppliers within a short span of time.[21] Fourth, at the same time that numerous small firms emerged to take advantage of the swiftly changing technology and new market niches, successful older firms were able to grow in scale with the help of fierce market competition. Take the largest sub-sector — monitors — for example. The

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[20] A famous example of this adaptability is given by the fact that, while it took about a year- and-a-half (early 1984 *versus* late 1982) for Taiwanese firms to catch up with the world's first model of IBM-compatible 80286 PC XT (introduced by Compaq), it took less than a month for them to develop a compatible Pentium PC (May 1993 *versus* April 1993).

[21] For example, Acer Peripherals, a subsidiary of Acer Inc. specialized in the production of PC peripherals, grew to be the largest local supplier of CD-ROM drives in 1995 — one year after it decided to enter the market — with an annual output of 1 million sets. See Chou (1996), ibid., p.324.

ten biggest producers in Taiwan accounted for more than 70 percent of production in 1992, and the trend is for continuing expansion of company scale. With increasing scale, these firms have been able to cut down on average cost and gain further competitiveness.

However, there are also weaknesses in the Taiwan PC industry. First of all, Taiwanese PC producers are still too limited in size by international standards. Aside from Acer, Tatung, and Mitac, no Taiwanese PC producers are on the list of world 100 PC producers. Because of their small size, these firms are financially weak (and often less motivated) to support major R&D activities, and rarely engage in self-conducted marketing. Most of them rely on OEM/ODM orders to supply PCs to the international market in IBM-compatible models. More importantly, Taiwanese firms are still unable to supply for themselves some of the key components of PCs (such as CPUs and, until recently, DRAMs) and depend heavily on the United States and Japan (and, in some cases, Korea) for these items. Although its upstream integrated circuit (IC) industry spent some 6 percent of its annual turnover on R&D activities in 1995, that amounted to only one-fifth of the R&D expenditure made by Intel alone.[22] Except for a few prestigious firms that are able to cross-license technology with leading multinational firms (such as Macronix with IBM), most Taiwanese companies are basically followers of the latest product designs developed elsewhere with minor modifications. In this sense, the PC industry in Taiwan is still largely an assembly-type manufacturing activity, with more than 60 percent of its exports being OEM/ODM production not associated with Taiwan producers' own brand names.[23] As a result, although total sales volumes are substantial, the profits these firms get out of their operations and the value-added they provide tend to be limited.

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[22] In 1995, Taiwanese IC industry's total R&D expenses amounted to US$230 million, whereas Intel spent US$1.3 billion. Data obtained from Industrial Technology Information Services (ITIS), Industrial Technology Research Institute (ITRI), Taiwan.

[23] This has come down from some 70 percent in the early 1990s when many Taiwanese PC producers were vigorously grabbing OEM and ODM opportunities arising from an acute price competition in the global PC market ignited by Compaq.

FDI by Taiwanese PC Firms

As with other industries on the island, Taiwan's PC industry in recent years also suffered from a deteriorating investment climate at home. An acute labor shortage and escalating domestic land costs inevitably eroded Taiwan's comparative advantage in producing lower-end PC products. Before the "China option" was open to Taiwanese firms, most of them were forced to relocate their labor-intensive production processes to ASEAN countries, especially Malaysia and Thailand. Figure 1 traces the timeline of Taiwanese hardware producers' FDI pilgrimage toward low-wage countries. It is interesting to note the sequence in which different products are moved overseas, starting from the most labor-intensive keyboards and PC mice to switch power supply units, and then to motherboards and monitors. Leading peripheral producers such as Acer Peripherals, Silitek, and Clevo led the way in relocating keyboard assembly lines to Southeast Asia. They were soon followed by companies such as Taiwan Liton, Rectron, and Delta Electronics for the production of switch power supply units; Silitek, Chicony, and Autocomputer for the production of motherboards; and Tatung, Chuntex, and Lite-On Technology in the realm of monitors (Table 8). Acer Peripherals, Autocomputer and a number of other firms, in particular, established extensive facilities in Southeast Asia that covered a wide range of PC-related products. The extent of overseas production in some of these items have been substantial. Take keyboards for example. Almost 86 percent of the total output in 1995 was derived from overseas production. Similar figures for switch power supply units, monitors, motherboards, and PC mice were 77 percent, 49 percent, 37 percent, and 24 percent, respectively. Overall, offshore production of PC hardware accounted for 27 percent of the industry output in 1995, rising rapidly from 10 percent in 1992.[24]

In the growing pie of offshore production, mainland China is claiming an increasing share. It may be noted that Taiwanese PC firms did not migrate across the Strait until 1990.[25] In 1993, however, China's share of

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[24] Starting in 1995/96, some of the emerging products at home, including drawing interface and CD-ROM drives, also began to move offshore as a result of fierce market competition.

[25] Officially, Taiwanese PC firms were forbidden by law to conduct FDI on the

Taiwan's offshore production of PC hardware already rose to a remarkable 34.6 percent, surpassing both Malaysia (29.4 percent) and Thailand (27.3 percent) (Figure 2). Although the ban on investment did not effectively prevent smaller firms from sneaking into China, it did have a prohibitive effect on the major (and thus more transparent) producers in Taiwan. When the government finally legalized investment in China for a certain number of PC-related products in 1992, leading producers such as Acer, First International Computer, and Mitac wasted no time in moving FDI into China. In 1993, there were already 35 Taiwanese PC subsidiaries in China, compared with ten in Thailand, nine in Malaysia, and four in Indonesia (Table 9).[26] Take monitors -- one of the latest items to go abroad -- for example. Operations in China produced some 2 million monitors in 1993, accounting for almost 80 percent of China's total monitor output and more than 50 percent of the entire offshore production of monitors by Taiwanese firms.[27]

The cost factor, of course, is the main driving force underlying these developments. Table 10 compares the estimated production costs for major PC hardware components in Taiwan, the ASEAN countries, and China. Taking monitors for example, it is estimated that operating on the mainland can save up to 3 percent on direct labor costs and another 5 percent on indirect costs (such as management and production overhead) so that total cost savings can amount to 8 percent of the final product value, which is much higher than the 5 percent savings expected by operations in the ASEAN countries. As the degree of labor intensity increases, total cost savings also increase and can be as high as 21 percent for keyboards and 22 percent for PC mice when compared with production in Taiwan. Cost differentials of this magnitude prove important for Taiwanese firms since most must rely on price competition in the world marketplace. Therefore,

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mainland until as late as 1992. The 1990 "positive list" of 3,353 items did not include PC products, which were deemed "high-tech" by the authorities. Still, many Taiwanese PC producers, especially smaller ones, took advantage of the low production cost in Guangdong and Fujian by conducting "lailiaojiagong," or outward processing, for various low-end PC items.

[26] The number increased to 41 in 1995, constituting 70 percent of all PC firms that were running overseas subsidiaries. See *Almanac of Taiwan's Information and Electronics Industry (1996),* Taiwan Economic Research Institute, Taipei, p.118.

[27] Shu, E. (1994), pp.32-40.

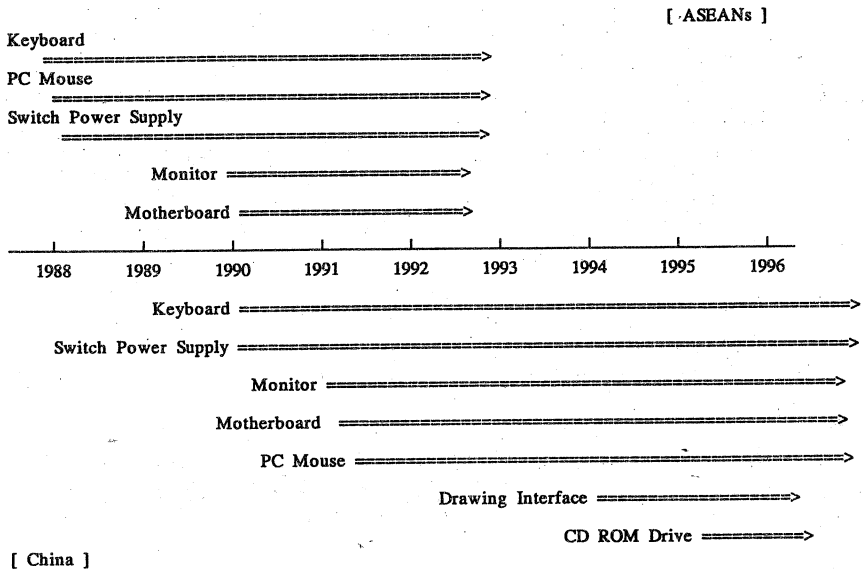
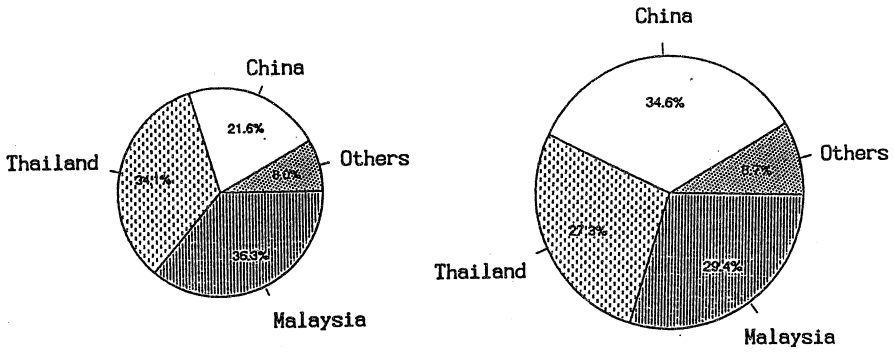


Figure 1 Timeline of Taiwan PC Producers' Outward FDI

Table 8 Taiwan's Major PC-related Projects in ASEANs and China

Destination	Producer and Content of Investment
Malaysia	Acer Peripherals (keyboard, monitor), Lite-on Technology (monitor) Silitek (keyboard), CLEVO (keyboard), Shamrock (monitor), Taiwan Liton (switch power supply), Rectron (switch power supply)
Thailand	Tatung (monitor), ADI (monitor), Chuntex (monitor), Delta (switch power supply), Compal (monitor), Chicony (keyboard, motherboard), Autocomputer (motherboard, keyboard), Capetronic (monitor)
Mainland China	Acer Peripherals (monitor, keyboard, motherboard), First Int'l Computer (motherboard, monitor), Copam (monitor), Mitac (monitor, PC assembly), Datatech (motherboard), Logitech (PC mice), Primax Electronics (PC mice), Delta (switch power supply, PC mice), Chung Hua Picture Tubes (CRT), Picvue Electronics (small-sized LCD)

Source: *Data Bank on the Production and Sales of the Electronics and Information Industry* (in Chinese), Market Intelligence Center, Institute for Information Industry, ROC, 1993, and various press releases.



1992: Total Value of Offshore Production: US$787 million (excluding POS assembly US$182 million)

1993: Total Value of Offshore Production: US$1,691 million

Source: MIC, III.

Figure 2 Geographical Distribution of Offshore Hardware Production (1992/93)

Table 9 Distribution of Taiwan PC Producers' Overseas Subsidiaries in China and ASEAN Countries (1992/93)

Unit: Number of establishments

Region / Product	Mainland China	Thailand	Malaysia	Indonesia	TOTAL
Keyboard	5	2	3	2	12
Switch Power Supply	3	4	3	0	10
Monitor	9	4	3	2	18
Motherboard	7	2	0	1	10
Desk-Top PC	0	1	1	0	2
PC Mouse	3	0	1	0	4
Drawing Interface	8	0	0	0	8
Total	35	10	9	4	58

Source: *Data Bank on the Production and Sales of the Electronics and Information Industry* (in Chinese), Market Intelligence Center, Institute for Information Industry, ROC, 1993.

Table 10
Estimated Cost Savings to Taiwan Companies in Manufacturing Various PC-Related Products in Overseas Operations (1993)

Product Item / Cost Item	Monitor			Motherboard			Switch Power Supply		
	Taiwan	ASEAN*	China	Taiwan	ASEAN*	China	Taiwan	ASEAN*	China
Material Cost	85%	83%	85%	80%	80%	80%	70%	69%	70%
Direct Labor	4%	3%	1%	5%	3%	1%	10%	5%	2%
Indirect Cost	11%	9%	6%	15%	13%	9%	20%	18%	12%
Total Cost	100%	95%	92%	100%	96%	90%	100%	92%	84%
Cost Savings	-	5%	8%	-	4%	10%	-	8%	16%

Product Item / Cost Item	Keyboard			Mouse		
	Taiwan	ASEAN*	China	Taiwan	ASEAN*	China
Material Cost	60%	56%	56%	52%	-	48%
Direct Labor	22%	13%	10%	23%	-	10%
Indirect Cost	18%	15%	13%	25%	-	20%
Total Cost	100%	84%	79%	100%	-	78%
Cost Savings	-	16%	21%	-	-	22%

* "ASEAN" refers mainly to Malaysia.

Source: *Data Bank on the Production and Sales of the ELectronics and Information Industry* (in Chinese), Market Intelligence Center, Institute for Information Industry, ROC, 1993.

these differentials, by themselves, are enough to attract FDI toward China at the expense of the ASEAN countries.[28]

Accelerating outward FDI by downstream firms also induces upstream producers to follow suit. CRT and LCD manufacturers such as Chung Hua Picture Tubes and Picvue Electronics are quickly moving to China. Having established two major facilities in Malaysia, Chung Hua Picture Tubes plowed more than US$26 million into Suzhou and Shanghai for the production of 14-inch monochrome and color CRTs, with additional investment plans laid out for 1995-1996. Another major upstream producer that showed great interest in China is Picvue Electronics, a leading manufacturer of LCDs in Taiwan. Picvue already located a small-size LCD plant to Shanghai, hoping to supply the local PC industry as well as FDI firms originating from Taiwan. Similarly, Lite-on Technology, a major producer of diodes, also announced two major investment projects in early 1996 to build factories in Tianjin and Guangzhou, respectively, for the production of diodes and related semiconductor components. A number of earlier entrants to the Chinese market, including WUS Printed Circuit Co. (PCBs), Hon Hai Precision (calculator components), and Delta Electronics (power supplies and color monitors) are now among the most profitable electronics firms to have established a presence in China.

Judging from this persistent trend of FDI toward the PRC, close production cooperation combining Taiwanese capital, managerial skills, and OEM reputation with Chinese land and labor (both skilled and unskilled) seems an irreversible trend into the future. In terms of division of labor across the Strait, the crucial question is whether Taiwanese firms are capable of "moving up the product ladder" and finding new niches for domestic operations, so that the PC industry may continue to thrive in Taiwan along with successful redeployment of its lower-grade products to China.

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[28] When asked to compare the investment environment between Taiwan, ASEAN countries, and China, Taiwanese hardware producers typically find China superior not only in terms of labor and land costs and ease in daily communications, but also in terms of tax benefits for foreign investors. The only area where China has scored lower than Malaysia is in the provision of public infrastructure. See *Data Bank on the Production and Sales of the Information and Electronics Industry* (in Chinese), Market Intelligence Center, Institute for Information Industry, project report commissioned by the Ministry of Economic Affairs, 1994, p.15-17.

Pressure on Domestic Restructuring

Theoretically speaking, there are three possible ways in which a firm can deal with its domestic capacity after an overseas transplant is made. They can:

1. Reduce the scale of domestic production or totally cease operations at home;

2. Engage in product differentiation and upgrading (horizontal integration); or

3. Diversify and/or vertically integrate.

In Taiwan's case, all three modes of behavior are observable, and the reason underlying the selection of each mode seems to be closely related with the particular scale and scope of the firm in question. More specifically, one can distinguish between three types of PC producers, which correspond to the three modes of behavior indicated earlier.

The first type of firm, adopting the first option, consists of small- and medium-sized PC firms producing a single product on a limited scale. As these firms were the hardest hit by the changing domestic environment in recent years, they were also the first to move offshore. Once they relocate production in China, they typically discontinue manufacturing activities in Taiwan, retaining only the partial functions of marketing and product development. Overseas production by these firms tends to concentrate on low-price, labor-intensive, and standard technology items such as keyboards, PC mice, and switch power supply units.

The second type of producer is medium-sized firms producing a spectrum of closely-related products in Taiwan. They maintain operations at home through product upgrading and/or differentiation (that is, a horizontal division of labor between the parent and the subsidiary) but lack the managerial, financial, and technological capability to engage in vertical integration and/or production diversification. The majority of smaller-scale monitor and motherboard producers in Taiwan fall into this category. For example, when Mitac and Copam moved the assembly of small-size monitors to overseas bases, they switched to larger-size monitors for production at home. In 1993, production relocated in mainland China was mostly of 14-inch monochrome VGA, 14-inch color VGA, and 14-inch color SVGA monitors, whereas domestic production was upgraded to higher-end products such as 15- and 17-inch color SVGA monitors.

Similarly, Clevo and Chicony switched their emphases to notebook PCs for home production soon after they moved their keyboard production to Malaysia and Thailand.

The third type of firm consists of large-scale, multi-product manufacturers that are increasingly approaching MNC status by international standards. Acer, First International Computer, and Tatung certainly belong to this select group. For these firms, overseas operations are an integral part of their global production and marketing strategy and therefore are viewed as a supplement to, rather than a substitute for, domestic production. Another feature of these firms is that they were very cautious in moving into China. Acer, for example, was among the last to make a move because of political concerns. However, in the long run, these are the firms most capable of extensive investments in the PRC. In 1994, major PC producers in Taiwan, led by Acer, persuaded the government to loosen restrictions on FDI ventures in China for the assembly of the post-486 PC series (now known as Pentium), which was the most recent model introduced for production in Taiwan. The argument put forth is that the assembly process is labor-intensive, and thus better situated in China than in Taiwan. Given that, the question left for Taiwanese producers is one of domestic product realignment (for example, moving into the area of key PC components), which, in turn, will place these firms in direct competition with established foreign MNCs currently dominating the scene. Whether Taiwanese producers will be able to win this high-tech battle and gain a solid stance in the arena remains an open question.

Faced with this challenge, Taiwan's response was two-fold. First, at the policy level, a regulation scheme of *counterpart investment* was put forth in 1992.[29] This requires certain (especially high-tech) China-bound FDI firms to commit to new investment projects at home in accord with the changing comparative advantage of the domestic economy. The government subsequently adopted a categorical regulation scheme to screen FDI projects destined for China, in which a positive list of over 4,500 items are permitted as legal FDI toward the PRC and a negative list of a few military and government-sponsored items are not allowed. There is a gray area in between subject to special screening and guided by the *counterpart investment* principle. Apart from this categorical regulation scheme, any

[29] The idea was first proposed in 1991 but was not fully adopted by the government until late 1992. See Chung, Chin (1991b) and Yen, Lin, and Chung, (1992), ibid.

mainland-bound FDI project exceeding US$10 million automatically falls into the special screening category. The main concerns here are with potential transplants of high-tech capacities that Taiwan is itself trying to develop, in the hope that Taiwan's current technological lead *vis-a-vis* China will not be disturbed by successive waves of Taiwanese FDI toward the mainland.

Second, at the firm level, major producers such as Acer, Tatung, and First International Computer also took spontaneous steps toward diversifying their product range and, in particular, investing in vertically interrelated PC key components. Acer, for example, formed a JV with Texas Instruments (TI-Acer) in 1989 to set up Taiwan's first 6-inch wafer plant for the manufacturing of 4Mb DRAM. The facility was expanded to produce 16Mb DRAM using 8-inch wafers in 1995, and TI-Acer is now spending another US$1.3 billion for a new 8-inch wafer plant, which is expected to start production in 1997 for 64Mb DRAMs (and gradually extending into 256Mb DRAMs) at a geometry of 0.35/0.25 micron (Table 11). Another major PC and peripherals producer in Taiwan, First International Computer (FIC), also extended its operations into the realm of semiconductor design and manufacturing, making high-powered 386 and 486 ICs in the early 1990s and multimedia ICs more recently. Similar effort of production integration/upgrading is observed for Chung Hua Picture Tubes, a close affiliate of the consumer electronics giant Tatung. Since 1993, Chung Hua Picture Tubes has invested quite extensively in China, but it also has major upgrading plans for Taiwan in the area of color STN LCDs and large-sized (32-inch) CRTs to be used in HDTV, in addition to its newly acquired capacity for the production of 17-inch color VGAs.

Perhaps more illuminating are the waves of investment made by firms outside the PC industry proper, i.e., those coming from the more traditional sectors of textiles, plastic materials, wire and cable, and heavy metals, which resulted in an inter-industry restructuring spree dictated by changing comparative advantages in the domestic economy. Under the promotion schemes of the government, key PC components in particular have become a major area for extensive investment by these traditional firms. Take the Formosa Plastics group for example. Originating in the petrochemical industry, the Formosa group began to invest in First International Computer in the mid-1980s, which soon became the world's largest motherboard producer and a formidable competitor in the PC assembly industry. It is now extending operations into the realm of 8-inch 16/64Mb DRAM as well

Table 11 Recent Taiwanese Investment in PC Key Components

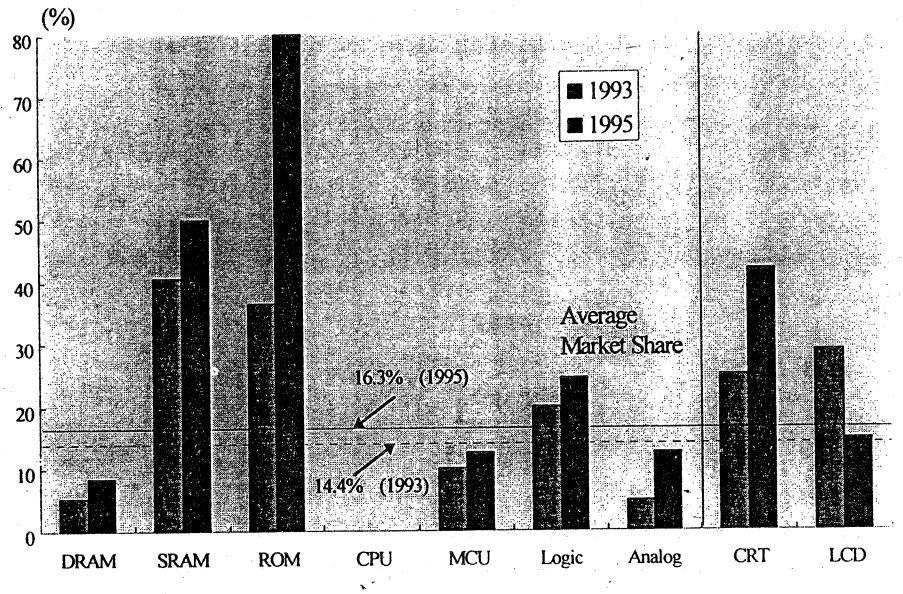
Company Name	Content of Investment	$ Amount (US$ Mil.)	Monthly Output (1,000)	Process Technology (Micron)	Expected Startup Date
1. Vanguard Int'l (plant IA & B)	8" DRAM, 4/16Mb SRAM	1380	15 15	0.5 0.4	1994/4Q 1996/4Q
2. TI-Acer (plant I, IA, & plant II)	6" DRAM, 4/16Mb 8" DRAM, 16Mb 8" DRAM, 64Mb	250 470 1280	10 20 40	0.8/0.5 0.5 0.35/0.25	1992 1995/3Q 1997/2Q
3. TSMC (plant III, IV, & V)	Foundry	2900	35/30/25	0.5 0.35	1995/3Q 1996/97
4. UMC (plant III)	LOGIC, SRAM, Foundry	910	25	0.5/0.35	1995/3Q
5. UMC's 3 JVs	Foundry	3030	25/25/25	0.35/0.25	1996/97
6. Nan Ya Technology	8" DRAM, 16/64Mb STN LCD	580 44	24 30	0.45	1996/4Q 1994/4Q
7. Powerchip	8" DRAM, 16Mb	75	25	0.4	1996/3Q
8. Mosel-Vitelic (plant II)	6" & 8" DRAM	1450	25	0.55/0.35	1997/1Q
9. SMV Technology (Siemens-Mosel JV)	64/256Mb DRAM --> 1Gb DRAM	1700	20	0.35/0.25	1997/98
10. Winbond (plant III)	SRAM, Logic, DRAM	1300	40	0.35/0.25	1997/1Q
11. Macronix (plant II)	NV Memory, ASIC	1100	30	0.35/0.25	1997/2Q
12. Ta Tung/ Chung-hua Picture Tubes	Memory 17" & 32" CRT; Color STN LCD	730 230 110	25 - -	- - Toshiba	1997 1994 1995
13. Teco	17" & 32" CRT;		-	NEC	1997/3Q
14. Unitac Optic.	Color TFT LCD	365	-	for PC	1995/96
15. Prime View	Color TFT LCD	255	20	for PC	1997
16. Asia-Pacific Investment Co.	15", 17", & 32" CRT;	-	-	-	-
17. Tysil Electr. Materials Co.	Silicon Wafer	400	-	MEMC	1996/1Q
18. Nan Ya/Komatsu	Silicon Wafer	500	-	Komatsu	1997/98

Source: *The Semiconductor Yearbook of Taiwan* (1995) and various news releases.

as STC LCDs via its main arm, Nan Ya Technology, in anticipation of these sectors' strong growth. Another example is Walsin Lihwa, the second largest cable and wire manufacturer in Taiwan, who invested in Winbond (a spin-off from ERSO) in the 1980s and found it one of the biggest cash earners among all its affiliates. Similarly, the Hualon group from the textiles industry recently announced a plan to build an 8-inch wafer fab, in addition to its established affiliate, Hualon Microelectronics (HMC), which produces semiconductors and is moving fast to CCDs. Finally, one of the leading automobile producers in Taiwan, the Yulong group, also bought out Photron Semiconductor recently and is negotiating with OKI to transfer 4Mb and 16Mb DRAM technology from Japan. Even in the more upstream arena, China Steel has teamed up with MEMC to set up a JV (by the name of Tysil Electronic Materials Inc.) for the manufacture of silicon wafers, the first such establishment in Taiwan. Following its lead, one of the world's leading manufacturers of silicon wafers, Komatsu, also stepped in Taiwan recently in a JV with Nan Ya Technology and Asia Development Holding Co. (in which the Formosa group has a strong hold) to produce silicon wafers directly in Taiwan. With the rich spectrum of vertical linkages thus created, Taiwan's IC and PC industries are now in a position to operate more efficiently than ever before — except for the two still-missing segments of semiconductor manufacturing equipment (capital goods) and systems design (CPUs).

Placed at a Crossroad

Taiwan has come a long way in developing its PC and IC industries, but it has admittedly not gone far enough. Despite the fact that its IC industry grew at a spectacular average annual rate of 50 percent over the past five years, its downstream PC producers still imported 84 percent of the required information ICs, 85 percent of the LCDs, and 99 percent of the CPUs in 1995. Domestic manufacturers' market share in DRAMs was a mere 8.5 percent in 1995 (up from 5.2 percent in 1993), and close to nil for CPUs (Figure 3). The five largest DRAM suppliers in Taiwan are Goldstar, Mitsubishi, NEC, Samsung, and Texas Instruments. The only domestic firms that have achieved some market share are Mosel-Vitelic, Vanguard, and TI-Acer. However, in view of the major domestic investment plans in the 16/64Mb DRAM area listed above and the fact that Taiwan has managed to keep pace with state-of-the-art process technology in the field (Table



Source: Original sources from ERSO, ITRI.

Figure 3 Market Shares for Domestic Producers of PC Key Components (1993-95)

Table 12 Catching up with Top-notch Process Technology: The Case of IC

Micron	Taiwan	World Leader	Gap in Years
7μ	1976		
5μ	1980		
3.5μ	1983		
1.5μ	1986	1980	6 Yrs
1.2μ	1988	1983	5 Yrs
1μ	1990	1686	4 Yrs
0.8μ	1991	1990	1 Yrs
0.5μ	1994	1992/3	1-2 Yrs
0.35μ	1996.10.	1996.1.	9 months
0.18μ	2000*	2000*	-

* Expected date for mass production.
Source: Adapted from ERSO, ITRI.

12),[30] its dependence on Korean and Japanese suppliers for the procurement of DRAMs may fall steadily in the next few years.

The prospect for CPUs is less certain. Currently, U.S. firms such as Intel, AMD, Cyrix, Motorola, and Texas Instruments are the prime suppliers in the domestic CPU market. These firms occupied more than 99 percent of the Taiwanese market in 1995. The main problem here lies not with technology *per se* but with marketing barriers and intellectual property rights (IPR). Taiwanese firms proved able to develop independently the world's second prototype of 32-bit PC — after Compaq but ahead of IBM — in 1986.[31] They have also acquired a proficiency in the development of the Chinese language software, which has led a number of MNCs to utilize Taiwanese software designers to develop software in both Chinese and other languages not using the Roman alphabet (for instance, Thai and Korean in the case of word processing systems).[32] But Taiwanese producers, as latecomers, simply cannot help stepping on U.S. firms' toes.[33] Leading U.S. hardware producers, such as IBM and Intel,

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[30] The government-supported research institution, ERSO, played a pivotal role in accelerating the development and dissemination of IC processing technologies in Taiwan. On the other hand, the tremendous growth in the indigenous IC industry, together with the handsome profits to be earned, also enabled individual firms to accumulate technology through self-directed R&Ds and by forging strategic alliances with foreign multinationals.

[31] Acer launched its first 32-bit microcomputer in 1986 and took all of its Western competitors, including IBM and Compaq, by surprise. This, however, had come only naturally in view that Acer had a proven history of being first in launching new ideas: it developed the first Chinese operating systems for computers in 1980, as well as its own 4-bit, 8-bit, and 16-bit microcomputers in subsequent years. In 1988, Acer further announced the world's first PC86 chip designed for PS/2 model 30 PCs through its central research hub, Acer Laboratories Inc. See Mathews (1995), ibid., pp.90-91. Also, see *The Economist* (1991:19).

[32] *Far Eastern Economic Review* (1984), p.65. See, also, Dieter Earnst (1985).

[33] For example, United Microelectronics Corp. (UMC), the largest own-brand IC manufacturer/designer in Taiwan, developed its own CPU in 1994 after painstaking endeavor. But the company was forced to stop entry into the industry because of an alleged infringement of Intel's IPR. Similarly, when Acer introduced its first IBM-compatible PC in 1983 and was receiving rising orders form overseas (including from the U.S. company NCR), its products were detained by the U.S. customs because of an alleged IPR violation against the BIOS adopted by IBM. Even though the BIOS used in Acer PC was developed

and system software makers, such as Microsoft, have long set the global standards for personal computers. This poses a problem of "compatibility" for other firms. On the one hand, the existence of *de facto* standards in personal computers means that hardware and software producers around the world have already invested large sums in application products designed around those chips, making the costs of conversion to another microprocessor design extremely high (the disadvantage of the latecomer).[34] Moreover, since software development is characterized by large upfront investment but negligible marginal costs of production once the product has been developed, the companies whose operating systems have been adopted as industry standards have a sizable cost advantage as they can spread their development costs over a large number of units, thereby raising the hurdles for new entrants by way of price competition.[35] On the other hand, if a newcomer tries to produce CPUs within the existing framework of design, it then has to face a complicated network of IPRs spawned by the same market leaders. The established producers can easily forestall competition by pursuing prohibitive royalty fees and/or outright prohibition of usage rights. In order to circumvent the web of IPRs spawned by these producers, the R&D effort of a new entrant must exceed those of Intel and Microsoft by many times just to break through the existing framework, which again places the new entrant at a cost disadvantage. Market leaders can further blockade competitors with their well-orchestrated distribution networks and established brand names. Consequently, for a newcomer such as Taiwan, if domestic R&D capacity cannot ensure follow-up development of an entire product series at extremely low costs, Taiwanese CPU producers will not

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independently in Taiwan (by ERSO and at a cost to Acer), it was not developed under a "clean room" concept. The dispute was later resolved by Acer obtaining a different system developed by DRI. In both cases, however, evidence of plagiarism was never really established.

[34] As O'connor explained it, since the established industry standards already possess a voluminous library of programs written to run under them, a new entrant would need to convince both the applications software writers and hardware producers of the viability of its own product so as to induce them to develop new applications to run on it well before the product is shipped to market. In other words, only an operating system that represents a true technological breakthrough beyond the state-of-the-art is able to induce such a result. See O'connor, David C. (1985).

[35] See O'connor, ibid., pp.314-315.

be able to gain trust and loyalty from downstream users at home and abroad, and will thus lose the momentum necessary to grow in the long run.

All of the above have placed Taiwan at a precarious crossroad. Having established itself as a credible manufacturer of PC hardware, it now faces the difficult choice of continuing exploiting its manufacturing capabilities — but increasingly at another geographical location — or making an entry into new product areas characterized by high risk and uncertainty. A comparatively weak marketing ability and limited owner-specific technology are among the main constraints facing Taiwanese firms. Most of these constraints are directly related to firm size, which, in turn, is endogenous to Taiwan's industry structure and further strengthened by the oligopolistic nature of global competition in the PC industry (the strong get stronger).[36] Formidable constraints notwithstanding, if Taiwan does not upgrade quickly enough it may come under increasing danger of losing competitive strength even in the area of hardware manufacturing, as most of its production know-how and managerial proficiency are bound to be transferred offshore to ensure the success of its overseas FDI operations. Furthermore, the large number of entrants into the PC industry in recent years has resulted in aggressive price competition. Market forces may thus demand a change from the present division of labor as China and other East Asian countries emerge on the electronics scene.

At the same time, the opportunity for product diversification/upgrading seems brighter than ever for Taiwanese firms. The global PC market is being reshaped by buoyant advances in technology, new ideas, and an ever-heightening demand for user-friendly innovations. Recent developments in digital technology and the widespread use of the Internet, in particular, have brought about a rapid convergence between "3-C" (computer, communications, and consumer electronics) products, redirecting the global PC market toward a multimedia and network-centric age. Under the new platform, which is only taking shape gradually and leaves many producers confounded at its eventual configurations, new products and devices are introduced to the market at a speed baffling even to the most sophisticated suppliers. The current global structure of production is entering a new

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[36] Taking (and assigning) OEM orders may be one source of this perpetuated power imbalance. Taiwanese PC producers often fall into the "OEM trap" in which market orders are forthcoming and production capacities are filled, but the firm in question is left with little incentive or free resources to pursue a more independent route for corporate development.

phase of change. The U.S., having lost its market dominance to its competitors (particularly those from Japan), first in hardware manufacturing and then in key PC components, is now clinging to its leading position in systems software and special chip design to sustain a global market share. While Japan has taken over most of the key component markets, it is increasingly losing comparative advantage in PC hardware manufacturing (Figure 4). Lower down the value chain, Taiwan (and, to some extent, South Korea and Singapore as well) is now assuming the role of a prominenthardware manufacturer and ODM and OEM subcontractor capable of replenishing new peripherals and devices as the market progresses. At the bottom of the global production network stand China, the ASEAN countries, and a host of other developing countries that constitute the latest target for production redeployment by first-tier, second-tier, and third-tier PC firms. The objects of such transplants presently consist of standardized peripheral equipment, low-end PC hardware, and some application software designs, but increasingly more advanced models may be relocated to these low-wage countries as market competition becomes more severe.

Within a reasonable time frame, the U.S. and Japan are expected to maintain a controlling edge in global competition in 3-C products, considering their decades-old expertise in product and process development and established market status substantiated by large-scale and diversified operations. The U.S., in particular, is backed further by a winning edge in telecommunications technologies, whereas Japan is likely to remain dominant in the realm of consumer electronics. While the two countries vie for leadership in the emerging struggle between multimedia versus network-based PCs, the "third-tier" countries, including Taiwan and other NIEs ready for the game, stand to gain OEM and ODM opportunities coming from either camp and created by whatever market niches open to their manufacturers. At the same time, it also seems opportune for these "in and system software segments of the industry, both as a countervailing act to break away Japan's (and the U.S.'s) stronghold and as a preemptive move in anticipation of emerging market opportunities. It is only through such efforts that Taiwan, as a latecomer, may have a chance to surpass its present role as a pure "manufacturer" of PC products.

In a slightly different context, Soete (1985), among others, has argued that developing countries with adequate industrial infrastructure and skill levels may benefit from the "windows of opportunity" provided by a *new*

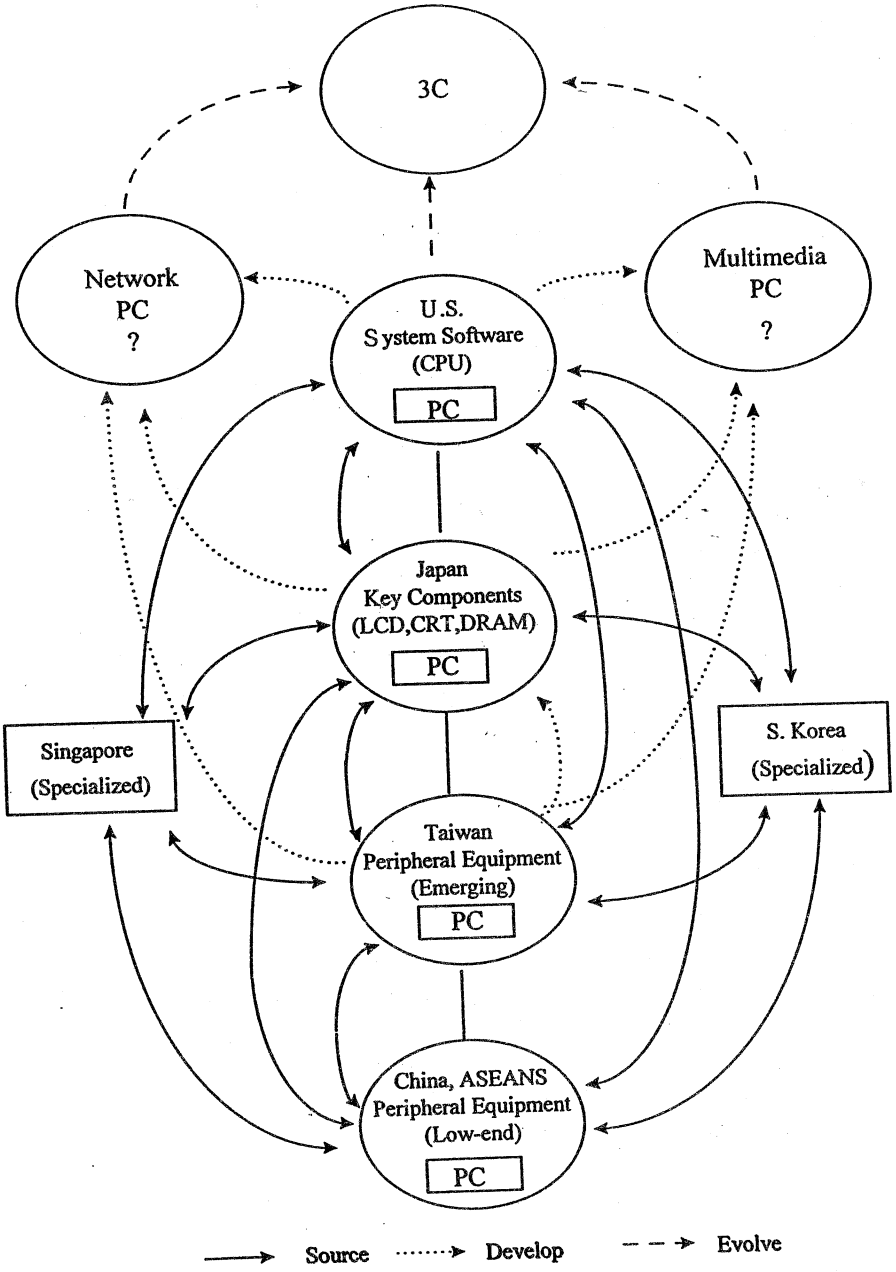

Figure 4 Global PC Market: Present & Future Division of Labor?

technological paradigm, especially at an early stage of diffusion when barriers to entry are relatively low and markets are in a state of upheaval. The degree of competition that exists in the PC market today has rarely been more intense, and the pace with which ideas and products evolve has never been more acute. In other words, the *possibility* for making inroads into more advanced areas of production has rarely been more favorable for a country that is prepared to do so. Indeed, with a proven history of indigenous innovative capacity (although often checked prematurely by competitors due to a lack of financial and distributional muscle), Taiwan is placed in a strategic position to benefit from its quick time-to-market, versatile design capability, strong production engineering, and exquisite product targeting, all supported by a highly functional system of institutional infrastructure.[37] In order to accomplish the above aim, however, Taiwan has to overcome its two main ills with both heavier doses of R&D and stronger emphasis on marketing, including establishing its own distributional networks, in order to compete effectively with the first-tier and second-tier producers. Acer, for example, has recently teamed up with Legend Computer, the biggest distributor/manufacturer of PC-related products in China, in an effort to preempt Japanese and U.S. distribution networks in the vast Chinese market. Strategies like this, coupled with proper product targeting, may prove to be more important than simple accumulation of technological capabilities in Taiwan's future competition with the world's most advanced PC producers.

China's Role: Partner or Competitor?

An obvious question arises: if Taiwan is bestowed with the *possibility* of a quantum leap into the realm of key PC components and product and process innovations, why cannot China do the same thing — and thus undercut Taiwan — given that FDIs are now rushing into the country at a speed unprecedented in any other developing country in the world? Following Motorola, Philips, IBM, Apple, and HP, among still others, Intel Technology has recently announced a US$99 million SRAM project in Shanghai, which will complement its current operation in Manila, for the manufacturing of memory chips for PCs, cellular phones and other digital

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[37] For an excellent discussion of the institutional innovations of Taiwan's IC industry, as well as an in-depth comparison between the different paths taken by Taiwanese and Korean IC firms, see Mathews, John A. (1995). Also, see Wade, Robert (1990).

consumer electronic products.[38] Once Intel is in China, before long most other competitors that have not already done so will be forced to follow suit, as will IC companies from Taiwan.[39] The Chinese policy of "technology in exchange for market", targeting the world's largest electronics multinationals, is likely to reinforce this tendency for high-tech electronics multinationals to invest and manufacture in China. As the Chinese market develops in both technical sophistication and size over the next decades, will the "mantle of electronics leadership" eventually pass from the U.S. and Japan to China, as anticipated by Borrus (1994) among others?

It must be remembered, however, that the potential for technological leapfrogging in a highly dynamic sector such as the PC or IC industry is particularly subject to the absorptive capacity of the country in question, in the sense that the latter must possess an adequate local base in terms of technological, institutional, and human resources (in addition to outright financial means) so as to successfully transform *foreign initiation* into *indigenous industrial activities*. Several points may be noted to highlight China's present deficiency to foster such technological and industrial "leapfrogging".

First among these may be, ironically, the extent of foreign participation and dominance in the current Chinese electronics industry. MNCs come to China to penetrate its vast internal market, not to disseminate core technologies. Massive amounts of FDI may be pouring in, but research and development activities as well as basic chip design are likely to be retained in the home bases of the investing firms, as exemplified by the experience of previous FDI recipients in the field, including Taiwan, Korea, and Singapore.[40] Thus, in the foreseeable future, China will more likely be

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[38] According to Intel Vice President Parker, the project will be "no less spectacular than any other high-tech center around the globe." *See Commercial Times,* November 14, 1996.

[39] So far, FDI made by Taiwan IC firms has been directe mainly toward the advanced country markets — the U.S. and Europe in particular — in an attempt to gain technology or to forge strategic alliance with local firms. China remains a high-risk region in the eyes of these firms, owing both to the tremendous stake (in terms of financial outlays) involved and to their relative inability to spread these risks.

[40] As noted elsewhere, the extent to which each of these economies has been exposed to FDI by MNCs is different, as are the resulting impacts upon the development of

assigned the role of a regional manufacturer, servicing the Chinese market in particular and under strict control of foreign MNCs, and only gradually be burdened with more locally-oriented OEM and ODM contracts as its infrastructural and technological capabilities build up. At the same time, however, it is entirely possible for FDIs to "crowd out" domestic activities given the formers' competitive strengths in the marketplace and the current supply conditions in China. Singapore provides a good example here. The semiconductor industry in Singapore is represented overwhelmingly by foreign MNCs. Firms like Texas Instrument, SGS-Thomson, NEC, Linear Technology, AMD, Seimens, Toshiba, Fujitsu, Matsushita, and Hitachi competed with one another to enter the small city state in the 1970s and 1980s, and fostered a rapid development in its IC-testing, packaging, and application industries. By 1995 there were a total of 28 semiconductor MNCs operating in Singapore, making it the world's primary supplier of disk drives (Seagate), Apple computers (Apple), and printers (HP). However, domestic capacity remained quite underdeveloped due primarily to a brain-drain effect, with foreign MNCs absorbing and preempting local talent necessary for an indigenous IC sector to thrive. For example, when Chartered Semiconductor (a JV between the Singapore government and National Semiconductor that specializes in wafer fabrication — in part modeled after TSMC of Taiwan) ran into a management crisis in early 1991, shortly after its 1989 inauguration, it had to solicit help from TSMC to send high-level personnel to review and reorient its corporate strategies.[41] This example serves to illustrate the importance of a locally-based approach to high-tech industrial development, along with proper human capital accumulation and industrial learning, for subsequent breakthroughs to be at all possible.

At present, the Chinese economy is still plagued by a large state-owned sector in which institutional and structural rigidities abound. The defects of this sector, in terms of fostering the growth of a high-tech industry, include a sluggish information gathering/assessment mechanism and therefore slow decision-making, a lack of efficiency and creativity in general corporate

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indigenous capacities. See Borrus (1994), Mathews (1995), and Earnst (1994).

[41] See Chang, Shun-chiao (1996), "The Analysis of Taiwan's Semiconductor Industry: A Test of the Technological Leapfrogging Theory," forthcoming discussion paper (in Chinese), CIER, Taipei.

management, and, in particular, low morale of the workforce due to a noncompetitive salary scale. As is generally recognized, a pool of highly-skilled, richly-experienced, and well-rewarded personnel from home and overseas is one of the most important factors contributing to the rapid development of indigenous high-tech industries.[42] Given its current reward system, however, it is virtually impossible for the state-owned sector to attract even local talent, not to mention foreign-trained expertise, *vis-a-vis* MNC entrants into the Chinese economy.

Second, and closely related to the first point, China seems to have placed an overly heavy emphasis on the generation of large industrial conglomerates (implicitly to counter the dominance of foreign multinationals) to the neglect of spontaneous small- and medium-sized enterprises. By pursuing this Korean (or Japanese) model of industrial development, China may be inadvertently placing itself in a deadlock situation in the sense that it is forced to choose between two evils -- a much bolder embrace of the MNCs (with JVs being the norm to stimulate growth in state-owned conglomerates) or a bleak retreat to its own noncompetitive industrial establishments (in the case where an independent development strategy is pursued). The difficulties for present-day China in adopting the Korean model stem, of course, from the fact that its state-owned sector is not as market-tested and "ready" as the Korean *chaebols* in the late 1970s and early 1980s. An alternative, and highly viable, approach to developing high-tech industries is given by the case of Taiwan, which essentially encouraged a pool of innovative and dynamic SMEs to work side by side with large-scale operators such as TSMC and UMC in the semiconductor industry (which are spin-offs from the public research institution, ERSO), and Acer and FIC in the PC industry (which are natural outgrowths of SMEs). This more balanced approach to development (one that is more market-oriented and, perhaps, more akin to the U.S. model) has helped create an environment in which different segments of the PC and IC industries are given incentives and viability to thrive, each depending on the success of the others, and in the meantime helped spawn an efficient indigenous production network which greatly enhanced the stability of the

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[42] This is certainly true for Taiwan and Singapore, where a significant backflow of talent contributed significantly to the development of the local PC and semiconductor industries. It is also true for the U.S., where numerous American-trained Asian engineers and programmers work in the Silicon Valley and enhanced greatly its competitiveness in the PC and semiconductor industries.

entire industry, giving it more structure to sustain market fluctuations and to gain international competitiveness. Viewed in this light, the current Chinese policy of "implicit oppression" of private SMEs can prove to be most counterproductive, if not devastating.

Finally, the erection of high tariff walls and other forms of industrial protection may also work to the detriment of indigenous growth of the PC industry. Take again the case of Taiwan. It is striking how the PC and IC industries have developed in Taiwan almost without any protective barriers being erected at any time.[43] Such measures are purposely avoided to give downstream producers an edge in international competition. As a result, Taiwanese PC producers and chip makers are forced to control production and managerial costs to the extent that they emulate the best practice exercised by some of the top-ranking MNCs.[44] On the contrary, protective measures are used extensively in China both as a means to attract foreign investment and to foster domestic industrial growth. This policy orientation may again prove counterproductive because it would hamper necessary competition from foreign firms and breed inefficiency in domestic suppliers such that the latter may never "grow up" to be internationally competitive manufacturers. An FDI "enclave", rather than a flourishing domestic supply base, may be the result of this policy package of high protection, FDI attraction, and a lopsided reliance on rigid state-owned sectors.

For indigenous capacity to grow in China, the more important factors are the provision of flexible and efficient institutional support, good management, calculated product choice, and strategic corporate planning (and, of course, always with a heavy dose of learning and self-directed R&D). A lot of these have to do with the overall progress of economic reform in China. Before China is able to accomplish these — and it may take a long time — it is unlikely that China will become a strong power in electronics except for its manufacturing potential and its role as a regional production base dominated by foreign MNCs. In the interim, if Taiwan is able to cross its own "threshold of quantum leap" with continual domestic upgrading and a carefully balanced (and policy-regulated, if necessary) outflow of FDI, China is likely to remain a help rather than a hindrance to

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[43] Taiwan's tariffs on IC and PC products have been low, as a tradition, at about five percent in the 1980s and averaging one percent in 1996.

[44] See Borrus, Michael (1994) based on industry discussions.

Taiwan's future expansion of the PC industry.

V. Conclusion

The emergence of China and other Asian developing economies in the 1980s has induced a drastic shift in comparative advantages in production and trade for all the regional economies involved. Sharing both cultural and linguistic proximity with China, Taiwan has made extensive FDI toward the mainland in the past decade and is expected to continue upgrading its operations in China over the long haul. The impact of this FDI has so far been limited to a relocation of lower value-adding production activities, but the process may increasingly demand more substantive transfers of production technology, managerial know-how, and marketing skills. This has put tremendous pressure on investing firms, both as a spontaneous market reaction and in answer to the government's requirement, to engage in extensive product realignment at home. The process is reminiscent of Krugman's model of North-South technology trade,[45] in which it is described how new industries have to emerge constantly in the North in order to offset declining comparative advantage in the traditional sectors that are being driven out of existence in the face of low-wage competition from the South. The "monopoly" power of the North is continually eroded by "technological borrowing" from the South, and thus must be maintained by constant innovation of new products.

In more complicated real-life situations, Taiwan is like a country in the "Middle" whose technologies are "borrowed" by the South while it may encounter difficulties "borrowing" technology from the North. Furthermore, capital (implicitly, technology itself) can now move across borders. Given that the growth prospect is stagnant in the North but rising ever more rapidly in the South, and that governments in the South rely heavily on trade protectionism to foster industrial development at home (no matter how inefficient that may be), will there be anything left in the North, in the long run, except for profit remittance and royalty fees? And what

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[45] Krugman, Paul (1979), "A Model of Innovation, Technology Transfer and the World Distribution of Income," *Journal of Political Economy*, Vol. 87, pp. 253-266.

about the country in the Middle? Should it use the low-wage advantage of the South to undercut the North (and perhaps the South as well)? Or will it eventually undercut itself by driving out of existence its own industries? These are the issues this paper is basically about. It is the author's view that, for countries in the Middle in particular, who do not yet have a proven ability in technology innovation, there is clearly a *normative scope* for policy interventions. It is also in this sense that the emerging pattern of division of labor, although initially induced by free-market forces and played out by independent private actors, may in due time invite public-sector interventions of various sorts.[46] The case of Taiwan *vs.* China — with all its peculiar tone tinged with tight cultural bondage and treacherous political undercurrents — only provides an extreme example of a general issue that merits multilatral attention.

The PC industry provides a small-scale synopsis of the situation facing Taiwan today. While domestic downstream manufacturers are eagerly seeking offshore bases to relocate their assembly lines, emphasis for home production must break new ground and confront new challenges. In its lines of production, whether they be labor-intensive, capital-intensive, or technology-intensive, Taiwan now faces the challenge of abrupt restructuring and upfront competition with advanced country producers which, in turn, requires Taiwanese firms to engage in substantial R&D and to establish their own brand names. This will not be an easy task for typically small-scale Taiwanese firms. We have learned from the case study of the PC industry that Taiwanese small-scale producers often found relocating to China an easier option than upgrading product lines at home. Only the medium- and large-sized firms showed a tendency to engage in product differentiation and/or diversification. Under proper policy guidance, though, we also witnessed numerous cases of inter-industry restructuring by large-scale traditional firms — those coming from textiles, petrochemicals, cable and wire, and heavy metals — making impressive advances in the PC and IC industries. The investment booms thus created in these sectors accounted for almost a third of Taiwan's private industrial investment in the past few years, and have rendered the PC and IC industries the most dynamic sectors in the economy. Important areas for investment include large-sized CRTs, LCDs, LEDs, DRAMs, as well as silicon wafer plants. All of these seem

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[46] The Information Technology Agreement (ITA) recently proposed by the U.S. in the first ministerial meeting of the World Trade Organization (WTO) provides a good example of this point.

better suited to Taiwan's current and future comparative advantage. Thanks also to buoyant advances in technology and emerging market niches, Taiwan is in a favorable position to benefit from its quick time-to-market, versatile design capability, manufacturing expertise, and ingenious institutional innovations to develop new competitive edges in the upcoming 3-C era. China, in this context, can provide Taiwanese firms with an excellent location for intra-regional division of labor, given its abundant labor supply, a well-trained reservoir of local talent, a vast internal market, and an additional advantage of minimal (implicit) entry costs.

At the same time, the precarious nature of the future competition facing Taiwan can hardly be exaggerated. Currently, Taiwan lags considerably behind its potential competitors (the U.S., Japan, European countries, and South Korea) in almost every front of the battle: technology, R&D, marketing, and general corporate strengths. Although Taiwan's PC and IC industries grew rapidly at a combined annual rate of nearly 30 percent in recent years, they nonetheless constituted only 5.5 percent of world supply (in value terms) and less than 10 percent of Taiwan's GDP in 1995. The IC industry in Taiwan (the "star of stars" in electronics) has recently set the target of reaching an output value of US$25 billion and a world market share of 8 ~ 10 percent by the year 2000, gaining substantially from its 1995 status of US$3.5 billion and 2.8 percent. The PC industry has similarly set a target of US$65 billion and a world market share of 14 percent by 2000, up from its 1995 status of US$21 billion and 7 percent. Since the PC and IC industries currently constitute the two most lucrative and dynamic sectors in Taiwan's economy, whether they can achieve their goals will have an important impact upon the overall performance of Taiwan's manufacturing sector.

As far as China is concerned, its role in the emerging pattern of the intra- and inter-regional division of labor is likely to remain that of a manufacturing base — albeit an incredibly *gigantic* one — until it is able to rid itself of the various institutional and structural rigidities embedded, in particular, in its state-owned sectors. As a related point, although it is true that, in Taiwan, a new emphasis on large-scaled operators (and operations) may be coming to the forefront of its industrial development strategy, it is equally true that, in China, it is really a growing pool of spontaneous and versatile SMEs that is missing for a successful fostering of an indigenous PC supply base. Viewed in this light, the shifting comparative advantage across geographical regions not only engenders a new pattern of division of labor among different locations, but also implies a need for fundamental changes

in the organizational structure of the economies involved. In this respect, too, both Taiwan and China have much to accomplish in the years to come.

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