



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*



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*

December 1996



財團  
法人 中華經濟研究院

CHUNG-HUA INSTITUTION FOR ECONOMIC RESEARCH  
75 Chang-Hsing St., Taipei, Taiwan, 106  
Republic of China  
TEL: 886-2-735-6006  
FAX: 886-2-735-6035

ISBN 957-9676-19-4

Discussion papers are intended to provide prompt distribution of CIER's preliminary research work to interested scholars and to invite their discussions and critical comments.

The opinions expressed in these papers are those of the authors and do not necessarily reflect the views of the CIER.

Any comment or communication, please write to: Publications Department, Chung-Hua Institution for Economic Research, 75 Chang-Hsing Street, Taipei, Taiwan 106, ROC.



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



財團  
法人 中華經濟研究院

CHUNG-HUA INSTITUTION FOR ECONOMIC RESEARCH  
75 Chang-Hsing St., Taipei, Taiwan, 106  
Republic of China  
TEL : 886-2-735-6006  
FAX : 886-2-735-6035

ISBN 957-9676-19-4

*DISCUSSION PAPER SERIES No.9611*

December 1996

Discussion papers are intended to provide prompt distribution of CIER's preliminary research work to interested scholars and to invite their discussions and critical comments.

The opinions expressed in these papers are those of the authors and do not necessarily reflect the views of the CIER.

Any comment or communication, please write to: Publications Department, Chung-Hua Institution for Economic Research, 75 Chang-Hsing Street, Taipei, Taiwan 106, ROC.

*Discussion Paper Series No. 9611*

**The Emerging Pattern of Division of  
Labor across the Taiwan Strait:  
Macro Overview and Sectoral Analysis  
of the Electronics Industry**

by

**Chin Chung**

*Associate Research Fellow*

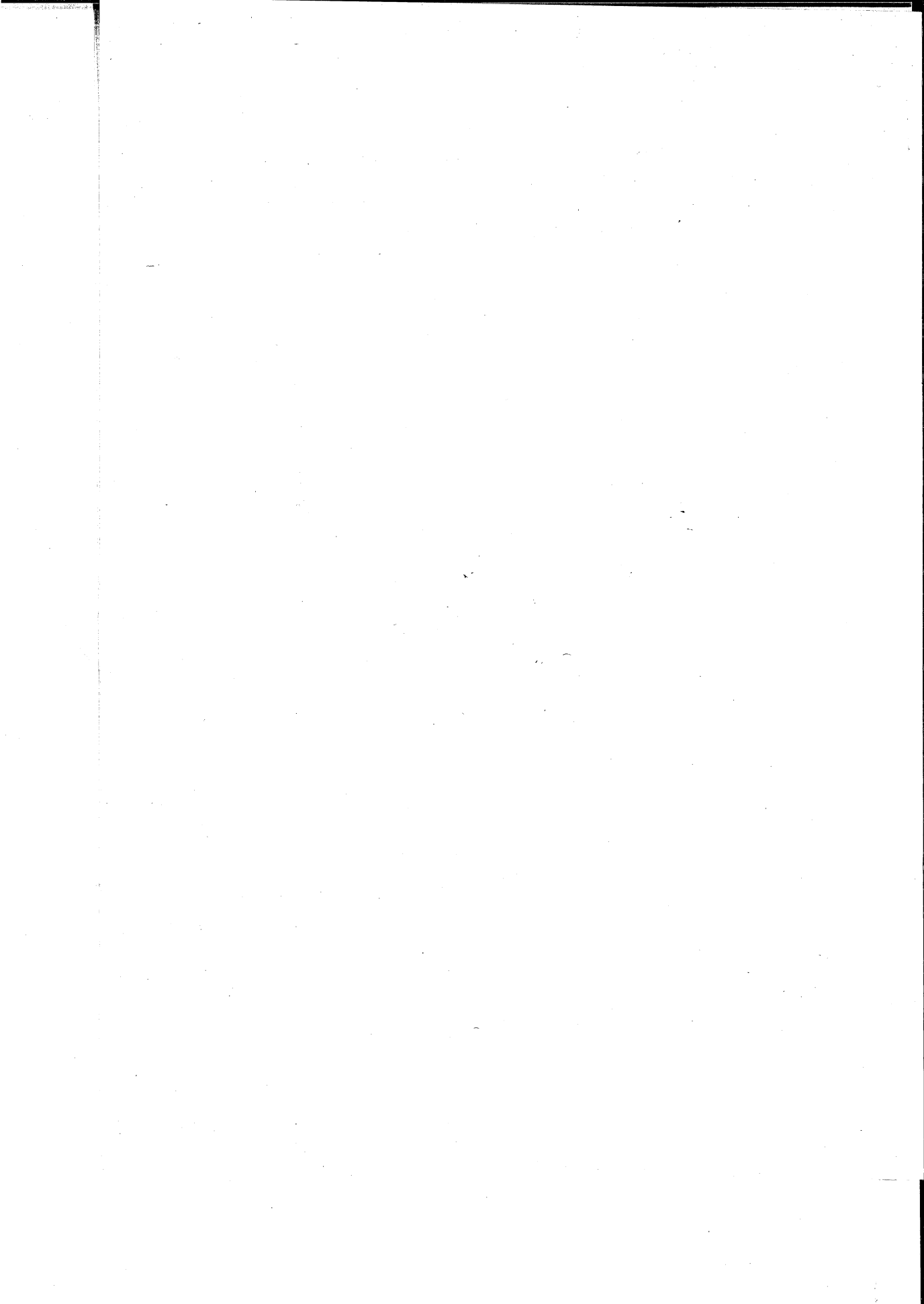
*Chung-Hua Institution for Economic Research*

**December 1996**

**Chung-Hua Institution for Economic Research**

**75 Chang-Hsing St., Taipei, Taiwan 106**

**Republic of China**



---

CHIN CHUNG\*

---

**The Emerging Pattern of Division of Labor  
across the Taiwan Strait:  
Macro Overview and Sectoral Analysis  
of the Electronics Industry\*\***

**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

---

\* Associate Research Fellow, Chung-Hua Institution for Economic Research.

\*\* 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/<br>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.<sup>1</sup> 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

---

<sup>1</sup> 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.<sup>2</sup> 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.<sup>3</sup> 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.

---

<sup>2</sup> For a detailed account of Taiwanese SMEs’ investment behavior in China, including their motivations, limitations, and trade consequences, see Chung, Chin (1995).

<sup>3</sup> 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.<sup>4</sup> 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.<sup>5</sup> Equation 1 shows the increase in output in the PRC ( $\Delta Y_i$ ) as a function of the amount of FDI ( $\Delta K_i$ ) 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.<sup>6</sup> Equation 2 shows the FDI-induced increase in exports from China ( $\Delta X_i$ ) to the rest of the world, where  $\alpha_i$  is the export propensity of the FDI firms in the  $i$ th industry. Equation 3 shows the

---

<sup>4</sup> The figures are obtained from an official survey of all FDI operations in China as of February 1993. See Kao, Chang and Shih-Ing Wu (1994).

<sup>5</sup> For details of the set-up of this model and a discussion of the underlying assumptions, see Chung, Chin (1991a), *ibid.*, pp.226-230.

<sup>6</sup> 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

| Manufacturing sector                        | Total Foreign Direct Investment |         | Taiwan's Direct Investment |         |
|---------------------------------------------|---------------------------------|---------|----------------------------|---------|
|                                             | 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 ( $\Delta T$ , a  $29 \times 1$  vector) created by FDI-related production in China ( $\Delta Y^*$ , a  $29 \times 1$  vector), where  $D$  is the  $29 \times 29$  domestic input coefficient matrix derived from the 1989 input-output table for Taiwan, and  $\delta_i$  is a sector-specific scalar representing the propensity to acquire these inputs from original sources by the  $i$ th-sector FDI firms.<sup>7</sup> Equation 4 shows the "reverse imports" or "sellbacks" to the home market of the  $i$ th industry ( $\Delta M_i$ ), based on an estimate of  $\gamma_i$ , the "reverse-import propensity" of the  $i$ th-sector FDI firms operating in China.<sup>8</sup>

$$\Delta Y_i^* = \Delta K_i(Y/K)_i^* \quad i=1, \dots, 29 \quad (1)$$

$$\Delta X_i^* = \alpha_i \Delta Y_i^* \quad i=1, \dots, 29 \quad (2)$$

$$\Delta T = \delta_i D \Delta Y^* \quad i=1, \dots, 29 \quad (3)$$

$$\Delta M_i = \gamma_i Y_i^* \quad i=1, \dots, 29 \quad (4)$$

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.<sup>9</sup>

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

---

<sup>7</sup> Operationally, the  $\delta_i$ s enter the equation in the form of a  $29 \times 29$  diagonal matrix with the  $\delta_i$ s sitting on the diagonal and zeros everywhere else.

<sup>8</sup> 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).

<sup>9</sup> 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.<sup>10</sup> 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.<sup>11</sup> These

---

<sup>10</sup> Chung, Chin (1991a), *ibid.*, pp.237-238.

<sup>11</sup>According to Taiwan's input-output table for 1989, these are all labor-intensive

### *The Emerging Pattern of Division of Labor across the Taiwan Strait*

include the manufacture of apparel, leather and fur products, wood and bamboo products, miscellaneous products (such as toys and sporting goods), plastic products, nonmetallic mineral products, metal products, and electrical and electronic products. These sectors all fall into the labor-intensive 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

---

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 *               |
| <b>Nondurables Subtotal</b>         | <b>16,583</b>          | <b>13.49%</b>                | <b>35,426</b>                 | <b>21,198</b>          | <b>18,843</b>                 | <b>4,615</b>                   | <b>-14,228</b>         |
| 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                           | 1,750                          | 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 *               |
| <b>Intermediates Subtotal</b>       | <b>9,527</b>           | <b>19.14%</b>                | <b>27,243</b>                 | <b>17,869</b>          | <b>17,716</b>                 | <b>8,342</b>                   | <b>-9,373</b>          |
| 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                    |
| <b>Durables &amp; Capital Goods</b> | <b>12,997</b>          | <b>20.48%</b>                | <b>39,759</b>                 | <b>33,927</b>          | <b>26,762</b>                 | <b>20,930</b>                  | <b>-5,832</b>          |
| <b>All Manufactures</b>             | <b>39,107</b>          | <b>17.41%</b>                | <b>102,428</b>                | <b>72,995</b>          | <b>63,321</b>                 | <b>33,888</b>                  | <b>-29,433</b>         |

\* 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                           | 5,771                  | 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 *                |
| <b>Nondurables Subtotal</b>         | <b>12,236</b>          | <b>19.24%</b>                | <b>35,166</b>                 | <b>42,684</b>          | <b>22,930</b>                 | <b>30,448</b>                  | <b>7,518</b>           |
| 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 *                  |
| <b>Intermediates Subtotal</b>       | <b>3,844</b>           | <b>7.04%</b>                 | <b>5,783</b>                  | <b>16,284</b>          | <b>1,939</b>                  | <b>12,440</b>                  | <b>10,501</b>          |
| 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                  |
| <b>Durables &amp; Capital Goods</b> | <b>1,274</b>           | <b>3.32%</b>                 | <b>1,550</b>                  | <b>16,004</b>          | <b>276</b>                    | <b>14,730</b>                  | <b>14,454</b>          |
| <b>All Manufactures</b>             | <b>17,353</b>          | <b>16.10%</b>                | <b>42,499</b>                 | <b>74,971</b>          | <b>25,145</b>                 | <b>57,618</b>                  | <b>32,473</b>          |

\* 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.<sup>12</sup> 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.<sup>13</sup> 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.<sup>14</sup> 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"

---

<sup>12</sup> For a detailed discussion of these recent changes, see Chung, Chin (1996).

<sup>13</sup> 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.

<sup>14</sup> 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, Mitsubishi, 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 its total exports.<sup>15</sup>

The PC industry, unlike the earlier consumer electronics industries, was established in Taiwan largely based on indigenous effort.<sup>16</sup>

---

<sup>15</sup> *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.

<sup>16</sup> 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,<br>Video Tape<br>Recorders<br>& Players | Radio Tape<br>Recorders<br>& Record<br>Players | Record &<br>Stereo<br>Equipment     | Electric<br>Fans       | Lighting<br>Fixtures           | Electric<br>Heating<br>Appliances           | Other Elec<br>Appliances<br>&<br>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<br>Storage<br>Media Unit                    | Data<br>Terminal<br>Equipment                  | Data I/O<br>Peripheral<br>Equipment | Computer<br>Components | Other<br>Computer<br>Equipment | Electronic<br>Tube &<br>Semi-<br>Conductors | Other<br>Electronic<br>Parts &<br>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.<sup>17</sup> 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.<sup>18</sup> 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.<sup>19</sup> 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

---

<sup>17</sup> Kawakami (1996), *ibid.*, pp.25-27.

<sup>18</sup> Chou, C. S. (1996), *The Computer Legend of Stan Shih* (in Chinese), Lianking Publishing Co., Taipei, pp.119-128.

<sup>19</sup> 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%         |                     | -   | -           |                                 |
| 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.<sup>20</sup> 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.<sup>21</sup> 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

---

<sup>20</sup> 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).

<sup>21</sup> 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.<sup>22</sup> 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.<sup>23</sup> 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.

---

<sup>22</sup> 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.

<sup>23</sup> 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.<sup>24</sup>

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.<sup>25</sup> In 1993, however, China's share of

---

<sup>24</sup> 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.

<sup>25</sup> 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).<sup>26</sup> 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.<sup>27</sup>

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,

---

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.

<sup>26</sup> 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.

<sup>27</sup> Shu, E. (1994), pp.32-40.

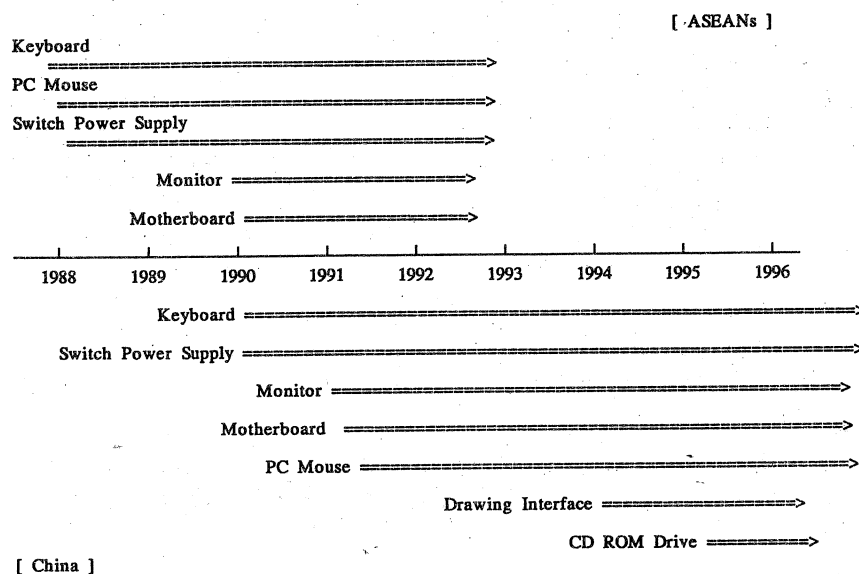


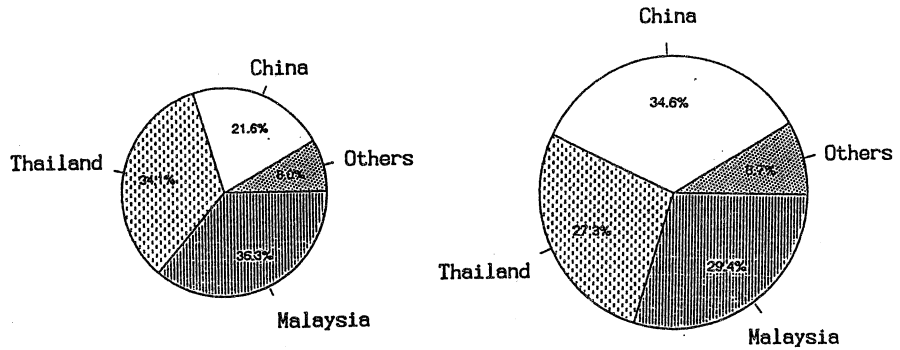
Figure 1 Timeline of Taiwan PC Producers' Outward FDI

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) Silitex (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

| Product             | Region | 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  | 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  | 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.<sup>28</sup>

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.

---

<sup>28</sup> 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.<sup>29</sup> 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

---

<sup>29</sup> 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<br>15               | 0.5<br>0.4                  | 1994/4Q<br>1996/4Q         |
| 2. TI-Acer (plant I, IA, & plant II) | 6" DRAM, 4/16Mb<br>8" DRAM, 16Mb<br>8" DRAM, 64Mb | 250<br>470<br>1280    | 10<br>20<br>40         | 0.8/0.5<br>0.5<br>0.35/0.25 | 1992<br>1995/3Q<br>1997/2Q |
| 3. TSMC (plant III, IV, & V)         | Foundry                                           | 2900                  | 35/30/25               | 0.5<br>0.35                 | 1995/3Q<br>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<br>STN LCD                       | 580<br>44             | 24<br>30               | 0.45                        | 1996/4Q<br>1994/4Q         |
| 7. Powerchip                         | 8" DRAM, 16Mb                                     | 75                    | 25                     | 0.4                         | 1996/3Q                    |
| 8. Mosel-Vitellic (plant II)         | 6" & 8" DRAM                                      | 1450                  | 25                     | 0.55/0.35                   | 1997/1Q                    |
| 9. SMV Technology (Siemens-Mosel JV) | 64/256Mb DRAM<br>--> 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<br>17" & 32" CRT;<br>Color STN LCD         | 730<br>230<br>110     | 25<br>-<br>-           | -<br>-<br>Toshiba           | 1997<br>1994<br>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                    |

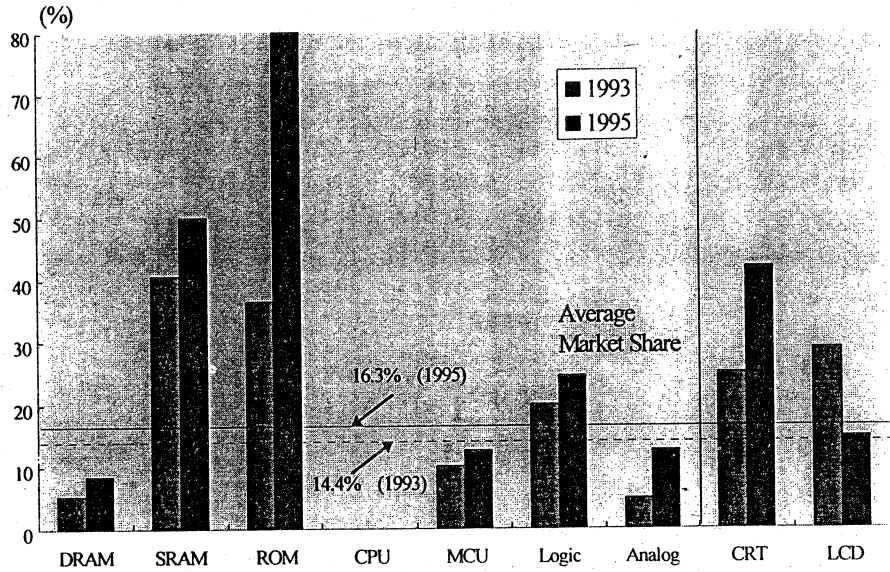
Source: *The Semiconductor Yearbook of Taiwan* (1995) and various news releases.

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-Vitellic, 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 |
|------------|----------|--------------|--------------|
| 7 $\mu$    | 1976     |              |              |
| 5 $\mu$    | 1980     |              |              |
| 3.5 $\mu$  | 1983     |              |              |
| 1.5 $\mu$  | 1986     | 1980         | 6 Yrs        |
| 1.2 $\mu$  | 1988     | 1983         | 5 Yrs        |
| 1 $\mu$    | 1990     | 1986         | 4 Yrs        |
| 0.8 $\mu$  | 1991     | 1990         | 1 Yrs        |
| 0.5 $\mu$  | 1994     | 1992/3       | 1-2 Yrs      |
| 0.35 $\mu$ | 1996.10. | 1996.1.      | 9 months     |
| 0.18 $\mu$ | 2000*    | 2000*        | -            |

\* Expected date for mass production.

Source: Adapted from ERSO, ITRI.

12),<sup>30</sup> 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.<sup>31</sup> 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).<sup>32</sup> But Taiwanese producers, as latecomers, simply cannot help stepping on U.S. firms' toes.<sup>33</sup> Leading U.S. hardware producers, such as IBM and Intel,

---

<sup>30</sup> 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.

<sup>31</sup> 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).

<sup>32</sup> *Far Eastern Economic Review* (1984), p.65. See, also, Dieter Earnst (1985).

<sup>33</sup> 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 from 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).<sup>34</sup> 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.<sup>35</sup> 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

---

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.

<sup>34</sup> 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).

<sup>35</sup> 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).<sup>36</sup> 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

---

<sup>36</sup> 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 prominent hardware 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*

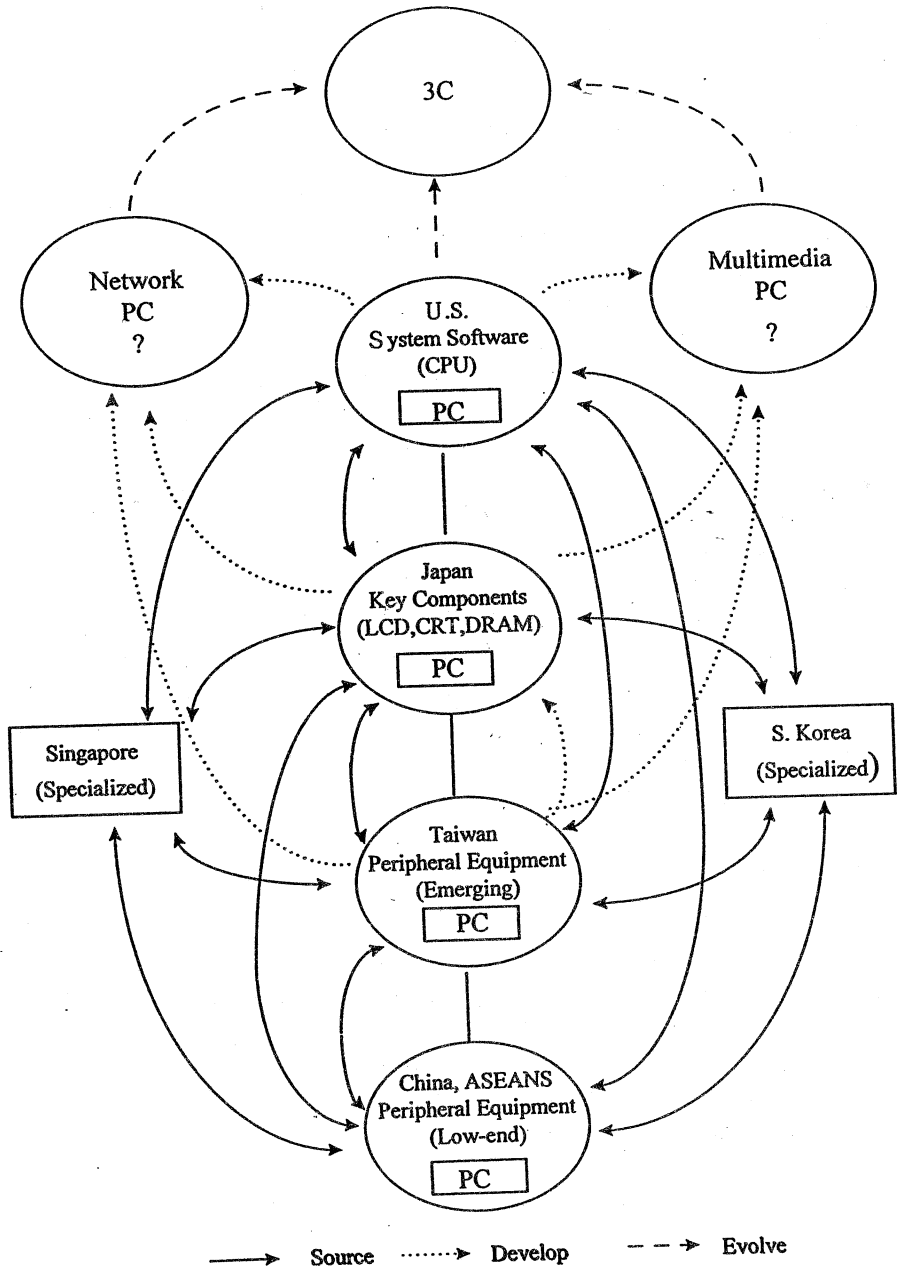


Figure 4 Global PC Market: Present & Future Division of Labor?

*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.<sup>37</sup> 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

---

<sup>37</sup> 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.<sup>38</sup> 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.<sup>39</sup> 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.<sup>40</sup> Thus, in the foreseeable future, China will more likely be

---

<sup>38</sup> 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.

<sup>39</sup> So far, FDI made by Taiwan IC firms has been directed 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.

<sup>40</sup> 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.<sup>41</sup> 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

---

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

<sup>41</sup> 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.<sup>42</sup> 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

---

<sup>42</sup> 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.<sup>43</sup> 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.<sup>44</sup> 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

---

<sup>43</sup> 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.

<sup>44</sup> 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,<sup>45</sup> 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

---

<sup>45</sup> 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.<sup>46</sup> 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 multilateral 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

---

<sup>46</sup> 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.

## References

- Almanac of Taiwan's Information and Electronics Industry* (1996).
- Borrus, Michael (1994), "Left for Dead: Asian Production Networks and the Revival of U.S. Electronics," paper presented at the International Conference on the China Circle, sponsored by the Institute for Global Conflict and Cooperation, University of California at San Diego, December 11-12, 1994, Hong Kong.
- 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.
- Chou, C. S. (1996), *The Computer Legend of Stan Shih* (in Chinese), Leinking Publishing Co., Taipei.
- Chung, Chin (1991a), "Taiwan's DFI in Mainland China: Impact on the Domestic and Host Economies," paper presented at the Third Annual Conference of the Chinese Economic Association (U.K.), Dec. 1991, London; later collected in Lyons, Thomas and Victor Nee (eds.), *The Economic Transformation of South China: Reform and Development in the Post-Mao Era*, Cornell East Asian Series, Ithaca, 1995, pp. 215-242.
- Chung, Chin (1991b), "Macroeconomic Impacts on the Domestic Economy of Taiwanese DFI towards Mainland China," (in Chinese), in *Taiwan's Direct Investment in Mainland China: Policy and Strategies*, CIER, Taipei, pp.91-120.
- Chung, Chin (1995), "Double-edged Trade Effect of Direct Foreign Investment and Firm-specific Assets: Evidence from the Chinese Trio," paper presented at the International Conference on Sino-US Economic Relations, sponsored by the Center for Asian Pacific Studies, Lingnan College, June 21-23, 1995, Hong Kong; then published in CIER Discussion Paper No.9609, December 1996, Chung-Hua Institution for Economic Research Taipei.
- Chung, Chin (1996), "Industry Characteristics and FDI Strategy: A Three-way Typology of Taiwanese Investment in Mainland China," in



Joseph S. Lee (ed.), *The Emergence of the South China Growth Triangle*, Chung-Hua Institution for Economic Research, Taipei, pp.287-326.

*Commercial Times*, November 14, 1996.

*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.

Dunning, John (1977), "Trade, Location of Economic Activity and the MNE: A Search for an Eclectic Approach," in Berlin Olin Hesselborn and per magnus Wijkman (eds.) *The International Allocation of Economic Activity*, New York: Holms and Merier Publishers.

Earnst, Dieter (1985), "Automation and the Worldwide Restructuring of the Electronics Industry: Strategic Implications for Developing Countries," *World Development*, Vol. 13, pp.333-352.

Earnst, Dieter (1994), *What are the Limits to the Korean Model? The Korean Electronics Industry Under Pressure*, Berkeley Roundtable on the International Economy, University of California.

*Far Eastern Economic Review* (1984).

Hymer, Stephen (1960), *The International Operation of National Firms: A Study of Direct Foreign Investment*, Ph.D. Dissertation, MIT, Cambridge, MA: MIT Press (1976).

Kao, H. C., Joseph S. Lee, and C. C. Lin (1993), *An Empirical Study of Taiwanese Firms' "Mainland Investment" on Industrial Upgrading in Taiwan and on the Vertical Division of Labor across the Taiwan Strait*, project report commissioned by the Ministry of Economic Affairs, ROC.

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.

Kawakami, Momoko (1996), "Development of the Small- and Medium-Sized Manufacturers in Taiwan's PC Industry," Discussion Paper No.9606, November, CIER, Taipei.

Krugman, Paul (1979), "A Model of Innovation, Technology Transfer and the World Distribution of Income," *Journal of Political Economy*,

Vol. 87, pp. 253-266.

- Mathews John A. (1995), *High-Technology Industrialization in East Asia: The Case of the Semiconductor Industry in Taiwan and Korea*, CIER Contemporary Economic Issues Series, No.4, December, CIER, Taipei.
- Monthly Statistics of the Import/Export Trade, Taiwan Area, ROC* (1996), Department of Statistics, Ministry of Economic Affairs, ROC, September.
- O'Connor, David C. (1985), "The Computer Industry in the Third World: Policy Options and Constraints," *World Development*, Volume 13, No. 3, pp.311-332.
- Ouyang, C. H. et al., (1990), *A Trade-Warning System for Monitoring Taiwan-Mainland Economic Interdependence and Its Applications* (in Chinese), CIER, Taipei.
- Samuelson, Paul A. (1948), "International Trade and Equalization of Factor Prices," *Economic Journal*, 68, pp.163-184.
- Shu, E. (1994), "DFI in Mainland China: A Case Study of the Monitor Industry," in Chung, Chin et al., *The Industrial Competition across the Taiwan Strait: Past Trends and Future Prospects* (in Chinese), project report commissioned by the Council for Economic Planning and Development, ROC, 1994, Chapter 8.
- Soete, Luc (1985), "International Diffusion of Technology, Industrial Development and Technological Leapfrogging," *World Development*, Volume 13, No. 3, pp. 409-422.
- Statistics of Industrial Production Monthly, Taiwan Area, ROC*, Department of Statistics, Ministry of Economic Affairs, ROC.
- The Economist* (1991:19).
- Wade, Robert (1990), *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*, Princeton University Press, Princeton, NJ.
- Yen, Tsong-ta, Y. J. Lin, and C. Chung (1992), *A Study of Taiwanese Investment and Trade Relations with Mainland China* (in Chinese), CIER, Taipei.

[The body of the page contains extremely faint and illegible text, likely bleed-through from the reverse side of the page. The text is too light to transcribe accurately.]

## Discussion Paper Series

1. Kang Chao and Ellen S. S. Chien. "The Relative Real GDP and Price Structure of Mainland China," 1981. (No. 8101)
2. Kang Chao. "Economic Readjustment in Mainland China," 1981. (No. 8102)
3. Mingshu Hua. "The Inflationary Effect on the Structure of Trade," 1981. (No. 8103)
4. Kang Chao and P. C. Chang. "A Study of Regional Factor Productivities in Chinese Agriculture," 1982. (No. 8201)
5. Chun-yuan Wang. "The Spillover Monetary Effect of Devaluation: A Disequilibrium Interpretation of the Cooper Paradox and the 'Reversed'," 1982. (No. 8202)
6. Chihwa Kao. "Second-Order Efficiency in the Estimation of Heteroscedastic Regression Models," 1984. (No. 8401)
7. Chihwa Kao. "An Em Algorithm for the Heteroscedastic Regression Models with Censored Data," 1984. (No. 8402)
8. Hak Choi. "Methods of Generating Demand Functions - A Tabular Review," 1984. (No. 8403)
9. Chihwa Kao. "Robust Regression with Censored Data," 1984. (No. 8404)
10. Chihwa Kao. "The Bootstrap and the Censored Regression," 1984. (No. 8405)
11. San, Gee. "The Early Labor Force Experience of College Students and Their Post-College Success," 1984. (No. 8406)
12. Chihwa Kao. "Small Sample Studies of Estimating, the Regression Models with Multiplicative Heteroscedasticity: The Results of Some Monte Carlo Experiments," 1984. (No. 8407)
13. San, Gee. "Student Financial Aid, In-School Employment, and Educational and Labor Market Outcomes," 1984. (No. 8408)
14. An-loh Lin and Scott A. Monroe. "The Structure of Gasoline Demand Across the United States," 1985. (No. 8501)
15. Hak Choi. "Why the EEC-ROC Trade Remains Unimportant," 1985. (No. 8502)
16. Hak Choi, J. Chou and D. E. Nyhus. "A Disaggregated Exports Forecasting Model for Taiwan," 1985. (No. 8503)

17. Diagee Shaw. "On-site Samples' Regression: Problems of Nonnegative Integers, Truncation, and Endogenous Stratification," 1987. (No.8701)
18. Li-min Hsueh and Su-wan Wang. "The Implicit Value of Life in the Labor Market in Taiwan," 1988. (No.8801)
19. Chien-hsun Chen. "Modernization in Mainland China: Self-Reliance and Dependence," December, 1990. (No.9001)
20. Tain-jy Chen and Wen-thuen Wang. "The Effects of Production Quotas on Economic Efficiency: The Case of Taiwan's Canned Food Industry," December 1990. (No.9002)
21. Ya-hwei Yang. "The Influence of Preferential Policies on Strategic Industries: An Empirical Study of Taiwan," December 1990. (No.9003)
22. Solomon W. Polachek and Charng Kao. "Lifetime Work Expectations and Estimates of Sex Discrimination," January 1991. (No.9101)
23. Ke-jeng Lan. "Inflation Effects on the Labor Market: A Transition Rate Model," April, 1991. (No.9102)
24. Hui-lin Wu, Quen-leng Miao, and Ke-jeng Lan. "Wage Differentials: Among College-and-Above Graduates in Taiwan," April 1991. (No.9103)
25. George J. Y. Hsu and Tser-yieth Chen. "Uncertainty and Asymmetric Information in the Modelling of Electric-Utility Tariff Regulation," May 1991. (No.9104)
26. Ya-hwei Yang. "An Analysis on the Structure of Interest Rate in the Banking Sector, the Money Market and the Curb Market," June 1991. (No.9105)
27. Jiann-chyuan Wang. "Quota Restriction Policies and Their Impact on Firms' Quantity Setting Decision Under 'Learning-By-Doing'," June 1991. (No.9106)
28. Jiann-chyuan Wang. "Cooperative Research in Taiwanese Manufacturing," October 1991. (No.9107)
29. Mo-huan Hsing. "The Empirical Relevance of the Orthodox Demand Theory," October 1991. (No.9108)
30. Hui-lin Wu and Ke-jeng Lan. "Labor Shortage and Foreign Workers in Taiwan," October 1991. (No.9109)
31. Ji Chou and De-min Wu. "The Cost of Capital and the Effective Tax Rate in Taiwan: 1961 - 1985," October 1991. (No.9110)
32. George J. Y. Hsu, Pao-long Chang, and Tser-yieth Chen. "Industrial Outage Costs in Taiwan: Estimation from a Proposed Curtailable Rate Program in Taiwan," January 1992. (No.9201)
33. Charng Kao, Solomon W. Polachek, and Phanindra V. Wunnava. "Male-

- Female Wage Differentials in Taiwan: A Human Capital Approach," Feb. 1992. (No.9202)
34. Lee-in Chen Chiu. "The Economic Reunion of Taiwan and the Mainland China: The Impact on Industrial Development," May 1992. (No.9203)
  35. Yi Chou, Pao-long and Chyau Tuan. "TQC Chinese Style and Its Management Implication -- Taiwan V.S. Mainland China," June 1992. (No.9204)
  36. Chung-hua Shen and Lee-rong Wang. "Testing Efficiency of the Coffee Futures Market -- A Markov Switching Model," June 1992. (No.9205)
  37. Tain-jy Chen and Hsien-yang Su. "On-the-Job Training as a Cause of Brain Drain" July 1992. (No.9206)
  38. George J. Y. Hsu, Pao-long Chang and Tser-yieth Chen. "A Priority Service Program and Power Outage Costs: The Case of Taiwan's Cement Industry," October 1992. (No.9207)
  39. George J. Y. Hsu and Ai-chi Hsu. "Energy Intensity in Taiwan's Industrial Sectors: Divisia Index vs. Laspeyres Index," October 1992. (No.9208)
  40. Lee-in Chen Chiu. "Regional Differential of Enterprise Efficiency and Labor Productivity in Coastal China," December 1992. (No.9209)
  41. Chi-ming Hou and Chien-nan Wang. "Globalization and Regionalization -- Taiwan's Perspective," March 1993. (No.9301)
  42. Yi Chou. "The Practice Beyond Property Right Boundaries -- Quality Management in Chinese State-owned Enterprises and Rural Enterprises," March 1993. (No.9302)
  43. Tzong-shian Yu. "Economic Development in Transition -- The Case of Taiwan," June 1993. (No.9303)
  44. Tzong-shian Yu. "An Analysis of the Effects of Economic Policies on Taiwan's Economic Growth and Stability," June 1993. (No.9304)
  45. Ke-jeng Lan. "An Evaluation of the Effectiveness of Government Automation Promotion Schemes in the Electrical Component Industry," June 1993. (No.9305)
  46. Yi Chou. "Measurement of Technical Efficiency and Its Management Implications -- The Example of Taiwan Sugar Corporation," June 1993. (No.9306)
  47. Chien-nan Wang. "On the Choice of Exchange Rate Regimes," June 1993. (No.9307)
  48. Yi Chou and Chyau Tuan. "Quality Management of Chinese Township Enterprises in Inland and in Coastal Areas," November 1993. (No.9308)
  49. Lee-in Chen, Chiu and Jr-tsung Huang. "Improvement of Capital Productivity

- and Technical Efficiency via DFI: Evidence from the Industrial Interaction between
50. An-loh Lin. "Trade Effects of Direct Foreign Investment: The Bilateral Case," February 1994. (No. 9401)
  51. Jiann-chyuan Wang and Homin Chen. "The Impact of North American Economic Integration on Taiwan," March 1994. (No. 9402)
  52. Joseph S. Lee. "Is There a Bona Fide Labor Movement in Taiwan?" April 1994. (No. 9403)
  53. Jiann-chyuan Wang and Kuen-hung Tsai. "An Evaluation of the Effect of Government Research and Development Promotion Schemes in the Electrical Component Industry," June 1994. (No. 9404)
  54. Anthony H. Tu. "The Dynamic Self-Hedged Behavior During the Period of 1987 Crash: Evidence from the U.S. Stock Market," August 1994. (No. 9405)
  55. Ji Chou, Yun-peng Chu and Shiu-tung Wang. "Effects of Trade Liberalization on Taiwan -- A Computable General Equilibrium Analysis," October 1994. (No. 9406)
  56. Ya-hwei Yang. "Economic Crime and Business Cycles in Taiwan," January 1995. (No. 9501)
  57. Jiann-chyuan Wang and Homin Chen. "An Evaluation of the Effectiveness of Government R&D Tax Credits," March 1995. (No. 9502)
  58. Tzong-shian Yu. "Policies for Industrial Development and Evaluation of their Achievements in the Republic of China on Taiwan," April 1995. (No. 9503)
  59. King-min Wang. "Grazing Management and Rehabilitation of Degraded Rangeland in Western Australia," August 1995. (No. 9504)
  60. Hui-lin Wu, Chia-hui Lin, and Ke-jeng Lan. "An Empirical Study of Youth Mobility in Taiwan," November 1995. (No. 9505)
  61. Mo-huan Hsing. "A Demand System with Homothetic Utility Function: Measurability and Empirical Relevance," November 1995. (No. 9506)
  62. An-loh Lin. "Dummy Functions in the Koyck Distributed-lag Model," December 1995. (No. 9507)
  63. An-loh Lin. "Estimation of the AR(1) Model Containing a Dummy Variable," January 1996. (No. 9601)
  64. Ya-hwei Yang, Yenpao Chen, and Tzung-ta Yen, Ying-yi Tu. "The Financial Aspects of Taiwanese Investment in South China," March 1996. (No. 9602)
  65. Jiann-chyuan Wang, and Kuen-hung Tsai. "Success Factors in Cooperative Research in Taiwan," May 1996. (No. 9603)
  66. Lee-in Chen Chiu. "Toward an Interregional Integration of Habitat,

- Production and Ecosystem — Developing Taiwan into a Regional Operations Center,” September 1996. *(No.9604)*
67. Sze-yueh Wang and Lee-in Chen Chiu. “The Impact of Mainland China’s Open Door Policy on Regional Industrial Development,” November 1996. *(No.9605)*
  68. Momoko Kawakami. “Development of the Small- and Medium-Sized Manufacturers in Taiwan’s PC Industry,” November 1996 *(No.9606)*
  69. Tser-yieth Chen and Oliver S. Yu. “A Performance Evaluation of the Commercial Lighting Programs of the United States,” November 1996. *(No.9607)*
  70. Yunchang Jeffrey Bor, Wen-jung Lien and Su-wan Wang. “The Impacts of Traff Liberalization on Taiwan and APEC Economies: A Multiregional General Equilibrium Analysis,” December 1996. *(No.9608)*
  71. Chin Chung. “Doulbe-edged Trade Effect of Foreign Direct Investment and Firm-Specific Assets: Evidence from the Chinese Trio” December 1996. *(No.9609)*
  72. Chin Chung. “Industry Characteristics and FDI Strategy: A Three-Way Typology of Taiwanese Investment in Mainland China” December 1996. *(No.9610)*
  73. Chin Chung. “The Emerging Pattern of Division of Labor across the Taiwan Strait: Macro Overview and Sectoral Analysis of the Electronics Industry” December 1996. *(No.9611)*