SINGAPORE: TOWARDS A KNOWLEDGE-BASED ECONOMY

Chia Siow Yue

INTRODUCTION

The Singapore economy grew at an average annual rate of over 8.5 percent from 1965 to 1997, before the regional financial and economic crisis of 1997-98. Having recovered from the crisis, the challenge facing the economy as it enters the twenty-first century is to sustain sustaining its record of nearly four decades of high economic growth.

Because Singapore is small and lacks a natural resource base, rapid economic development brought labour shortages and rising costs, and the economy has been losing its cost-advantage vis-à-vis other producers in the developing economies of East Asia. It has to continually upgrade into higher value added manufacturing and services and move up the value chain. Externally, globalisation and the information technology revolution are triggering the restructuring of corporations and national economies. Corporations are restructuring, downsizing, relocating activities to optimise use of global resources, and re-engineering job processes to harness new technologies. Knowledge-related activities have become central to creating national wealth and sustaining economic growth. By some estimates, more than 50 percent of the GDP in in major OECD economies is now knowledge-based. As Singapore moves out of the low-wage, low-cost league, it has to compete with these OECD economies and their knowledge-based industries. Hence, Singapore faces an urgent need to address the issue of transforming towards a knowledge-based economy.

The OECD (1996) defines a knowledge-based economy as one in which the production, distribution and use of knowledge are the main drivers of growth, wealth-creation, and employment for all industries. In its most basic form the knowledge-based economy (KBE) should be qualitatively different from the industrial economy, where labour is a factor of production and competitive advantage comes from more resources, cheaper labour, and better machines. In the KBE, people and their ideas and capabilities are the key source of wealth and opportunities.

The emergence of the KBE is characterised by four changes—a rise in the residual component of labour productivity growth; the growth of investment in education; a rise in real stocks of intangible capital (education); and a decline in conventional capital share. The revolution in information and communications technology (ICT) is not synonymous with the emergence of the KBE, but the two are closely inter-related. Many features of the KBE are based on the increasing use of ICT. ICT gives the KBE a new and different technological base that radically changes the conditions for the production and distribution of knowledge as well as its coupling to the production system. The rise of ICT has spawned a host of new industries, created new areas of demand, and transformed the way we work and live. The KBE offers new possibilities for both individuals and nation states.

The 1998 Report of the Committee on Singapore's Competitiveness and the Economic

Development Board's Industry 21 Master Plan set the goal for Singapore to become a globally competitive knowledge-based economy. In the coming years, Singapore's economy will be powered by knowledge-intensive and high value added manufacturing and manufacturing-related services and by exportable services. In support of this vision, Singapore has set in motion specific plans to transform key sectors to move Singapore up the value chain. While high-growth exportable products and services will drive the KBE, its proper functioning will depend on upgrading domestic-based industries. In addition to building capabilities in existing industries, the success of the KBE will require entrepreneurship and research to create new products, services, markets, and opportunities. Furthermore, investment in skills, knowledge, and creativity are necessary to ensure that Singapore's workforce has capabilities appropriate for a KBE.

This chapter examines the changing industrial structure of Singapore and the policy initiatives for the structural change towards the KBE.

CHANGING INDUSTRIAL STRUCTURE AND STRATEGIES

Changing Production and Employment Structures

As a city-state Singapore's pre-industrial economic structure was atypical, dominated by entrepôt trading rather than by agriculture or natural resources. Since the 1960s, both manufacturing and services have been the pillars of the economic structure. The manufacturing sector's share of GDP began declining in the 1990s, reflecting the process of de-industrialisation. It reached a low of 23.0 percent before the onset of the regional financial crisis in 1997. In 1999 the goods sectors accounted for 35.9 percent of GDP, while the service sector accounted for 67.3 percent (Table 6.1). The manufacturing sector is dominated by electronics, chemicals and petrochemicals, and transport equipment, while the service sector is dominated by trade, finance, business services, and transport and communications. Traditional trade has been declining as a share of the service sector, while financial services and business services are growing rapidly.

Reflecting these changes in production structure, manufacturing's share of employment has been falling since 1980 and the shares of financial and business services have been rising (Table 6.2). The skill level of Singapore's workforce has been increasing. The proportion of administrative, managerial, professional and technical personnel rose from 18.0 percent of the workforce in 1980 to 40.3 percent by 1999 and the share of production workers and labourers declined from 46.3 percent to 29.1 percent over the same period (Table 6.3).

Competitiveness Factors

The *Global Competitiveness Report* of the Geneva-based World Economic Forum (WEF) and the *World Competitiveness Yearbook* of the Lausanne-based International Institute of Management Development (IMD) have consistently ranked Singapore as the world's most competitive or second most competitive economy in recent years (Tables 6.4 and 6.5).

Of the factor resources that gave Singapore its competitive advantages, only one, strategic location at the crossroads of international shipping and in a time zone straddling Europe and the Pacific, is an inherited factor. All the others are created factors. The initial competitive advantage conferred by Singapore's geographical location and natural harbour were buttressed by the free trade policy pursued by the colonial government and continued after political independence and by investment in world-class transportation and telecommunications infrastructure, facilities, and services. Extensive air, sea, and telecommunications networks link Singapore with major cities and ports in the region and around the world. Within only a 3-hour flying time radius are the ASEAN capitals, and in an 8-hour radius are Beijing, Tokyo, Seoul, Taipei, and Hong Kong in the north, Sydney in the south, and New Delhi in the west. Singapore's seaport is the busiest in the world, and its airport carries a growing volume of air cargo and passenger traffic. Singapore is also being developed as an "intelligent island" with the comprehensive development of information technology infrastructure.

The quality of economic management and political governance are also a significant factor in Singapore's global economic competitiveness. Policies pursued since the mid-1960s created a strong macro-economic environment characterised by high savings and investment and low inflation. Savings rates exceeding 45 percent of GNP in recent years reflected the high rates of private compulsory savings under the Central Provident Fund and private voluntary savings, as well as the public sector's budgetary and operating surpluses. The low-inflation environment reflects prudent monetary and fiscal policies, a free trade policy that ensures access to world goods at world prices, and an efficient retail distribution system. Economic openness has contributed to economic efficiency and helped overcome the constraints of a small domestic market and a small resource base. Social equity has been maintained with rapid economic growth, full employment, low incidence of absolute poverty, and upward social mobility. Full employment and the Central Provident Fund provide a social safety net. In addition, subsidised public housing enables 85 percent of the population to enjoy home-ownership. Policy and practice have enabled Singapore to achieve social cohesion despite a multi-racial, multi-cultural and multi-religious population. Political stability and the probity and competence of the political leadership and bureaucracy are well known. Good governance helped Singapore escape the ravages of the 1997-98 regional financial crisis.

Effective harnessing of foreign direct investment (FDI) has been another important factor in Singapore's economic competitiveness. Up to 1990, Singapore was the largest recipient of FDI among Asian developing economies. FDI played a particularly crucial role in Singapore's pursuit of export manufacturing and the development of its financial centre. By adopting a liberal FDI policy regime and providing effective trading and financial infrastructure, Singapore enjoyed a first-mover advantage as a production base for MNCs looking for a location to produce the labour-intensive parts of the value chain. As labour costs in Singapore rose and the capacity for labour-intensive manufacturing in neighbouring countries improved, Singapore attracted FDI for higher value-added manufacturing and

as regional headquarters for MNCs. International banks and other financial institutions were also crucial in the development of the Singapore financial centre. Singapore's success in attracting FDI despite its lack of natural resources and small domestic market may be attributed to the holistic approach—providing both an efficient business and comfortable living environment and attractive investment incentives.

Singapore has worked to develop the quality of its human resources to maintain economic competitiveness. To provide an industrial workforce Singapore revamped the educational system in the 1960s to emphasise technical and vocational education and established specialised industrial training institutes to turn out qualified technicians and craftsmen. The Skills Development Fund was established in the 1970s to support training to upgrade workers' skills using levies on employers. Tertiary education expanded rapidly to provide professionals and managers in science, engineering, business, and computing. To augment the small domestic labour pool, in recent years Singapore has been actively recruiting foreign talent for both the public and private sectors. English is the language of instruction in schools and universities as well as the language of government and business, facilitating the operations of foreign MNCs in Singapore and linking Singapore effectively with the global economy.

From Entrepôt to Manufacturing

In colonial times, Singapore's economic pillars were entrepôt trade and the British military base. By the late 1950s, though, Singapore's prospects as the regional entrepôt were uncertain because neighbouring countries had developed competing ports and begun trading directly. Moreover, in the late 1960s Britain announced the phased closure of the military base. After self-rule in 1959 and more particularly after political independence in August 1965, the Singapore government began a systematic effort to restructure and diversify the economy through industrialisation.

The industrialisation strategy was based on:

- strong government policy intervention, initially to jump-start industrialisation and increasingly to encourage specific types of investments and activities;
- continuing reliance on a free-trade regime and on FDI, particularly from U.S., EU, and Japanese MNCs, to spearhead export manufacturing, against the conventional models of industrialisation;
- investments in human capital and infrastructure to ease supply constraints and improve productivity;
- maintenance of a stable macro-economic environment and stable industrial relations; and
- lowering the burden of taxation for businesses through fiscal incentives.

Singapore faced several drawbacks as it tried to jump-start industrialisation. The small economy (581 sq km land area, 1.6 million population, and S$2 billion GDP) and the lack of natural resources precluded industries with scale economies and those based on local natural resources. Moreover high prevailing wages rates from entrepôt and military base activities were above levels for competitiveness

in labour-intensive industries. Singapore had certain favourable conditions as well, including its strategic geographical location and excellent natural harbour and its well-developed transportation, communication, and commercial and financial infrastructure. In addition, as a trading economy Singapore already had a sizeable literate and skilled labour force, trading and financial expertise, and capital resources, making the transition to an industrial economy easier than from an agrarian economy.

Singapore's initial import-substitution strategy of 1960-65 was premised on a Malaysian common market, but it shifted to export manufacturing spearheaded by foreign direct investment (FDI) when it seceded from the Malaysian Federation and became politically independent two years later. From 1967 to 1969 Singapore undertook to restructure institutions, expand tax incentives, create industrial estates, pass labour legislation to improve industrial relations, and restructure the education system to emphasise technical education and industrial training. The inflow of FDI surged between 1968 and 1973 and rapid industrial and GDP growth ensued. The manufacturing sector rose from 15 percent of GDP in 1965 to 28 percent by 1980. Labour-intensive industries such as textiles and garments, electronic components assembly, and ship repairing expanded rapidly and contributed to full employment by the early 1970s. As labour became scarcer and capital became more abundant, more capital-intensive processes and product lines emerged. As the stock of human capital grew, Singapore developed an advantage as a production base for human capital-intensive parts of the value chain.

By the 1970s Singapore had three major clusters of industry, all dependent on imported inputs and export markets. One industry cluster centred on petroleum refining using crude oil imported from the Middle East. Singapore's competitive advantage came from the large bunkering needs of its seaport and airport, its established entrepôt trade in petroleum, and its proximity to Asia-Pacific markets. When new refineries in the Middle East and in neighbouring countries came on-stream in the 1980s, Singapore upgraded its refinery operations and also developed a petrochemical complex. A second industry cluster was in shipbuilding and ship repair. This originated with the conversion of the British naval dockyards to commercial use. This and the legacy of engineering skills from the British naval base and the role of Singapore as a major port-of-call provided the initial locational conditions. A boom in petroleum exploration in Southeast Asian waters in the 1970s led to the growth of rig construction as well. Shipbuilding and ship repairing activities declined with waterfront shortages and rising labour costs in Singapore in the 1980s, resulting in major relocation of activities to elsewhere in the region.

The third industry cluster centred on electronics. In the 1960s American electronics MNCs were seeking offshore assembly and export platforms in East Asia, followed soon by European and Japanese MNCs. Singapore began courting them, offering low-cost, easily trainable young female

labour, well-developed physical infrastructure, and generous investment incentives. Since then, the Singapore electronics industry has experienced dynamic growth as well as continual upgrading, restructuring from labour-intensive processes and products to production of computers and computer peripherals and components and further into semiconductors in response to changing costs and technologies. From the 1980s a large local and supporting industry supplying computer components and parts, facilitated by a growing pool of engineering expertise from the polytechnics and universities, emerged to service the foreign multinationals. Many MNCs established international purchasing offices to source their worldwide products and parts and components requirements from Singapore and the region. Singapore's well-developed logistics infrastructure provided efficient, timely, and low-cost delivery.

The tripartite National Wages Council, with representatives from the government, employers, and trade unions, was established to provide for orderly wage increases with the emergence of full employment in the early 1970s. Inflow of foreign labour was also liberalised. Worsening labour shortages and ensuing rising costs eroded Singapore's competitive advantage as a low-wage manufacturing base and necessitated a shift in industrial structure towards high-tech manufacturing and high value added services. Industrial restructuring policies were launched in the late 1970s, with parallel policies for accelerated wage increases and for automation, mechanisation, and computerisation. The restructuring programme was disrupted by the 1985-86 recession.

New Directions and Strategies for the 1990s

In 1985 the government convened the Economic Committee to review the progress of the economy and to identify new directions for future growth. The 1986 Economic Committee Report (ECR) focused on short-term measures to lead the economy out of the recession. For the longer term, the Economic Committee argued that Singapore needed to find a new niche because its niche as an offshore production centre for the developed world would have eroded by the 1990s. First, Singapore had to move beyond being a production base to being an international business centre and attract companies to establish operational headquarters to do product development, manage treasury activities, and provide administrative, technical, and management services. Second, Singapore had to become an exporter of services, not just Singapore-based activities such as tourism or banking, but also offshore-based activities. To accomplish this transition the ECR proposed strategies to ensure good fundamentals (good government, efficient infrastructure, education and training, free enterprise, flexibility), to maintain a high savings rate, to create a conducive business environment (competitive costs, low taxes, friendly regulations, good work attitudes), to depend on the private sector, to promote offshore activities, and to nurture both foreign MNCs and local companies.

Once recovery from the 1985-86 recession was assured, the Singapore government began to plan for the longer term. The Strategic Economic Plan (SEP) drawn up by the Economic Planning Committee and issued in 1991 provided an overview of the economic landscape over the next two to three decades. The SEP called for promoting and developing Singapore as a "total business centre" and developing high-tech and high value added manufacturing and services as twin engines of growth. It made two strategic proposals: evolving highly developed manufacturing and service clusters and upgrading the low productivity domestic sector. The cluster proposal adopted Michael Porter's framework for competitiveness—that business enterprises need access to various suppliers, qualified manpower, competency centres in relevant technologies, and efficient infrastructure and other services.

The key thrusts of the SEP were to develop an international orientation, to maintain international competitiveness, to develop manufacturing and service clusters, to spearhead economic redevelopment, to create a climate conducive to innovation, to enhance human resources, to promote national teamwork, and to reduce vulnerability. Strategies were grouped under the Manufacturing 2000 and International Business Hub 2000 Programmes. The Economic Development Board (EDB) was the lead agency to implement these programmes. .

The Manufacturing 2000 Programme (M2000) affirmed the continuing role of manufacturing as a mainstay of the economy. The strategic goal was to sustain manufacturing at 25 percent of GDP and at 20 percent of national employment. These targets were only slightly below the sector's shares in the first half of 1990s. Policymakers wanted to avoid the kind of rapid industrial hollowing-out that was occurring in Hong Kong as industries relocated in droves across the border to Guangzhou. The model for Singapore's continued role as a manufacturing base was value-chain analysis, which saw modern manufacturing and services as integrated and complementary activities. In this view, industrial capability is an essential component of any advanced economy, providing the foundation for building advanced capabilities in science and technology, logistics, and operations management.

The key element of M2000 was the development of industry clusters and the programme had specific action plans for major sectors including electronics. The strategy was to upgrade capabilities across the value chain in each industry cluster, including product and process development, production, engineering, and strategic marketing. Based on detailed analysis of the value chain for various industries, the plan identified gaps in existing industry clusters and formulated initiatives and strategies to close them.

The plan for developing industrial clusters had two key components, the Cluster Development Fund and the Co-Investment Programme. The S$1 billion Cluster Development Fund was to promote strategic projects in manufacturing and services through equity participation in joint ventures and co-investment projects. The Co-Investment Programme involved government equity participation in joint ventures in three areas: new capabilities and supporting industries to fill critical gaps in industry clusters; developing local enterprises; and strategic investments in local companies and MNCs going

regional. Investment partnerships with foreign MNCs recognise that traditional tax incentives offered by government may be inadequate in capital- and technology-intensive projects, and that government equity participation may be necessary to share in the capital requirements and risks. An example of this type of development is the semiconductor wafer fabrication industry, where EDB co-invested in SemiTech together with Texas Instruments, Hewlett Packard, and Canon.

The International Business Hub 2000 Programme focused on strategies to develop Singapore into a hub for business and finance, logistics and distribution, and communications and information. The basis for the hub strategy was the notion that key economic activities such as finance, shipping, air transport, telecommunications, and information are becoming concentrated in a few strategic nodes around the world. Each node acts as a hub providing services to the extended hinterland and linking it with the rest of the world.

Singapore seeks to secure the first-mover advantage as the business hub in the Asia-Pacific. Its competitive advantage as a regional trading, financial, transport, and telecommunications centre arises from its strategic location and its developed physical infrastructure and human resources, as well as its minimal restrictions on the movement of goods, services, and factors of production. Singapore has been providing trading, transhipment, storage, breaking of bulk, grading and processing, and financing since the nineteenth century as the entrepôt of Southeast Asia. As the region's economies industrialised, the entrepôt trade shifted from the two-way exchange of the primary products of Southeast Asia for western manufactures to two-way trade in manufactures and intra-industry trade. Because of its advantageous location for time-sensitive shipments Singapore became the hub for distribution and transhipment in the region. It also became a host to over 4,000 multinational corporations, many having divisions that perform regional headquarters functions.

Singapore emerged as a regional financial centre in the early 1970s with the establishment of the Asian Dollar Market collecting offshore funds for offshore lending. It ranks third after Tokyo and Hong Kong as an Asian financial centre. The assets of the Asian Currency Unit (ACU) peaked at US$557.2 billion in 1997, but shrank in 1998-99 as a result of the regional financial crisis. Over the years, the strategy has been to establish Singapore as a risk management centre with active foreign exchange trading, money market operations, and trading in capital market instruments, equities, and futures. Many foreign financial institutions have located in Singapore, including over 200 commercial and merchant banks, to enjoy its time zone advantage (straddling Asia and Europe), efficient transport and telecommunications facilities, a well-established financial regulatory framework, ready availability of professional manpower, attractive investment incentives, and political, economic, and financial stability.

TOWARDS A KNOWLEDGE-BASED ECONOMY IN THE 21ST CENTURY

The 1997-98 regional financial crisis heightened Singapore's awareness that it had lost competitiveness

vis-à-vis the other economies in the region where currencies had devalued sharply. Cost-cutting measures in existing industries would only keep Singapore competitive in the short-term. Upgrading was hampered by Singapore's lack of the skills, technology base, and other capabilities of developed economies. Singapore must develop these capabilities in order to move up the value chain. In an increasingly challenging global environment characterised by intensified competition and rapid technological change, and facing severe domestic labour and resource constraints, Singapore must tap new sources of economic growth to maintain its competitive edge.

The current challenge facing Singapore is to transform into a knowledge-based economy. To become a KBE, Singapore will need human and intellectual capital to create, absorb, process, and apply knowledge, a strong technological capability, an entrepreneurial culture, an open cosmopolitan society attractive to global talent, and connections to other global knowledge nodes. To realise this vision requires a quantum leap in capabilities.

In May 1997, before the financial crisis took hold in the region, the Singapore government established the Committee on Singapore's Competitiveness (CSC) to assess Singapore's economic competitiveness over the next 10 years and to recommend strategies and policies. Together, the main committee, five industry subcommittees (manufacturing, finance and banking, hub services, domestic businesses, manpower, and productivity), and a panel of resource persons comprise over 100 individuals representing the public, private, and academic sectors. As with the 1986 Economic Committee Report, the Competitiveness Report released in November 1998 contained both short-term measures aimed at recovery from the 1998 recession and measures intended to transform Singapore into an advanced and globally competitive knowledge-based economy. The Competitiveness Report recommended specific plans for key sectors, including manufacturing, finance, and telecommunications, to move Singapore up the value chain.

The eight recommended underlying strategies were:

- to maintain manufacturing and services as twin engines of growth;
- to strengthen the external wing to complement the domestic economy as a source of growth;
- to build world-class companies with core competencies to compete in the global economy;
- to nurture and strengthen local enterprises;
- to develop human and intellectual capital with cost-competitive and outstanding capabilities;
- to leverage on science, technology, and innovation as competitive tools;
- to optimise resource management by promoting alternative supply and efficient usage; and
- to use government as facilitator of the private sector by providing sound economic policies and regulatory environment for the conduct of business.

The major initiatives arising from the Competitiveness Report's recommendations are discussed below.

Manufacturing and Services as Twin Engines

Singapore has stressed maintaining manufacturing and services as twin engines of growth since the late 1980s. This strategy recognises the strong linkage between the two sectors and Singapore's need for a broad economic base to reduce its vulnerability. Also, Singapore needs to balance the global orientation of export manufacturing with the regional orientation of exportable services. Singapore's exportable services were more adversely affected by the 1997-98 regional financial crisis than its exports of manufactures because service exports were more dependent on regional demand.

In 1999 manufacturing investment commitments in Singapore show the following sectoral distribution: electronics, 42 percent in electronics, 33 percent in chemicals, 17 percent in engineering, 4 percent; general industries, and 4 percent life sciences. Services Investment commitments in services were distributed with 36 percent in infocomms (information and telecommunications) and media, 34 percent in headquarters services, 20 percent in logistics and supply chain management, and 10 percent in education and healthcare.

Manufacturing makes a large contribution to Singapore's GDP, employment, and foreign exchange earnings, as well as to technological progress, productivity improvement, and entrepreneurship. But Singapore can no longer remain a production base because of the growing problem of maintaining cost competitiveness. It seeks to become a location where foreign MNCs and local enterprises produce high value added products and to provide manufacturing-related and headquarters services to the region. It also seeks to move along the value chain into R&D, design, logistics, marketing, and sales.

Strategies recommended by the Competitiveness Report to develop the manufacturing sector included:

- integrating Singapore into the global economy to leverage on international talent, knowledge, and technology;
- positioning Singapore as the premier regional hub to attract foreign MNCs and local enterprises to use Singapore as a production base for high value added products and to provide manufacturing-related services for their subsidiaries in the region;
- developing a strong external wing to overcome Singapore's small size and limited resources and distributing resource-intensive activities to the region;
- maintaining cost competitiveness by ensuring productivity growth;
- providing an entrepreneurial environment that tolerates business failures and allows freedom for the generation of ideas;
- embracing innovation to generate new businesses and growth;
- grooming world-class local and foreign companies in niche areas;
- having a balanced mix of manufacturing activities to provide economic resilience;
- building strong manufacturing capabilities in existing niche areas such as electronics and chemicals and emerging areas; and
- developing strong competencies in other parts of the manufacturing value chain, including

R&D, design, logistics, marketing and sales.

For the services sector, the Competitiveness Report envisions Singapore becoming the premier Asian service hub by expanding existing financial services, international trading, transport and logistics, exhibition management, and tourism services as well as by developing new high-growth hub services such as healthcare, education, media, information and communications technology services, e-commerce and direct marketing. The Report recommended the following strategies:

- becoming the centre in Asia for knowledge- and skill-intensive and other high value added services in which Singapore has core competency;
- providing a business environment to attract top global service companies;
- having an externally oriented services sector focused on the international market;
- having a pool of local services companies with established niches in overseas markets;
- tapping the world market to attract creative manpower and talent;
- using ICT to enhance competency and overcome Singapore's physical and manpower limitations.

Following on the recommendations of the Competitiveness Report, the EDB launched Industry 21 (I21), a 10-year plan to develop Singapore into a vibrant and robust global hub of knowledge-driven industries in manufacturing and traded services with emphasis on technology, innovation, and capabilities. I21 encourages MNCs to locate more of their key knowledge-intensive activities in Singapore and encourages local companies to embrace more knowledge-intensive activities and become world-class players. I21 proposes five broad strategies:

- diversifying among and within industry clusters for a balanced and robust mix of industries and markets;
- building up world-class capabilities and global coverage;
- promoting innovation;
- developing local talent and attracting foreign talent; and
- creating a business-friendly environment and world-class infrastructure.

I21 identified electronics, chemicals, engineering, life sciences, education and healthcare, headquarters, communications and media, and logistics as industry clusters to be nurtured.

- To create a world-class electronics hub in Singapore by attracting global leaders with the latest product-design, manufacturing, and applications in semiconductors, infocomms products, data storage, and key modules and global leaders in the management of new products, applications, and markets.
- To nurture the chemicals industry cluster, I21 aims to make Singapore a world-class petroleum and petrochemicals hub based at a 3,200 hectare site located on Jurong Island with S$40 billion of capital investment targeted by 2010. Ten chemical plants came on-stream in 1999. The IT master plan for Jurong Island adds an e-business dimension to the chemicals cluster.
- I21 envisions a life science cluster with world-class capabilities in pharmaceuticals,

medical devices, biotechnology, agri-biotech products, and food intermediates. Singapore is already a world-class manufacturing hub for pharmaceutical bulk actives. With several new projects in Tuas Pharma Park, biotechnology manufacturing output will double by 2005. The goal is to have 15 world-class companies and a regional centre for clinical trials and drug development by 2010. The EDB will invest in R&D and manpower development and nurture start-up companies through co-investment and venture capital in three dedicated investment funds, Singapore Bio-Innovations, Pharmbio Growth Fund, and Life Sciences Investments. More activities are also seen in R&D, product and process development, clinical trials, and manufacturing.

- Engineering has always supported the electronics and chemicals clusters. It now supports new fields such as optics, semiconductors, and pharmaceuticals and it promotes new business models to embrace e-capability. By nurturing engineering, I21 aims to generate growth potential for existing industry clusters and to improve the possibilities for creating new industries by developing multi-disciplinary capabilities and state-of-the-art technologies. Singapore will build on strengths in precision, process, and transport engineering and create synergy among disciplines. The target is to nurture five new industries and attract 20 global engineering centres and 50 manufacturing headquarters.

- To position Singapore as a world-class education and healthcare hub, I21's emphasis is on attracting world-class universities, executive learning centres, corporate training centres, and distance learning providers. To date, MIT, INSEAD, Wharton, Chicago Graduate School of Business, Georgia Tech, and Johns Hopkins have set up teaching and research facilities in Singapore. For the healthcare service cluster the plan envisions Singapore as the place for timely, reliable clinical trials and analysis. The strong cluster of education and healthcare companies will also support the life sciences industry.

- I21's goal for the infocomms and media cluster is to build Singapore into a global hub in Asia for the digital economy offering a wide range of initiatives and developments in telecommunications, IT, media, e-commerce, and the Internet. The telecommunications sector has been liberalised and more competition introduced into the local broadcast and print media industries. Parallel with efforts to strengthen the telecommunications infrastructure is the active promotion of software development, Internet builders, application service providers, portals, and intermediaries.

- I21 aims to build on Singapore's reputation as the premier location for MNCs to attract them to base regional and business headquarters. Singapore offers political and social stability and excellent infrastructure to allow MNCs to manage regional or international operations effectively, spearhead new developments, and undertake high value added activities. From 1997-99, 75 companies received the HQ incentive, creating high-value jobs and transferring technology, management, and marketing expertise.

- By nurturing a logistics and supply-chain management cluster, I21's vision is to develop Singapore into a leading integrated logistics hub for the Asia-Pacific region. The strategy is build up supply chain capabilities by getting third-party logistics players, cargo airlines, value-added distributors, and manufacturers locate their supply chain centres for Asia in Singapore. These companies provide world-class logistics services, and enhance manufacturers' global supply chains. A 23-hectare Free Trade Zone Logistics Park has been established at Changi Airport and a 80-hectare Chemical Logistics Hub on Jurong Island.

In addition to the industry cluster programme, five other programmes under I21 aim to support the manufacturing and service sectors.

- The World Class Companies/Promising Local Enterprises Programme aims to build at least 50 local knowledge-based enterprises that offer world-class products, services or capabilities by 2010. EDB works closely with potential companies on financial resources for mergers and acquisitions, resource support, image building, technology acquisition,

strategic alliances, and business partnerships. This programme complements the EDB's Promising Local Enterprises programme, which aims to develop at least 100 local enterprises, each with an annual turnover of $100 million, by year 2005.

- The International Business Programme aims to build an external economy that enhances and is strongly linked to Singapore's domestic growth. EDB supports and nurtures local companies with strong overseas growth plans through schemes to develop their manpower and market capabilities.
- The Innovation Programme aims pro-actively to identify and promote innovation projects for each industry cluster, to introduce innovation systems and practices in companies, to expand the innovation infrastructure, and to intensify innovation awareness. Through innovation capability development programmes, innovation will be undertaken at the national level through a concerted multi-agency effort.
- The Resource Development Programme encompasses the planning, development, and optimisation of the use of Singapore's manpower, land, utilities and housing resources to support industrial growth. The International Manpower Programme supports companies in their international manpower needs. Industrial land policies support the dynamic and changing needs of the economy.
- The Co-investment Programme aims to strengthen partnerships between foreign MNCs and promising local enterprises in key industry clusters, through equity co-investment within and beyond Singapore. The EDB manages the Cluster Development Fund and the Venture Capital Fund (VCF), aimed at developing new capabilities, technology projects, and innovative start-ups to fill critical gaps in the industry clusters. Since 1985 the EDB has engaged in direct venture capital (VC) investment activities to grow the VC industry and support industry cluster development and regionalisation and to promote innovation and entrepreneurship. Venture capital funds had grown to S$10.2 billion by 2000. The VCF is also leveraging on partnership with global VC funds and government agencies to invest in more young companies in Singapore and abroad.

Paralleling the EDB's work, the Trade Development Board (TDB) is promoting and marketing Singapore's total trade capabilities through its trade regulation, facilitation, and promotion functions. An open global trading environment is critical for ensuring Singapore's prosperity. As regulator, TDB monitors foreign trade policies and their impact on Singapore's trade, recommends trade policy responses, and participates in international trade negotiations. As facilitator, TDB helps Singapore leverage its advantage in information technology (IT) and position it as a centre for e-business. It seeks to build on Singapore's IT infrastructure to facilitate trade transactions and further business efficiency through IT applications. As trade promoter, TDB leads Singapore's participation in international fairs and exhibitions and sectoral missions to targeted overseas markets. As part of the vision of Singapore as an e-commerce hub, TDB is attracting companies to set up regional e-commerce trading centres in Singapore, with a target of 25 companies over the next five years under the Approved Cyber Traders scheme. This scheme is similar to those for international traders and oil traders, which have attracted over 130 companies to do their international trading activities from Singapore.

Outward Investment and Regionalisation

Singapore began the drive to create an external wing in 1993, pushed by the increasing constraints of space and labour at home and pulled by the burgeoning business opportunities in the booming East Asian region. Besides allowing Singapore's increasingly abundant capital to earn higher rates of return, outward investments would bring spillover benefits from increased trade flows through Singapore, consolidation of Singapore's headquarters function, development of domestic technology, know-how,

and R&D, and tapping of foreign expertise.

The government believes its role is to facilitate regionalisation by providing basic infrastructure. It makes bilateral agreements with countries that interest Singapore's private sector, encourages government-linked companies (GLCs) to partner with private-sector companies in larger scale projects, disburses various regionalisation financial schemes to assist companies venturing abroad, and establishes bilateral business councils as a means of networking and exchanging business information. The EDB facilitates the efforts of Singapore companies to diversify in the region through tax incentives and grants, risk-sharing partnerships, and other broad-based support mechanisms, including the Overseas Enterprise Incentive and the INTECH scheme, which trains Singapore managers for overseas postings.

Singapore government initiatives extend to promoting ASEAN growth triangles and overseas industrial parks. The ASEAN southern growth triangle links the infrastructure, capital, and expertise of Singapore with the natural and labour resources of Johor (in Malaysia) and Riau (in Indonesia). Singapore government agencies also play an active role in establishing overseas industrial parks, which offer one-stop services facilitating investor approvals, licences, employment, and other requirements for start up operations. By mid-1999, investment commitments in eight overseas industrial parks reached S$14 billion with potential to create more than 114,000 jobs. The Batamindo Industrial Park and Bintan Industrial Estate in Indonesia have created 74,000 direct jobs in production, supervision and management as of 1998. The International Tech Park in Bangalore, India was launched in 1994, commenced operations in the second half of 1998, and 28 investors had started operations by the end of 1999. The Vietnam Singapore Technical Training Centre set up in August 1997 supports the Vietnam Singapore Industrial Park and human resource training needs in Vietnam.

With the regional initiatives, factor income from abroad increased. The contribution of foreign operations to value added in the Singapore economy averaged 11-12 percent a year, and 20 percent of the total sales of overseas manufacturing affiliates was shipped back to Singapore. However, the regional financial crisis exposed the downside of this strategy. Singapore businesses that had expanded into the region were badly affected by the sharp contraction of demand in host markets, currency volatility, and non-performing loans, resulting in some companies having to trim or even shut down their regional operations.

Nevertheless, outward investment remains crucial for Singapore's continued development. The indigenous private sector is still weak and it takes time to develop a critical mass of world-class Singaporean companies with a global reach. Regionalisation will have to remain a strategic pillar, and Singapore firms need to position themselves to take advantage of opportunities when the regional economies recover. Both GLCs and private companies that have the resource capacity are encouraged to continue investing in the region's economies, especially because these economies have liberalised their FDI policies, opening up formerly closed sectors and allowing for mergers and

acquisitions to re-capitalise their financial and corporate sectors. But to reduce the vulnerability of Singaporean corporations to future adverse developments in the region, the Competitiveness Report also recommended a broader global dimension to the external wing strategy as well.

Strategies to develop the external wing recommended in the Competitiveness Report included:

- generating linkages between overseas affiliates and the home economy through trade flows through Singapore;
- consolidating Singapore's headquarters, high-tech operation and R&D functions;
- pooling the resources of Singapore companies venturing overseas, particularly by forming clusters and tie-ups to maximise collective leverage;
- promoting strategic flagship projects;
- promoting tripartite co-operation, enhancing Singapore's role as a partner for foreign investors into the region;
- developing globally- and regionally-minded managers and investors; and
- tapping foreign talent to overcome domestic manpower constraints.

Domestic Enterprises

Unlike the other Asian Newly Industrialised Economies (NIEs). Singapore's industrial strategy neglected domestic enterprises, until recently. From the mid-1960s, Singapore focused on foreign MNCs to spearhead export manufacturing and exportable services. It did not abandon its long-standing free trade policy to protect domestic manufacturing and nurture domestic entrepreneurs. As a result, after more than three decades of industrialisation, Singapore's indigenous entrepreneurs have only a marginal role in export manufacturing and have limited capacity to venture abroad.

Since the mid-1980s, the EDB has been promoting SMEs in supporting industries and linking them with foreign MNCs to facilitate technology transfer and market networking, particularly in the electronics industry. Earlier on, there was a dearth of local industrial entrepreneurs to reliably supply quality parts and components to foreign MNCs. Industrial and FDI policies had no local-content requirements to pressure foreign MNCs to source locally. By the 1990s, a sizeable local supporting industry emerged, with local contract manufacturers producing parts and components to supply foreign MNCs. Massive government investment to raise the stock of human capital, particularly in engineering, business management, and information technology, created a pool of technically savvy entrepreneurs. In addition, the EDB's Local Industry Upgrading Programme (LIUP) gave more capital subsidies to raise a pool of local entrepreneurs. Many top- and middle-level managers once employed by Singapore-based MNCs eventually established their own businesses and become subcontractors. Foreign MNCs were encouraged to source components and parts locally, based on their trust in these former employees.

Except for a handful of large GLCs, the bulk of domestic enterprises are small- or medium-sized. SMEs comprise over 90 percent of business establishments, employ half the workforce, and contribute a third of value added. But productivity of SMEs is only about half that of non-SME establishments.

The poor productivity performance is due to several structural weaknesses—weak entrepreneurial culture, insufficient management know-how and professionalism, shortage of professional and technical manpower, insufficient use of technology, outmoded, unproductive methods of operation, limited ability to tap economies of scale, and small domestic market. However, Singapore has come to realise that building local enterprises is important for its sustained development and economic depth and resilience.

As noted earlier, the EDB aims to build at least 50 local world-class, knowledge-based enterprises in product, service or capability by 2010, to serve MNC clients or to create their own niche markets. These business entities will be professionally managed and they will have excellent process and customer service management, capabilities to create new knowledge and technology to develop high value added products and services, and the ability to compete globally. To develop the type of world-class, knowledge-based enterprises targeted under the I21 World Class Companies Programme, the Competitiveness Report recommended leveraging off the capabilities of existing GLCs. This would help local enterprises to overcome inadequacies in skilled manpower, R&D capability, capital and financing, and market networks for access to regional markets. These companies will complement those from the EDB's Promising Local Enterprises (PLE) programme which aims to develop at least 100 local enterprises, each with an annual turnover of $100 million, by the year 2005 through its co-investment programme.

The 1988 SME Master Plan marked the first co-ordinated national effort to upgrade SMEs and promote entrepreneurship. Its aims were to nurture a business environment that promotes entrepreneurship and innovation; to increase market efficiency by encouraging information exchange and provision of information about new methods and opportunities; to promote best practices in business through easy access to consultancy, technology adoption, and training; and to encourage local enterprises to go international. The SME Master Plan had five underlying thrusts: technology adoption, application and innovation; business planning and finance; human resource management; productivity improvement and training; and international marketing and business collaboration.

A decade after the 1988 SME Master Plan and a plethora of SME-assistance schemes under several government agencies, SMEs remain a problem in Singapore. Local enterprises accounted for more than 60 percent of value added by supporting industries in the manufacturing sector where local SMEs are active in transport engineering, electronic contract manufacturing, and precision engineering. More problematic are the majority of SMEs concentrated in the service sector. They serve domestic consumers in commerce, construction and real estate, and community, personal, and social services, and they operate on a relatively small scale and shielded from international competition, resulting in low productivity.

In the knowledge-based economy, SMEs need to keep pace with the rest of the economy. Firm size is not critical in the KBE; what is needed is the expertise to undertake knowledge-intensive

activities, the ability to innovate, and the enterprise to identify and capitalise quickly on commercial opportunities. SMEs need to build up distinctive competencies, exploit and harness technology and knowledge, and establish strategic alliances with customers, suppliers, and competitors. The Competitiveness Report recommended the following strategies to strengthen local enterprises:

- consolidate and pool resources among local enterprises to achieve synergy and competitiveness, such as through linking private-sector companies with GLCs to take advantage of the latter's size, financial resources, core capabilities and experience in venturing abroad;
- improve the supply of engineering and managerial manpower through expanded education and training facilities;
- promote innovation and technology, such as through government provision of funding and facilities and incentives for commercialisation of innovation, acquisition of technology, and technological upgrading;
- build indigenous products and brand names; and
- increase international and regional orientation.

The latest effort to build up the capabilities of Singapore's SMEs is detained in the SME 21 Report, which appeared in 2000. According to the report, SMEs are needed in the KBE, as a source of entrepreneurship and innovation, as a base of strong supporting industries and strategic partners for foreign SMEs and MNCs, as manufacturers of high value added products and global providers of professional services, and as robust domestic service sectors enhancing the quality of life. The SME21 Report specifies three strategic goals as part of a 10-year strategic plan.

- To nurture innovative high-growth SMEs with the capacity to compete globally on a sustained basis so that a steady stream of Singapore SMEs reach world-class status. These SMEs will produce innovative products and services, use ICT to add value to new products and services, develop and use brands to increase the knowledge-component of their products, and have superior distribution channels. The target is to treble the number of local SMEs with more than $10 million in sales turnover to 6,000 by 2010.
- To enhance the productivity of SMEs and improve land and labour resource utilisation by restructuring, revitalising, and upgrading SMEs in the domestic service sector, particularly retail trade. The target is by 2010 to double annual labour productivity in the retail sector from $28,000 to $56,000, which is 70 percent of the national productivity level.
- To create a knowledge-based, pro-enterprise environment that inculcates the appropriate mindset for business, encourages entrepreneurship and innovation, and eliminates barriers to organisational growth. A key enabling factor is e-commerce, which will open up vast opportunities and remove the traditional barriers to SME growth. The target is to quadruple the number of local SMEs with e-commerce transactions from 8,000 to 32,000 by 2010.

The SME 21 Report recommends several programmes to achieve these three goals. Broad-based programmes include promoting entrepreneurship; financing growth; facilitating market access; strengthening local talent; accelerating e-commerce; and promoting Singapore as an SME hub. Recommended sector-level programmes include facilitating collaborative partnerships and strategic alliances and upgrading domestic service sectors. Enterprise-level programmes cover developing

entrepreneurs and employees, managing for business excellence, harnessing technologies and knowledge for growth, and designing new business models for competitive advantage. The SME 21 plan is being implemented jointly by the government, chambers of commerce, industry associations, and the private sector. A multi-agency SME 21 Implementation Committee led by the Singapore Productivity and Standards Board (PSB) has been formed to oversee the implementation of the recommendations.

Local and Foreign Manpower

Lack of land and natural resources has forced Singapore to focus on human resources as the engine of economic growth. The pool of human talent remained limited up to the 1980s, though, not only because of Singapore's small population base but also as the legacy from neglect of education during the colonial era and the immediate post-independence years. According to the 1990 population census 61 percent of the non-student population had not completed secondary education and only 14 percent had upper secondary and tertiary education. Near 40 percent of the current workforce is still without secondary education. About 40 percent of these workers are still relatively young, aged 40 or under.

By 1998 the skill profile of the workforce had improved considerably, with 34 percent skilled, 28 percent semi-skilled, and 38 percent unskilled. But more top-end professional, managerial, technical and specialist personnel will be required in the future. Official projections show that over the next 10 to 15 years, 65 percent of jobs will require a post-secondary education (25 percent degrees, 20 percent diplomas, 20 percent post-secondary certifications), 20 percent will require at least a secondary education, and 15 percent of jobs will require only a primary education or below. The EDB is aiming to attract new investments that require at least a post-secondary education for two out of three jobs in manufacturing and three out of four jobs in the exportable services sector. The National Computer Board expects 90 percent of IT jobs in Singapore to require at least a good polytechnic/university qualification. Singapore faces a serious mismatch of skills and structural unemployment unless workers are re-trained and their skills upgraded. On the bright side, the proportion of the workforce comprised of skilled workers has been increasing. Among new workforce entrants, 80 percent have at least post-secondary and diploma qualifications.

For the KBE, the Singapore workforce must be able to meet the changing needs of industry and enterprises and have the know-how to create new products, markets, and wealth. There is need to nurture a workforce with the skills, quality, and mindset to support the demands of the New Economy. As Singapore makes the transition to the KBE, its manpower faces four challenges: to develop expertise, innovation, and entrepreneurial capabilities that will enhance competitiveness and enable Singapore to stay ahead in the rapidly changing economic environment; to support growth industries with the appropriate quality and quantity of manpower resources; to minimise structural unemployment; and to ensure that Singapore workers can be engaged in meaningful jobs in which they realise and develop their capabilities to the fullest and achieve a good quality of life.

The Competitiveness Report recommended a two-pronged manpower strategy consisting of upgrading the domestic workforce and augmenting the domestic labour pool with foreign talents. To upgrade the domestic workforce, Singapore needs to encourage life-long learning for lifetime employment and to continue harmonious industrial relations through closer co-operation among the government, employers, and trade unions. Funds for education and training have grown rapidly in the past two decades. In particular, government expenditures on education tripled and enrolment in polytechnics and universities more than doubled from 1987 to 1997. At the end of the 1990s, 60 percent of the relevant age cohort were receiving polytechnic and university education.

Singapore has been recruiting foreign manpower to augment its limited domestic workforce. Employment of foreign workers has increased rapidly. Foreign manpower accounted for over 20 percent of the workforce with 80,000 employment pass holders and more than 450,000 work-permit holders in 1998. The trend seems to be a growing dependence on low-skilled foreign labour. In making the transition to the KBE Singapore needs to ensure that foreign manpower contributes to upgrading the profile of Singapore's workforce. Dependence on unskilled foreign workers needs to be reduced and their distribution across economic sectors rationalised. Hence, the EDB is spearheading a systematic policy of recruiting foreign talent. Th emphasis has met resistance from some Singapore citizens who are concerned over the "crowding out" effect, particularly for better-paying jobs. The government has gone to great lengths to explain that the foreign talent pool will enable Singapore to remain competitive and that a larger economic pie means an absolute gain for all Singaporeans.

The Manpower 21 (M21) Report lays out the blueprint for Singapore's manpower development in the 21st century. It recommends six manpower strategies.

- To identify and enhance the short- and long-term fit between manpower demand and supply through integrated manpower planning. The Report recommends forming a National Manpower Council to oversee national manpower strategies and targets and an enhanced Manpower Information System to provide relevant and timely labour market information.
- To provide lifelong learning for lifelong employability through a comprehensive in-employment education and training framework. The framework includes a National Skills Recognition System to define and recognise skill competencies; an enhancement of the existing Skills Development Fund and tax incentives for employers and workers; and a network of One-stop Career Centres to provide training and career information and counselling. University education must equip students with problem-solving skills for the modern workplace, invest in high-tech, cutting-edge research, and develop programmes for continuing education and worker training. The onus is on universities to teach students to "learn to learn". They must also be analytical, creative, entrepreneurial, and possess good problem-solving and inter-personal skills. The issue of creativity and innovation in Singapore is being debated publicly, with critics arguing that a dominant government and Asian values are inhibiting factors. The education system and curriculum in both schools and universities are undergoing a major revamp to encourage greater creativity among students.
- To augment the domestic talent pool with immigration. The "Contact Singapore" scheme is being expanded to attract high-end international talent. In 1998 alone, EDB facilitated the entry of more than 3,500 professionals, technicians, and skilled personnel and 19 recruitment

missions abroad involving 38 organisations. Singapore is establishing an Internet site for recruiting international talent, developing programmes to enable talents to work in overseas operations of Singapore companies, and cultivating a wide network of "Friends of Singapore". At the same time, a foreign manpower management system has been established to review the allocation and deployment of low-skilled foreign workers among the economic sectors.

- To transform the work environment. The nature of work, the workplace, and workplace practices need realignment for the KBE. The M21 Report recommends flexible work arrangements and job re-design to keep pace with the nature of knowledge-based work and to increase participation rates of women and older people. It also advocates adopting best practices in human resource management and development and improving safety and health at the workplace.
- To develop a vibrant manpower industry comprising learning providers, manpower management services, and manpower recruitment and deployment services.
- To redefine partnerships to enlist all stakeholders at the national, industry, and community levels in realising the vision and recommendations.

Science, Technology, and Innovation

While Singapore has depended heavily on foreign MNCs introducing advanced and sophisticated technology and know-how through the FDI process, it has reached a developmental stage where it must also develop its own science, technology, and innovation capabilities. Serious efforts to develop such capability began in the 1990s. In 1991 a National Technology Plan was launched with strategies for developing technology infrastructure, encouraging private sector R&D activities, as well as formulating a human resource plan to complement the science, technology, and innovation needs. In 1996 the National Science and Technology Plan (NSTP) continued the core strategies of the earlier plan and sought to increase the development of research institutes and centres, gross expenditures on R&D (GERD), the number of research scientists and engineers (RSEs), and the number of patents introduced. The Innovation Programme was launched in 1995 to enhance innovation awareness, introduce new innovation systems and practices in companies, expand innovation infrastructure, and launch a national innovation framework for action.

Despite a decade of such efforts, Singapore's R&D thrusts remain modest in absolute terms, reflecting the economy's small size and strong services orientation. Total R&D expenditure reached ***S***$2.5 billion in 1998. GERD reached 1.8 percent of GDP. Private R&D spending accounted for 62 percent of national GERD, with spending concentrated in the electronics industry followed by engineering, chemicals, and IT and communications. Compared to the private sector's S$1.6 billion spending on R&D, public research institutes and centres spent ***S***$351 million, higher education institutions spent $306 million, and the government sector spent ***S***$300 million. In 1998, 0.66 percent of the labour force or 19,007 workers were engaged in R&D and R&D investment commitments stood at ***S***$890 million with the majority in microelectronics, advanced IC development, semiconductors, multimedia, consumer electronics, PC communications, Internet-based product development, biotechnology, and medical devices. R&D expenditures and manpower in Singapore are small in

absolute size and their shares of GDP and total employment are still behind those of South Korea and Taiwan and many advanced industrial countries. On the positive side, Singapore's high-tech domestic exports reached S$66.1 billion in 1999, accounting for 65 percent of non-oil domestic exports. Furthermore, over half of recent student admissions into polytechnics and universities are in science and engineering courses.

The Competitiveness Report made several recommendations on how to improve Singapore's science, technology, and innovation position.

- Focus R&D on areas where Singapore has already demonstrated reasonable capability and that have eventual economic relevance. Possible areas include software development, data storage, and biotechnology.
- Target R&D funding to ensure continual competitive capabilities to industry. Limit government role to providing co-financing and tax incentives and grants. Persuade foreign MNCs to locate some R&D activities in Singapore. Deepen the technological capabilities of local universities in upstream and strategic research.
- Make capabilities developed in universities and research institutes available to the private sector through industry assistance schemes to enable local enterprises upgrade their technological level. Encourage universities and research institutes to set up spin-off companies to commercialise new technologies and innovation, especially through joint ventures with the private sector. Use government grants and tax incentives to promote entrepreneurship and technology acquisitions from abroad.
- Continue to secure technology transfers through linkages with global technology centres. while pursuing indigenous technology development. Government to facilitate technology transfer by initiating contacts with overseas technology centres, acting as an information-gathering house, and setting up overseas business and technology incubator centres.
- Enhance R&D manpower through joint collaborations with overseas research programmes; programmes to strengthen the effectiveness of the existing technical workforce, including use of innovation; and a mechanism to attach potential techno-preneurs to business development units of MNCs abroad.
- Create an environment conducive to intelligent risk-taking and entrepreneurship, including acceptance of failure as a learning process, to nurture creativity and innovation.

The Technopreneurship 21 (T21) initiative was announced in April 1999 specifically to boost development of techno-preneurship in Singapore. It recommended strategies to promote start-ups and harness new products, services, and markets through entrepreneurship and applied research. A Technopreneurship 21 Ministerial Committee supported by a working group from the public and private sectors was established to oversee the effort. The T21 plan's four broad thrusts are developing: a pro-enterprise environment, a conducive physical infrastructure, a venture investment infrastructure, and education:

- Specific measures to create a environment favourable to enterprise include adopting a qualified employee stock option scheme to encourage equity ownership; revising bankruptcy laws to promote responsible risk-taking; allowing high-tech start-ups to tender for government projects; relaxing work pass and long-term social visit pass rules to facilitate foreigners starting technopreneurial businesses in Singapore; and allowing technopreneurs to use their residential premises as offices.
- To provide physical infrastructure conducive to entrepreneurial high-tech business a Science Hub will be developed in the Bouna Vista area. The integrated development will

encompass industrial, R&D, commercial, social, recreational, and residential uses.

- To build up Singapore's venture investment infrastructure a US$1 billion Technopreneurship Investment Fund (TIF) has been established. The TIF will co-invest with the private sector to provide seed money for technopreneurial start ups, to draw venture capital into Singapore, and to develop strategic linkages and networks with other top-tier venture capital companies worldwide. The TIF is co-managed by the NSTB and the Government of Singapore Investment Corporation Special Investments. To date, it has invested US$237 million in a total of 14 funds. NTSB also initiated two other venture co-investment programmes (the Business Angel Fund and the Venture Investment Support for Start Ups) to stimulate early-stage investments in promising start-up companies. Under the Technopreneur Investment Incentive scheme, companies and individuals are allowed tax deductions on losses from selling qualifying shares or liquidating investments in approved start-ups.
- Effective in 2003 the National University of Singapore and Nanyang Technological University will supplement the GCE A-Level examinations with a reasoning test, project work, and extra-curricular activities in determining admissions. This move will reinforce and complement the ongoing reorientation of the education system to ensure that the next generation of university graduates will be able to contribute effectively to the growth of the KBE.

The National Science and Technology Board (NSTB) is building a knowledge infrastructure to facilitate technology development. The 13 research institutes and centres supported by NSTB have achieved economic impact by developing technologies jointly with industry, by training R&D manpower, and by transferring know-how to industry. To date, these research institutes and centres have spun off a total of 35 high-tech start-ups.

Singapore is pushing for further development in information technology (IT) both to enable business and to position itself as an IT hub in the Asia-Pacific region. In 1992 the National Computer Board (NCB) released the IT2000 Report which envisioned Singapore as an Intelligent Island, with an advanced National Information Infrastructure (NII) connecting computers in virtually every home, office, school, public library, community club, factory, and workplace, and linking government, business, and people in cyberspace. The major thrusts of IT2000 were intensified development of ICT-related manpower, improved quality of life, improved personal and community communications, and competitive advantage using the NII.

The key vehicle for making Singapore an intelligent island is Singapore ONE, an island-wide broadband infrastructure of high capacity networks and switches for multimedia applications and services, which was launched commercially in June 1999. Users have access to entertainment, news, education, online shopping, and other e-commerce services, video-conferencing, and government transactions, as well as fast Internet. At end-1999, Singapore ONE offered a total of 180 applications, and had 100,000 users. As a city-state with world-class physical infrastructure and adequate financial resources, Singapore has little difficulty in developing nation-wide IT infrastructure. What is problematic is achieving the quantity and quality of IT manpower targets.

The Competitiveness Report recommended that as IT is a key technology and to become an IT

hub, Singapore should initially focus on the following areas:

- Communications and media: Singapore's educated, multilingual, multicultural background gives it a competitive edge as the content gateway to both the East and the West. To that end, Singapore should attract creative talents from around the world and improve enforcement of intellectual property rights protection. Singapore ONE can be used to jumpstart the local multimedia and broadband industries.
- IT innovation: Singapore should position itself as a test bed where new and innovative products and services are created, customised, and tested before export.
- E-commerce: E-commerce is expected to present tremendous business opportunities and impact on such sectors as logistics, transportation and financial services. The government is already setting up the infrastructure to establish Singapore as an e-commerce hub.

In December 1999, reflecting the global convergence of information technology and communications, the NCB and the Telecommunications Authority of Singapore (TAS) were merged to form the Infocomm Development Authority of Singapore (IDA). To position Singapore as an infocomm hub with a thriving knowledge-based digital economy, IDA formulated the Information and Communications Technology 21 Master Plan (ICT 21). The three strategic thrusts of ICT21 are: to develop ICT as a major growth sector; to leverage on ICT to boost the competitiveness of key economic sectors; and to prepare Singapore for the information society of the future.

In January 2000 the government unveiled a programme for liberalisation of the telecommunications sector to ensure that Singapore remains competitive. It accelerated by two years the timetable for full competition in the sector, to 1 April 2000, and immediately lifted the existing 49-percent direct and indirect foreign equity limits for public telecomms service licences. IDA is to adopt a liberal policy when assessing new entrants and in general it will not restrict the number of new licences issued except where there are spectrum limitations. The government followed the liberalisation by measures to support ICT development, including changes to the legal and policy environment, assistance to promising local enterprises and SMEs, development of a strong broadband network and introduction of an ICT manpower development programme.

Financial Sector Development

A key pillar of the knowledge-based economy is a robust financial sector to finance domestic development and provide competitive exportable financial services. Singapore has been pursuing a regional financial centre strategy since the early 1970s. With the rapid changes in the global financial industry, falling regulatory barriers, advances in IT, and mergers and acquisitions among financial institutions, global financial markets are becoming increasingly integrated. To thrive as a financial hub, Singapore needs to at least keep pace, if not be ahead of the curve, and quicken the pace of market development and innovation. The thrust of financial sector reforms in Singapore is not like the financial reforms in countries ravaged by the regional financial crisis. The lead agency, the Monetary Authority of Singapore (MAS) is taking steps to provide a more conducive regulatory environment and become more pro-active in promoting the financial sector.

Singapore's stringent system of prudential regulation and supervision helped the financial sector come through the 1997-98 regional financial crisis relatively unscathed. Nevertheless, markets were becoming concerned that over-regulation of the financial sector in Singapore, particularly compared to Hong Kong, had slowed Singapore's development as a financial centre. This led Singapore to recognise that it needed to liberalise further in order to retain its competitive position in this sector. MAS shifted from a "one-size-fits-all" regulation to a risk-focused supervisory approach, focusing on systemic risk rather than the risks of individual institutions or transactions. The new approach entails monitoring and examining institutions for compliance with guidelines and assessing the adequacy of internal controls and risk management systems. It gives stronger and better-managed players greater leeway. MAS is also promoting more disclosure and transparency in the financial market to enable investors to make informed decisions.

A five-year liberalisation programme for the domestic banking sector was launched in May 1999. The aims are to move towards a more open and competitive environment to spur the development of local banks to strengthen the banking system, to provide Singaporeans with quality banking services, and to enhance Singapore's position as an international financial centre. The government warned that local banks will become progressively marginalised if they do not undertake positive changes. The programme to liberalise the banking sector has four elements.

1. Implementing a 5-year liberalisation package: MAS will implement a 5-year programme to liberalise access by foreign banks to Singapore's domestic market. A new category of full banking licence known as Qualifying Full Banks (QFBs) has been introduced and MAS will issue up to 6 QFBs over the 1999-2001 period; incumbent foreign full banks not awarded QFBs will retain their existing privileges. MAS will also increase the number of restricted banks, and give offshore banks greater flexibility in Singapore Dollar wholesale business.
2. Improving corporate governance: Unlike the lack of protection for Singapore's manufacturing sector, the government has protected and nurtured the local banks and enabled them to grow to their present size and strength. However, to survive in the new liberalised environment, local banks have to increased emphasis on efficiency, quality of service and shareholder returns; most importantly, they must strengthen corporate governance, attract leadership talent endowed with the necessary autonomy to make professional management decisions. The local banks need to institute systems for ensuring appointment of capable individuals to their boards and key posts --- MAS requires all local banks to appoint Nominating Committees within their boards to ensure the appointment of the most competent individuals to their boards and key posts; the majority of board members must be Singapore citizens or permanent residents and comprises mainly independent directors.
3. Lifting the 40-percent foreign shareholding limit: MAS lifted the 40-percent limit on foreign investors' total shareholding in local banks. It viewed that the requirement for Nominating Committees and for board members to comprise a majority of Singapore citizens and permanent residents are adequate to ensure national control.
4. MAS will review all regulations concerning local banks so as to give them greater flexibility in their operations without compromising on prudential objectives.

Areas of major revision of bank supervision requirements included:

- Capital adequacy ratio (CAR) requirement: MAS had required local banks to maintain a CAR of 12 percent, comprised entirely of Tier-1 (equity) capital, compared to the 8-percent CAR required by the BIS, with 4 percent each of Tier-1 and Tier-2 capital. As a result Singapore banks are overcapitalised, which raises their cost of funds and lowers their return on equity. Effective December 1998, the requirement for local banks was reduced to a minimum of 10 percent Tier 1 capital, while the remaining 2 percent may be Upper Tier 2 capital (comprising perpetual cumulative preference shares and subordinated debt which satisfy strict qualifying conditions). The definition of Tier 1 capital is also widened to include equity-like capital instruments in line with BIS recommendations.
- Internal models for computing market risk capital: Effective December 1998, MAS allowed banks to use internal models to calculate market risk capital, giving them an incentive to improve their risk-management systems. In March 1999 MAS sent guidelines on the use of internal models and back-testing to the five local banks.
- Disclosure standards: MAS prescribed a minimum disclosure standard for banks and merchant banks, taking into account the recommendations of the Committee on Banking Disclosure.
- Prudential guidelines on asset securitisation: In line with its plan to develop the securitisation market, MAS prepared a set of prudential guidelines for asset securitisation activities by financial institutions.
- Minimum cash balances (MCB) of finance companies: To align with the July 1998 reduction in banks' minimum cash balance, the MCB requirement for finance companies was reduced from 6 percent to 3 percent in December 1998.
- Common risk framework: Innovations in technology and business products have obscured the distinctions among banking, securities, and insurance activities and international regulatory and supervisory practices are converging towards a consistent risk-focused approach at a consolidated enterprise-wide level. MAS is developing a common risk framework.

Apart from these measures to build a strong and competitive banking industry, measures have been taken to strengthen other parts of the financial industry in order to enhance Singapore's overall position as a financial centre. For example,

- Measures to develop the securities industry include enhancing the competitiveness of the Stock Exchange of Singapore (SES), de-mutualising and merging SES and the Singapore International Monetary Exchange (SIMEX), and making capital market funding more transparent, efficient, and flexible by establishing more flexible listing requirements for growth enterprises and more flexible rules on foreign listings in Singapore dollars, by reducing capital requirements for securities firms; freeing commission fees, and by allowing free access to stock exchange trading by January 2002.
- To develop the debt market, restrictions on borrowing in Singapore dollars are being relaxed to enable foreign players to issue Singapore-dollar denominated bonds. An approved Bond Intermediary scheme is established to encourage the origination, placement, and management of debt issues in Singapore. To create a more liquid market for government bonds, issuance of Singapore government securities has increased and the maturity profile extended to 10 years.
- Measures for the fund management industry include increasing access to the large pool of Central Provident Fund (CPF) funds and government funds farmed out by the MAS and the Government Investment Corporation. Tax incentives and more flexible licensing requirements are intended to attract more foreign fund managers to Singapore.
- Measures for the futures industry include revising the requirements for futures brokers

and abolishing the minimum commission structure.

- Measures for the insurance industry include reducing capital requirements for captive insurers; granting blanket approval for captives to write certain non-inhouse risks; enhancing the regulatory framework for investment-linked policies under the CPF investment scheme; and reviewing insurance and financial reinsurance regulations.

CONCLUSION

Domestic constraints on growth and a rapidly changing external environment have forced Singapore, a small and highly open city-state, to restructure its economy more frequently than larger and less open economies.

Since the early 1960s the government has been an active leader in initiating and directing change. To that extent, economic restructuring in Singapore has not been market-driven but government-directed, although the restructuring was in response to changing domestic and external circumstances. This reflects not only the strength of the government sector but also the weakness of the domestic private enterprise sector. The weak domestic sector is attributed in part to the dominance of foreign multinational corporations and government-linked companies in the economy and to the slow process of transforming the traditional domestic entrepreneurial class steeped in trade and real estate into industrial entrepreneurs and technopreneurs.

The situation is changing. In the 1990s a second generation of domestic entrepreneurs emerged, who are better educated and more tech-savvy than their predecessors, reflecting the fruits of the educational investments of the past three decades and the managerial and technical expertise acquired by a generation of Singaporeans working for foreign MNCs. The dominant role of the government in directing restructuring reflects the high quality of Singapore's political leadership and its bureaucracy. Facilitated by its long stay in power, the political leadership was forward-looking and strategic in planning. Nevertheless, restructuring was not entirely a top-down matter. The numerous official restructuring committees and programmes have always had broad-based input from the private sector, professionals, and academia to create synergies among planners and implementers and constituents.

Having escaped being ravaged by the regional financial crisis and the ensuing burden of rebuilding, Singapore is fortunate in having the leadership and financial resources to chart a course towards a knowledge-based and digital economy to take advantage of the opportunities offered by accelerating globalisation and technological revolution. Domestic resource constraints, however, necessitate that Singapore continues to leverage on external resources and external markets to achieve its economic vision.

References

Chia Siow Yue. 1998. "Singapore: Advanced Production Base and Smart Hub of the Electronics Industry." In *Multinationals and East Asian Integration* eds Wendy Dobson and Chia Siow Yue. Canada and Singapore: IDRC and ISEAS.

Committee on Singapore's Competitiveness. 1998. *Report*. Singapore: Ministry of Trade and Industry. November.

Department of Statistics. *Yearbook of Statistics Singapore.* Singapore: Department of Statistics. Various years.

Economic Committee. 1986. *The Singapore Economy: New Directions.* Singapore: Ministry of Trade and Industry, February.

Economic Development Board. *Yearbook*. Singapore: Economic Development Board. Various years.

Economic Planning Committee. 1991. *The Strategic Economic Plan: Towards a Developed Nation.* Singapore: Ministry of Trade and Industry.

International Institute of Management Development. 2000. *The World Competitiveness Yearbook 2000*. Lausanne: International Institute of Management Development.

Ministry of Labour. 1999. *Manpower 21: Vision of Talent Capital*. Singapore: Ministry of Labour.

Ministry of Trade and Industry. 2000. *Economic Survey of Singapore 1999*. Singapore: Ministry of Trade and Industry.

Organisation for Economic Cooperation and Development (OECD). 1996. *The Knowledge-Based Economy*. Paris: OECD.

Productivity and Standards Board. 2000. *SME 21: Positioning SMEs for the 21st Century.* Singapore: Productivity and Standards Board.

World Economic Forum. 1999. *The World Competitiveness Report 1999*. Geneva: World Economic Forum.

TABLE 6.1
Composition of GDP by Sector, 1970-99

(Percent)

	1970	1980	1990	1995	1997	1999
Goods producing sectors	31.8	39.2	34.7	34.1	34.9	35.9
Manufacturing	19.9	29.1	27.1	24.7	23.0	25.9
Construction	6.7	6.4	5.4	7.5	9.5	8.0
Utilities	2.6	2.2	1.9	1.7	2.1	1.9
Other	2.6	1.6	0.4	0.2	0.2	0.2
Services producing sectors	64.3	62.3	66.3	69.0	67.5	67.3
Wholesale and retail trade	23.6	17.6	15.0	16.7	15.2	15.0
Hotels and restaurants	3.5	4.1	3.9	3.1	2.9	2.7
Transport and communications	10.5	14.0	13.2	12.0	11.3	11.4
Financial services	4.7	8.4	10.9	13.0	12.9	14.2
Business services	8.9	8.9	12.2	13.4	14.2	12.8
Other	13.1	9.4	11.1	10.7	11.0	11.1
Owner-occupied dwellings	2.8	2.4	4.2	3.5	3.3	3.6
Add: taxes and duties on imports	3.0	1.7	0.9	0.6	0.5	0.6
Less: imputed bank service charges	1.9	5.6	6.1	7.1	6.2	7.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Economic Survey of Singapore*, 1999.

TABLE 6.2
Composition of Employment by Industry, 1980-99

(Percent)

	1980	1985	1990	1995	1997	1999
Manufacturing	30.1	25.4	29.1	24.2	22.6	21.0
Construction	6.6	8.9	7.9	6.7	6.9	6.9
Commerce	21.3	23.5	22.0	20.4	21.8	21.2
Transport, storage and communications	11.2	10.1	9.5	10.7	11.5	10.8
Finance, insurance, real estate, and business services	7.8	8.7	10.9	14.6	14.9	16.0
Community, social, and personal services	0.0	0.0	0.0	22.1	21.3	23.1
Other services	23.1	23.1	20.6	1.2	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Singapore Yearbook of Statistics*, various years.

TABLE 6.3
Composition of Employment by Occupation, 1980-99

(Percent)

	1980	1985	1990	1995	1997	1999
Legislative, administrative, managerial	6.3	7.6	8.6	12.8	12.6	12.4
Professional	0.0	4.5	4.2	7.3	9.0	9.9
Technical and associate professional	11.7	9.9	11.5	15.8	17.5	18.0
Clerical	13.8	14.4	13.1	12.9	15.2	14.0
Service, shop, and market sales	14.6	15.4	13.8	12.3	12.5	13.1
Agricultural and fishery	1.6	1.1	0.3	0.1	0.1	0.1
Production,, operators, cleaners, labourers	46.3	42.3	44.5	34.6	29.8	29.1
Other	5.8	4.7	4.0	4.2	3.3	3.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Singapore Yearbook of Statistics*, various years.

TABLE 6.4
WEF's National Competitiveness Balance Sheet for Singapore, 1999

(Ranking out of 59 countries surveyed)

Assets	Rank	Liabilities	Rank
Overall	1		
Openness	2		
Average tariff rate	2	Foreign access to capital markets	31
Export position	2		
Government	1		
Tax evasion	1	Government influence	39
Government economic policies	1		
Government subsidies	1		
Composition of government spending	1		
Public sector competence	1		
Administrative regulations	1		
Inflation	1		
Value added tariff rate	2		
Government savings	2		
Tax system	2		
Government bureaucracy	3		
General government surplus	4		
Pension indicator	4		
Payroll tax rates	5		
Finance	2		
Gross domestic savings	1	Share of domestic credit to private sector	31
Financial sector risk rating	3	Access to credit	32
Gross domestic investment	4	Bond markets	34
Banking sector assets	4	Domestic banks	39
		Change in gross domestic investment	43
		Entry into banking industry	52
Infrastructure	7		
Overall infrastructure	1	Private investment in ifrstructure	38
Infrastructure investment	1		
Roads, air transport, ports	1		
Telephones and fax machines	4		
Cellular telephones	4		
Technology	2		
Math and science education	1	Internet for customer service	31
Technology licensing	1	Internet and supplier relations	45
Technology transfer	2		
Labour	1		
Unemployment insurance	1	Primary education enrolment	30
Labour-employer relations	1	Secondary education enrolment	40
Strikes	2		
Labour regulations	2		
Hiring and firing practices	2		
Labour tax wedge	2		
Work days lost to labour disputes	2		
Social welfare system	2		
Minimum wage regulations	3		
Unemployment rate	3		
Institutions	2		
Trust in politicians' honesty	1	Compensation for interference	30
Organised crime	1	Litigation against government	47
Additional payments	2	Litigation costs	48
Effectiveness of police force	2		
Forced contributions	3		
Irregular payments	3		
Institutional stability	3		
Government favourites	4		
Compliance	4		

Source: World Economic Forum (WEF), *Global Competitiveness Report, 1999*.

TABLE 6.5
IMD's National Competitiveness Balance Sheet for Singapore, 2000

(Ranking out of 47 countries surveyed)

Strengths	Rank	Weaknesses	Rank
Overall	**2**		
Domestic economy	8		
Gross domestic savings	1	Government final consumption	42
Companies and government	1	Gross domestic investment real growth	42
Restructuring of the economy	1	Cost of living comparisons	31
Real growth in private consumption	7	Gross domestic savings real growth	31
Customer sophistication	15	Total gross domestic investment	30
Internationalisation	**2**		
Current account balance %	1	Growth in exports of commercial services	46
Exports of goods %	1	Growth in direct investment stocks abroad	38
Trade to GDP ratio	1	Growth in direct investment stocks inward	35
Tourism receipts	1	Portfolio investments liabilities	26
Exports of commercial services	2	Direct investment flows abroad	19
Government	**1**		
Government economic policies	1	Employee's social security contribution rate	45
General government expenditure	1	Central government domestic debt %	41
Unemployment legislation	1	Effective personal income tax rate	31
Bureaucracy	1	Employer's social security contribution rate	30
Collected indirect tax revenue	3	Collected capital and property taxes	27
Finance	**10**		
Central bank policy	1	Foreign financial institutions	29
Insider trading	3	Access to local capital markets	29
Legal regulation of financial institutions	3	Interest rate spread	24
Venture capital	7	Access to foreign capital markets	13
Country credit rating	16	Value traded on stock markets	9
Infrastructure	**13**		
Environmental laws	1	Computers in use	39
Urbanisation	1	Computer power	35
Infrastructure maintenance and development	1	GDP and energy consumption	33
Sustainable development	1	Electricity costs for industrial clients	29
Labour regulations	2	Investments in telecommunications	28
Management	**15**		
Industrial relations	11	Productivity in services	27
Process management	11	Labour productivity	22
Corporate credibility	21	Competence level	21
Employee training	2	Entrepreneurship	19
Overall productivity growth	7	Creation of firms	15
Science and technology	**9**		
Science and education	1	Securing patents abroad	35
Development and application of technology	1	Patents granted to residents	34
Science and technology and youth	2	Total R&D personnel nation-wide per capita	16
Company-university co-operation	3	Total expenditure on R&D per capita	16
Financial resources	3	Business expenditure on R&D per capita	14
People	**5**		
Values of society	1	Total and current public education expenditure	42
Educational system	1	Employment	42
Alcohol and drug abuse	1	Pupil-teacher ration (secondary education)	41
Economic literacy	1	Pupil teacher ratio (primary education)	39
University education	1	Illiteracy	37

Source: International Institute of Management Development (IMD), *World Competitiveness Yearbook 2000*.