

**CAPITAL, LABOR AND THE STATE IN THE
INTERNATIONALIZATION OF HIGH-TECH INDUSTRY:
THE CASE OF SINGAPORE**

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The Electronics Industry in Singapore

Singapore's manufacturing sector has undergone a well-known transformation since it became a sovereign nation, reluctantly, in 1965. At the time there was only a small manufacturing sector producing simple consumer goods for the domestic market, which had been expected to grow with Singapore's inclusion in the Federation of Malaysia. It included two local firms assembling TV sets under licence from Japanese consumer electronics firms. Two years later, in 1967, the American electronics giant Texas Instruments set up an offshore sourcing semiconductor plant in Singapore to perform labor-intensive assembly activities for export. This event quickly catapulted Singapore's manufacturing into the fast-growing, rapidly-changing world of internationalized high-tech industry.

Within a few years of TI's move, virtually every major US semiconductor manufacturer had an offshore plant in Singapore, which became the largest exporter of semiconductors in the world. By the early 1970s, these American semiconductor firms had been joined by Japanese, European and other American firms mainly engaged in producing electronic components and consumer products for export to world markets. The electronics industry became the largest employer in Singapore, with two consumer electronics firms -- GEUSA and Philips of the Netherlands -- becoming the two largest private sector employers in the nation, with 6 or 7 plants and 8,000 to 10,000 workers each. Although today it shares the high-tech stage with a range of other industries, electronics remains the prototypical and most important example of high-tech transformation of industry in Singapore, and I will concentrate my analysis on this industry.

Twenty years is a long time, and particularly so in as volatile and dynamic an industry as electronics. Generations of new products have come and gone in the international industry, and so have many firms. The industry in Singapore has likewise followed suit. Output, exports, value added, capital invested, value added per worker, remuneration per worker, the capital-labor and capital-output ratios have all increased, and so has employment, although it peaked in 1984. (See accompanying tables.) The industry has progressively become more diversified, more capital-intensive, skill-intensive and technologically complex, with ever-increasing local value-added as labor-intensive and low-wage operations have been automated or phased out, and higher-value products and capital-intensive processes introduced. There has been a shift from manual assembly to machine production, and an increasing component of local purchasing, testing, design, product development and even some research.

Singapore's position in the ranking of top semiconductor exporters declined from first to third after Malaysia and the Philippines by the early 1980s, but at the same time it became the world's largest exporter of computer disk-drives. Consumer electronics and component manufacture have declined in importance while industrial electronics has increased, and besides computers and computer peripherals, printed circuit boards, etc., varied products such as telecommunications, biomedical and avionics equipment have been booming. Related service and software industries are also starting to bloom.

TI, GE and Philips have lost their pre-eminence to disk-drive manufacturers in particular. Seagate Technologies, the world's largest

disk-drive manufacturing company, has been relentlessly expanding since it set up in Singapore with 50 workers in 1982, and is now the largest private employer in the country, with 7,000 to 8,000 workers in three plants. In the depths of the 1985/86 recession in Singapore, Seagate eagerly employed workers laid off from other sectors of the electronics industry, mostly at their old wages, but it had considerable competition. In 1986 alone, new foreign companies investing in Singapore for the first time, and established companies which expanded their existing investments there, included the American firms Sperry, Apple Computers, Compaq Computers, Data General, National Semiconductor, Printonix, AT&T, IBM, EDS, Cipher Data and GEUSA (which increased its capital investment even as it reduced its labor force); the Japanese companies Hitachi, Fujitsu, Toshiba, Matsushita, Sony and Aiwa; and the German computer company Nixdorf. Many of these companies expanded in Singapore as they were contracting in other countries, including both home and host developing countries.[1]

Explaining the 1960s

The beginnings of the electronics industry in Singapore in the late 1960s are well-understood and have been widely reported. Briefly, the industry's genesis reflected a marriage of interests between the host country and foreign firms, many of which became multinational only when

1. According to the World Bank, in the early 1980s Singapore received nearly half of all the foreign investment which went to Asia as a whole. In a typical year (since 1980) Singapore receives about five times as much foreign investment as China -- most of it from the West and Japan whereas foreign investment in China is dominated by overseas Chinese capital, mostly from Hong Kong.

they moved to Singapore, often at the explicit and insistent behest of the Singapore government -- an experience which continues to be repeated in more recent foreign investments.

For Singapore, its 1965 ejection from the Federation of Malaysia, and the 1968 pullout of British military services which accounted for one-third of the economy, left it deprived of a domestic market for its planned import-substituting industries, and of a major source of employment. With the traditional entrepot trade and services sectors stagnant, and unemployment still high, it was felt that the former colonial port-city had no alternative but to turn to export-oriented manufacturing for its livelihood; much as Hong Kong had done more than a decade earlier. Unlike Hong Kong, however, Singapore's lack of local industrial expertise (since most local business was still concentrated in trade and merchant activities) and of a local manufacturing reputation in foreign markets meant that the newly-sovereign nation had to rely on established foreign firms, which were needed not only for their entrepreneurship, technology and market access, but also for the contribution of foreign capital inflow to a balance of payments in chronic trade deficit (which is still the case today).

Note then that Singapore's motivation for embarking on a development strategy of multinational-led, labor-intensive manufacturing for export was wholly dictated by domestic political and economic circumstances, and very much a second-best choice necessitated by the lack of other feasible alternatives. The "pull" factor of new world market opportunities and growing internationalization of production (see below) helped ensure the

success of this development strategy, but it did not initiate it. Note also that unlike many other countries which earlier or subsequently embarked on export-oriented manufacturing, Singapore was neither a recipient of U.S. military or economic aid (as were Taiwan and South Korea), nor a debtor nation and therefore hostage to World Bank and IMF policy prescriptions (as, arguably, were countries like Mexico, Brazil and the Philippines (e.g. Bello, O'Connor and Broad, 1972)).

In preparation for its aborted take-off into import-substituting manufacturing for the now-lost Malaysian common market, Singapore already had in place infrastructure and incentives designed to attract new manufacturing investment. These included government-built and -administered industrial estates and factory buildings, many of them located within densely-populated new public housing estates, and the Pioneer Industries tax incentive offering profit tax holidays to qualifying new investors (both foreign and local).

It remained to ensure the complete pacification of a once-powerful labor movement, already severely weakened by the 1962 mass arrests and incarceration without trial of unionists and opposition political leaders opposed to Singapore's 1963 merger with Malaysia.[2] This was achieved with the passing of a new Employment Act and Industrial Relations Act in 1968, which standardized terms and conditions of employment, set limits on negotiable fringe benefits, excluded issues such as recruitment, retrenchment, dismissal and promotion from collective bargaining, and

2. Note that export manufacturing was not the motivation here as in 1962 it was not even conceived yet as a development strategy for Singapore.

detailed new procedures for labor negotiation and conflict resolution which in effect severely limited strikes. Labor unions were also reorganized under the ruling People's Action Party (PAP)-led National Trades Union Congress (NTUC), the sole trade union federation, whose two umbrella unions, the Singapore Industrial Labour Organisation (SILO) and the Pioneer Industries Employees Union (^{PIEU}~~NTUC~~) dominated the manufacturing sector.

Note that these moves to control the labor movement were not aimed solely at ensuring labor peace for export-oriented multinationals. They also served the purpose of consolidating the PAP's domestic political control by further weakening its left-leaning opposition, which retained seats in parliament until it boycotted the general elections in 1968.

The government then went aggressively hunting for manufacturing investment from abroad, and found in California the US semiconductor industry, poised in the late 1960s for a take-off in growth of its world markets. The export-oriented consumer electronics industry was already taking off in Japan, South Korea, Taiwan and Hong Kong, and Fairchild Semiconductor had established its first offshore plant in Hong Kong in 1962. The semiconductor industry was, and still is, characterized by heavy R&D expenditures, a short product life-cycle, an accentuated learning and experience curve, intense oligopolistic competition, and a relatively high-value product incorporating capital-intensive, skill-intensive and labor-intensive processes at different stages of production. Technological input is high, and U.S. firms at the time had technological leadership of the industry and virtually monopolized it. At home, these firms were faced with labor shortages and labor unrest, the outcome of the Vietnam War boom

economy of the late 1960s. They looked offshore for peaceful, low-wage locations which could perform the labor-intensive assembly parts of their operations at a low cost. This would enable them to rapidly lower price and increase volume in order to deprive latecoming competitors of the brief period of monopoly profits required to sustain heavy R&D expenditures. Offshore assembly was made particularly attractive by Items 806.30 and 807.00 of the U.S. Tariff Schedule, which assessed U.S. import duty only on the foreign value-added of re-imports, and not on the full import price which included U.S.-made components.

A few of these companies had already established offshore plants in Mexico, the Caribbean, Hong Kong and Taiwan, and Singapore was a more-than-reasonable location for expansion and diversification, although its wages were higher than in most of these other locations, and its distance from California greater (thus implying the disadvantages of higher transport costs and longer turnaround time). What Singapore did offer in compensation was excellent infrastructure, political stability, a very welcoming government, and labor peace. Texas Instruments' immediate excellent performance (it reportedly began production 40 days after starting negotiations with the government, and was profitable within 9 months) attracted a whole "bandwagon" of followers among its competitors.

Explaining the 1970s

In addition to this "bandwagon" effect, common among oligopolistic industries with their follow-the-leader behavior, several other factors contributed to the continuing attraction of foreign electronics firms to

Singapore in the 1970s. Trade policy was particularly important. In 1970, GATT instituted GSP -- the Generalized System of Preferences under which selected developing country manufactured exports were exempt from tariffs in importing developed countries, subject to a required minimum local content, and to annual quotas which varied by product and by exporting and importing country. The goal was to encourage manufactured exports from developing countries by affording them a temporary "infant industry" form of protection against other developed country competitors in developed country markets. (The U.S. instituted its GSP program only in 1976.) At the same time, the 1970s saw the beginnings or threatened beginnings of selective trade restrictions in Europe and the U.S. against Japan, South Korea and Taiwan in consumer electronics products, particularly the institution of "orderly marketing agreements" in color TVs and radio cassette recorders.

To avoid such restrictions, and to avail themselves of GSP privileges, many Japanese consumer electronics companies began to locate production for export to Europe and the U.S. in Southeast Asian countries, including Singapore. Their European competitors did the same, to benefit both from lower costs of production and from GSP, and also in some cases to escape from strong unions and labor unrest at home. The acceptance of ASEAN regional origin for meeting the local content requirement of GSP gave a further boost to export-oriented industry in Singapore and its neighbors, and increased industrial integration among them. GSP also provided an incentive for increasing local purchases, thus generating backward linkages and developing local suppliers in Singapore itself (Lim and Pang, 1982).

Note that to a large extent European and U.S. electronics companies were using low-cost production bases in Asia as a means of fending off low-priced Japanese competition in their own home markets i.e. these were defensive investments aimed at preserving company world market shares and home country jobs, rather than destroying them. Japanese companies, on the other hand, were using these same production bases as a means of access to the U.S. and European markets, to evade protectionism directed at them i.e. their investments here were an aggressive competitive tactic aimed at increasing their world market shares. Singapore, and some of its neighbors, benefitted from both sides of this competitive struggle between foreign national capitals in the world market.

The Singapore economy itself was undergoing further changes in the 1970s. In part because of the success of export-oriented manufacturing, labor absorption increased rapidly during the economic boom years of the late 1960s and early 1970s, and full employment was reached by 1972. Faced with rising wages and incipient labor shortages -- given the small economy and sharply falling population growth -- the government quickly (in 1972) saw the need to restructure the economy in the direction of less labor-intensity. In the meantime it instituted two new labor market policies designed to preserve the international cost-competitiveness of existing labor-intensive export manufacturing industries.

The first policy involved the variable admission of foreign labor -- at the unskilled level, mostly from Malaysia, and at the skilled level, from around the world, but again especially from Malaysia. At the peak of the economic boom in 1973, foreign workers reportedly accounted for

one-eighth of the Singapore labor force (Pang and Lim, 1982). They included large numbers of female migrant workers in labor-intensive export industries, particularly textiles and garments, but also electronics. Many of these workers were laid off and sent home to Malaysia in the deep world recession of 1974/75, when the electronics industry alone reduced its mostly female workforce by about one-third, before recovering by 1976. The recession caused the government to put aside its earlier plan to restructure the economy to de-emphasize the use of labor in production.

The second policy was the establishment of the tripartite National Wages Council (NWC) in 1972, whose task it was to ensure "orderly wage increases" in the labor market. The NWC set annual wage increase guidelines which were largely followed, especially by big, unionized firms such as dominated the electronics industry. This in effect ensured relatively low (but positive) real wage increases in manufacturing for the remainder of the 1970s.

Industrial relations policy remained unchanged through this decade. Union membership, which had started to decline before the passage of the two 1968 acts, increased from 17% of the labor force in 1970 to a peak number of 250,000 or 24% of the labor force in 1979.[3] From the viewpoint of the multinational employer, government support (or control) of the labor unions did not necessarily render them less powerful in their bargaining with employers. Indeed, some employers considered that it meant that they had to take union demands more seriously, because of their implied

3. Data on labor cited in this paper are drawn from Lim, 1987a and the references therein.

government backing. That the government and the multinational employers did not necessarily see eye-to-eye was shown by the government's rejection of some multinationals' requests for exemption from union organization (e.g. Kassalow, 1978). This reportedly lost Singapore a few investments in the 1970s, such as that of Motorola, which went to Malaysia instead. The NTUC also made repeated attempts to organize multinationals opposed to unionization, and was usually successful, with Texas Instruments being a notable, and notorious, exception. In the electronics industry, unions were established in many companies which did not have unions in their own home countries or elsewhere, such as Fairchild and National Semiconductor. However, in general the Singapore unions were "cooperative" with employers, with strikes being virtually unheard-of. Part of the reason for this was the partial pre-emption of collective wage bargaining by the tripartite consultations and guidelines of the NWC. Also since 1969 the NTUC had concentrated its activities on social, educational and recreational programs for workers, including child-care and consumer advocacy, and on running various cooperative enterprises such as supermarkets, taxis and insurance (what has been called a system of "welfare unionism").

New foreign investments continued to be attracted into the Singapore electronics industry in the latter half of the 1970s, although generous tax incentives were much less forthcoming for labor-intensive investments. Rising wages and labor shortages -- despite the re-introduction of foreign labor -- also made Singapore a less and less attractive location for labor-intensive activities, which began to be phased out or automated by established firms. New products and the technologies which came with them tended to be more capital- than labor-intensive anyway -- for example, in

the semiconductor industry. Only in more "traditional" industries like garments, textiles and consumer electronics did manufacturers really have a choice of different techniques involving different capital-labor ratios. Elsewhere in the electronics industry, technological upgrading proceeded in line with world market developments. The industry appears to have become increasingly reluctant to employ foreign workers, who by 1980 accounted for less than one-tenth of its labor force, compared with more than one-quarter for the similarly female-intensive textile and garments industry. One reason for the avoidance of foreign workers was the fear that, in the event of another recession like that of 1974/75, employers might once again be forced by the government to lay off increasingly valuable skilled foreign workers in order to preserve jobs for Singaporeans.

In 1979, the government launched what it called a "Second Industrial Revolution" to increase value-added and reduce labor content in Singapore manufacturing, in line with changing relative resource endowments. The linchpin of this program was an unusual high-wage policy intended to encourage capital-labor substitution and the phasing out of labor-intensive industries and operations (Pang and Lim, 1987). The government acknowledged that previous NWC wage increases and excessive use of foreign labor had caused wages to fall "below market levels", thereby encouraging an "over-use" of increasingly scarce labor resources and resulting in lagging productivity growth. Three years of very large NWC wage increases were instituted to "restore wages to market levels" and promote productivity growth.

Explaining the 1980s

Wages and Labor Relations

In addition to the high-wage policy, the industrial relations system in existence since 1968 was restructured to decentralize wage bargaining and "to foster closer relations of loyalty and mutual obligation between employers and workers, reducing their dependence on the state as intermediary and benefactor. It is hoped that this will raise productivity, and wages in line with productivity, and reduce labour turnover in a tight labour market" (Lim and Pang, 1984, p. 29). The government retained control over the union movement, with a Cabinet Member in charge of the NTUC since 1978. But in 1982 the umbrella industrial unions SILO and PIEU were reconstituted into nine industry-based unions, including one of electrical and electronics workers. The formation of house unions was also strongly promoted, to encourage labor-management cooperation and joint consultation at the enterprise level. The Trade Unions Act itself was amended in 1982, and the Employment Act amended in 1984 to give employers greater flexibility in the scheduling of labor, a measure designed to benefit emerging high-tech industries. For example, women could now be employed in night-shift work without the formal waivers previously required from the Ministry of Labour; and 12-hour shifts could be worked so long as total weekly hours worked did not exceed the statutory maximum of 48 hours.[4]

4. For more on changes in the Singapore industrial relations system in the 1980s, see e.g. Lim and Pang, 1984; Tan, 1984; Wilkinson and Leggett, 1985.

House unions and 12-hour shifts have not been popular or widely-instituted, but the high-wage policy, aided by market forces, apparently worked. In the years 1980-1984, real average weekly earnings in the economy as a whole rose an average of 7.3% a year, outstripping the 4.6% annual growth in productivity as measured by real value-added per worker.[5] Real earnings in manufacturing rose at the same rate. Manufacturing employment, which peaked in 1980 at 285,250 workers or 30.1% of the total labor force, declined by 4% in absolute numbers by 1984, when it accounted for 27.4% of the labor force. At the same time, output and value-added in manufacturing both increased by 30%, and value-added per worker in manufacturing increased by one-third, over the five-year period.[6] The national unemployment rate fell sharply from 3.5% of the labor force in 1980 to 2.7% in 1984.[7]

The 1985 Recession

In 1985 Singapore experienced the first economic recession in its twenty years of sovereign existence, with real GDP declining by 1.8% and unemployment rising to 4.1% of the labor force, the highest rate since 1976. The manufacturing sector experienced a 7.3% decline in real output; its only previous declines had been marginal declines of 0.2% in 1975 and 0.5% in 1982. Manufacturing employment fell by 4% or a net loss of some 10,000 jobs between the 1984 and 1985 industrial censuses, and by 11% or a

5. Calculated from Table 6 in Lim, 1987a.

6. Department of Statistics, Singapore, Report on the Census of Industrial Production 1984, Table 1.

7. Table 1 in Lim, 1987a.

net loss of 35,000 jobs between the beginning and the end of 1985, when its share of total employment fell to 25%. Layoffs in the electronics industry affected mainly the consumer electronics sector, and to a lesser extent, semiconductors, while the computer sector, which had become increasingly important since 1980, continued to expand.[8] The machinery and appliances industry group, to which most electronics manufacturers belong, retained its share of 40% of total manufacturing employment. Value-added per worker declined slightly while remuneration per worker increased between 1984 and 1985 in both this industry group and the manufacturing sector as a whole.[9]

The faster increase of wages than of productivity in the first half of the 1980s has been identified as a major cause of the severe 1985 recession, from which a weak recovery was made in 1986.[10] Certainly between 1980 and 1985 Singapore's international competitiveness in manufacturing declined as measured by unit labor costs, which rose from 78% of U.S. unit labor costs (or lower than in Japan, Hong Kong and Taiwan) in 1980, to 98% of U.S. unit labor costs (higher than Taiwan, Hong Kong and even Japan) in 1985. Note that labor costs in Singapore have been rising

8. For details on layoffs by individual electronics companies, see the Industry News section of Southeast Asia Business Nos. 6 (Summer 1985) and 7 (Fall 1985).

9. Figures from Ministry of Trade and Industry, Singapore, Economic Survey of Singapore 1985, Tables A2.2, A2.3, A6.5.

10. For a full official discussion of the recession, see Ministry of Trade and Industry, Singapore, The Singapore Economy: New Directions, Report of the Economic Committee, February 1986, a report prepared by a 9-member committee of high-level public and private sector representatives, including senior multinational executives, who drew on the work of 8 sub-committees involving a total of over 1,000 persons.

more rapidly than workers' average weekly earnings, which do not include the employer's compulsory contribution to the employees' Central Provident Fund (CPF), a government-run pension fund, the rate of contribution to which increased from 37% of the wage in 1979 to 50% (evenly split between employer and employee) in 1984.[11] Part of the relative increase in unit labor costs also reflects the rapid rise of the Singapore dollar in tandem with the U.S. dollar between 1984 and early 1985.

Besides excessively high labor costs, other factors were also identified as causes of the recession. One was the over-extended role of the government in the economy,[12] especially the high (profit-making) rates charged to the private sector for delivery of products and services provided by government agencies and state enterprises, including utilities, telecommunications, port and airport charges, industrial and commercial space, etc.. Another factor was the poor external market environment, both in the surrounding Southeast Asian region badly hit by declining oil and commodity prices, and rising external debt burdens, and in specific world industries of particular importance to Singapore, particularly petroleum and petrochemicals, shipbuilding and repair, and electronics.

In electronics, the world and especially U.S. computer and semiconductor industries were experiencing a market slump which began in late 1984, while consumer electronics faced fierce competition from Taiwan and South Korea in particular. In the battle for global market share

11. Table 8 in Lim, 1987b. For more discussion on the CPF, see Pang and Lim, 1987a, and Lim, 1987c.

12. On this see, for example, Lim, 1983a and Lim and Pang, 1987.

between Japanese and U.S. semiconductor manufacturers, and between Japanese, U.S. and European consumer electronics manufacturers, the U.S. and European manufacturers located in Singapore were losing, and Singapore's economic fortunes suffered with the declining corporate fortunes of such multinational giants as GEUSA and Philips of the Netherlands. GE, for example, was forced to pull out of television manufacture altogether, and hence closed down both its U.S. and Singapore plants belonging to this division.

Protectionism and Reindustrialization in the West

At the same time, Japanese manufacturers, buoyed by the competitive edge imparted by a seriously undervalued yen (especially relative to the U.S. and Singapore dollars), were facing increased protectionistic pressures in Western export markets. One of their responses to forestall protectionism was to increasingly relocate production in those markets themselves, rather than in low-cost developing country locations like Singapore and its regional neighbors. Thus whereas international trade policy developments in the 1970s favored multinational export production in Singapore in industries like electronics, in the 1980s they did not.

It should be noted, however, that because of its small size, free trade policies, and preponderance of high-tech electronics and (especially U.S.) multinationals, Singapore's own export industry has not itself been a serious target of Western protectionism. This compares, for example, with South Korea and Taiwan, which have protected domestic markets and much larger export surpluses, and Hong Kong, whose exports are concentrated in the mature garments industry which is heavily subject to protectionism and

protectionist pressures abroad. Exports in all three of these countries also originate primarily in indigenous enterprises, which lack the lobbying clout in export markets that Singapore's high-tech multinationals have in what are their own home markets. And unlike South Korea and Taiwan, Singapore has not been accused of abusing labor rights and exploiting labor in its export industries, and thus has not been subject to foreign protectionistic pressure on the grounds of "unfair labor practices"[13]. In 1986 Singapore also passed domestic legislation agreeing to uphold intellectual property rights, thereby defusing the one trade policy issue that might have been used against it. On the other hand, its high per capita income (over US\$7,000 in 1985) makes Singapore the most likely candidate for "graduation" from eligibility for U.S. GSP privileges, which under the 1984 Trade Law sets the upper income limit for eligibility at US\$8,500 (subject to inflationary adjustments). Fortunately, however, only 7% of Singapore's exports are currently covered by GSP, and this proportion excludes high-tech electronics.

Despite this relatively favorable trade policy position, however, the growing trend in the 1980s towards cross-national mergers, take-overs, joint ventures and co-production agreements, especially between U.S. and Japanese corporations, accentuated the tendency to locate production in developed country markets, as did increasingly aggressive moves by depressed regions and states in Europe and the U.S. to attract this type of Japanese investment. Many of these states and regions sent investment missions abroad in search of foreign investment much as Singapore and other

13. For more on this subject, see Lim, 1987b.

developing countries had done for two decades. They compared themselves favorably with the developing countries (as, for example, in Southern Oregon's favorable comparison of its cost structure with that of Singapore's), and offered investors infrastructural support and various tax breaks, as well as the attractions of cheap land and relatively cheap and docile labor in regions experiencing high unemployment -- such as Scotland, Wales and Ireland in Europe, and parts of the Midwest, Northwest and South in the U.S.. These regional "reindustrialization" attempts in the developed countries are virtually an inversion of the situation prevailing in the 1960s in developing countries like Singapore.

Technological Change

It has often been assumed that technological change is also biased against continued location of industry in developing countries to serve developed country markets. Certainly automation in electronics and related high-tech industries has reduced the labor content in many products and processes, thereby reducing or even eliminating the cost advantage of producing in low labor-cost locations. This is true, but there are also countervailing features of the new technologies. For one thing, while relative labor content may have declined, this does not necessarily mean an absolute decline in labor used -- with market growth, the same or even increased numbers of workers may be hired, together with much-increased quantities of capital, and to produce products of much higher value, such that the labor component of total cost or value shrinks even though absolute employment and total wage-bills may increase. This is particularly likely in high-growth high-tech industries.

Very short product lives in such industries (e.g. 18 months for a new computer disk-drive that may have taken longer than that to design) may also forestall complete automation, in that the product becomes obsolete so fast that there is no time to design automated production facilities which in any case may be too costly. Even automated production, however, may be more cheaply done in low-wage countries, especially if high R&D costs, very brief monopoly periods for new products, intense oligopolistic competition, and the existence of economies of scale and learning favor quick expansion to maximise volume and market share, and minimize costs. This means that locations which can offer the cheapest total costs (including labor costs), the possibility of 24-hour production employing shift workers round-the-clock (which also aids in the rapid depreciation of expensive machinery and equipment), and guarantees against any disruption of production or delivery (whether from faulty infrastructure or labor unrest), remain attractive. With the increasing proportion of total costs accounted for by financial/physical capital, human capital (i.e. skilled labor) and material inputs, these also become important factors in industrial location. Cheap loans or equity and tax holidays which reduce the capital cost burden (especially in the high-real-interest-rate environment of the early 1980s), ample and cheap supplies of competent scientific and technically-trained manpower which reduce training costs and times, and available local and regional supplies of cheap material inputs all become important, considerably outweighing the significance of cheap labor alone.[14]

14. For more discussion on this, see Lim and Pang, 1985.

Singapore has probably benefitted more, and suffered less, from recent technological developments than almost any other developing country, largely for reasons having to do with indigenous conditions, but also with its regional location and relationships, and with parallels between its own and international developments. For example, rising local labor costs and labor shortages have been mitigated on the supply side by the ready availability of foreign skilled and unskilled labor, and by the ease of transferring labor-intensive operations to lower-wage neighboring countries, mainly Malaysia and Thailand -- which are also the major sources of much of the foreign labor employed in Singapore itself. In some instances, foreign workers have been sent back to their own countries to set up, manage, run and train workers for labor-intensive operations transferred out of Singapore.

On the demand side, rising local labor costs and labor shortages have been mitigated by the declining relative demand for unskilled labor in high-tech industry. Employment has been growing much slower than output. Singapore has also been expanding its supplies of skilled labor through government investment in education -- including the education of foreign students, many of whom subsequently stay to enlarge the local labor force.[15] (Note that Singapore's skilled labor, unlike that in the other Asian NICs, is English-speaking, an important asset in high-tech industry.) Rising local labor costs and labor shortages have themselves encouraged established firms, including multinationals, to phase out

15. Most notable in this category are Chinese Malaysians, who account for nearly half of the engineering students at the National University of Singapore and the Nanyang Technological Institute.

labor-intensive activities and to introduce new, higher-value, higher-skill and higher-tech products and processes, employing increasing quantities and proportions of skilled labor and capital. As a now capital-rich country, running perpetual government budget and balance of payments surpluses (on both current and long-term capital accounts), with the highest savings rate in the world as of 1985, and one of the highest per capita foreign reserves, Singapore can well afford generous investment incentives including tax holidays and various capital assistance schemes (such as equity participation by government enterprises). Such incentives which cheapen the cost of capital and increase the rate of return on capital invested are particularly important in capital-intensive high-tech industry, much more so than in earlier labor-intensive industry. Incentives and assistance for establishing local R&D work also encourage high-tech industry.

The Singapore Environment

At the same time, Singapore continues to provide one of the stablest and most hospitable political environments in the world for international investment, where (even socialist) opposition political parties and labor unions alike are ever-anxious to proclaim their support for multinationals. The resulting reduction of risk and uncertainty is very welcome especially for capital-intensive investment projects with a longer gestation period than low-cost, low-risk, labor-intensive projects. Relations between unions, employers and the government (labor, capital and the state) are excellent, even though their interests do not always coincide. The physical and social infrastructure is superb, among the best

in the world. This is especially important for high-tech industry which depends on reliable utility supplies, constant international communications, and quick and frequent transport to all parts of the world. Singapore offers "quick turnaround time" which is very important in fast-paced, highly-competitive industries where quick delivery is necessary for cost savings and market share, especially with the spread of just-in-time manufacturing. (Its distant location from major markets is still, however, a disadvantage for customized products, the design and production of which require frequent and close interaction between manufacturer and customer.)

Regional Linkages

These advantages of political stability, labor peace and excellent infrastructure are highly unusual for a developing country (and even for many developed countries), yet they exist in conjunction with labor costs which, though they have been rapidly rising and are comparatively high, are still below those for comparably skilled labor in developed countries like the U.S..[16] More importantly, much cheaper labor is readily available through direct and indirect outsourcing or subcontracting of labor-intensive operations in neighboring Malaysia and Thailand. In the newer industries (such as computer peripherals), 80% to 85% of total manufacturing cost is accounted for by material inputs, and these are cheaply purchased in Singapore both because it is a free port and because

16. In the electronics industry, wages of production workers in Singapore are between 20% and 25% of U.S. levels, while salaries of engineers are about half of U.S. levels.

cheap materials are readily available from the surrounding region -- from Japan through South Korea, Taiwan, Hong Kong, Thailand and Malaysia, even the Philippines, Indonesia and India. Materials are sourced from Japan because of the high quality needed in many high-tech products, from South Korea and Taiwan because of their high efficiency, and from the Southeast Asian countries because of their cheap and abundant labor. Indeed, in my research, new high-tech companies established in the 1980s mentioned cheap material supplies as the chief reason for their locating manufacturing production in Singapore. The advent of "just-in-time" manufacturing techniques has also made it essential for companies to locate production close to sources of supply, which in the computer industry are overwhelmingly in the Asian region.

In other words, Singapore has benefitted from the industrial development of its regional neighbors, whose resources and economies are often complementary rather than competitive with its own. The complementarity with Malaysia is probably most marked, as there is essentially free trade between Singapore and Malaysia's Free Trade Zones where most of the export-oriented subsidiaries of electronics multinationals are located, not more than a few hundred miles from Singapore at the most, and with excellent communications and other linkages between the two countries. Some American electronics firms have production facilities located in Malaysia which are serviced by purchasing, marketing, finance, engineering, technical support and even R&D functions located in Singapore. Often the managerial and especially engineering personnel employed in Singapore are Chinese Malaysians, who have difficulty finding equivalent professional employment in their own country due to its

bumiputra policies favoring Malays, and/or who are escaping what they perceive to be ethnic discrimination at home.[17] In this case, Malaysian government policy -- which is also less generous in the offering of investment incentives such as tax holidays to the electronics industry, and has many more performance requirements related to ethnic ownership and employment goals, local content, etc. -- has been a factor in enhancing Singapore's attractiveness to continued high-tech foreign investment despite its own limited domestic resource base. Malaysia is also perceived as being less politically stable, which makes capital-intensive investments there more risky than they would be in Singapore.

New Multinational Investments

Singapore is both well-located and well-equipped to serve the growing regional electronics industry. In recent years, besides new manufacturing ventures, increasingly with some R&D attached to them, many multinationals -- such as IBM and AT&T -- have set up international (not merely regional) purchasing offices (IPOs) in Singapore, to supply their plants worldwide. Singapore has also launched a new initiative to make itself a "world (not merely regional) operational headquarters" for multinationals. The agreement to protect intellectual property rights, combined with the fact that Singapore lacks the indigenous industrial entrepreneurial and

17. Note, however, that many of these Chinese Malaysians eventually return home with knowledge and experience gained from their work in Singapore, so that there is not necessarily a net "brain drain" from Malaysia to Singapore.

scientific capacity to imitate or copy new technology,[18] has also made it a more secure and therefore favored location for foreign high-tech companies concerned about losing proprietary technology before its developmental costs have been recouped, especially where product lives are extremely short.

In all this, particularly in attracting new high-tech companies, Singapore has benefitted from another asset frequently mentioned by companies I interviewed -- being "a very pleasant place to live" (some even said -- "like Hawaii"). Much has been said about the importance of the lure of lifestyle to high-tech companies in the U.S., especially. Singapore is an attractive (though not a cheap[19]) place to live for expatriate managers, but high-tech industry in Singapore actually has very few such managers. Most companies -- both large, long-established companies like the U.S. semiconductor firms -- and smaller, newer companies like those in computer parts and peripherals -- are now run completely by local management, many of them from their very beginning. Still, foreign owners or managers say they want to locate their plants in places which they "don't mind visiting" several times a year, and being a nice place to live is important in attracting Asian expatriates, such as engineers from Malaysia, Hong Kong, Taiwan or India. The fact that Singapore is English-speaking is a further attraction, especially for high-tech

18. Compared, for example, with South Korea's huge industrial conglomerates or Taiwan's experienced and agile companies.

19. However, Singapore is cheaper than Hong Kong, where high rents drove not a few companies -- including Data-General -- to relocate to Singapore after property prices fell in Singapore in the 1985 recession.

industry.

Given all these advantages, it is not surprising that Singapore has continued to attract new investments in electronics and other high-tech industry in the 1980s, despite its rapidly rising costs and declining international competitiveness, which mainly affected older, more labor-intensive industries such as consumer electronics. In the 1980s, net investment commitments in "electrical machinery and appliances" have varied between S\$320 million and S\$660 million annually, rising from 28% of total net investment commitments in manufacturing in 1980 to 36% in 1984, and declining slightly to 34% in 1985.[20] Even in the recession of 1985/1986 there were many new investments, and some companies (e.g. Seagate) were hiring as others (e.g. GE) were laying off workers. Even GEUSA, which reduced its employment in Singapore from over 12,000 in 1980 (when it was the largest private sector employer) to 6,000 in mid-1986 as part of the global restructuring of its consumer electronics business, increased its investment in Singapore, bringing new technology and automation to four of its ten affiliates there in 1986, including wafer diffusion to its semiconductor facility..

Other major companies' restructuring brought more investment and employment to Singapore in 1986. Data General relocated from Hong Kong to Singapore (and from Austin, Texas to Manila), and Seagate Technology shifted most of its manufacturing operations from the U.S. to Singapore, where it became the largest employer (7,000 workers) in the manufacturing

20. Ministry of Trade and Industry, Singapore, Economic Survey of Singapore 1985, Table A2.5.

sector, turning out half of the world's output of computer disk-drives. Seagate has two sub-assembly plants in Manila and Bangkok. Like Data General, Hewlett Packard and many other multinationals, it has begun product development work in Singapore, and now describes itself as "a Singapore company doing a little bit of R&D in the U.S.". According to one new investor, Singapore is going to be "the No. 1 center among the newly industrialising countries for the high-technology segment of the electronics industry", because of the presence of "all the key world players". Increasingly, investments are being made by the foreign suppliers of these established multinationals, to provide cost and time savings from "just-in-time" manufacturing operations within the region.[21] Singapore has also emerged as a major beneficiary of Japanese multinationals' attempt to escape the effects of the strong yen by relocating some export and even home-market production abroad, in Asian developing countries. In the electronics industry, companies such as Matsushita, Toshiba and Fujitsu have expanded their investments and production in Singapore accordingly. Sony, which the Singapore government had been courting unsuccessfully for more than ten years, finally decided to establish a major world manufacturing facility in Singapore in 1987, making new, high-value consumer products. The Sony President's comment on the choice of Singapore as an important production site: "You can't produce just anywhere." Clearly, Singapore is not "just anywhere".

Because of these new investments, and an upturn in the market, the

21. For more information on recent investments in Singapore, see Southeast Asia Business, Nos. 6-11, quarterly issues in 1985 and 1986.

recession in the Singapore electronics industry itself lasted little more than a year. While GE's massive layoffs had been the result of global corporate restructuring rather than of the cyclical downturn alone, the underlying tight labor market situation had caused many other firms (e.g. Hewlett Packard) to refrain from laying off workers during the recession, resorting to reduced work-weeks and temporary pay cuts instead. By mid-1986 the recession was over, at least in this industry, and labor shortages appeared. Companies re-hired workers, re-established full work-weeks, restored pay-cuts and in some cases even worked overtime to meet increased demand. There was intense competition among both long- and newly-established firms to hire both new and experienced workers, who were in short supply; and wages rose despite an official policy of "severe wage restraint".

Government Policy Responses to the Recession

This wage restraint policy was a key part of the Singapore government's response to the recession, which focussed on reducing costs and increasing productivity to improve international competitiveness. Labor costs were directly and immediately reduced by a cut in the employers' CPF contribution from 25% to 10% of the wage, thereby lowering the entire CPF share to 35% of the wage, as the employees' 25% contribution remained unchanged. In addition, the NWC recommended "severe wage restraint", meaning zero wage growth, for two to three years. But firms which could show that they were expanding and profitable would be allowed to increase wages in line with their individual profits and productivity. Wage reform has also been proposed, to make wage-determination more

flexible and more closely tied to company and individual productivity, rather than, for example, to seniority as has been the case in the past. Productivity itself would be raised by closer labor-management relations, and by increased government investments in education and training.

At the same time, the surpluses of government monopolies have been reduced by rate reductions, and taxes on property and on individual and corporate incomes have been decreased, although the corporate income tax is still, at 33% (down from the previous 40%), considerably above Hong Kong's 15% rate. Many of these rate and tax changes are, like the wage restraint policy, intended to be in effect for only two to three years in the first instance. Longer-run changes include the government's pledge to progressively reduce its size and role in the economy -- for example, through the gradual privatization of state enterprises, especially in sectors where they compete with private business. It is also trying to find ways to stimulate and nurture indigenous entrepreneurship, and has, for example, set up a new Small Enterprises Bureau to provide assistance to small firms. While the country still intends to move up the technological ladder, there will be less insistence that new investments be high-tech, especially to qualify for investment incentives, as the previous emphasis on high-tech is considered to have discriminated against local and regional firms in favor of multinationals.

This does not, however, mean that there is to be any less emphasis on foreign participation in the Singapore economy. On the contrary, the government has repeated its explicit rejection of any domestic market protection for the local private sector, and has intensified its efforts to

attract foreign investment -- for example, by doubling the EDB's overseas staff, and by offering more incentives for R&D and service activities. It is now trying to promote Singapore not only as a high-tech manufacturing location, but also as an international information and services center, and particularly as a purchasing center and operational headquarters for multinationals. At the same time it is exhorting local firms and local salaried employees to seek business and employment abroad, i.e. to "go multinational" much as the other Asian NICs (South Korea, Taiwan, Hong Kong) and small European countries (Netherlands, Sweden, Switzerland) have done, in order to avoid the growth constraints imposed by a small and mature home economy.[22]

The economic recovery from mid-1986 seems to suggest that these government policies have borne some fruit, although much of the recovery is also due to external factors such as the worldwide currency realignment (improving Singapore's export competitiveness in Japan, Western Europe and even the U.S.), and sectoral improvements in the two major manufacturing industries, petroleum and, especially, electronics. The government estimated that its cost-cutting measures between mid-1985 and mid-1986 had reduced average total business costs by 2.3%, thereby raising the rate of return on investments in Singapore from 10% in 1985 to 16% in 1986, still below the OECD average rate of 18% in 1985.[23] This despite the fact that the implementation of wage restraint has been slow, and workers' real

22. For more details on recent government policies in Singapore, see the Around the Region section of Southeast Asia Business, quarterly issues Spring 1985 - Winter 1987.

23. Southeast Asia Business No. 10 (Summer 1986), p. 20.

incomes continued to rise in 1985 and 1986, by 3% each year, in part because of a decline in the price level. By the end of 1986, unemployment, which had risen above 6% earlier in the year, was back down at 4.5% of the labor force.

Wage Restraint and The Labor Market

Wage restraint has been slow in part because employers are required to open their books to unions in order to justify holding down wage increases, and many have been reluctant to do so. GEUSA has been held up as a model employer in this respect, as it gave the union its financial accounts with detailed explanation of each affiliate's performance and business projections, including preparing a 63-page booklet explaining the various issues with the help of cartoons and pictures. The company's 5,000 bargainable employees in five of its Singapore affiliates accepted a one-year wage freeze, as did its executive and non-bargainable staff[24]; workers in the aviation servicing affiliate were exempted because their division was doing very well.

Note that GE was earlier held up as a model employer so far as layoffs were concerned, as it worked with the electronics union, the American Business Council and the Singapore Manufacturers' Association to help workers find alternative jobs, mostly elsewhere in the electronics and computers industry. This involved advertising, calling up potential

24. Bargainable employees in GE Singapore earned wages significantly higher than in the ASEAN countries, Hong Kong, South Korea and Taiwan, while executive and non-bargainable staff, including secretaries, had among the highest pay rates in the world, surpassing those in Australia, New Zealand and Britain as well as other Asian countries. Ibid., p. 42.

employers, and running individual and group job counselling sessions for former employees, including some senior managerial and office personnel. As half of the laid-off employees were Malaysians who returned to their own country[25] (where GE has three factories to which it had earlier transferred labor-intensive product lines from Singapore), while many other workers said they were "in no hurry" to accept alternative jobs because they wanted to have "a holiday" with their considerable retrenchment benefits, and as other electronics and computer firms were hiring even in the depths of the recession, this task of obtaining re-employment for laid-off workers was quite manageable. Workers turned out to be more fussy about the type of jobs they would accept (being particularly reluctant to work for lower pay), than new employers were in hiring them, indicating that the seller's market for female production labor was not completely destroyed by the recession, at least in this industry.

The experience of the 1985/86 recession in Singapore and its aftermath reveal the complexity of Singapore's labor market, which is highly segmented on the demand side especially. For example, wage restraint, and more easy access to foreign labor, are needed most by low-tech small local enterprises, because they are the most labor-intensive and cannot afford

25. In GE as in other companies during the recession, Malaysians were not necessarily particularly singled out for layoff, but they were more ready to respond to "voluntary" retrenchment incentives -- "i.e. "golden handshakes" -- for fear that if they did not, they would eventually be laid off anyway without these benefits. Also, companies which were forced to lay off workers tended to employ a disproportionate number of Malaysians because they were less competitive firms which found it difficult to attract Singapore workers and had to resort to foreigners instead, especially for night-shift work. Note that all workers in the same job receive the same wages, benefits and job protection, regardless of their nationality.

high wages like the more capital-intensive high-tech multinationals can. In 1985 labor costs accounted for 22% of the total costs in local businesses, compared with 14% in foreign firms, and the government acknowledged that the earlier high-wage policy had thus hurt local firms much more than foreign firms.

The foreign firms themselves are not homogeneous, even in the electronics industry. For example, on the one hand, there are very large, long-established consumer electronics firms like Philips and GE, employing thousands of workers each; their workers are unionized, and very well-paid because of many years of seniority wage increments compounded by the large NWC wage increments of the high-wage policy period.[26] Yet these industries are essentially engaged in low-value production (audio and video equipment) in a highly-competitive segment of the international market where European and U.S. producers have been losing market share to more aggressive Japanese and South Korean competitors. They are in the decline stage of the Vernon product life-cycle. Wage restraint (and the currency realignment) is obviously important to them.

On the other hand, there are the relatively new, computer and other high-tech firms, mostly employing only a few hundred workers each, who are generally not unionized and have not yet accumulated many years of seniority wage increments. These firms, which make up an increasing proportion of the electronics industry, are mostly engaged in

26. Thus, for example, in 1984, a ten-year veteran of Philips or GE would be earning more as a production worker than a new university graduate only a few years' younger.

capital-intensive, high-value production where labor often accounts for less than 1% of total manufacturing cost. They are in the new or growth stages of Vernon's product life-cycle, possessing a technological monopoly, and poised at the beginning of declining learning curves and scale economies. Such firms could not and did not abide by wage restraint because it would make it difficult for them to attract and keep workers, especially on the unpopular night shift. Although the government also in effect relaxed restrictions on the hiring of foreign workers, many of these companies did not want to incur the expense and uncertainty of foreign workers[27]. New American investors, for example, have complained that "We came to Singapore to hire Singapore workers, not to employ Malaysians and Thai," when told by the government to recruit workers from Malaysia. In 1986 I was told of at least one major new U.S. investor who complained of being lured to Singapore under "false pretences" and was threatening to abandon the promised investment because of the unavailability of local labor.

The crucial labor shortage in Singapore is the shortage of unskilled female production labor, a resource which happens to be complementary with skilled (usually male) technical labor and capital in high-tech industry. The causes of this shortage include: a small, relatively affluent population, whose educational levels and occupational aspirations have been

27. Foreign workers are generally more costly than local workers in Singapore because of the added costs of recruitment, two-way transportation (by air, in the case of Thai workers), housing, recreation, training, supervision and requirements imposed by the Singapore government, such as the posting of "good behavior" bonds and frequent medical checkups for women especially. Except for Malaysians, their employment period is also limited, usually to two years only.

rising and readily fulfilled in a rapidly-growing, full-employment economy; an improving labor market position for women, whose labor force participation rate is already 46% (Lim, 1982, 1984); a nuclear family structure where child-care is often a problem; and the high and relatively secure living standards of an upwardly-mobile working class, making a second income often unnecessary (see Lim, 1987a).[28] The government has for years been exhorting married women to return to the labor force, and employers to offer them more flexible working-hours such as part-time evening shifts, and company child-care facilities, but this has not been very successful in expanding supply, despite the increasing provision of both public and private child-care services.

There is also a shortage of engineers, mainly of those with working experience. But the supply of engineers from local universities (many of them foreign citizens) has been increasing, and is augmented by engineers trained abroad and by foreign engineers, including expatriate Asians who are encouraged to settle permanently in Singapore. Privatization may also eventually help alleviate the engineer shortage, since the government is currently a major employer of (about half of all) engineering graduates. A majority of engineering graduates currently work in non-engineering jobs, such as managerial and bureaucratic occupations. Engineers, like other managers and professionals (including university professors), in Singapore are paid salaries much above those earned in the other Asian NICs, and even many Western European countries and (until the currency realignment)

28. While many factory women work to buy after-school private tuition for their children, others quit work to spend more time supervising their children's education. See e.g. Salaff and Wong, 1984.

Japan. In 1983, the Prime Minister, foreseeing the growing demand for highly-skilled labor in a high-tech society, embarked on a national campaign to increase the low marriage and reproduction rates of women university graduates, which he believes would increase the supply of "talented" individuals in the future. At the time he also worried about the higher birth-rate of poor, lowly-educated women, and offered them additional incentives to limit their family size and be sterilized. By 1986, however, this selective pro-natalist policy, following on two decades of very strict anti-natalist policy, was generalized to cover most of the population, with public exhortations to increase the nation's "baby output" by having "at least two, preferably three, four (children) if you can afford it". The 1987 government budget has introduced extremely generous tax rebates for couples who have three or more children; children from these larger families will also receive priority entry into the best schools. All this is an attempt to prevent the economic decline which the Prime Minister believes will set in if the present below-replacement levels of population growth are not reversed.

This population policy, although mildly ridiculous and unlikely to succeed, does show the seriousness with which Singapore's government regards the final, major constraint on its long-run economic growth in general, and the success of high-tech industry and services in particular, and that is the country's small size. Despite this small size and already scarce supplies of both skilled and unskilled labor, however, Singapore has managed to continue attracting new foreign investments in high-tech manufacturing through the 1980s, otherwise a time of declining international competitiveness for the economy as a whole. I submit that

this is largely explained by the declining importance of cheap labor, and the increasing importance of political stability, infrastructure, capital incentives, skilled labor and security of technology, in international high-tech industry. GEUSA, for example, while closing down part of its operations in Singapore, is retaining a significant and even increased presence there in other operations, because of Singapore's "hard-to-replace engineering skills, including design engineering for various divisions.....availability of skilled workers, good infrastructure and political stability".[29] To remain price competitive, the company is automating and moving into high value-added products.

The Importance of Location

New investors cite similar reasons, including especially Singapore's strategic geographical location. In high-tech industry, the complementarity of human and physical capital with skilled and unskilled labor, the importance of minimizing costs and turnaround time, the necessity for increased technical and other support services for production facilities, and the economies of locating R&D activities close to production, all favor a location which is stable, secure, with excellent infrastructure and rich in human and physical capital, yet close to other locations which are abundant in cheap labor and cheap material supplies, and easily accessible by modern transportation and telecommunications to sources and markets in the rest of the world. The entire East and Southeast Asian region -- besides Singapore, including ASEAN, the East

29. Southeast Asia Business No. 6 (Summer 1985), p. 42.

Asian NICs and Japan -- has become perhaps the most important world center of electronics and high-tech production, both by non-Asian multinationals and by local and regional enterprises. Considerable inter- and intra-industry linkages and economies of agglomeration have developed within the electronics industry in this region over the past two decades, such that for many firms, this is now a major market as well as sourcing location. Semiconductor companies, for example, find customers among computer and consumer electronics firms in the region, while various component producers, chemical manufacturers, etc. have also flocked here to supply their final customers. Even the final market for electronic and high-tech products is likely to grow more rapidly in this region than in almost any other because of rapidly rising income levels, Asians' demonstrated fetishism about electronic consumer products, and proximity to the huge future markets of China and India, both of which are slowly liberalizing their economies. If the Japanese eventually open their home market -- the second largest in the world -- to foreign producers as promised, the region will be particularly well-located and equipped to supply it.

Summary Analysis and Conclusions

This paper has described and sought to explain the evolution of the electronics industry in Singapore over the past two decades, linking it on the one hand to international technological, market and policy (including trade and industrial policy) developments in high-tech industry, and on the other, to local market and government policy developments in Singapore

itself. My contention is that the transformation of the Singapore industry can only be explained in this unified historical context, involving a multiplicity of related factors operating at the international, regional and local levels. It remains to summarily discuss the respective roles of capital, labor and the state in high-tech industrial development in Singapore, and the impact of such development on each of them, focussing on the situation as it stands in the 1980s.

Capital

It has become conventional in studies of the international location of high-tech industry to see production for export in developing or "peripheral" countries as originating in the drive for ever-increasing profits of multinational corporations headquartered in developed or "core" countries. This paper has suggested a more complex process, whereby, for example, new high-tech companies in developed countries, initially ignorant of international operations, are approached and solicited for investment by the government of a developing country. In moving to such a country, these companies instantly become "multinational", but they do not necessarily conform to the stereotypical characteristics of "classic" large and oligopolistic multinational firms in mature industries. As high-tech firms, they do have certain industry characteristics -- such as high R&D costs, short product life-cycles, short imitation lags, and learning curves -- which make early cost-reduction an important element in market competition and indeed, survival. Hence the attraction of an efficient, low-cost location like Singapore, which makes possible the rapid expansion of capital and attainment of dominant market share. (Note that this

contrasts with Vernon's traditional product life-cycle where cost-reduction becomes important only in the phases of maturity and decline. In more recent high-tech industry, on the other hand, location in a country like Singapore occurs in the growth or even the new phase -- for example, Seagate undertakes pilot production in Singapore, while other companies conduct some design and development here as well.)

The international division of labor within such high-tech industry also challenges the stereotypical view of a concentration of higher-skill, higher-value operations in the developed home country of the multinational, and of lower-skill, lower-value operations in the developing host country. While this is how a particular venture might begin, over time more and more higher-skill and higher-value operations, including some R&D, are transferred to the "offshore" manufacturing location, to benefit from vertical linkages, economies of common location, reduced turnaround time, etc.. This, of course, requires that the offshore location develop the capability -- both in terms of infrastructure and skill -- of handling these higher-level operations. Eventually, as in the case of Seagate, most functions are transferred to the offshore location which employs the bulk of the company's international work-force, with the "home" office existing mainly to service it.

(Seagate is not an isolated example. For example, the world market and technological leader in oil-rig design and production is a Singapore-owned company which began life as a U.S.-owned company that was subsequently taken over by Singapore interests who used their link with the U.S. company to acquire technology and expertise that they then packaged

and sold to the rest of the world. Today the U.S. office is a subsidiary of the Singapore headquarters, and is maintained solely for the employment of a half-dozen U.S. design engineers. Oil-rig production, of course, is an industry in which Singapore has a competitive advantage partly on the basis of its location and function as an oil-transshipment port.)

In the host developing country, meanwhile, high-tech production is dominated by these multinationals from the developed countries. In the Singapore case, foreign capital was invited in in part because of the lack of local capital and enterprise in manufacturing. This lack would be particularly acute in high-tech industry, which is more likely to develop in countries with large rich markets and relatively abundant supplies of financial and human capital, like the U.S.. Nevertheless, over time the multinational (high-tech or not) tends to spawn local manufacturing industry, both by providing a market demand (for industrial inputs -- perhaps accentuated by GSP local content rules), and by supplying the entrepreneurs for local supplier industries, many of whom are drawn from the ranks of experienced local multinational employees (e.g. Lim and Pang, 1982). The local capital which develops may be considered to be dependent on the multinational, but this dependence is in fact mutual, since it is difficult for the multinational to obtain alternate sources of supply of the quality and at the speed required by high-tech industry. Indeed, it is likely that the local capital which develops in this way may readily develop alternate customers among the originating multinationals' competitors, making the multinational customer more vulnerable to this mutual dependency than the local supplier -- a kind of "dependency reversal", perhaps.

The Singapore case does show, however, that high-tech multinationals do compete with local capital in other sectors of the economy, for both skilled and unskilled labor which are in short supply. Even in the manufacturing sector itself, since the multinational is more capital-intensive and presumably more profitable, it can typically afford to pay higher wages and salaries than more labor-intensive local firms. The result is some "crowding out" of local capital, at least in the labor market (not so much in the product or capital markets). This weakening of local capital must be offset against the strengthening of local capital generated by the multinational's vertical linkages to local supply firms and services. Note also that dominance by multinationals has probably facilitated foreign market access for, and restrained protectionism against, Singapore's manufactured exports in the multinationals' home markets, which may have benefitted local capital.

Contrary to popular expectation, within the multinational subsidiary itself, control quickly passes from home country expatriates to local managers (some of whom eventually leave to become their own bosses in complementary or competitive ventures). This of course depends on suitable local managerial expertise being available. In Singapore in the 1980s, many if not most new high-tech multinationals started off with local management, who often not only had the authority to do what they wanted, but also were from the beginning relied on by their inexperienced foreign "head-office" for managerial decisions.

In the case of Seagate, for example, the visiting American owner employed a Singaporean engineer who had worked for 8 years for IBM in the

U.S., provided him on second meeting with a blank checkbook (literally) to get the operation started, and then flew back to the U.S.. The Singaporean assembled a team which got the operation started from scratch, then decided to set up a labor-intensive sub-assembly facility in Bangkok (because he had a brother there whom he recruited for this purpose), chose the factory site (a non-flooding site near the airport), and then telephoned to inform the owner in California of this decision. Similar tales have been recounted at other companies. Increasingly, Singaporeans are responsible not only for production, but also for marketing, finance and strategic planning of their operations, which may constitute the bulk of the operations of the parent company. Other familiar American multinationals headed by local management in Singapore include National Semiconductor and Hewlett Packard. Japanese multinationals, on the other hand, almost never employ locals in powerful, let alone top, positions.

Another early, stereotypical characteristic of offshore sourcing multinationals that is absent in the Singapore case, and I believe also in most other cases of electronics production, is "footlooseness", defined as the propensity to shift between low-cost locations as comparative costs, especially wage costs, change. High-tech multinationals, especially, have not done this because their investments in human and physical capital in any particular chosen location are usually considerable, and constant start-up and relocation costs and delays would mean the loss of valuable time as well as money where product lives and imitation lags are short. Workers' and managers' learning curves may also be longer in higher-skill operations, and skilled labor for high-tech industry is scarce the world over. It is not easily abandoned for a new, cheaper location. Many of the

newer high-tech multinationals are also heavily dependent on their Singapore locations and local managers, who may produce and handle the bulk of the entire company's supplies. This is another case of possible "dependency reversal" i.e. where the multinational is more dependent on a given location (say, Singapore) than that location is on a given multinational. Where there are so few "Singapore" suitable for the capital-intensive, high-tech multinational's complex operations, the bargaining power may shift in their favor.[30]

Besides heavy capital commitments and a reservoir of valuable local skills, multinationals also over time develop a network of local suppliers and distributors which would be disrupted and difficult to replace if they shift to another location. In the case of Singapore, the presence of so many multinationals in the same industry has encouraged many of their suppliers to locate there to supply their customers directly, benefitting from agglomeration and scale economies and quicker turnaround time, as well as cheaper materials. Such a concentration could not be found in any lower-wage location in Asia, except perhaps for South Korea and Taiwan, which have other disadvantages when compared with Singapore[31].

30. Another example of technological "dependency reversal" is cited in Business Week's famous March 3, 1986 special issue on "The Hollow Corporation", where it is mentioned that the U.S. semiconductor company Intel Corp. had to import three Malaysian engineers from Penang to design its new automated production facility in Arizona, as no-one in the U.S. knew how to do this since they had been divorced from production for so long.

31. Such as a lack of English-speakers, a higher risk of technology imitation/violation of intellectual property rights, and a higher risk of being subject to protectionistic trade barriers, all of which are particularly important to high-tech industry.

It remains to consider the implications of these developments for the evolution of the "local territorially-based production complex" which so concerns some observers.[32] The assumption behind this concern is that a multinational-dominated "production complex" which concentrates on only a narrow range of parts and products is shallow, inherently insecure and inferior in terms of its developmental consequences (whatever they may be), as compared to a self-sufficient, well-integrated locally-owned and operated industrial sector (which, for example, better characterize the other three Asian NICs). This assumption ignores both content and context, rendering the ideal of a "local territorially-based production complex" little more than a theoretical abstraction. First, as Robert Reich for one has recently argued,[33] ownership of an industrial enterprise is of little relevance in the generation of national technological capability i.e. what is done in an enterprise is more important than who owns the enterprise, in terms of generating lasting local skills and experience, if locals are employed in the doing. Thus more lasting benefit -- in terms of a higher level of skill -- may be generated by the employment of Singapore engineers and managers in high-tech operations in multinational subsidiaries making sophisticated electronic components and equipment, than in wholly locally-owned simple-technology industrial enterprises making shoes, shirts and plastic toys in Hong Kong or Taiwan. Second, making only part of a sophisticated high-tech product may well generate more local

32. At the UCLA conference, this question was persistently raised by Jeff Henderson and Michael Storper.

33. Robert B. Reich, "The Rise of Techno-Nationalism", The Atlantic, Vol. 259, No. 5 (May 1987), pp. 62-69.

"human capital" than making every part of a simple shoe or plastic trinket, besides likely yielding a higher absolute local value added i.e. 10% of the value of a computer may be greater than 100% of the value of a shoe or umbrella.

Third, particularly in high-tech world industries, it is impossible for most developing countries to generate a "local territorially-based production complex" on their own -- for one thing, because of their typically small size, and limited skill, capital and technological resources. Singapore is simply too small (with 2.5 million people) to operate an integrated, self-sufficient local manufacturing sector. Hitching itself to large multinationals operating at the frontiers of technology and producing for world markets has enabled Singapore to leapfrog many stages of technology, to grow more rapidly than would be permitted by its own negligible domestic market and resources, and to have a more diversified industrial structure than relying only on local capital and technology would allow. After the 1985/86 recession, for example, it was the fast-growth export-oriented high-tech manufacturing sectors which led the recovery, while domestically-oriented sectors of the economy remain in the doldrums.

Fourth, even if a "local territorially-based production complex" were possible in a developing country, it need not be desirable. Much depends on the opportunity cost. I have already suggested that it might be better to be dependent in the production of computers and telecommunications equipment than independent in the production of shoes and umbrellas. Where local entrepreneurs are scarce, it may be just as well that they

concentrate in non-manufacturing sectors of the economy if those generate high returns with less risk, leaving multinationals to develop the manufacturing sector and local technical, managerial and entrepreneurial skills within it. While it is obviously good to do some R and D locally, it is not necessary or desirable to do all or even most of the R and D that one needs, since R and D is a high-cost, high-risk activity, very intensive in the use of scarce technically-trained and experienced personnel. Singapore may have been wise to eschew the heavy capital subsidies that South Korea, for example, favored in its only partially-successful search for technological advancement and independence. Rather, with earnings generated in trade, commerce, services and finance, private and public sector Singapore companies have begun establishing venture capital funds with which they are buying cash-starved high-tech "seed companies" in the U.S. i.e. buying R and D and technology, some of which is to be applied in manufacturing in Singapore. Local capital and entrepreneurship may be more fruitfully employed in this manner than in struggling to operate a "local territorially-based production complex" which may doom developing countries to be forever technologically far behind the advanced industrial countries.

Finally, the entire concept of a "local territorially-based production complex" may be simply obsolete in a world where even among large developed countries, industries and economies are becoming increasingly interdependent across national boundaries, particularly in high-tech industry. Witness, for example, the increasing collaboration among U.S. and Japanese electronics and computer companies in each other's markets, and the continued growth of multinational offshore sourcing in developing

countries, with the Japanese now leading the pack. For multinationals, almost by definition, it is global rather than national integration of production which counts, with nation states and national government policies operating as only one variable to be considered in the international location of production. In East and Southeast Asia, it is arguable that the industrial sectors of national economies are already being regionally integrated through the multinational -- for example, in the computer industry. In a sense, a "local territorially-based production complex" does exist in this region, and Singapore is part of it; but the "local territory" is a geographical region, not a nation state, which makes sense if only because the individual nation states are too small to each constitute a "local territorially-based production complex" by itself. Presumably an analagous situation exists in the European Community.

Labor

The importance of labor, particularly cheap, unskilled production labor, has clearly declined as the electronics industry in Singapore has evolved over time. Even in the late 1960s, however, Singapore was the highest-wage country in Asia after Japan, so in relative terms labor has never been cheap except when compared to labor in the multinationals' home countries. Rising wages, whether induced by the tight labor market or by government policy, have not, however, forced the multinationals out, as some early theorists predicted. On the contrary, the companies tried to accommodate to rising labor costs, by shifting more labor-intensive operations out to neighboring low-wage countries, while substituting capital for labor in Singapore and moving in newer, higher-skill,

higher-value operations with lower labor content. In other words, they have adjusted to the shifts in Singapore's relative resource endowment and government policy priorities. Even in the early days, the importance of wage costs alone has been exaggerated, and today it is low total costs of production which are important.[34] For the newer, high-tech firms, especially, labor cost is virtually irrelevant, and many have found it both unnecessary and unwise to conform to the government's wage restraint policy.

As pointed out at the end of the last section, there is an interesting conflict here between different employers and different sectors of the economy over labor. For the high-tech multinationals producing for a world market, the Singapore domestic wage is still not at a market-clearing level i.e. they cannot get the workers they need except by raising wages, perhaps considerably. This, however, would price local employers, including manufacturers, and including some local suppliers of the multinationals, out of the labor market, reducing Singapore to a nation of (albeit highly-paid) employees of foreign corporations, employing other foreigners from the region to perform lower-wage service and production work in the domestic economy.[35] Indeed, Singapore is so desirable as an investment location for foreign multinationals (including two-thirds of the

34. Note that unit labor costs, which include labor productivity, and not absolute wage rates, are important in determining international competitiveness. See the discussion in Lim, 1987b.

35. For example, many Singapore women factory workers already employ foreign domestic servants, usually from Malaysia or the Philippines. Many of the Filipina maids, in particular, have higher educations than their employers.

top Fortune 100 U.S. companies), that many of them would be happy to pay much higher wages than they do now, if not constrained by Singapore's domestic policies. Labor is no longer Singapore's strong point in attracting high-tech multinationals, if it ever was; instead labor availability is the country's greatest liability and constraint on growth.

What has been the impact on local labor of these developments in Singapore manufacturing, and in high-tech industry in particular? Industrial relations developments have arguably weakened labor's bargaining power, although government backing and labor's representation in many tripartite decision-making bodies (like the NWC) may counteract this somewhat.[36] Union membership declined from its peak in 1979 through 1984, before recovering somewhat in 1985 due to a strong push for organization by the government-led NTUC. The increase in high-tech manufacturing may have contributed to this decline, since the smaller, more capital-intensive enterprises, skill upgrading (and the associated reduction of the "bargainable" proportion of the labor force), and more sophisticated personnel management practices characteristic of high-tech companies make them harder to organize than the earlier large, labor-intensive enterprises (such as GE and Philips). At the same time, however, a tight labor market in the first half of the 1980s enhanced workers' individual and collective bargaining power, contributing to large wage increases which were also an outcome of the government's high-wage policy. Thus, though institutionally labor organization may have weakened

36. See Lim, 1987a for a fuller discussion of export manufacturing and the labor movement.

during this period, economically workers did extremely well, with dramatic improvements in all indicators of labor welfare (Lim, 1987a).

While it is true that wage rates in Singapore remain a fraction of U.S. wages for equivalent work, they may purchase a much higher standard of living in Singapore than the higher U.S. wages purchase in the U.S.. Thus, for example, in 1983, a female electronics factory worker, one of the lowest-paid workers in Singapore, then earning an average basic wage (which understates the total wage) of S\$450, or about US\$200, per month, belonged to a household income group[37] where

96.2% of the households had a refrigerator, 95.9% a television set, 23.1% a video cassette recorder, 12.8% a motor-car, 17.5% a motor-cycle, 44.7% a washing-machine, 3.6% an airconditioner, and 3.8% a piano/organ. (Lim, 1987a)

Even among the lowest-income households in Singapore -- to which few electronics factory workers would belong -- those earning less than S\$500 a month and constituting the bottom 4.8% of all households,

84.8%...had refrigerators, 81.1% had televisions, 55.6% had telephones, 19.3% had washing machines, 13.2% had motor-cycles/scooters, 6.2% had video cassette-recorders, 1.2% had air-conditioners, and 0.8% each had a piano/organ and a car. (Lim, 1987a)

Note that per capita income in Singapore is less than half that of the U.S.. Other interesting statistics include the fact that Singapore has a lower infant mortality rate than the U.S., and that the top medical problem among 12-year-old schoolchildren is obesity (Lim, 1987c).

37. Counting the electronics worker as a secondary income earner, the typical situation,

Because of the underlying labor shortage, even the recession and the ensuing policy of wage restraint have only served to slow down, not eliminate or reverse, annual real wage increases, and even this may fade away if the current recovery continues. However, the government is determined that wages should not ever again increase more rapidly than productivity, and the recently-proposed wage reforms -- downgrading the importance of seniority, increasing the importance of individual skill and productivity and the bonus component of the wage, etc. -- are likely to ensure this. Wage dispersion will increase, and average wage increases will be smaller than in the first half of the 1980s.

The State

Clearly the state in Singapore has played a very central role in the attraction of multinationals and the evolution of high-tech industry, for example, by investment promotion and the offering of investment incentives (in recent years especially for skill and technology upgrading and R&D), by controlling the flow of foreign labor, and setting wage policy, as well as by public investments in human capital and physical infrastructure, and the maintenance of political and financial stability. Not all of these actions were motivated solely or mainly by the desire to attract high-tech multinationals, of course, for most of the government's policies have multiple goals, including domestic social and political as well as economic goals. The cumulative result, however, has been a large and very powerful role for the government in the economy. This prominent state role is generally regarded as having been necessary in the early years of sovereignty and industrial development, but more recently it has been

criticized as excessive, and even a major contributor to the recent recession.[38]

The government has now pledged to reduce its role in the economy, but for a variety of political and economic reasons, this is unlikely to progress very far or very fast. For one thing, many of Singapore's highly-efficient and profitable state enterprises are among the best candidates for the preferred strategy of "multinationalization" -- for example, the Telecommunications Authority of Singapore, and Singapore Airlines, which already has a 20% foreign ownership share following its partial public stock offering in 1985. For another, the local private sector is still too small and weak to take over much of the government's current activity, which would likely fall into foreign hands instead. Some of the government's recent policy moves -- such as wage restraint, the easing of foreign labor imports, a lesser insistence on high-tech, and efforts to help small local enterprises -- could ultimately strengthen this sector.

Capital, Labor and the State in the Internationalization of High-Tech Industry

As far as the internationalization of high-tech industry is concerned, the state has played an active, aggressive and leading role in developing high-tech multinational manufacturing for export in Singapore. Labor has played an initially permissive, but finally constraining role, while local

38. For more on the changing role of the state in the Singapore economy, see Lim, Pang and Findlay, 1987.

private capital has played a supportive, and somewhat subordinate, role. All three local actors, however, have benefitted in various ways from the presence of high-tech multinationals in Singapore: the state from the extension of its own power and revenues (e.g. in supplying public services to the multinationals), and the increase in its political popularity resulting from sustained economic prosperity; labor from increased employment, skills, incomes, welfare and market (though not institutional) power, causing labor to be among the most enthusiastic supporters of multinational investment (perhaps a "comprador proletariat?"); local private capital from increased business experience and opportunities, though these must be weighed against being "crowded out" of the domestic labor market. Multinational capital itself generally did not actively initiate or seek out, but rather enthusiastically responded to, the changing opportunities provided by Singapore to manufacture competitively there for a world market, and appears to have profited handsomely.

Global developments in high-tech industry and in world trade generally have on balance, though not unambiguously, favored Singapore's changed circumstances of the 1980s. In particular, Singapore has benefitted both from the declining relative importance of labor, and from the growing tendency to consolidate production in fewer locations, rather than disperse it in many, as was common earlier. Its advantage over comparable developed country locations, however, is provided by its geographical location in a dynamic economic region which has also become a major world center of electronics and high-tech production. To some extent, Singapore has served as a focal point for high-tech industry in Southeast Asia especially -- as a source of labor-intensive sub-assembly activities phased out because of

its own labor shortages and high labor costs; as a final or intermediary purchaser and supplier of material inputs; as a financing, marketing, information, transportation, technical and engineering support services center; as an employer and trainer of skilled and unskilled labor, etc.. Increasingly it hosts not only offshore manufacturing plants, but also international purchasing offices (IPOs) and operational headquarters (OHQs) of multinational companies. The surrounding countries, particularly Malaysia, the Philippines and Thailand, have also had their own domestically-motivated programs to attract export-oriented multinational manufacturing investment (see e.g. Lim, 1983b). But it is likely that the electronics industry in particular has been attracted to these countries at least partly because of their proximity to, and the industry's own favorable experience in, Singapore.

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TABLE 1 PRINCIPAL STATISTICS OF MANUFACTURING, 1960-1984 SINGAPORE

YEAR	ESTABLISHMENTS	WORKERS	MATERIALS	OUTPUT	VALUE ADDED	SALES		EMPLOYEES' REMUNERATION	CAPITAL EXPENDITURE
						TOTAL	DIRECT EXPORTS		
THOUSAND DOLLARS									
1960	548	27,416	302,846	465,568	142,143	457,033	164,310	66,795	9,806
1961	562	27,562	321,143	518,373	174,364	520,672	179,068	71,633	10,539
1962	605	28,642	432,626	660,300	201,680	664,285	217,501	76,803	33,274
1963	858	36,586	558,560	843,753	252,566	836,816	223,807	97,552	17,720
1964	930	41,488	605,744	927,928	282,462	914,907	266,422	111,125	52,688
1965	47,334	693,345	693,345	1,086,363	348,361	1,075,494	349,163	131,692	59,226
1966	1,123	52,807	870,605	1,325,782	415,043	1,313,699	404,865	150,754	75,533
1967	1,200	58,347	1,160,857	1,687,234	478,629	1,666,443	508,204	170,310	84,805
1968	1,586	74,833	1,498,244	2,175,668	611,758	2,172,291	598,466	210,699	89,573
1969 ¹	1,714	100,758	2,271,584	3,213,899	856,631	3,255,401	1,265,286	319,803	212,578
1970 ²	1,747	120,509	2,668,394	3,891,012	1,093,722	3,846,164	1,523,033	397,618	421,342
1971	1,813	140,552	3,150,082	4,699,246	1,366,520	4,654,892	1,954,683	503,209	460,571
1972	1,931	170,352	3,742,598	5,722,224	1,782,278	5,679,554	2,641,681	648,676	647,961
1973	2,079	198,574	5,064,990	7,938,073	2,540,597	7,961,293	4,269,774	861,407	787,954
1974	2,179	206,067	9,236,569	13,346,913	3,528,220	13,228,138	7,811,939	1,075,892	620,543
1975	2,385	191,528	8,586,011	12,610,144	3,411,129	12,401,049	7,200,693	1,180,524	622,635
1976	2,505	207,234	10,622,406	15,317,439	3,961,813	15,556,536	9,575,927	1,309,841	618,670
1977	2,638	219,112	12,224,625	17,518,249	4,475,458	17,390,502	10,969,405	1,471,749	751,639
1978	2,946	243,724	13,561,952	19,666,884	5,162,922	19,555,504	12,632,733	1,724,243	821,838
1979	3,122	269,334	17,513,440	25,133,686	6,412,934	25,172,888	16,202,989	2,085,918	1,424,443
1980 ³	3,355	285,250	21,415,150	31,657,895	8,521,888	30,946,697	19,172,916	2,526,873	1,861,859
1981	3,439	281,675	24,891,517	36,787,096	9,720,545	36,543,494	22,375,250	2,938,058	1,966,771
1982	3,586	275,450	24,854,426	36,467,443	9,355,941	36,437,020	21,858,690	3,270,625	2,222,730
1983	3,616	271,106	25,116,313	37,221,519	9,822,090	37,411,118	22,640,771	3,623,693	2,113,351
1984	3,648	274,391	27,474,362	41,077,861	11,106,272	40,910,708	25,057,754	4,044,994	2,168,080

NOTE: RUBBER PROCESSING AND GRANITE QUARRYING ARE EXCLUDED.

1 DATA FOR THE PETROLEUM INDUSTRY IN THE 1969 CENSUS WAS EXTENDED TO INCLUDE BLENDING ACTIVITY, WHICH ACCOUNTED FOR ABOUT 28% OF THE INCREASE IN OUTPUT.

2 PRIOR TO 1970 DATA INCLUDED REPAIR AND SERVICING OF MOTOR VEHICLES AND OTHER HOUSEHOLD GOODS AND CARPENTRY AND JOINERY WORK WHICH ACCOUNTED FOR ABOUT 0.6% OF OUTPUT AND 1.0% OF VALUE ADDED IN 1969.

3 PRIOR TO 1980, DATA ON OUTPUT AND SALES OF PETROLEUM REFINING INDUSTRY INCLUDED THE VALUE OF PRODUCTS PROCESSED FOR THIRD PARTY OVERSEAS.

SOURCE: Department of Statistics, Singapore, Report on the Census of Industrial Production 1984.

TABLE 2. Selected Ratios of Singapore's Manufacturing Sector

	<u>1960</u>	<u>1970</u>	<u>1980</u>	<u>1984</u>
Workers per Establishment (No.)	50	69	85	75
Value Added/Output (%)	31	28	27	27
Value Added per Worker (S\$)	5,188	9,077	29,880	40,490
Direct Exports/Sales (%)	36	40	62	61
Employees' Remuneration/ Value Added (%)	47	36	30	36
Capital Expenditure per Worker (S\$)	358	3,497	6,528	7,904
Employees' Remuneration per Worker (S\$)	2,436	3,300	8,860	14,741

Source: Department of Statistics, Singapore, December 1985,
Report on the Census of Industrial Production 1984,
Table 1.

Notes: (1) S\$1 = US\$0.33 in 1960 and 1970; S\$1 = US\$0.45 in 1980
and 1984.

(2) Dollar figures are nominal values. The consumer price
index at 1960 = 100.0 was 111.5 in 1970, 214.4 in 1980,
and 251.5 in 1984. See Lim, 1987a.

TABLE 3. Selected Ratios of the Electronic Products and Components Industry¹

	<u>1970</u>	<u>1980</u>	<u>1984</u>
Establishments (No.)	64	172	214
Workers (No.)	13,586	71,727	73,271
Output (S\$'000)	283,012	5,343,995	9,703,387
Direct Exports/Output (%)	75	84	85
Workers per Establishment (No.)	212	417	342
Value Added per Worker (S\$)	9,400	23,300	39,800
Value Added/Output (%)	45	36	37
Capital Expenditure per Worker (S\$)	2,760	3,562	9,027

Sources: Department of Statistics, Singapore, Report on the Census of Industrial Production, 1978 and 1984.

Notes: (1) This three-digit category 384 includes computers and computer peripherals; electronic office machinery and equipment; communications equipment; color television sets; microphones, loudspeakers and amplifiers; gramophone records and pre-recorded magnetic tapes; radio receiving sets and audio and video combination equipment; semiconductor devices; capacitors and resistors; printed circuit boards; and other electronic products and components.

(2) See notes to Table 2.

TABLE 4. Ratios of Selected Electronic Product and Component Industries, 1984

	Estab- lish- ments (No.)	Workers (No.)	Output (S\$'000)	Workers/ Establi- shment (No.)	Value Added/ Worker (S\$)	Value Added/ Output (%)	Direct Exports/ Sales (%)	Remune- ration/ Value Added (%)	Remune- ration/ Worker (S\$)	Capital Expenditure/ Worker (S\$)
Computers & computer peripherals (38411)	35	11,515	2,625,755	329	70,283	31	81	14	9,695	9,099
Electronic office machinery & equipment (38412)	6	5,096	537,754	849	50,726	48	72	29	14,679	5,207
Communications equipment (38413)	15	2,115	171,088	141	30,259	37	80	54	16,219	22,057
Semiconductor devices (38441/3/9)	15	14,487	2,503,409	966	37,640	22	95	42	15,653	16,721
Printed circuit boards (38462)	17	4,818	750,121	283	60,546	39	85	22	13,337	9,415

Source: Department of Statistics, Singapore, Report on the Census of Industrial Production 1984, Table 41.

Notes: (1) Remuneration is average employee remuneration for the year.

(2) These point-of-time figures must be interpreted with care. Such factors as relative capital-intensity, the skill level and seniority of the labor force, and the "lumpiness" of capital expenditure would affect the interpretation of these figures, and are not adequately considered here. For example, the relatively low remuneration per worker in computers and computer peripherals may simply reflect the recent vintage of this industry and the lack of seniority of its workers; the high capital expenditure in communications equipment may reflect large new investments in this one year alone, etc.