Japan's Role in the Transfer of Technology in Singapore*

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1 Introduction

Many developing countries including those in the Association of Southeast Asian Nations (ASEAN) have adopted first the import substitution strategy for industrialisation, followed by the swtich to export orientation which has proven successful in many cases.[1] Both the import substitution and export orientation strategies of these developing countries rely heavily on foreign investment which brought a package of capital, technology, expertise and markets. These foreign investors have been attracted as much by the host countries as by push factors including the product cycle and other technological developments.

In particular, the transfer of technology has become a critical component in the industrialisation and growth processes of developing countries. This subject has been, and is still intensely being studied by many scholars and researchers.[2] As one of the most dynamic industrial economies and a leading investor in the ASEAN region, Japan's role in the transfer of technology is an important area for research. In this context, an understanding of Japan's industrialisation, growth and development would be useful to understand and apppreciate its

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role in technology transfer in ASEAN.[3] Japan is also a major supplier in ASEAN markets, competing with other US and European suppliers and these are important agents for technology flows (Hermenz and Langhammer, 1987).

As part of a study on the role of Japan in the transfer of technology in ASEAN, this paper will analyse its role in Singapore. Section 2 will provide a brief overview of the industrialisation process in Singapore and highlight Japan's position relative to other foreign investors. The subject of technology transfer will be more closely examined in Section 3 while the issues and prospects will be discussed in Section 4. The last section closes with some conclusions and policy implications, both for Singapore and Japan.

2 Singapore's industrialisation and the role of Japan

The transformation of the Singapore economy from an entrepot port into a newly industrialising economy (NIE) occurred in less than two decades.[4] Although many local, cottage industries were found in the 1950s, its industrialisation programme officially started with its first development plan in 1960. By the early 1970s, industries such as textiles and garments and electrical and electronics have created sufficient jobs to wipe off the postwar unemployment problem. Instead, a deficit labour situation resulted. With real growth rates which reached double digit in some years, Singapore ascended to become a NIE by the early 1980s but just as quickly began to face the issue of graduation.

Together with other NIEs, it lost its Generalised System of Preferences (GSP) from the US in 1989 (Toh and Low, 1991).

The Economic Development Board (EDB) followed a few criteria in its pursuit of foreign investment (see Low et al, 1992 forthcoming). Over time, capital became less crucial and the accent is on quality investment which complements its changing comparative advantages and resource constraints. Second, while not having an industrial policy, the EDB follows a niche creating or strategic industrial targeting policy. Third, in budgrafting MNC operations and culture into Singapore, the EDB has ensured that the gains, especially from technology transfer, are maximised and costs minimised and the distinguishing feature is that this has been successful. Finally, MNCs are attracted to build up the local supporting industry as local small and medium enterprises (SMEs) are not yet self-sustaining.

There is no antagonistic, exploitative relationship by multinational corporations (MNCs) as found in other developing countries. Singapore's attractions have revolved around its locational advantages and infrastructural facilities. Unlike resource abundant developing countries, even its labour factor was quickly exhausted and there was no opportunity a one-sided exploitative colonial pattern. Instead, MNCs have to transfer relevant product lines and technology compatible to with Singapore's strengths and weaknesses in factor endowment to keep their competitiveness, thus creating a symbiotic rather than

exploitative relationship.

Following the economic restructuring policy in 1979, the priority was to upgrade into high technology and research and development (R&D), deemphasising low skilled and labour intensive industries. By the early 1980s, more fiscal and other incentives were directed at R&D. But it is clear that more development than research would be the case in Singapore given its small base.

Throughout the 1980s, the five top foreign investors were the US, Japan, the UK, Hong Kong and Malaysia (Table 1). However, their share of total foreign equity investment has fallen from 79.1% in 1980 to 63.4% in 1989 and only Japan's share has increased. One interesting point is that there has been no trend

Table 1 Total equity investment of all companies by country, 1980-89

No/S$m

	1980	1985	1986	1987	1988	1989	1980-89 gr %
Total	34010.7	74644.3	77744.0	87159.8	102123.8	125147.7	14.5
Local	21008.4	49141.8	49160.0	52619.5	60847.0	78071.0	14.6
Foreign	13002.3	25502.5	28584.0	34540.3	41276.8	47076.7	14.3
US	2551.5	6170.0	7233.5	8500.1	8319.2	9157.7	14.2
Aust	403.9	593.9	1105.2	1607.3	3346.3	3132.6	22.8
Europe	4814.8	7688.7	8790.5	10025.5	11584.8	13135.2	11.2
EC	4237.5	6134.9	6876.8	7668.0	8941.2	10112.4	9.7
Asian	4679.0	9068.1	9053.5	10476.0	13258.9	16037.6	13.7
Japan	1420.6	3261.3	3771.8	4730.6	6646.0	8606.7	20.0
HK	1707.0	2352.8	2121.8	2636.2	2886.1	3530.3	8.1
Taiwan	61.6	82.0	83.9	120.6	161.3	208.1	13.5
ASEAN	1361.0	3165.6	2859.2	2721.4	3310.3	3390.2	10.1
Msia	1171.4	2784.8	2492.8	2280.3	2911.8	2913.5	10.1
Indon	105.0	194.2	186.1	248.5	181.4	232.6	8.8
Others	553.1	1981.8	2401.3	3931.4	4767.6	5613.6	25.7

Source: Singapore, Department of Statistics, Foreign Equity Investment in Singapore, 1980-89, January 1992.

of a rising share of investment in Singapore from the other Asian NIEs as experienced in other ASEAN countries probably because of their similiar, competitive industrial structures.

Within the manufacturing sector, Table 2 shows that the electrical and electronics industry was the largest, accounting for 39.7% of total foreign investments. Foreign investment in the petroleum and industrial chemical industries also surged in 1990, accounting for 15.3% and 10.7% respectively of the total. The shares of the machinery industry and fabricated metal industries were 7.7% and 4.2% respectively in 1990.

By country of origin, net foreign investments commitments from the US accounted for 38.2% of total foreign commitments in 1974, followed by Japan, 26.4% and the EC, 16.6%. In 1990 as shown in Table 3, these shares were respectively 47.6%, 31.9% and 17.8%. Most nationalities of the MNCs are represented in Table 3. This is a matter of tapping worldclass MNCs as well as ensuring no lopsided dependence on either the US or Japanese investors.

While Japan appears to be catching up in terms of net investment commitments, the US is still a big MNC player based on the cumulative gross fixed assets. Noting possible problems of accuracy using cumulative d ta Table 4, the US accounts for 35.4% of foreign gross fixed assets in the manufacturing sector in 1988. It is followed by Europe, 29.6% and the EC, 27.6%. Japan accounts for 28.1% of foreign gross fixed assets. The annual average growth rates of Japan over the period 1970 to 1988 is the highest at 24.1%, followed by the US, 16.4% and the EC, 14.2%.

Table 2 Net investment commitments in manufacturing by industry, 1986 - 1990 (excluding petrochemicals) S$m

	1986	1987	1988	1989	1990
Food & bev	83.3	156.6	168.4	34.1	43.8
Textiles	5.6	3.0	10.6	2.0	2.8
Wearing app	0.0	6.8	0.9	0.4	0.2
Leather & rubber	0.4	8.5	5.6	0.0	10.0
Wood prods	11.4	14.7	0.0	2.1	8.6
Paper & printing	36.2	25.1	72.0	93.8	76.2
Ind chemicals	78.0	32.9	124.7	213.5	265.9
Plastic prods	42.6	115.9	53.5	37.8	14.5
Other chem prods	111.5	11.0	25.7	21.7	35.0
Petroleum	116.0	122.4	0.0	290.0	381.0
Non-metallic prods	9.3	6.2	133.8	0.0	9.0
Basic metals	8.3	5.2	15.3	86.6	0.0
Fab metal prods	82.0	104.3	109.9	101.0	103.1
Mach except elect	205.6	93.5	180.5	131.0	177.5
Elect mach & app	130.9	128.1	97.3	77.7	98.5
Electronics	391.1	710.3	838.3	699.2	1098.6
Transp equip	64.0	61.7	110.4	50.	114.1
Precision equip	53.8	116.6	44.0	93.0	21.1
Other prods	0.0	11.8	0.7	14.3	0.0
Servicing/engrg	19.9	8.4	15.9	9.8	24.3
Total	1449.9	1743.0	2007.5	1958.8	2484.2
Foreign	1190.6	1448.0	1657.8	1625.4	2217.5
Local	259.3	295.0	349.7	333.3	266.7
Local as % of total	17.9	16.9	17.4	17.0	10.7

Source: Economic Development Board Annual Reports, various years and Ministry of Trade and Industry, Annual Economic Survey of Singapore, 1990

Table 3 Net investments commitments in manufacturing by country of origin, 1974 - 1990 (excluding petrochemicals) S$m

	1986	1987	1988	1989	1990
Total	1443.0	1743.0	2007.4	1958.7	2484.3
Local	253.4	295.0	349.6	333.3	266.8
Foreign	1189.6	1448.0	1657.8	1625.4	2217.5
US	443.4	543.5	586.6	520.2	1054.8
Japan	492.8	601.1	691.3	541.2	708.2
Europe	218.8	285.8	358.1	544.2	435.3
EC	204.8	241.0	345.1	525.4	395.5
Other European	14.0	44.8	13.0	18.9	39.8
Others	34.6	17.6	21.7	19.8	19.2

Source: As in Table 2

Table 4 Cumulative foreign investments in manufacturing by country 1980 - 1988 (Gross fixed assets, S$m)

	1980	1981	1982	1983	
US	2091	2606	3118	3558	
Japan	1187	1396	1614	1845	
Europe	2992	3414	3795	4137	
EC	2813	3159	3529	3868	
Other EC	106	155	201	319	
Other Europe	177	255	267	270	
Others	822	966	1092	1237	
Cumulative foreign	7092	8382	9619	10777	
Total cumulative	10561	12442	14529	16423	
% of foreign to total	67.2	67.4	66.2	65.6	

	1984	1985	1986	1987	1988
US	4156	4656	5137	5828	6521
Japan	2858	2943	3369	4153	5175
Europe	4406	4480	4595	4818	5452
EC	4126	4171	4294	4478	5086
Other	380	467	479	467	569
Other Europe	279	312	300	341	436
Others	1231	1081	1019	1086	1249
Cumulative foreign	12651	13160	14120	15885	18397
Total cumulative	19449	20260	20924	22774	25965
% of foreign to total	65.0	65.0	67.5	69.8	70.9

Source: As in Table 2

The change in comparative advantage in Singapore's industries also coincided with the opening and development of industries in neighbouring ASEAN countries. As foreign investment surges into Malaysia and Thailand accelerated their economic growth and industrial development, Singapore found not only keener competition for foreign investment in the immediate term, but also for process and technology transfers and trade prospects in the longer run. In one study (Tan and Natarajan, 1990) which surveyed 570 MNCs operating in Singapore from a cross section of industries and nationalities, 128 (25% of 510 which responded)

were found to also have operations in Malaysia and Thailand. Of these, 91 of them have started operations in Singapore before moving up north while 30 of them started in either Malaysia or Thailand before they gravitated south and only 7 started in the three ASEAN countries at about the same time. The 30 companies which chose Malaysia or Thailand first did so because their domestic markets which were protected by import substitution policies. The preference for Singapore by 91 companies which acknowledged its political stability, infrastructure, workforce and investment incentives as attractive, makes it logical for the EDB to adopt a beach head strategy to draw the MNCs.

By the mid-1980s, the EDB realised that a simple and traditional relationship of being a hospitable host to the MNCs is not sufficient. Competing forces in the region, Singapore's own inadequacies in labour and land, new technologies, globalisation strategies and developments like borderless economics and production (Kahler, 1991 and Ohmae, 1991) require a more innovative and dynamic partnership. The result is a more integrated and competitive cooperation among ASEAN countries (Tan, et al, 1992). The most exemplary of these efforts is the growth triangle involving Johor in Malaysia, Singapore and the Riau Province in Indonesia, spearheaded by Singapore, capitalising on proximity and complementarity.[5]

3 Technology transfer

The pattern of technology transfer from Japan to Singapore

as to other ASEAN countries can be discerned from the composition of their exports. Between 1970 and 1987, the composition of exports of the NIEs have shifted from natural-resource based and unskilled labour-intensive type to physical and human-capital intensive products (Tan, et al, 1992). As at 1987, about half of their exports consisted of physical and human-capital intensive products, as compared to less than 20% in 1970.

Japan has also moved from an exporter of labour intensive manufactured products like cotton textile, fabric, apparel and toys in the 1950s to physical capital and human capital intensive manufactured products like steel, ships, automobiles and optical instruments in the 1960s. In the 1980s, the ANIEs, driven by rising wage cost, stronger exchange rates, land scarcity and environmental concern, have begun to relocate the labour intensive industries into the ASEAN region.

It thus appear that the ASEAN countries, even China and Indochina have become vital components of the specialisation system operated by Japanese capital and increasingly too, capital from the ANIEs. The transition of the Japanese industrial structure, from "heavy, thick, long and big" to "light, thin, short and small" (Tamazawa, 1990), decanting the former type of activities elsewhere, is being replicated by the NIEs. This resulting interdependence in trade and investment and regional division of labour have spun a "spider's web" that links and networks many countries and industries (Bhagwati, 1988).

A scrutiny of cumulative Japanese investment abroad is germane to see the kind of technology it transfers. Table 5 shows the cumulative Japanese foreign investment in 1976, 1985 and 1988 for comparison. The largest concentration of Japanese foreign investment is in developing Asia where all industries accounted for 28.2% of total in 1976, dropping to 17.3% in 1988 and manufacturing accounted for 36.6% and 24.8% respectively. Within Asia, the four ASEAN countries appear to have a larger share of Japanese foreign investment in all industries in the earlier period, being 18.8% in 1976 and 7.9% in 1988 compared to 8.6% and 8.1% respectively in the four NIEs. For Japanese foreign investment in manufacturing, the ASEAN's share are 19.0% in 1976 and 12.6% in 1988 whereas in the Asian NIEs, the percentages are 16.7% and 11.1% respectively.

Table 5 Cumulative Japanese foreign investment abroad, 1976, 1985 and 1988* US$m

	All industries			Manufacturing		
	1976	1985	1988	1976	1985	1988
World	19405	83650	186356	6065	24400	49843
Developing Asia	5464	19463	32227	2218	7518	12371
Asian NIEs	1666	7642	15018	1012	3318	5544
Hong Kong	448	2930	6167	99	247	492
Singapore	690	1683	3248	484	945	1589
South Korea	301	2268	3812	218	1444	1990
Taiwan	227	761	1791	211	682	1473
ASEAN-4	3645	11199	14749	1150	4013	6271
Indonesia	2709	8423	9804	682	2336	2955
Malaysia	354	1125	1833	204	791	1350
Philippines	354	892	1120	92	354	510
Thailand	228	759	1992	172	532	1456

* refers to fiscal year from beginning March to end next April
Source: Table 3. p 16, Ramstetter, 1991

Table 6 provides finer breakdowns of Japanese foreign investment by sectors. For the world, Japanese foreign investment in textiles accounted for 18.6% of total manufacturing foreign investment in 1976 which shrank to 5.4% in 1988. In 1988, the largest share of manufacturing foreign investment went into electrical machinery which absorbed 20.5% of the total.

Table 6 Cumulative Japanese foreign investment by industries, 1976, 1985 and 1988* US$m

	1976	1985	1988	1976	1985	1988
		World			Developing Asia	
Food	314	1091	1965	99	256	516
Textiles	1127	2083	2669	718	1182	1380
Wood	575	1121	2099	113	190	389
Chemicals	1044	3982	6540	201	1292	1785
Basic metals	952	5190	7671	270	1696	2268
Machinery	452	1971	4716	97	580	1036
Elec mach	687	3747	10196	294	833	2414
Tpt mach	453	3374	6956	136	692	1183
Other mfg	460	1842	7031	290	796	1399
Total mfg	6064	24401	49843	2218	7517	12370
Mining	4859	11756	13949	2152	6199	6912
Trade	2611	12677	20011	170	1058	1913
Other inds	5870	65834	102553	924	4688	11031
Total non-mfg	13340	90267	136513	3246	11945	19856
		ANIEs			ASEAN-4	
Food	15	79	199	81	153	269
Textiles	269	356	401	447	819	942
Wood	22	29	42	88	156	335
Chemicals	98	843	1169	99	429	571
Basic metals	79	192	354	171	1476	1865
Machinery	79	479	678	13	94	331
Elec mach	234	629	1377	53	195	860
Tpt mach	100	284	544	35	369	562
Other mfg	118	427	779	164	328	535
Total mfg	1014	3318	5543	1151	4019	6270
Mining	4	13	14	2058	6080	6790
Trade	1514	780	139	30	264	351
Other inds	510	3531	7946	406	842	571
Total non-mfg	2028	4324	8099	2494	7186	7712

Source: As in Table 5

As expected, in the ANIEs, the share of textiles dropped from 26.5% in 1976 to 7.2% in 1988 as also in ASEAN, from 38.8% to 15.0% over the same years. In the ANIEs, the share of electrical machinery rose marginlly from 23.1% in 1976 to 24.8% in 1988, but much higher than similar shares of 4.6% and 13.7% in ASEAN in same years. While Japanese foreign investment in electrical machinery in 1988 is twice the amount in the ASEAN countries, the latter's amount in textiles is more than twice that in the NIEs. The ASEAN countries absorbed more Japanese foreign investment in total manufacturing in 1988 while the ANIE's amount in non-manufacturing is only slightly larger than the ASEAN countries in 1988.

From this macro picture of Japanese foreign investment, a micro analysis of the actual process of technology transfer in Singapore draws on a study which surveyed 71 firms in Singapore in 1987 (Chng, et al, 1986 and 1988), augmented by more field studies in 1990 and 1991 (Low, et al, 1992).

Japanese investors have cited political stability, good infrastructure, low wages and investment incentives in that order of ranking, for choosing to come to Singapore (Chng, et al, 1986). While low wages may no longer be valid, it is noted that the other factors are conducive in providing the tight environment for technology transfer. Another equally relevant factor is the rising education and skills of the workforce, including for engineering, technical and scientific manpower.

This is the direct result of the efforts of the government and the EDB to upgrade human resource development, tapping on foreign governments and MNCs to set up joint training institutes and centres for general and specific skills for the industries.

However, one lament of the Japanese MNCs has been the difficult of finding and keeping good research and development (R&D) engineers, exacerbated by impatient enginners not staying long enough to develop skills for specialised work when job opportunities are abundant (Chng, et al, 1986). On the other hand, local Singaporeans have also complained that Japanese MNCs are less open than the US and European MNCs in technology transfer. For instance, one Japanese precision firm still relies on its Japanese managing director to test its products in the final stage, probably also because the firm's reputation is also to be guarded.

While turnkey projects is the most coomon mode of technolgy tranfer by parent companies, it creates dependence and proprietory control of technology used. The most popular mode of the Japanese and other foreign investors in Singapore is sending locals for training in their parent companies (Chng, et al, 1986). For the Japanese MNCs, the second most popular mode is to have Japanese engineers resident in Singapore for a few years. In contrast, other foreign MNCs prefer relying on local engineers. This may reflect the tighter corporate and management control policies of Japanese fimrs in general where decentralisation is

not as far and wide as the Anglo-Saxon corporate culture.

Joint ventures are regarded as the most effective to transfer technology and SMEs in Singapore seem preferred as partners. This is in line with the EDB's master plan for the SMEs. It is noted that the government linked companies (GLCs) have also formed many joint ventures, even acquiring them when necessary, to buy into the technologies of these acquisitions. In some cases government support is desired, as in the case of the EDB teaming up with Texas Instruments and Cannon, Hewlett Packard in 1991 to set up joint venture to produce sophisticated RAM devices for the electronics industry.

On reasons for transferring technology into Singapore, the main reason for Japanese MNCs is to maximise Singapore as a regional distribution and servicing centre. Other factors include tax incentives, automation, changes in scale and integration. The case study of Sony Precision Engineering Centre (SPEC), set up in 1987 with the mission to provide the key components, namely precision metal and plastic parts and optical pick-ups for Sony's consumer electronic manufacturing plants worldwide, is illustrative (Low, et al, 1992).

As the regional promotion development centre, providing engineering support for sister plants in Malaysia, Indonesia and Thailand, SPEC is termed as the "value added creator" in the sense that the components made in the plants are the key and usually the most expensive parts in the final audio or video

products. In 1988, it product and service range increased to transformers, power supplies, magnetic heads, software and R & D. Factory automation was added to its range of activities in 1989 and in 1990, VCR drums and heads were also produced followed by 8mm drums and heads in 1991.

SPEC is an important development to augment existing Sony activities which came to Singapore in 1973. In 1982, Sony has expanded to sourcing and distribution of components and by 1987, to high value added manufacturing of moulded and machined precision components as well as into SPEC, in production engineering, namely, into software, R&D, automation services and technical support. Further expansion of its service functions were on overseas headquarters (OHQ) product design services, OHQ management services in finance and administrataion, expanded regional distribution and OHQ communications centre. In 1988, its OHQ management services for the Asia Pacific further expanded into HQ marketing and as a central distribution centre.

Technology transfer to subcontractors is another important area in the process. For many Japanese firms producing under original equipment manufacture (OEM), the need for supporting industries is established. It is however observed that while Philips (Dutch) and General Electric (US) operate with a philosophy of bringing up local supporting industries and transfer their know how, Japanese MNCs like Nichicon and Murata tend to encourage to their Japanese suppliers to come over,

replicating the relationship of support of their parent companies by local Japanese firms (Low, et al, 1992). In one joint venture between a local and a Japanese partner, the local partner learnt the hard way to wean himself off the dependence on the Japanese with help from the EDB.

4 Issues and prospects

The above characterisation of technology transfer by MNCs in Singapore must also take into consideration a number of other factors. One is the usual guarded and protective policy of the MNCs where R&D is conducted in their home bases. Second, they argue that depackaging such R&D facilities to other locations would be costly and scale economies are not reaped. In the Singapore context, the small market and the lack of technological and scientific manpower constitute good excuses. Thus, while some developmental work are transferred over to Singapore, the basic research are kept in the MNC headquarters. Such market determined decisions with respect to R&D cannot be opposed. But, wherever possible, local scientists and engineers have tried to further R&D and technology on their own to improve and innovate. Some of them have done quite well as in the case of Hewlett Packard in Singapore (Low, et al, 1992).

As much to ameliorate the above difficulties and to augment the environment for technology transfer, it is noted that the government through the EDB and other statutory boards like the national Computer Board (NCB), Singapore Institute for Standards

and Industrial Research (SISIR) and the National Science and Technology Board (NSTB) have also many development assistance schemes to help.

Under the EDB's Economic Development Assistance Scheme (EDAS) in operation since 1986, this covers all of the EDB's financial schemes for investment promotion and economic development. It has five components, namely the Capital Assistance Scheme (CAS), CAS loan subsidy, venture capital, industrial development and consultancy and business development. The CAS further comprises the Small Industry Finance Scheme (SIFS) and equity participation while industrial development include the Product Development Assistance Scheme (PDAS) and Initiative in New Technologies (INTECH), various automation studies and leasing scheme and the consultancy and business development schemes include Small Industry Assistance Scheme (SITAS) and Business Development Scheme (BDS). For schemes under the Skills Development Fund (SDF), these include the Small Industries Technical Assistance Scheme (SITAS), Interest Grant for Mechanisation Scheme (IGMS), Initiatives in New Technologies (INTECH), and Development Consultancy Scheme. In 1986, these schemes were consolidated under the EDAS.

On the other hand, with the existence of so many public agencies and schemes, more coordination and collaboration would be needed. For instance, the EDB will have to work more closely with the NCB and the NSTB. The latter oversees the S$2 billion

National Technology Plan (NTP, NSTB, 1991) which aims to propel Singapore from a NIE into the major league of a world-class innovation-driven economy by 1995. The aim is to double R&D spending from 1% of GDP to 5% by 1995. In the 1990 National R&D Survey, R&D expenditure stood at S$571.7 million or 0.9% of GDP.

Under the NTP, there is a technology corridor encompassing, universities, polytechnics, research institutes and centres in the public sector and R&D facilities of MNCs in the Science Park being developed. Appropriately titled as window of opportunities, the government is supportive in terms of basic research, applied research and development. The development of venture capital, improving the patent system and manpower development are other aspects to complement the physical aspect of the NTP.

While the NTP is ambitious, one problem it faces is the shortage of manpower. In terms of R&D manpower, there are only 7,094 persons engaged either full-time or part-time of whom 61% are research scientists and engineers (RSE) in 1990. The expenditure per RSE in 1990 was S$132,000 compared to S$111,000 in 1987-88 which reflects some growing investment in R&D. If the accuracy, reliability and comparability over time of these statistics can indeed be accepted, the high technology drive has the concommitant implication for the EDB and other agencies to also intensify the global search for research talent.

While the high technology route with intensified efforts on R&D is clearly a desirable and most viable one for Singapore, the

question posed is can Singapore attain it? The evidence is that the base, whether in terms of the population, manpower, market or other criteria to support high technoloy and R&D, is too small in Singapore. Given the number of engineers and scientists in Singapore and that the bulk of them are indeed employed in many public sector agencies, it is not even sure that one is comparing like with like when assessing R&D indicators vis-a-vis other industrial economies or MNCs in the frontier of more inventive and innovative R&D.

From another perspective, local enterprises in Singapore report that there is not so much the lack of opportunities for upgrading technologically but constraints exist more in terms of finance principally, in their efforts to upgrade (Low, et al, 1992). With many younger, more enterprising and better educated entrepreneurs among the new breed of industrialists, they are receptive to technology and its applications.

But they find difficulties with finance and credit from commercial banks despite the apparent array of EDB financial schemes, The reasons are related. They stem from the reluctance of local entrepreneurs to expose their books for scrutiny to financing institutions or banks which also mean some degree of control. To help promising local firms to expand, a second stock market called the Stock Exchange of Singapore Dealing and Automated Quotation (SESDAQ) has been established which has less stringent requirement than the main board for floating public

shares.

While aspriring to be a developed country like other industrial economies, Singapore needs to have a clearer picture of how far and deep its industries can go based on its technological capabilities. One promising area is the teaming up with MNCs in medium level technology industries to branch out into the ASEAN region as in the growth triangle concept. Singapore's infrastructure and manpower becomes a useful intermediary instaed of MNCs going into other ASEAN countries from scratch.

5 Conclusions and policy implications

Information technology may transform Singapore into an intelligent island and perhaps strengthen its competitive edge among nations as well as enhance the quality of life of Singaporeans. The net impact may increase efficiency, open new business opportunities or change work patterns and lifestyles. However, moving up the technological ladder for Singapore is not as easy and simple in terms of competing with the big league countries. Thus, the potential for technology transfer may be limited by physical size both in terms of economies on the part of the MNCs and in terms of supply of skills and manpower by Singapore.

The role of technology, information technology, telecommunications, microelectronics, and other processes may well have replaced the traditional product cycle in affecting

foreign investment which impinge on technology transfer as well. These innovations have enabled computer-aided design and manufacturing (CAD/CAM), computer-integrated manufacturing (CIM), flexible manufacturing system (FMS), just-in-time (JIT) inventory system and others which are just revolutionary. Speed and efficiency are further enabled by satellite and fibre optics telecommunication systems and the link-up can practically happen in nanoseconds. Together, they constitute a force inducing global industrial shift which is not easy for any government or economic power to control or manage. The merging of manufacturing and services or the growth of "servicisation" in modern economies further induces profound structural changes. There are total or partial technological shakeouts in industries such as in electronics, textiles and garments, automobile industry which have worldwide repercussions (Dicken, 1986).

There is also a trend toward heterogenous, integrated products prompted by technological development and the drive for more service oriented function embedded in a modern product. The production of integrated products is a complex task requiring coordination, maintaining long term, faithful business relationships rather than short term cost advantages. The networking concept from suppliers of hardware and software, financial services and suppliers is likened to "strategic corporate family planning". Translated into operational terms, location at source is crucial to ensure "closeness to market" or

"time to market". Technology transfer thus cannot be lacking or slow for Japanese MNCs to stay competive.

A number of external factors also have a bearing on competition, collaboration and technology transfer for Japanese as for all MNCs. The opening of economies as in China, Indochina and perhaps later Eastern Europe and the Commonwealth of Independent States (CIS) succeeding the ASEAN economies, have caused new expectations of liberalisation and the resurgence of market forces. In Asia, growth triangles and economic zones have sprouted. These include the Baht Economic Zone covering Thailand and Southern Vietnam, the Pan Yellow Sea (Huang Hai) Economic Zone covering the west coast of South Korea, Shantung and Liaotung in China and Kyushu and Yamaguchi in Japan, the Hong Kong-Guandong Economic Zone, the Taiwan-Fujian Economic Zone covers the areas on both sides of the Formosa Strait extending to Shanghai in China and finally, the Tumen Jiang Economic Zone covering the cities of Vladivostok and Yenchi in Chilin near the mouth of Tumen Jiang River and the Pan Japan Sea Economic Zone surrounding the outer rim of the Tumen Jiang Economic Zone. Within ASEAN, there is the proposal to establish the ASEAN Free Trade Area (AFTA) in ten to fifteen years time as enunciated at the last ASEAN Summit Meeting in Singapore in 1992.

The area for Singapore to promote is to generate more value added other than from production value added. For instance, Singapore has the facilities to provide pre-qualification test

for the procurement of components. Subsidiaries of MNCs need not send the components back to their headquarters for prequalification and this would lower costs. Equipment in materials handling is also encouraged to grow, as is quality control and testing. The value added chain can further be extended to servicing such as in marketing, distribution, warehousing and fund management activities carried out at the headquarters. Those electronics firms with OHQ status like Philips, Matsushita and Thomson, have all the value added activities. The OHQ incentive is thus a viable concept to promote in view of the enlarging Asia Pacific market.

At the implementational level, there are current gaps to be bridged in terms of the rather low take up rate for financial and other development assistance schemes under the EDB. This is a serious problem as some local entrepreneurs explicitly cite finance as one of their constraints in the quest for technology. The difficulty may be more psychological than real, but it needs attention if local enterprises are to upgrade technologically.

On the NTP, it appears ambitious and in the right direction. Again, the details on implementing it in terms of tapping the MNCs and other private sector bodies, apart from committees to drive the plan, are not clear. In fact, the issue of technology transfer seems altogether missing in the NTP (NSTB, 1991) despite its other well elaborated thrusts. It is inconceivable that the NSTB and other government agencies alone would make the

goals of the NTP succeed.

From an external perspective, Singapore needs to continue to build up strong partnerships with the MNCs as well as with regional economies, especially in ASEAN in view of the global networking linkages being spawned by technology and globalisation. The growth triangle is a good start so far and Singapore must make itself relevant to both over 3,000 MNCs presently located here as well as to neigbouring countries as an intermediary for the transfer of even medium level technology. In this regard, Singapore is behaving no less differently as other ANIEs which are also going heavily into ASEAN countries as investors.

Finally, in respect of developing the partnership further with Japanese MNCs, an understanding of Japan's goals and visions in the region is crucial. With the loss of US hegemony in global trade and technology, the emergence of a more multipolar international economic system, noth Japan and the NIEs have to take a higher profile. Japan's interests are spread all over the world, from traditional areas like the US and Europe to the Oceania, Latin America and Asia. While not exactly losing its interest in the ASEAN region, competition from other areas is obvious. In this context, Singapore must make itself relevant to Japanese MNCs and being a bridge in its process of technology transfer would be one form. This would serve both Japanese as well as ASEAN interests. But first, Singapore firms must itself gear up in technology.

Footnotes

1 See for instance, Bala and Associates, 1982, Lee, ed, 1981, Chen, 1979, Hughes, ed, 1988, Lincoln, 1988, Sekiguchi in Scalapino, et al, 1988, Patrick, ed 1991 and Ramstetter, ed, 1991).

2 Among many are Chng, et al, 1986 and 1988 for Singapore and Ernst and O'Connor 1989 and Lim and Pang, 1991 for other countries.

3 See for instance, Patrick and Rosovsky, 1976, Vogel, 1979, Wolf, 1983, Kosai and Yoshitaro, 1984, Perestowitz, 1988, Hirono, 1988 and Friedman and LeBard, 1991.

4 Studies include Hughes and You, 1969, Lee, 1973, Yoshihara, 1976, Tan and Ow, 1982, Chng, et al, 1986 and 1988, Low et al, 1992, forthcoming, among many others.

5 For the southern growth triangle in ASEAN, see Ng and Wong, 1991 and Lee, ed, 1992 while Toh and Low, 1992 analyses the prospects of the northern triangle as well.

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