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May 2024

Working Papers in Trade and Development

No. 2024/04

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International Production and Industrial Transformation: The Singapore Story*

Prema-chandra Athukorala and Raveen Ekanayake

Abstract

The expansion of global manufacturing value chains (GMVCs) as a major mode of economic globalization opens up opportunities for latecomer countries to industrialize and carve out niches to specialize within the value chain, instead of producing a good from start to finish within their national boundaries. However, whether this provides a pathway for self-sustained industrialization remains a debatable issue. Sceptics argue that, since multinational enterprises (MNEs), which are the 'lead firms' of GMVCs, dominate upper-end activities of the value chain such as product design, research and development, global marketing, and after-sales care and services, a country located lower rungs of the value chain has little room for industrial upgrading. This paper aims to contribute to this debate through an in-depth case study of industrial transformation over the past six decades in Singapore, the first country to embark on an MNE-led export-oriented industrialization strategy based on the prophetic foresight of unfolding opportunities for global economic integration within GMVCs. The findings suggest that, while Singapore had some country-specific advantages, it was hard-headed national development policy that was instrumental in transforming the country from 'the third world to the first' within a generation. The key general lesson from the Singaporean experience is that industrialization success within GMVCs requires embedding FDI promotion in a comprehensive national development strategy that makes the country an attractive location for international production and continuously monitoring and recalibrating the development strategy in line with evolving patterns of international production.

Keywords: global manufacturing value chain, industrial upgrading, multinational enterprises, Singapore

JEL Codes: F21, F23, O24, O53

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* The authors gratefully acknowledge comments and suggestions by Tilak Abeysinghe, Hal Hill and Hang Chang Chieh.

1. Introduction

Global manufacturing value chains (GMVCs), that involves firms in different geographic locations specialise in specific tasks within the vertically integrated production process of a given product, have become an integral feature of the global economic landscape. There has been growing attention being paid in development circles to the opportunities for latecomers to industrialisation by participating in GMVCs. At first blush, it is easy for a country to carve out a niche within the value chain of a given production ('vertical' specialisation') instead of producing a good from start to finish, within its national boundary (the traditional 'horizontal specialisation'). However, whether vertical specialisation provides latecomers with a pathway to self-sustained industrial transformation remains a debatable issue. Sceptics argue that, since multinational enterprises (MNEs), as the 'lead firms' of GMVCs, dominate upper-end activities of the value chain such as product design, research and development, global marketing, and aftersales services, countries participating in lower rungs of the value chain have little room for industrial upgrading. Thus, even though industrialisation may seem apparently easier in this era of GMVCs, so the argument goes, we may not observe the same strong association between industrial transformation and economic advancement as was the case under the traditional horizontal specialisation (Szirmai et al. 2013, Milberg and Winkler 2013, Baldwin 20014, Doner and Schneider 2016. Kozul-Wright and Fortunato 2019).

The sizeable body of literature on GMVCs has so far come up with assertive inferences on this debate based on analysis of emerging trade patterns and casual empiricism of the industrialisation experiences of a select few countries. There is a dearth of in-depth country case studies to broaden our understanding of the process of industrial adjustment within GMVCs. This paper aims to fill this gap by examining the process of industrial transformation in Singapore within GMVCs over the past six decades. It is of course not possible to generalise meaningfully from a single country case study. However, case study analysis provides an opportunity to develop a rich understanding of the conditions, processes and outcomes that govern the growth experiences of actual economies.

Singapore provides an ideal case study of this subject. It was the first country to pursue export-oriented industrialisation strategy based on a prophetic foresight of unfolding opportunities for global economic integration within GMVCs. The 'multinational enterprise-led' (MNE-led) development strategy for specialisation within GMVCs pioneered by Singapore during the late 1960s was subsequently emulated by several late industrialising countries including Malaysia, Thailand and,

more recently, China[1], Vietnam and Cambodia. The Singaporean experience, therefore, provides a useful counterfactual for assessing industrialisation experience in this era of GMVCs.

The paper proceeds as follows. Section 2 surveys the initial condition followed by a succinct overview of the evolution and key elements of Singapore's innovative MNE-led strategy. Section 3 provides a broad-brush picture of the economic transition from the 'third world' to the 'first' through global economic integration via participation in GMVCs. Section 4 forms the core of the paper. It examines the patterns and sequence of industrial transformation over the past six decades with an emphasis on the process of industrial upgrading within GMVCs. The discussion also revisits the 'perspiration versus inspiration' debate (*a la* Krugman 1994) on the Singaporean growth model using up-to-date growth decomposition analysis. The final section offers some concluding remarks.

2. Initial conditions and policy context

For well over one-and-a-half centuries, Singapore under British rule prospered as the entrepôt city that served as a conduit for world trade with Malaysia and Indonesia and the other countries in the Southeast Asian hinterland. In addition to entrepôt trade and essential services as a port of call, the British military base there contributed significantly to shaping the initial socio-economic landscape of the island state. According to the first set of national income estimates released in 1956, per capita income in Singapore was much higher than elsewhere in Asia. However, by the time of independence from the British in 1959, there was growing concern about the ability of the economy to absorb a rapidly expanding labour force. Even though unemployment was not high, at around 5%, the bulk of the labour force remained stuck in casual work and/or was under-employed. According to data for 1957, an estimated 19% of Singaporean households and 25% of individuals were in poverty (Huff 1994).

Reflecting the development orthodoxy at the time, notwithstanding its small domestic market of two million people at the time, Singapore initially adopted policies of import-substitution industrialisation (ISI). The ISI strategy received added impetus when Singapore became part of the

[1] Special economic zones (SEZs) in China were modelled based on the Singaporean experience followings Deng Xiaoping Ping's visit to Singapore in 1978 (Vogel, 2011).

Federation of Malaysia in 1963 which provided the city-state with access to a common market of 12 million people. However, when Singapore was forced to leave the Federation in August 1965, hope for a Malaysian common market was dashed and doubts about survival as a separate state haunted the minds of the Singaporean leadership (Lee 2000[2]; Lim, Pang and Findlay 1993). The announcement by the British government that it would withdraw its military base in 1968 in Singapore further compounded the fear of the economic viability of the island state.[3] The leaders reasoned that, for economic survival, Singapore had little choice but to abandon the pursuit of the ISI strategy in favour of export-oriented industrialisation (Lee 2000).

The United Nations Industrial Survey Mission report, prepared under the aegis of Dutch economist Albert Winsemius during 1960-61, became the basic blueprint for Singapore's post-1965 industrialisation framework[4]. The policy advocacy of the report was based on the remarkable foresight that MNEs in the USA and other developed countries had begun to relocate labour-intensive talks in the manufacturing process in developing countries in response to rising domestic wages. It foresaw that Singapore was well placed to reap the gains from this process given its 'central geographic location and ... the relatively talented and adaptable people' and recommended the pursuit of an export-oriented industrialisation (EOI) strategy and advocated that, during the initial period, Singapore would have to attract foreign manufacturers, managers, and capital (Quah 2022).

Singapore's embrace of the development strategy proposed by Winsemius was reinforced by Prime Minister Lee Kuan Yew's two-month sabbatical at Harvard University in early 1968. At Harvard, Raymond Vernon convinced him of Singapore's prospects for reaping gains from this emerging international division of labour based on its endowment of low-cost labour:

> *Ray Vernon gave me a valuable lesson on the ever-changing nature of technology, industry, and markets, and how costs, especially labour wages in labour-intensive industries, determined profits…. He dispelled my previous belief that industries changed gradually and seldom moved from an advanced country to a less developed one' (Lee, 2000, p.73).*

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[2] 'We faced tremendous odds with an improbable chance of survival. Singapore was not a country but a man-made trading post .... We inherited the island without its hinterland, a heart without a body' (Lee 2000, 19).

[3] The economic implications of the British withdrawal were enormous: the expenditure of the military base contributed to 16% of the GDP and it employed directly and indirectly about 20% of the work force (Goh 1996).

[4] Winsemius was a successful entrepreneur in the Dutch shipping industry. As a former director general for industrialisation in Netherland, he laid the foundation for promoting foreign investment in that country (Schein 1996, p32). He played a vital role as an advisor to Singaporean government until 1984 (Lee 1996).

Attracting MNEs to set up production bases in the country turned out to be the lynchpin of the Singapore's development strategy. Lee Kuan Yew explains the rationale behind this policy choice as follows:

> *'We did not have a group of ready-made entrepreneurs as in Hong Kong. Hong Kong gained in the Chinese industrialists and bankers who came fleeing from Shanghai, Canton and other cities when the communists took over. Had we waited for our traders to learn to be industrialists, we would have starved. It is absurd for critics to suggest ... that had we grown our own entrepreneurs we would have been less at the mercy of the ruthless MNCs' - (Lee, 2000, p.66).*

When viewed against the development thinking at the time, Singapore's embrace of MNE-led development strategy was a 'major policy innovation' (Hobday 2013, 136). The dominant view amongst development circles at the time was that MNEs stifled domestic entrepreneurship in latecomer countries and, in particular, their business practices compounded the balance of payments difficulties faced by these countries and further constrained indigenous entrepreneurial development (Lal and Streeten 1977). The strategy of Korea and Taiwan, which had embarked on export-oriented industrialisation prior to Singapore, was to build local firm's capability by acquiring technology and marketing knowhow by forging links with foreign buyers and through subcontracting arrangements with MNEs while strictly regulating foreign direct investment (FDI) (Feenstra and Hamilton 2006).

The Economic Development Board (EDB) (established in 1961)[5] was reconstituted in 1965 as the apex body for implementing the plan to attract foreign investment. The EDB acted as a 'one-stop-shop' - a bridge between the investor and other line agencies. The EDB developed a unique 'symbiotic collaborative relationship that benefitted both the company and the country' (Schein 1996, p 22). The EDB introduced a range of fiscal incentives, in the form of concessionary tax rates, tax holidays, subsidised credit and tariff protection and embarked on a global investment promotion campaign. In 1965, the first overseas office was established in New York followed by offices in San Francisco, Stockholm, and London in 1967, and subsequently in Boston, Paris, Frankfurt, Milan, Hong Kong, Tokyo, Osaka, and Jakarta. Investment promotion effort was also stepped up through overseas representatives in cities like Seattle and Bangkok. 'In many ways, the EDB has elements of a typical

[5] Goh Keng Swee (the first finance minister of Singapore), who is considered the economic architect of the Singapore development strategy (Allison, Balckwill and Wyne 2013,148), modelled the EDB based on the economic development programme in Israel, a country that had been able to industrialise under conditions somewhat like Singapore's. Goh persuaded E.M. Mayer, a former director of the Industrial Planning Department of Israel, to become the first managing director of the EDB (Schein 1996)

sales organization of a large consumer-oriented corporation, only in this case what was being sold is a country' (Schein 1996, 18)

The investment promotion campaign of the EDB was effectively embedded in a comprehensive reform package designed to adapt the domestic economy to the requirements of the international investors and facilitate MNEs to operate successfully.[6] In 1968, the government passed an Employment Act and an Industrial Relations (Amendment) Act to discipline employment practices and promote industrial peace. The Employment Act standardised terms and conditions of employment and set limits on the negotiation of fringe benefits. The Act also introduced new procedures for labour negotiation and conflict resolution relating to worker recruitment, retrenchment, and dismissal from collective bargaining. It prohibited unions from bargaining beyond the stipulated minimum standards to stabilise labour costs during the first five years of operation of pioneer industries. In 1972, the National Wages Council (NWC), a tripartite advisory body comprising representation from government, employers and workers, was set up in 1972 to formulate annual wage guidelines, recommend wage adjustments and advise on incentive systems to ensure wage increases were orderly in line with the performance of the economy and were at internationally competitive levels (Chua 2017, Chapter 2).[7] These labour market reforms set the stage for the government to influence the structure of industry by managing the rate of increase in nominal wages and thus to play 'the role of an intermediary between Multinationals ... and the domestic labour force' (Findlay and Wellis 1993, 7).

The other elements of the policy package included trade policy reforms that made Singapore one of the most open economies in the world; infrastructure development; building a skilled workforce; a labour emigration policy consistent with industrial restructuring and competitiveness of the economy; fiscal management that helped generate ample structural budget surpluses to meet investment for infrastructure development without compromising macroeconomic stability; monetary and exchange rate policies to ensure the international competitiveness of the economy; and comprehensive administrative reforms. The administrative reforms were instrumental in assuring a symbiotic collaborative relationship between companies and the country and ensured speedy and efficient processing of investment applications (UNDP 2015).

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[6] For details on the Singaporean development strategy see Lim, Pang and Findlay 1993, Schein (1996), Wang (2007), Abeysinghe (2015), and Pang and Lim (2015) and the works cited therein.

[7] Following these reforms, man-days lost because of industrial stoppage fell from an average of some 40,000 per annum in the first half of 1960s to nil by the mid-1970s (Lim and Fang 1986).

Policy priorities were set and sequenced in line with the evolving domestic economy and unfolding opportunities in the global economy to reap gains from rapidly changing patterns of international production. For instance, the initial policy focus of building a skilled workforce was to develop capabilities to facilitate labour-intensive production activities such as component assembly and testing in electronics. As the economy matured and labour cost advantages began to dissipate, the policy emphasis gradually shifted towards developing capabilities to undertake skill and capital-intensive production activities such as component manufacture and product design relating to standard consumer goods as well as some advanced capital goods industries. In recent decades, the policy focus has been on facilitating research and development (R&D) and other knowledge-intensive tasks. Similarly, infrastructure development began with a focus on basic infrastructure development centred on industrial states and gradually the scope was extended to encompass the development of world-class infrastructure around the seaport and later the airport and telecommunications infrastructure.

Based on a firm-level survey conducted in Singapore in the mid-1990s, Schein (1996, 22?) provides a 6-point summary of the reasons why the executives from MNEs preferred to invest in Singapore: (1) a one-stop shop service that allows the investor to deal with only one person in the government in the event of a problem, (2) political stability and absence of corruption, (3) clarity of rules and the fact that the government keeps its promises, (4) commitment to solving whatever problems that come up in a timely and efficient manner (reflecting efficient internal communication), (5) the pro-business attitude of the government and professionalism of the EDB project officers ('They know more about my business than I do'); and (6) the high quality of the labour pool in terms of both technical aptitude, work motivation and work-place discipline.

In sum, the Singaporean MNE-led development strategy was a fine blend of policy initiatives to facilitate the global integration of domestic manufacturing with a central role played by the state in reshaping the economy (Findlay and Wellisz 1993, Perkins 2012, Stiglitz & Yusuf 2001). The government pursued a policy of 'industrial targeting' in a broader sense of focusing on electronics and subsequently on chemicals and pharmaceuticals in line with the competitive advantage of the economy and the changing context of international production, but there was no picking 'winning firms'[8] or rescuing failed firms. In promoting FDI, in contrast to other high-performing economies in Asia (notably Japan, South Korea, and Taiwan) and many other developing countries, Singapore welcomed all forms of foreign equity, both joint ventures and wholly owned foreign invested enterprises (FIEs). There was no conditionality (i.e., performance requirements) imposed on FIEs such as technology

[8] ''We left most of the picking of winners to the MNCs that brought them to Singapore' (Lee 2000, 85).

transfer, local equity ownership and licensing requirements. There was no direct government ownership of manufacturing other than some equity participation in shipbuilding, oil rig construction, and defence-related manufacturing. However, the Government is directly involved in the economy, through government-linked companies (GLCs), in providing world-class logistics and other business services. The government effectively used land ownership for industrial development (through long-term leasing at fair market rates) and infrastructure development (WTO 2008)[9].

An important, albeit less discussed, aspect of Singapore's development strategy during the first two decades or so was a conspicuous sidelining of the local private sector. Of course, as discussed, the design of the development strategy centred on MNEs was a logical policy choice given the nature of local entrepreneurship at the time. However, forging links with newly set up FIEs could have been a strategy for developing local entrepreneurship (Haggard and Cheng 1987).[10] Communist-inspired strikes and riots pervaded the economy during 1959-65. Moreover, the local Chinese business class interpreted much of the government policy as a conscious downgrading of Singapore's Chinese cultural heritage and sympathized with the opponents of the ruling party, notably the *Barisan Sosialis* (the now-defunct main opposition party (Rodan 1989, 98). Cushioning the reforms process against the influence of the left-leaning labour movement was, therefore, a key priority of under the MNE-led development strategy (Chua 2017). However, there has been policy emphasis on ways to stimulate local entrepreneurship and promoting linkages between FIEs and local firms following a major reassessment of economic performance after the economic recession of 1985 (Lim, Pang and Findlay 1993). Under a small and medium enterprise (SME) Master Plan announced in 1986, the EDB introduced a local industry-upgrading programme (LIUP). The LIUP involved revamping EDB's FIE supporting schemes with a focus on subcontracting and worker training initiatives to support SMEs and providing direct infrastructure support to SMEs (Goh 1996, Soon 2013).

3. Growth and industrial transformation

[9] As part of the colonial inheritance, the government owned more than 75% of land in the country (Lim, Pan mg and Findlay 1993).

[10] For instance, in the neighbouring Penang (Malaysia) that embarked on MNE-led development strategy following Singapore in the early 1970s, promoting MNE-local firm link was a key element of the development strategy of the state government. This policy was successful in creating a large local firm network based on MNE operations (Athukorala 2017).

MNEs' response to the reforms initiated in the late 1960s was swift and remarkable. Texas Instruments and National Semiconductors were the first to arrive in Singapore (in 1968) to set up plants to undertake simple labour-intensive testing and assembly of semiconductor parts and components. By the early 1970s, almost all other major industry players in the global electronics industry including AMD, NEC, Siemens, SGS-Thomson, Fujitsu and Matsushita had semiconductor assembly and testing plants in Singapore. The hard disk drive (HDD) industry started with the arrival of Seagate (formerly known as Aeon Corporation) in 1979 to undertake the simple labour-intensive task of sub-assembling HDD heads. The other major players of the industry followed suit. Singapore swiftly graduated to become a leading assembler of complete HDDs by the mid-1980s. The computer, electronics and optical products industry continued to receive the bulk of FDI inflows up until the late 1990s and early 2000s. From about 2000, the major recipients of FDI inflows have been pharmaceuticals, medical devices, and transport (mostly aerospace) industries (Grunwald and Flamm 1985, McKendrick et al 2000, Wong 1999, Pang and Low 2015).

The annual growth rate of manufacturing production (value added) increased from 8% during 1960-65 to over 15% in the next decade (1965-75) and recorded an average rate of over 8% during the next two decades (Table 1). The growth rate has gradually moderated since then with the difference compared to the average rate of (OECD) economies (about 3%) narrowing over the years. Manufacturing share of GDP increased from 11% in the late 1960s to 25% in 1990, when manufacturing directly accounted for over a third of total employment. The dominant role played by the manufacturing sector continued until the early 1990s, when the tertiary sector, in particular financial services, emerged as an engine of growth. However, interestingly, the data do not point to deindustrialisation: in most years, the manufacturing growth rate was higher than the overall GDP growth rate. Manufacturing share in GDP of Singapore has continued to remain well above the average level of all OECD countries.[11]

[11] During 2000-23, the average OECD figure was 11.2% compared to 19.3 of Singapore (OECD data from World Bank, *World Development Indicators* database).

Table 1: GDP Growth, Manufacturing Performance, and foreign-invested enterprises (FIEs), 1961-2023 (%)[1]

	GDP Growth[2]	Manufacturing Growth[2]	Manufacturing Share of GDP	Manufacturing real wage Index [4] (2015 = 100)	Export Growth[3]	Export-Gross Output Ratio	FIEs share in mfg. output[2]		FIEs share in manufacturing exports
							All FIEs	Fully owned FIEs	
1960-64	5.4	8.1	11.4	19.1	12.1	30.7	56.6	27.1	58.8
1965-69	10.9	15.3	14.7	19.9	31.2	32.0	60.8	31.2	67.1
1970-74	10.7	14.4	19.9	21.5	36.4	48.2	71.0	42.8	87.8
1975-79	6.9	8.3	22.9	27.6	14.6	62.3	77.9	50.2	91.6
1980-84	8.7	6.4	23.5	37.9	9.1	61.2	79.1	54.0	91.3
1985-89	6.3	8.6	23.6	49.0	10.5	65.8	80.9	58.9	91.0
1990-94	8.7	7.6	24.5	62.6	7.4	61.9	82.5	63.5	91.6
1995-99	5.1	5.6	23.2	79.0	6.5	61.6	82.9	67.3	92.8
2000-04	5.1	5.2	25.2	88.8	6.3	63.4	82.1	68.0	92.7
2005-09	5.3	3.5	23.7	89.1	5.1	64.8	78.4	67.4	88.2
2010-14	6.5	7.6	19.1	89.2	4.5	66.8	76.7	70.4	89.6
2015-19	3.1	2.7	18.8	102.4	3.7	69.2	82.5	78.7	87.3
2020-23	2.5	4.5	19.3	106.3	11.4	73.7	82.6	78.6	

Note: (1) Annual averages. (2) The data cover establishments with more than ten or more workers up to 2002 and all establishments since then.
(3) At current US$. (4) Average wage deflated by the consumer price index

Source: Compiled from data obtained from the Yearbook of Statistics (Various Years), Singapore: Department of Statistics; unpublished Returns of the Census of Industrial Production and the Census of Manufacturing Industries (Various Issues), Singapore: Economic Development Board

The share of FIEs in total manufacturing output increased from 56% in the early 1960s to over 80% by the late 2010s (Table 1. The share of fully owned FIEs, which basically represented MNE subsidiaries involved in GMVCs, increased even faster, from 27% to over 82%. In electronics, chemical products, and biomedical industries, FIEs have continued to account for over 90% of production (Table 1). Output shares of FIEs have recorded a notable decline in precision engineering and equipment sectors because of the entry of local firms through subcontracting links with FIEs. (Table 3) There is evidence that the LIUP programme played a significant role in forging these linkages (Mathews 1999, UNCTAD 2011).

Manufacturing growth was driven by a dramatic export orientation of domestic manufacturing: the export-gross output ratio increased from 24% in the early 1960s to over 73% in the late 2010s (Tables 1). The FIEs accounted for almost 90% of total manufacturing exports throughout the period from about the early 1970s.

Given that domestic manufacturing production is predominantly export-oriented, trends and patterns of manufacturing exports have largely mirrored those of domestic production (Tables 3). To begin with, electronics dominated the export composition. Even by the late 1990s, electronics accounted for more than two-thirds of output (value added) and employment. Since then, the product mix has gradually diversified with biomedical products, chemicals (excluding petroleum), precision engineering, and transport equipment (mostly aircraft parts and components), professional and scientific instruments, and photographic and optical goods gaining market shares.

Over the past three decades, Singapore has accounted for about 1 percent of total world manufactured goods exports (Table 3, panel b). Electronics exports from Singapore accounted for over 5% of total world exports by the late 1990s. This share has declined to about 2% by the early 2020s. Chemical and pharmaceutical products and other automobiles (predominantly airplane parts and components) have recorded a notable increase in world market share. In recent years, Singapore's world export share of chemicals and pharmaceutical products, professional and scientific equipment (mostly medical devices), photographic and optical products, and transport equipment (mostly aircraft parts and components) have recorded notable increases.

Table 2: Foreign Invested Enterprises' (FIEs) Share of Output (Value Added), 1980-2019[1] (%)

Industry Cluster	1980-89	1990-94	1995-99	2000-04	2005-09	2010-14	2015-19
Electronics	97.6	95.5	95.5	96.7	93.7	95.9	94.9
Chemicals	94.6	94.9	94.9	96.0	95.1	93.4	97.0
Specialty Chemicals	89.8	95.0	94.5	95.0	94.0	92.3	94.1
Other Chemicals	60.7	67.3	77.7	83.8	78.4	81.2	91.2
Biomedical manufacturing	96.1	98.1	98.9	99.3	99.1	98.5	95.6
Precision engineering	78.7	69.9	62.0	61.4	60.0	63.9	67.8
Machinery & Systems	81.3	79.3	68.9	72.1	68.5	75.1	78.6
Precision Modules & Components	77.3	65.7	59.0	56.0	53.3	48.2	48.7
Transport equipment	77.7	73.0	60.8	51.9	41.5	36.4	54.6
Marine & Offshore Engineering	80.6	62.4	63.4	44.9	24.6	20.2	36.1
General manufacturing	61.2	58.6	53.8	46.2	44.2	46.8	52.3
Food, Beverages & Tobacco	68.4	70.8	61.9	52.3	49.8	62.0	66.0
Printing	45.3	58.2	59.9	56.4	54.6	57.8	55.5
Miscellaneous Industries	63.1	54.5	46.8	35.8	34.4	28.8	34.9
Total manufacturing	81.7	81.2	80.1	81.7	78.4	76.7	82.5

Source: Compiled from unpublished returns of *The Census of Industrial Production and Census of Manufacturing Activities* (Various Issues), Singapore[1]: Economic Development Board.

Note: (1) Annual Averages. The data cover manufacturing firms with more than ten or more worker up to 2002 and all establishments since then

Table 3: Manufacturing exports from Singapore, 1988-2022[1] (%)

Products[2]	1988-89	1990-99	2000-09	2000-19	2020-22
(a) Commodity composition of exports					
Medical and pharmaceutical products (54)	0.6	0.4	3.3	8.7	9.9
Plastics[3] (57 + 58) (57 + 59)	2.9	2.1	5.8	10.4	10.5
Manufactured goods classified by material (6 - 68)	6.5	4.6	5.0	7.3	6.8
Power-generating machinery and equipment (71)	2.0	1.6	2.1	4.3	4.9
Machinery specialized for particular industries (72)	1.4	1.5	2.3	6.1	5.0
Metal working machinery (73)	0.5	0.4	0.8	0.8	0.6
General machinery and equipment and parts (74)	4.3	3.2	3.8	5.3	4.9
Electronics	65.2	74.0	62.8	31.0	28.8
Office and automatic data-processing machines (75)	27.1	37.9	27.9	12.1	9.4
Telecom. and sound-recording equipment (76)	16.0	11.4	6.5	3.3	3.5
Electrical machinery, apparatus and appliances (77 - 776)	8.6	7.9	6.6	8.3	8.4
Cathode valves & tubes[4] (776)	13.6	16.7	21.8	7.3	7.5
Road vehicles (78)	0.4	0.7	0.8	1.1	0.9
Other transport equipment (79)	3.1	1.6	3.0	6.6	6.2
Professional, scientific instruments and apparatus (87)	1.8	2.0	3.2	8.6	10.4
Photographic and optical goods and watches (88)	0.8	1.0	0.9	1.6	1.7
Parts of miscellaneous products (89)	4.0	3.6	4.3	5.1	5.8
Other manufacturing (unclassified)	6.7	3.4	1.9	3.2	3.7
Total manufacturing	100	100	100	100	100
... US$ billion	14.2	52.0	83.6	92.3	92.5
(b) Singapore's share in world exports (%)					
Medical and pharmaceutical products (54)	0.3	0.3	0.8	1.6	1.7
Plastics[2] (57 + 59)	0.8	1.1	2.1	2.3	2.2
Manufactured goods classified by material (6 - 68)	0.3	0.4	0.4	0.4	0.4
Power-generating machinery and equipment (71)	0.6	0.7	0.7	1.0	1.1
Machinery specialized for particular industries (72)	0.3	0.5	0.8	1.4	1.2
Metal working machinery (73)	0.4	0.6	1.1	0.9	0.8
General machinery and equipment and parts (74)	0.7	0.9	0.9	0.8	0.7
Electronics	3.3	5.2	3.4	1.5	1.3
Office and automatic data-processing machines (75)	4.2	8.7	5.5	2.4	1.9
Telecom. and sound-recording equipment (76)	3.7	3.7	1.4	0.6	0.5
Electrical machinery, apparatus and appliances (77 - 776)	1.4	2.0	1.2	1.0	0.9
Cathode valves & tubes[3] (776)	4.5	6.0	6.3	4.4	4.2
Road vehicles (78)	0.0	0.1	0.1	0.1	0.1
Other transport equipment (79)	0.9	0.9	1.3	2.0	2.0
Professional, scientific instruments and apparatus (87)	0.7	1.3	1.3	2.1	2.3
Photographic and optical goods and watches (88)	0.4	0.9	0.9	1.2	1.2
Parts of miscellaneous products (89)	0.8	1.3	1.4	1.2	1.2
Other manufacturing (unclassified)	1.2	0.4	0.1	0.2	0.1
Total manufacturing	1.0	1.7	1.4	1.0	0.9
(c) Share of parts and components in each products					

Chemical products (54, 57 and 58)	3.3	2.8	1.5	1.4	1.2
Manufactured goods classified by material (6 - 68)	13	13.9	12.5	7.6	5.7
Power-generating machinery and equipment (71)	60.9	51	67.5	81.4	89.8
Machinery specialized for particular industries (72)	52.1	43.6	44.7	40	65.3
Metal working machinery (73)	23.3	22.6	22	24.8	14.8
General machinery and equipment and parts (74)	39.8	40.6	43.5	46.5	44.1
Electronics	45.4	49	59.2	56.2	61.1
Office and automatic data-processing machines (75)	29.4	27.4	35.1	37.6	55.5
Telecom. and sound-recording equipment (76)	28.2	32.9	27.4	12.2	0.8
Electrical machinery, apparatus and appliances (77)[2]	81.7	87	89.6	79.7	77.7
Road vehicles (78)	87.2	79.3	61.1	64.9	81
Other transport equipment (79)	89.2	82.3	91.1	94.9	81.2
Professional, scientific instruments and apparatus (87)	14.3	14.5	17.6	10.9	8.2
Photographic and optical goods and watches (88)	73.8	62	68.7	62.9	48.1
Miscellaneous manufacturing	1.6	1.7	2.0	1.3	0.7
Total manufacturing	35.5	40.2	37.7	24.1	23.4

Notes: (1) Annual averages. (2) SITC division (two-digit) codes are given in brackets (2) Mostly thermoplastics used in consumer electronics and automobile industry. (3) Mostly semiconductors.

Source and method: Data compiled from UN Comtrade database based on the Standard International Trade Classification, Revision 3. 'Mirror data' of Singapore's exports (Singapore exports recorded in import records of destination countries) are used because direct export data contain re-exports. Parts and components are delineated from total exports using a list prepared by matching the UN broad economic classification with the SITC Rev 3 classification as detailed in Athukorala (2015).

Until about the late 1980s, Singapore's specialisation within GMVC was heavily concentrated in parts and components assembly (Athukorala 2008). As the production base of parts and components assembly became well established, MNEs began to diversify the product mix to the final assembly of consumer electronics and electrical goods (Goh 1996). More recently final assembly has rapidly expanded to medical devices and other scientific equipment backed by the development of R&D and human capital advancement in Precision engineering. Consequently, there has been a notable shift in the production stature towards final goods production. Parts and components accounted for only about a third of total manufacturing exports over the past three decades (Table 3, Panel c). The Singaporean experience therefore casts doubt about the still-dominant practice in the GMVC literature of focus solely on trade data of parts and components (or intermediate input content of production using input-output tables) to measure the role of global production sharing in world manufacturing trade.

4. Industrial Upgrading within Global Production Networks

This section begins with a survey of the changing structure of manufacturing production during the past six decades based on the existing literature and information gathered from the administrative

records of the EDB. The next subsection presents three indicators of industrial upgrading associated with the changing structure of manufacturing: R&D intensity, capital deepening and skill upgrading of the labour force. The third subsection revisits the debate on the relative role of factor accumulation versus productivity growth in Singapore's manufacturing expansion.

4.1 Changing composition of manufacturing production

Singapore's initial engagement within GMVCs was in labour-intensive tasks - predominantly semiconductor assembly. As labour cost advantages began to dissipate, the successful pursuit of policies to help industries move up the value chain into high-value-added skill-, capital- and knowledge-intensive activities began to take shape. From about the early 1980s, semiconductor production began to shift to testing and assembly of advanced components such as dynamic random-access memory chips and integrated circuits; followed by a surge of the computer peripherals and data storage and the information communication and consumer electronics industries.

A breakthrough in industrial upgrading within the semiconductor industry occurred in 1984 when the Swiss MNE SGS-Thomson (subsequently renamed STMicroelectronics) set up a state-of-the-art wafer fabrication plant in Singapore. Since then, almost all major semiconductor manufacturers including the likes of Intel, Micron, Nvidia and AMD have established wafer fabrication plants in Singapore. With wafer fabrication firmly established, the industry has witnessed a massive expansion in output by the late 1990s and early 2000s and has continued to expand since. Applied Materials (AMAT), the largest semiconductor equipment manufacturer in the world, since 2012, had anchored a significant part of its R&D operations in Singapore. Today, all wafer-level packaging research across AMAT is conducted in the Singapore lab, and the Centre undertakes complex multidisciplinary research for innovations in semiconductor wafer-level packaging (WLP). The success of the AMAT centre has also attracted collaborations by other major players in the industry of the likes of Dai Nippon Printing, DISCO, KLA-Tencor, Mentor Graphics, Nikon, Panasonic Factory Solutions Asia Pacific, PINK, Tokyo Electron Ltd, and Tokyo Ohka Kogy. By the dawn of the new millennium, more than 60 semiconductor companies were operating in Singapore.

By the mid-1980s, in the context of the rapid proliferation of the global personal computer industry, Singapore emerged as a global hub for hard disk drives and telecommunication equipment production. With the gradual relocation of labour-intensive HDD parts and components assembly, to low-wage locations in the region (notably Malaysia and Thailand), MNEs began to undertake more advanced aspects of HDD production such as product development and design in Singapore. With

HDD part and component production networks becoming firmly established in Southeast Asia, Singapore became the regional headquarters and logistics hub for the HDD industries' Southeast Asian operations. Since the 2000s, major industry players such as Seagate and Western Digital have invested heavily in research and development (R&D) activities in Singapore.

The growth of the semiconductor and HDD industries spawned a wide range of supporting industries such as the manufacture of printed circuit board (PCB) assembly, die casting, metal stamping, precision machining and plating of various mechanical components such as baseplates, cover and actuator arms, connectors, and automation equipment to name a few. Since the 1980s, this ecosystem of supporting industries, known as the 'precision engineering' cluster, and the associated skill base have played a pivotal supporting role in improving manufacturing processes and providing critical support base for the expansion of the diversification of manufacturing into aerospace, pharmaceuticals, medical technology products and scientific equipment.

Singapore is now home to over 130 aerospace companies, one of the largest and most diverse concentrations of global operations of these companies in a given country. Leading industry players such as Collins Aerospace, General Electric Aviation, Rolls-Royce, Pratt and Whitney and Thales to name a few have set up facilities to undertake the manufacture of aircraft parts and components including landing gear, aircraft management systems and engine-controls and other aircraft engine components. Rolls Royce assembles and tests its Trent 1000 and 7000 aircraft engines in Singapore. The facility is also the first of its kind outside of the UK to manufacture titanium wide-chord fan blades. The Thales Avionics production facility in Singapore manufactures critical systems for the A320, A350, and B787 fleets, including flight control computers, displays and electrical systems.

Major pharmaceutical MNEs such as Pfizer, Novartis, Sanofi, AbbVie, GlaxoSmithKline, MSD and Roche and Amgen have set up manufacturing hubs in Singapore for a wide range of products including active pharmaceutical ingredients, drug products and biological drug substances. Some of these MNEs have based in Singapore a range of ancillary service activities within their global operations, including Supply Chain Management, Regulatory Affairs and Medical Affairs. Singapore's medical technology industry is home to over 60 MNEs undertaking a range of activities from regional headquarter operations and manufacturing to R&D. Sixty per cent of the world's microarrays and nearly one-third of the world's thermal cyclers and mass spectrometers are manufactured in Singapore. The regional headquarters of the world's fifty leading Medic-tech firms are based in Singapore.

MNEs in the petroleum industry in Singapore began producing downstream petrochemicals such as ethylene and propylene. By the mid-1990s capabilities were developed to refine naphtha, a major petroleum by-product (speciality chemical), which is a basic building block for a variety of higher-value finished products such as plastics, polymers, and additives. Following the establishment of the Jurong Islands project in 2000, major industry players in the petrochemical industry of the likes of 3M, Mitsui Chemicals, Evonik and BASF chemicals have begun locating their R&D operations in Singapore.

4.2 R&D, skill upgrading and capital deepening

The transformation in the composition of manufacturing production has been associated with a significant increase in R&D expenditure in Singapore manufacturing. During the past three decades, R&D expenditure averaged 2.1 percent of GDP (Table 4). This figure is on par with the OECD average and only marginally below that of the US. The number of patents applications by Singapore-based firms increased from 7239 during 1995-10 to 12624 during 2016-20. The bulk of applications are from non-residents FIEs but applications by local firms have recorded a notable increase, albeit from low base, during this period (from 309 to 1717). Tax incentives and institutional support provided by the EDB under its local industry-upgrading programme, and the spillover effects through subcontracting arrangements with FIESs have contributed to developing R&D in local enterprises (Hill and Pang 1991, Hang, Thampuran and Png 2016). R&D expenditure is still heavily concentrated in electronics and related industries. However, recent years have seen a significant spread of R&D activities across industries, with chemicals, pharmaceutical and biomedical, and transport equipment (mostly aerospace products) indicating notable increases in R&D investment (Table 5).

Table 4: R&D in Manufacturing Industry, 1994-2016

	1995-00	2001-05	2006-10	2011-15	2016-20
Total R&D expenditure (S$ Mn)	2082.4	3426.6	5820.4	7455	4768.1
% of GDP	1.6	2.0	2.3	2.1	2.3
Private sector share[1] (%)	62.9	62.2	66.4	60.9	60.6
Patent applications	7239	8301	9463	10065	12624
Non-residents	6930	7705	8711	8855	10905
Residents	309	596	752	1210	1719

Note: (1) Predominantly by MNEs

Source: Compiled from Singapore Agency for Science Technology and Research, *National R&D Survey* (Various Issues) and the World Bank, *World Development Indicators* database.

Table 5: R&D Expenditure in Manufacturing Industry, 2002-2017[1] (%)

SSIC Code	**Industry**	**2002-04**	**2005-09**	**2010-14**	**2015-19**
10, 11, 12	Food, Beverage & Tobacco	1.0	0.8	1.4	2.0
20	Chemicals and chemical Products	3.0	2.3	7.4	9.4
21	Pharmaceutical & Biological Products	2.5	4.6	4.5	2.4
22	Rubber & Plastic Products	0.3	0.3	0.2	0.3
23	Non-Metallic Mineral Products	0.2	0.3	0.2	0.1
25	Fabricated Metal Products	1.6	5.4	4.4	1.2
26	Computer, Electronic & Optical Products	69.7	74.0	59.0	63.3
27	Electrical Equipment	0.5	0.4	0.7	0.5
28	Machinery & Equipment	7.6	4.7	8.8	8.5
30	Other Transport Equipment	3.7	4.4	8.4	5.9
32	Other Manufacturing Industries	13.6	7.2	13.4	12.3
	Total Manufacturing	100.0	100.0	100.0	100.0

Source: Compiled from unpublished returns of the National R&D Survey (Various Issues), Singapore: Agency for Science Technology and Research (A*STAR).

There has been a notable transformation in the skill composition of the workforce (Table 6). over time. Unskilled workers accounted for over 90% of manufacturing employment in the 1970s. This figure had declined to 34% by the 2010s, when professionals and technical workers accounted for close to 40% and managerial, and administrative workers accounted for close to 30% of the workforce. The structural shifts in the skill composition of the workforce are reflected in the increase in manufacturing wages. The index of real manufacturing wages (1915=100) recorded over a five-fold increased between 1960s and early 2020s (Table 1).

Capital deepening in Singapore manufacturing, measured by the nent capital stock per worker, increased from by about SS? 700 in the 1980s to over 1000 by the 2010s (Table 7). There rate of increase has, however, varied across industries depending on the vintage effect. The pioneer electrics cluster and the subindustries therein record the sharpest increases.

Table 6: Skills Composition in Manufacturing Employment, 1969-2017[1] (%)

Skill/Occupation category	1970-79	1980-89	1990-99	2000-09	2010-19
Skilled	8.4	12.55	35.45	54.85	66.4
Administrative & Managerial Workers	3.35	5.75	15.8	24.15	31.05
…Legislators, Senior Officials & Managers	---	---	8.75	13.35	15.55
…Managers & Administrators	---	---	6.8	11.15	13.2
…Working Proprietors	---	---	2.05	2.3	2.3
Professional, Technical & Related Workers	5.05	6.8	19.65	30.7	35.35
…Professionals	---	---	6.25	13.35	15.5
…Associate Professionals & Technicians	---	---	13.35	17.35	19.85
Unskilled	91.65	87.45	64.5	45.2	33.6
Clerical Support Workers	8.45	9.95	10.75	9.85	9.05
Service & Sales Workers	3.9	3.25	1.25	1.2	1.9
Production, transport and other manual workers	79.15	74.25	52.5	34.15	22.65
Total Employment	100	100	100	100	100

Note: (1) Annual averages. The data cover establishments with ten or more workers up to 2002 and all establishments since then. (2) --- no data available

Source: Compiled from Singapore Department of Statistics, *The Yearbook of Statistics* (Various Years),.

Table 7: Capital Deepening by Industry Cluster[1] (S$'000 per worker) 1980-2019

Industry Cluster	1980-89	1990-99	2000-09	2010-19
Electronics	263	732	2003	2095
..Semiconductors	418	1933	3825	3641
..Computer Peripherals & Data Storage	210	348	813	879
..Information & Consumer Electronics	216	358	312	331
..Other Electronic Components	310	751	1414	1443
Chemicals	3993	5154	7612	9086
..Petroleum	10246	13398	12858	12131
..Petrochemicals	7525	10306	20948	26552
..Specialty Chemicals	1241	2041	2839	3284
..Other Chemicals	585	1475	1726	1514
Biomedical manufacturing	763	1313	4053	3544
..Pharmaceuticals	1279	2820	10080	8824
..Medical devices	388	648	774	766

Precision engineering	410	544	511	507
..Machinery & Systems	342	477	408	429
..Precision Modules & Components	447	572	566	556
Transport equipment	582	548	410	494
..Marine & Offshore Engineering	610	500	303	408
..Aerospace	561	665	773	803
General manufacturing	347	602	652	669
Total manufacturing	723	1066	1005	1015

Note: (1) Annual averages. The data covers establishments with more than ten or more worker up to 2002 and all establishments since then.

Source and method: Compiled from the unpublished returns to the census of industrial production and the census of manufacturing industries conducted by the Economic Development Board. The data on net capital stock is deflated by the implicit investment deflated derived from the national accounts data.

4.3 Growth decomposition

Several early studies of economic growth in Singapore covering the period up to about the mid-1980s have depicted the growth process as predominantly factor accumulation driven and cast doubt about the sustainability of growth dynamism (Tsao 1985, val Elkan 1995 & 1996, Young 1992 & 1995). Young observed that the contribution of total factor productivity (TFP) to growth was 'next to nil' and advanced the notion that 'Singapore is a victim of its own targeting policies, which are increasingly driving the economy ahead of its learning maturity into the production of goods in which it has lower and lower productivity' (p 16). Drawing on TFP estimates by Young, Krugman (1994, p. 66) *drew a parallel* of the Singaporean 'miracle' with the *Soviet* experience. Based on this comparison he famously inferred that growth 'based on perspiration rather than inspiration' will slow down as the resources of factor inputs are exhausted.

Subsequently, several studies have brought under scrutiny these TFPG? estimates and the contrarian inferences about the sustainability of growth momentum in Singapore (and other East Asian countries).[12] Apart from data and methodological limitations, these studies have questioned the validity of the 'static' approach to examine the sources of growth at the formative stage of the development strategy. The critics argued that the relative importance of factor inputs as a source of growth would change over time with structural transformation from simple assembly activities to knowledge-intensive industries accompanied by investment in human capital and expansion in technological

[12] Goh and Low (1996), Chen (1997), Felipe (1999) and the works cited therein

capability. Motivated by this strong counter-arguments, we undertook a growth decomposition analysis using data for the period 1980-2019.

As in the previous studies, the methodology we used is the standard Tornquist formulation of total factor productivity growth (TFPG).

$$\Delta TFP_{i,t} = \Delta Y_{i,t} - \delta_{k\,i,t}\,\Delta K_{i,t} - \delta_{sl\,i,t}\,\Delta SL_{i,t} - \delta_{ul\,i,t}\,\Delta UL_{i,t}$$

where $\Delta Y, \Delta K$, ΔSL $\Delta \acute{U}L$ denote annual growth rates ~~on~~ of output, capital, skilled labour and unskilled labour, and δ_k, $\delta_{sl,}$ and δ_{ul} are output share of capital, skilled labour, and unskilled labour ~~and capital~~. Subscripts *i* and *t*, refer to industry and time respectively.

Data for output (value-added), remuneration, employment, and capital stock (net fixed assets) were compiled from published and unpublished returns? to the Census of Manufacturing Activities conducted by the Economic Development Board of Singapore. Data on the skills composition of the labour force were obtained from the *Yearbook of Manpower Statistics* of the Singapore Ministry of Manpower. The data series on output and capital stock (fixed capital) is deflated using the implicit deflator for manufacturing industries and the capital formation deflator, respectively. Data for both deflators were derived from the *Yearbook of Statistics*, Singapore: Department of Statistics. Both growth rates Y, K, SL and UL and the shares of K, SL, and UL in Y are estimated using annual data and then averaged to sub periods for comparison. The results are reported in Tables 9 and 10.

The estimates show improvement in productivity performance of Singaporean manufacturing growth over the successive decades compared to 1980s (Table 8). During 1995-2011, the average annual TFP growth in Singapore (2.3%) was notably higher compared to an average of 1.5 for OECD countries (1.5%).[13] During the 1980s capital deepening accounted for 71.5 percent of total output growth, with TFP growth accounting for a mere 19 percent., while human capital deepening (skills formation) contributed a modest 10.4 percent and TFP growth was 18.8 percent. The relative importance of TFP growth has increased during the subsequent years: during 2000-2019, TFP growth accounted for over half of output growth. The estimates show a modest increase in the contribution to output growth of the compositional shift in the labour force from unskilled to skilled labour.

[13] The OECD figure is the simple average for 20 OECD countries (OECD Statistics https://stats.oecd.org/Index.aspx?DataSetCode=MFP).

Table 8: Source of Manufacturing Growth,1980-2019

	1980-90	1990-00	2000-10	2010-19	1980-2019
Growth[1] (%)					
Output	5.6	5.9	4	6.3	5.3
Skilled Labour	0.6	1.3	1	0.2	0.7
Unskilled Labour	0.1	-1.1	-0.2	-0.3	-0.4
Capital	4	4.5	1	3.7	3.2
TFP	1	1.4	2.4	2.7	1.8
Share in output growth[1] (%)					
Output	100	100	100	100	100
Skilled Labour	10.4	21.6	25.7	3.3	13.9
Unskilled Labour	1.3	-18.8	-5.4	-4.7	-7.3
Capital	71.5	76	24.3	58.7	60.7
TFP	18.6	23.4	59.2	42.8	34.7

Note: (1) Annual Averages.

Source: Authors' calculations based on methodology and data described in section 4 negative shares? Contribution to output growth? Need the correct wording.

The overall patterns of TFP estimates by industry cluster are generally consistent with the aggregate estimates discussed above (Table 9). The Precision engineering cluster shows the most impressive productivity improvement throughout the period covered in our estimates. The relatively poor performance of biochemical and transport engineering clusters perhaps reflects their shorter history of operation in Singapore.

5. Concluding remarks

The embrace of the MNE-led development strategy in the mid-1960s set the stage for industrial transformation in Singapore that was instrumental in the graduation of the country from the 'third world to the first' (Lee 2000) well within a generation. This development strategy was a major policy innovation based on a prophetic foresight of the emerging opportunities for international specialisation within GMVCs. The strategic geographic location with the potential to emerge as a major industrial hub in the world, and the small size of the city-state, made it possible for the leaders to think of the entire nation as a community to articulate a vision of the country's future that everyone could identify with, greatly facilitate the development strategy. However, it was the overall policy package that

helped reap gains from these preconditions. To quote Albert Winsemius, the prescient economic advisor behind Singapore's success story: 'There was never a Singapore miracle. It was simply hard-headed policy' (UNDP, 2015, 47).

Table 9: TFP growth and its contribution to output growth by Industry clusters, 1981-2019 **(%)**

	Electronics	Chemicals[2]	Biomedical manufacturing[4]	Precision engineering	Transport engineering	Other manufacturing	Total manufacturing
(a) Output shares[1]							
1980-19	30.3	13.5	12.1	14.6	12.1	17.5	100
(b) TFP growth[1]							
1980-90	-0.2	-0.2	5.5	2.9	-1.2	1.4	1
1990-00	1.3	-2.8	0.1	2	1.5	2.1	1.4
2000-10	-1.4	2.3	-0.6	2.4	3.8	0.8	2.4
2010-19	7.2	5.9	1.5	5.2	1.7	2.4	2.7
1980-19	1.7	1.3	1.2	3.1	0.2	1.7	1.9
(c) Contribution of TFP growth to output growth[1]							
1980-90	-1.7	-5.3	34.6	33.3	54.5	46.7	18.6
1990-00	15.3	-104.4	0.9	35.1	26.8	110.5	23.4
2000-10	-16.9	74.8	4.4	40.7	33.9	53.3	59.2
2010-19	92.3	54.2	15.2	66.7	37.8	55.8	44.8
1980-19	24.9	26.4	10.7	55.2	5.5	65.9	34.7

Note: (1) Annual averages (2) Industry Clusters Based on Singapore Economic Development Board Classifications (3) excluding petroleum; (4) pharmaceuticals and medical devices.

Source: Authors' calculations based on methodology and data described in section 4

Given the unique country-specific factors mentioned above, it would not be possible to adapt the Singapore model in its entirety in any other country. However, there are some general lessons from Singapore that are useful to policymakers in other latecomers to industrialisation in this era of GMVC-led international production. First, a piecemeal approach to reforms, which specifically focuses on FDI promotion, trade liberalisation and infrastructure development, as advocated by the proponent of the so-called 'binding constraint' approach to policymaking, is not going to work. What is needed is to embody FDI promotion in a master plan of national development that makes the country an attractive location for international production. Second, the domestic investment environment requires continuous monitoring and recalibration by keeping in touch with global economic trends to ensure that the country maintains its position within GMVCs. Third, the Singapore model emphatically demonstrated that an extensive role for the government can be combined with market-oriented reforms to reshape the economy to facilitate the global economic integration of the economy. Finally in the context of a well-conceived and designed economy-wide policy framework, joining GMVCs at the

given slice/task in the global manufacturing value chain is not a dead-end strategy: there is ample scope for industrial upgrading within GMVCs.

It is of course necessary to treat these inferences with the caveat that the international context for industrialisation by joining GMVCs has significantly changed and has become more challenging and contested than when Singapore invented the MNE-led development strategy. The subsequent policy reforms and liberalisation drive across the world, and the entry of former centrally planned economies into the wider global economy, have spawned many more investment locations for MNEs to choose from. At the same time, a combination of advances in information and communication technology (ICT), stronger property rights protection legislation, the proliferation of investment protection agreements, and developments in global transportation systems that have greatly tamed the tyranny of geographic distance have made it increasingly easier for MNEs to movee capital across countries.

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