CHAPTER 5

Innovation Policy in Malaysia

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5.1 | Introduction

Malaysia, with a population of 30.3 million, gross domestic product (GDP) of US$292.2 billion and GDP per capita of US$26,314 (in purchasing power parity terms) in 2016, is considered an upper middle-income country. The country has recorded impressive economic growth rates since the 1980s (Table 5.1), and, aided by foreign direct investment (FDI), has successfully transformed itself from being an exporter of primary products into a major supplier of manufactured products.

Table 5.1: Contribution to Gross Domestic Product by Sector, 1980–2016 (%)

Period	Agriculture	Mining	Manufacturing	Construction	Services	GDP Growth
1980–1984	22.31	9.96	19.98	5.17	42.58	7.32
1985–1989	19.66	11.35	20.88	3.75	44.35	5.35
1990–1994	13.94	8.31	25.44	3.75	48.56	9.32
1995–1999	9.28	7.54	27.78	4.18	51.23	6.03
2000–2004	8.15	6.72	28.90	3.02	53.21	5.68
2005–2009	8.13	11.98	26.90	2.93	50.05	4.49
2010–2016	7.94	8.56	24.10	4.22	55.18	5.39

GDP = gross domestic product.
Source: Ministry of Finance.

The share of manufacturing in GDP increased from 19.9% in the early 1980s to a high of 28.9% during 2000–2004. With the rise of services, the share of manufacturing has since fallen. Despite the early emergence of manufacturing, the emphasis on innovation has been relatively recent. The first important incentive for firm-level research and development (R&D) came only in 1986 in the form of a tax deduction for qualifying research expenditure (Narayanan and Lai, 2000).

Innovation is critical for initiating and sustaining progress (Phelps, 2006). Developed economies have nurtured innovation, although similar efforts have been less evident among developing countries. Innovation has traditionally been viewed as heralding something new (OECD, 1996) that requires substantial investment in talent and funds. Furthermore, neoclassical theories of growth have conceptualised new technologies as diffusing from developed to developing countries, and the latter accepted this recipient role. All this changed when innovation was broadened to embrace incremental initiatives that improved productivity and generated products, processes, or ideas that were not necessarily new to the world but brought new solutions to existing problems (Chapter 2). In addition, the success of East Asian economies, such as Japan, the Republic of Korea (henceforth Korea), Singapore, and Taiwan, in enhancing their technological capabilities has inspired other developing economies.

Innovation in the Malaysian economy gained new momentum with the launch of the New Economic Model (NEM) in 2010. The NEM maintained that Malaysia's strategy of relying on cheap immigrant labour to keep exports competitive was no longer tenable. Instead, a robust manufacturing sector, grounded on independent innovative capabilities, was needed to drive the economy up the value chain in a sustained fashion (NEM, 2010).

5.2 | Current State of Innovation

With no specific policies to foster innovation, what little research there was in the early periods was done by multinational corporation (MNC) affiliates (UNDP and World Bank, 1995). The scale and extent was determined by their self-interest. The current state of innovation is pieced together from some micro- and macro-level indicators.

5.2.1 Micro indicators

The micro indicators are based on firm-level data, drawn from various national surveys undertaken by different agencies.

Extent of innovation

Data from the Second Malaysia Productivity and Investment Climate (PICS-2) Survey carried out by the World Bank in 2006,[1] for example, indicated that 64% of the firms in manufacturing were engaged in some form of innovation. This was a higher figure than that reported by the national innovation surveys carried out by the Malaysian Science and Technology Information Centre (MASTIC). Differences in definitions, sample size, and other details preclude a strict comparison, but it is safe to conclude that firm-level innovation has grown (Table 5.2).

Table 5.2: Extent of Innovation

		Non-innovating Firms		Innovating Firms	
Period	Sample Size	Number	Percentage	Number	Percentage
1990–1994 (NSI-1)	412[a]	144	35	268	65
1997–1999 (NSI-2)	1,044	825	79	219	21
2000–2001 (NSI-3)	749	487	65	263	35
2002–2004 (NSI-4)	485[a]	223	46	262	54
2005–2008 (NSI-5)	1,212[a]	588	49	624	51
2009–2011 (NSI-6)	1,682[a]	504	30	1,178	70
2006 (PICS-2)	**1,115**	**400**	**36**	**715**	**64**

NSI = National Innovation Survey, PICS = Productivity and Investment Climate Survey.

[a] Includes firms in the manufacturing and services sectors.

Sources: Malaysian Science and Technology Information Centre, various years; PICS-2 survey, 2007.

Types of innovation

Manufacturing companies conduct product, process, marketing, and organisational innovation. Product and process innovations are more important and relate directly to the diffusion of research knowledge in production. Product innovation includes new products in the market and products that are new to the firm. In 2012, under product innovation, 64% of manufacturing firms introduced new products, while 44% introduced products that were new to the firm (MOSTI, 2014a). Process innovation includes 'new' or 'significantly improved' supporting activities, improved logistics and distribution, and improved manufacturing methods. In 2012, 53% of firms were

1 The PICS-2 survey is a nationwide collaborative survey undertaken by the World Bank and the Malaysian Department of Statistics in 2007.

engaged in supporting activities, 36% in improved logistics and distribution, and 66% in improved manufacturing methods. During 2009–2011, more 'new' products than 'significantly improved' products were introduced (Table 5.3). About 80% were developed internally by firms (closed innovation system), and more 'new' products were produced (82%) based on a closed innovation system compared to 'significantly improved' products (78%).

Table 5.3: Development of 'New' Products and 'Significantly Improved' Products in Manufacturing, 2009–2011

	Manufacturing					
Innovation	NP	%	SIP	%	Total	%
Closed	7,632	82	4,331	78	11,963	80
Joint	1,584	17	1,113	20	2,697	18
Open	114	1	120	2	234	2
Total	**9,330**	**100**	**5,564**	**100**	**14,894**	**100**

NP = new product, SIP = significantly improved product.

Note: Closed innovations are innovations developed internally by the company itself or the company's group; joint innovations are innovations developed jointly by the company together with other companies and institutions; and open innovations are innovations developed mainly by other companies or institutions (externally).

Source: Ministry of Science, Technology and Innovation (2014a).

Data from the PICS-2 survey categorise innovation differently; firms are divided into three groups based on the innovation activity they were primarily engaged in (Table 5.4).

Table 5.4: Types of Innovation in Manufacturing, 2005–2006

Type of Innovation	Description	Number	%
Adoption	Upgraded machinery and equipment and/or introduced new technology over the last two years	100	14
Adaptation	Entered new markets due to improvements in quality or cost of products or processes and/or upgraded product line over the last two years	450	63
Creation	Firm filed patents, utility models, or copyright protected materials over the last two years	165	23
Total		**715**	**100**

Source: Adapted from Hosseini (2015, p. 92).

Of 715 firms that reported innovation over the two-year period (2005–2006), only 23% filed for patents or other protected materials. Most (63%) did adaptive work (improving products or processes), while the rest (14%) engaged in adoption (upgrading or renewing technologies). These findings are broadly consistent with the Ministry of Science, Technology and Innovation (MOSTI) data in Table 5.3.

Access to technology

Data from the PICS-2 survey indicate that 58% of innovating firms accessed technology through collaboration,[2] and nearly 53% gained technology from parent establishments. Only 24% secured technology as suppliers to MNCs (Table 5.5). About 17% had received research or technological support from publicly created institutions, such as SIRIM,[3] the Malaysian Agriculture Research and Development Institute,[4] and the Rubber Research Institute of Malaysia. Formal in-house R&D was less common (17%), and just 9% had outsourced innovative activities or engaged in 'open innovation'. This sidesteps the need for in-house innovation and leverages outside expertise (Chesbrough, 2003).

Table 5.5: Modes of Access to Technology

Mode	Innovating Firms (%)
Sought collaboration in R&D from different sources	58.04
Staff exclusively for design/R&D	16.78
Technology transferred from parent establishment	52.45
Subcontracted out R&D	8.81
Received research and/or technology support from institutions	16.50
Supplier to a multinational company	23.64
N = 1,115	

R&D = research and development.
Note: A firm can rely on several modes of access.
Source: Hosseini (2015, p. 81).

2 They collaborated with other firms, universities, multilateral agencies, or research institutions. Links with universities remain weak.
3 SIRIM is a solution-provider in quality and technology.
4 The Malaysian Agriculture Research and Development Institute conducts research in agriculture, food, and agro-based activities.

Factors motivating firm-level innovation

Hosseini (2015) estimated a simple Probit model using the firm-level data in the PICS-2 survey to determine the factors that predict firm-level innovation. The independent variables and their marginal effects are shown in Table 5.6. Royalty payments and chief executive officers with tertiary education qualifications were strong and significant predictors of innovation in large firms and small and medium-sized enterprises (SMEs), with the effects being stronger for SMEs than large firms.

Table 5.6: Marginal Effects of the Predictors of Innovation

	SMEs	Large Firms
Predictors	dy/dx	dy/dx
Market concentration (four-firm concentration ratio)	–19.58**	–1.15
Age of establishment	–0.19	0.52**
Equity ownership (% foreign)	0.03	0.01
University degree or higher degree completed by CEO or owner	14.28***	12.33***
CEO or owner makes all its investment decisions independently	–7.49	–1.71
Share of professionals and managerial workers (%)	–0.23	0.20
Share of sales exported directly (%)	0.17***	0.05
Made royalty payments	22.78***	15.62**
Share of foreign permanent workers (%)	0.10	–0.07
Penang	8.50**	5.47

CEO = chief executive officer; dy/dx = marginal effects; four-firm concentration ratio = sales of the four largest firms in a subsector divided by total sales in the subsector; large firms = >150 workers; SME = small and medium-sized enterprise, 50–150 workers.

Note: Coefficients are expressed in percentages; ** significant at 5%; *** significant at 1%.

Source: Hosseini (2015).

Exposure to the export market and a competitive environment were strong drivers of innovation among SMEs but not large firms. A 1% increase in the concentration ratio lowered the probability of innovation among SMEs by 19.6%. Thus, SME innovation was lowest in highly concentrated subsectors, such as textiles, machinery and equipment, electronics, and electrical machinery and apparatus, and highest in the food processing, rubber, and plastics subsectors.[5] While age predicted innovation only

[5] Based on the four-firm concentration ratios, the most concentrated subsectors were textiles (0.797), machinery and equipment (0.670), electronics (0.619), and electrical machinery and apparatus (0.617). The least concentrated were food processing (0.375) and rubber and plastics (0.211).

among large firms, cluster-specific advantages of being in Penang, the 'Silicon Valley' of Malaysia, predicted innovation among SMEs only. Penang-based SMEs had an 8.5% higher probability of innovation relative to SMEs located elsewhere. Finally, firm ownership, firm size, the share of foreign unskilled workers, and the share of professional and managerial workers did not predict innovation. Independent and sole owners appeared more risk averse and shied away from innovation, as evident from the negative coefficients, although they were not significant.

Linkages and technological spillovers

Spillover effects can occur either through horizontal linkages between firms in the same sector or industry or through vertical forward and backward linkages between firms in related sectors. Malaysian studies provide mixed evidence on this issue (Khalifah and Radziah, 2009; Choo, 2012; Kam, 2016).[6]

We compared the findings of two later studies. Choo (2012) used data from the PICS-2 survey and the Malaysian input–output tables for 2000 over a three-year period (2004–2006) and covering 938 firms. Kam (2016) relied on unpublished annual data for a longer period (2000–2008), drawn from the Annual Survey of Manufacturing Industries of the Department of Statistics, Malaysia. Firms with more than 50% of their equity owned by foreigners were classified as foreign firms by Kam and a similar cut-off was used to define domestic firms. Both studies found significant horizontal spillovers, but Choo noted that only non-export-oriented foreign affiliates and those with partial foreign ownership generated them. Kam, on the other hand, found that skill-oriented foreign affiliates, affiliates with high domestic sales, and affiliates with high imported input content generated horizontal spillovers, with skill-oriented foreign affiliates having the largest impact on the productivity growth of local firms.

Choo (2012) reported that domestic firms that gained the most from horizontal spillovers were either firms with high absorptive capacity or low export intensity, or small firms.[7] Kam (2016) found that only domestic firms with lower skill requirements

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6 Studies based on macro data cannot identify the channels of the spillovers. Spillovers are assumed to exist when there are significant associations between the presence of FDI affiliates and the productivity of domestic firms in a sector or across vertically related sectors. The studies also often give contradictory results based on the type of data used, the measures used to proxy foreign presence and the way spillovers are estimated. While panel data is superior to cross-section data, there are no preferred ways to proxy the other two variables (Görg and Strobl, 2001).

7 Firms with a high absorptive capacity were defined as those with a ratio of skilled to unskilled workers of 0.3 or above. Firms with a low export intensity were those that exported less than 30% of their sales. Small firms were defined as firms employing fewer than 50 workers. These are all arbitrary thresholds leaving open the possibility that the outcomes may change if the thresholds are changed.

benefitted. Skill-intensive domestic firms, on the other hand, showed productivity improvements, even without establishing links with foreign affiliates. Similarly, domestic firms with high imported input content experienced increased productivity even without such links, suggesting greater gains were secured from the global production network than from linkages in the domestic economy. However, firms linked with foreign affiliates registered greater productivity gains.

Vertical spillovers might be expected to occur primarily through backward linkages forged through purchases of intermediate inputs from domestic firms by MNC affiliates. Yet, Choo (2012) found no significant evidence of vertical backward spillovers in most cases. Where they occurred, they came from non-export-oriented firms and firms that were not fully foreign-owned. In contrast, Kam (2016) found evidence of significant vertical backward spillovers generated by export-oriented foreign affiliates, skill-intensive affiliates, and foreign affiliates with high domestic sales who utilise local inputs to lower costs. Affiliates with a high import content naturally showed no significant backward linkages. Although skill-oriented foreign establishments generated significant horizontal and backward spillovers to domestic firms, the foreign establishments had larger effects.

Both studies found no evidence of vertical forward spillovers, regardless of the characteristics of the foreign affiliate, possibly because the specialised inputs from foreign firms could not be used by domestic firms. Furthermore, there are restrictions on sales from foreign affiliates located in free trade zones to local firms.

5.2.2 Macro indicators

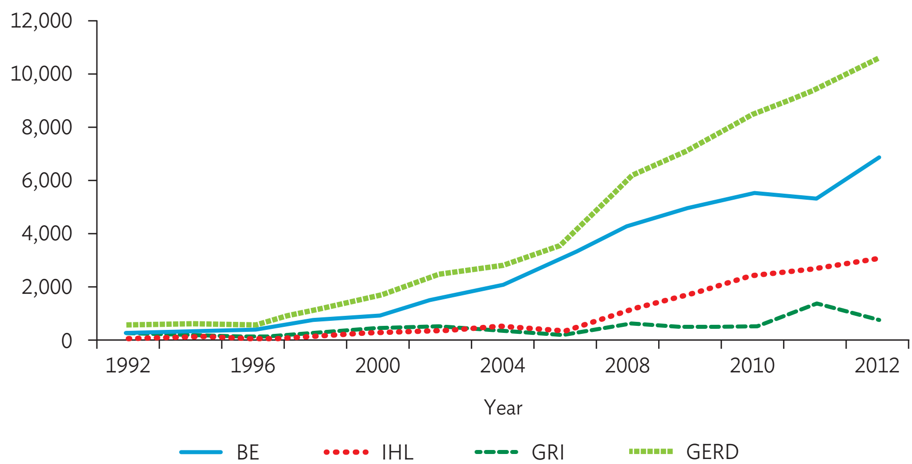
While there is micro-level evidence of growing innovation, macro indicators are used to evaluate the key inputs and outputs of innovation and to allow comparisons between countries.

Research and development expenditure by sector

A key input is expenditure on R&D. During 1992–2012, Malaysia's gross expenditure on R&D increased from RM550.6 million to RM10.6 billion, achieving an annual compound growth rate of nearly 15.9%.

In 1992, government research institutes were the main drivers of R&D activity, contributing RM2.5 billion or 46% of total R&D expenditure. However, by 1994, business sector spending overtook that of public research institutions. By 2008, R&D expenditure by institutions of higher learning surpassed that of government research institutes but remained behind the business sector. The bulk of business expenditures on research in Malaysia were undertaken by government-linked companies, such as Proton, Petronas, and Khazanah, rather than MNCs or domestic companies (Figure 5.1). By 2012, business sector expenditure stood at RM6.8 billion and accounted for 64.5% of total R&D expenditure; expenditure by institutions of higher learning stood at RM3.0 billion or 28.7% of the total; and government agencies and public research institutes spent RM7.3 million or 6.9%.

Figure 5.1: Research and Development Expenditure in Malaysia by Sector, 1992–2012 (RM million)



BE = business expenditure, GERD = gross expenditure on research and development (the sum of GRI, IHL, and BE), GRI = public research institutes, IHL = institutions of higher learning.

Sources: Compiled from Malaysian Science and Technology Information Centre, *National Survey of Research and Development*, various years.

Research and development expenditure as a proportion of gross domestic product

To allow meaningful comparisons across countries, research spending is expressed as a proportion of GDP. Despite allocating more funds to R&D, Malaysia's expenditure as a percentage of GDP (1.26% in 2014) remains low compared to Korea (4.29%), Japan (3.58%), Singapore (2.19%), and China (2.05%) (Figure 5.2).[8] It is particularly notable that it lagged China, a relative latecomer to export manufacturing.

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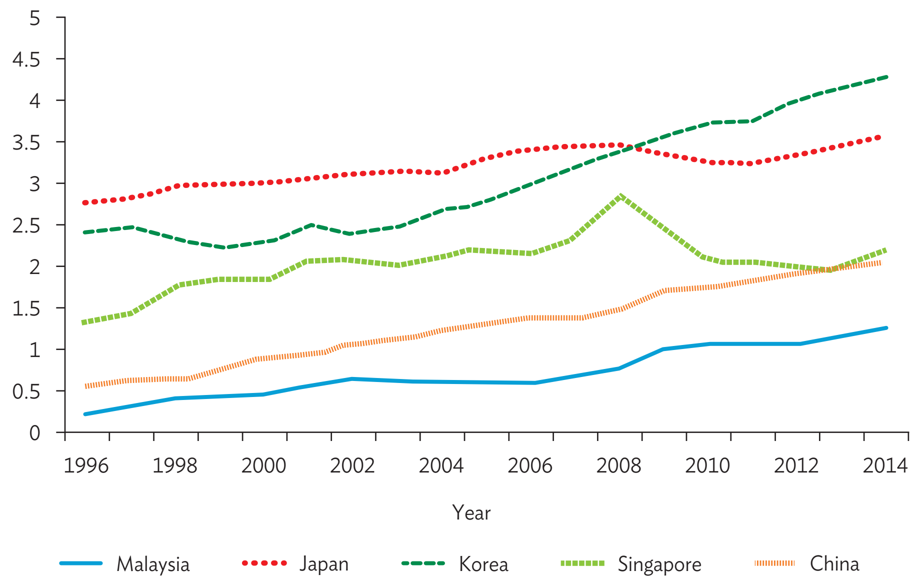
8 World Bank. Databank. Research and development expenditure (% of GDP). http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?page=1

Figure 5.2: Research and Development Expenditure as a Proportion of Gross Domestic Product (%)



Source: Graphed using World Bank World Development Indicators. http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?page=1

Research and development personnel per million population

Malaysia was also behind with respect to R&D personnel per million population in 2014 (Figure 5.3). Its figure of 2,051 compared unfavourably with those of Korea (6,899), Singapore (6,658), and Japan (5,386) but was ahead of China (1,113).[9] However, given its small base, Malaysia experienced a high compound annual growth rate (23.9%) in R&D personnel per million population during 2006–2014. This compares favourably with the figure for Korea (6.5%), Singapore (2.6%), China (2.2%), and Japan (which recorded no growth).

In 1994, Malaysian public research institutes employed 60.1% of all R&D personnel (Table 5.7). The proportion has since dropped to 8.0% in 2012. Correspondingly, the proportion of R&D personnel employed in institutions of higher learning increased from 12.3% in 1994 to 80.7% in 2012. Although the business sector still leads in R&D expenditure, its share of R&D personnel has declined from 27.6% in 1994 to 11.3% in 2012, reflecting the applied nature of the research.

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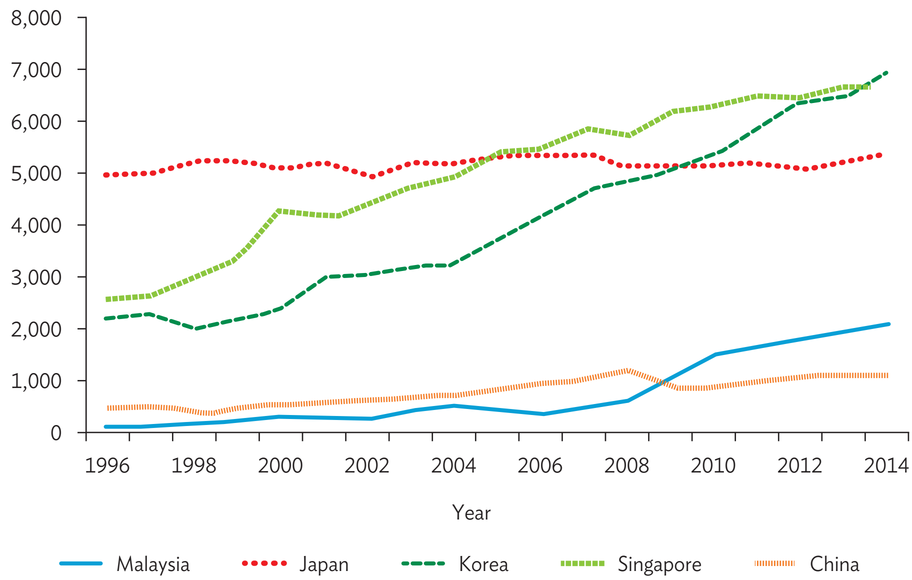
[9] World Bank. Databank. http://data.worldbank.org/country

Figure 5.3: Research and Development Personnel per Million Population



Source: Graphed using World Bank World Development Indicators. http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?page=1

Table 5.7: Number of Research and Development Personnel by Sector

	GRI		IHL		BE		Total
Year	No.	%	No.	%	No.	%	No.
1994	6,891	60.07	1,417	12.35	3,164	27.58	**11,472**
1996	4,231	45.82	1,757	19.03	3,245	35.15	**9,233**
1998	5,234	43.16	2,735	22.55	4,158	34.29	**12,127**
2000	7,777	33.43	11,239	48.31	4,246	18.25	**23,262**
2002	7,222	28.96	12,538	50.28	5,177	20.76	**24,937**
2004	7,437	24.00	14,809	47.80	8,737	28.20	**30,983**
2006	4,556	18.53	13,007	52.90	7,025	28.57	**24,588**
2008	5,899	14.44	28,775	70.46	6,166	15.10	**40,840**
2009	6,361	9.03	57,437	81.53	6,655	9.45	**70,453**
2010	6,877	7.79	71,579	81.05	9,858	11.16	**88,314**
2011	7,402	7.63	78,683	81.15	10,876	11.22	**96,961**
2012	8,343	8.02	83,919	80.70	11,724	11.27	**103,986**

BE = business expenditure, GRI = public research institutes, IHL = institutions of higher learning.

Sources: Compiled from Malaysian Science and Technology Information Centre, *National Survey of Research and Development*, various years.

Patents granted

Innovation often translates into patents. Patent applications by Malaysians handled by the Malaysian Patent Office during 2000–2010 show a rising trend, with 206 applications in 2000, 531 in 2006, and 1,275 in 2010. However, they accounted for a small share of all applications at 3.3%, 11.1%, and 19.7%, respectively (Zeufack and Lim, 2013). Data from the US Patent and Trademark Office show that during 2002–2015, Malaysia acquired 2,156 patents. In comparison, Japan collected 575,208, Korea 131,129, China 37,442, and Singapore 8,041 (Table 5.8).

Table 5.8: Patents Granted by the United States Patent and Trademark Office

Year	Malaysia	Japan	Korea	Singapore	China
Pre-2002	251	485,962	21,706	1,261	1,091
2002	55	34,858	3,786	410	288
2003	50	35,515	3,944	427	297
2004	80	35,346	4,428	449	403
2005	88	30,340	4,351	346	402
2006	113	36,807	5,908	412	659
2007	158	33,354	6,295	393	770
2008	152	33,682	7,548	399	1,223
2009	158	35,501	8,762	436	1,654
2010	202	44,813	11,671	603	2,655
2011	161	46,139	12,262	647	3,174
2012	210	50,677	13,233	810	4,637
2013	214	51,919	14,548	797	5,928
2014	259	53,848	16,469	946	7,236
2015	256	52,409	17,924	966	8,116
Total (2002–2015)	**2,156**	**575,208**	**131,129**	**8,041**	**37,442**

Source: United States Patent and Trademark Office (2015).

5.2.3 Global rankings

The overall impacts of the macro indicators are broadly reflected in global innovation indices, two of which are the Global Innovation Index (GII) and the Global Competitiveness Index (GCI).

Global Innovation Index

The GII is a broad measure indicating the extent to which countries integrate innovation into their political, business, and social spheres. Malaysia is the only country in Table 5.9 to record a continuous decline in its ranking during 2011–2016. Furthermore, all the other countries improved during 2014–2016, but Malaysia was ranked 35th of the 128 countries listed in 2016. While other countries' scores rose (China, Japan, and Korea) or remained almost static (Singapore), Malaysia's score fell from 45.6 in 2014 to 43.4 in 2016.

Table 5.9: Global Innovation Index

	Score (0–100)			Rank			
Country	2011	2014	2016	2009	2011	2014	2016
Malaysia	44.1	45.6	43.4	25	31	33	35
Japan	50.3	52.4	54.5	9	20	21	16
Korea	53.7	55.3	57.1	6	16	16	11
Singapore	59.6	59.2	59.2	5	3	7	6
China	46.4	46.6	50.6	37	29	29	25

Note: Scores for 2009 are based on a 1–7 scale in which Malaysia scored 4.06, Japan 4.65, Korea 4.73, Singapore 4.81, and China 3.59.

Sources: INSEAD and Confederation of Indian Industry (2009); INSEAD (2011); Cornell University, INSEAD, and World Intellectual Property Organization (2014, 2016).

Malaysia's rank among upper middle-income countries dropped from first in 2014, to second place in 2016, behind China. In the Southeast Asia and Oceanic group, Malaysia was again just below China in seventh place in 2016.

Malaysia's ranking on innovation inputs, which records the impact of increasing inputs, such as R&D spending and researchers, fell to 32nd place in 2016 from 30th in 2014 (Table 5.10). The country's ranking on innovation output fell to 39th position (from 35th in 2014), suggesting some inefficiency in translating inputs to outputs (including patents, publications, and citations). The innovation efficiency ranking (the ratio of output sub-index to input sub-index) for Malaysia improved from 72nd place in 2014 to 59th in 2016. Malaysia was ahead of Japan and Singapore but behind China and Korea. But this must be viewed in context; Malaysia's scores in both sub-indices were smaller than those of the countries listed in the table.

Table 5.10: Innovation Efficiency Ratio, Innovation Input and Output Sub-indices

	Malaysia		Japan		Korea		Singapore		China	
IER	2014	2016	2014	2016	2014	2016	2014	2016	2014	2016
Score	0.74	0.67	0.68	0.65	0.78	0.80	0.64	0.62	1.03	0.90
Rank	72	59	88	65	54	24	121	78	2	7
Input										
Score (0–100)	52.5	52.1	62.2	66	62.2	63.5	72.3	72.9	45.8	53.1
Rank	30	32	15	9	16	13	1	1	45	29
Output										
Score (0–100)	38.7	34.7	42.6	43	48.4	50.8	46.6	45.4	47.3	48
Rank	35	39	27	24	15	11	18	20	16	15

IER = innovation efficiency ratio.
Sources: Cornell University, INSEAD, and World Intellectual Property Organization (2014, 2016).

Global Competitiveness Index
The GCI, published by the World Economic Forum, is another globally recognised ranking of country competitiveness. It is used as a tool for benchmarking country strengths and weaknesses (World Economic Forum, 2008). The index is calculated based on 114 indicators grouped into 12 pillars.[10] Malaysia's ranking has changed little since the index was first computed in 2008, when it was ranked 21st (Table 5.11).

Table 5.11: Global Competitiveness Index, 2011–2016

	Score (1–7)			Rank		
Country	2011	2014	2016	2011	2014	2016
Malaysia	5.1	5.2	5.2	21	20	25
Japan	5.4	5.5	5.5	9	6	8
Korea	5.0	5.0	5.0	24	26	26
Singapore	5.6	5.6	5.7	2	2	2
China	4.9	4.9	5.0	26	28	28

Sources: World Economic Forum, *Global Competitiveness Index Report*, various years.

10 The CGI was first computed using this improved methodology in 2008 (World Economic Forum, 2008).

It stayed around that position until 2016, when it dropped to 25th (of 142 economies in 2011, 144 in 2014, and 138 in 2016). The scores indicate that the competitiveness of the country was growing slowly compared with competing economies. During 2011–2016, it lagged Japan and Singapore, and its advantage over China and Korea narrowed. Singapore has remained a very competitive economy, maintaining its second-place position since 2011, after improving from fifth place in 2008.

Two of the GCI pillars relate directly to innovation: technological readiness (pillar 9) and innovation (pillar 12). The technological readiness pillar has seven components, three of which relate to technology (availability of latest technologies, firm-level technology absorption, and FDI and technology transfer). Since 2014, Malaysia's ranking for FDI and technology transfer has been ranked in the top 10 of the 140 surveyed countries, but the rank for firm-level technology absorption was relatively low, despite improvements since 2011.

The rankings for the innovation-related pillar are of particular interest (Table 5.12). They are close to the overall GCI, hovering around the 21st to 24th positions. Of the seven components of this pillar, four selected ones are shown. The availability of scientists and engineers has improved significantly in recent years.

Table 5.12: Global Competitiveness Index Pillar Scores and Rankings of Malaysia, 2011–2016

	Score			Rank		
Pillars/Selected Components	2011	2014	2016	2011	2014	2016
Technological readiness	4.3	4.2	4.8	44	60	43
Availability of latest technologies	5.8	5.7	5.6	35	33	34
Firm-level technology absorption	5.6	5.6	5.5	28	24	19
FDI and technology transfer	5.3	5.5	5.4	12	8	8
Innovation	4.3	4.7	4.7	24	21	22
Capacity for innovation	4.3	5.2	5.4	19	13	13
Quality of scientific research institutions	4.9	5.2	5.3	24	20	23
Availability of scientists and engineers	4.9	5.2	5.3	22	9	7
Patent Cooperation Treaty patent applications per million population	7.2	12.6	11.3	32	32	36

FDI = foreign direct investment.

Note: The scores are measured on a scale of 1–7, except for Patent Cooperation Treaty patent applications.

Sources: World Economic Forum, *Global Competitiveness Index Report*, various years.

5.3 Innovation Policies

In 1991, Malaysia announced its Vision 2020, with the ambitious goal of becoming a developed nation by 2020. The sixth of the nine strategic challenges to be met was that of establishing a scientific and progressive society that is innovative and forward-looking. Policies and actions since the late 1980s have contributed to increasing the pace of innovation in the country.

Malaysia's commitment to harnessing, utilising, and advancing science and technology is reflected in the following science, technology, and innovation (STI) policies: the First National Science and Technology Policy (NSTP1), 1986–1989; the Industrial Technology Development: A National Action Plan, 1990–2001; the Second National Science and Technology Policy and Plan of Action (NSTP2), 2002–2010; and the National Policy on Science, Technology and Innovation, 2013–2020. The various initiatives implemented under these policies include enhancing the national capabilities and capacities of R&D, forging partnerships between publicly funded research organisations and industries, enhancing commercialisation through the National Innovation Model (MOSTI, 2007), and developing new knowledge-based industries. In addition, the government adopted the NEM in 2009, with its various thrusts being implemented through the Economic Transformation Programme, incorporating, among others, 12 National Key Economic Areas and 6 Strategic Reform Initiatives.

5.3.1 First National Science and Technology Policy, 1986–1989

The main objective of the NSTP1 was to promote scientific and technological self-reliance. It included plans to upgrade local R&D capabilities and improve scientific and educational infrastructure. Emphasis was placed on the improvement of human physical and spiritual well-being, the balanced development of natural resources and ecology, and environmental preservation (Government of Malaysia, 1986).

5.3.2 Industrial Technology Development National Action Plan, 1990–2001

The main thrusts of the Industrial Technology Development National Action Plan were to strengthen institutions and support infrastructure for technological innovation, increase the application and diffusion of technology, and promote public awareness on the importance of science and technology.

5.3.3 Second National Science and Technology Policy, 2002–2010

The NSTP2 specified in detail the goal and objectives of the policy, set the policy directions for science and technology, and developed strategic thrusts and initiatives to address seven key priority areas. Its broad goal was to accelerate the development of science and technology capability and the national capacity for competitiveness. The two objectives to be met by 2010 were to increase R&D expenditure to at least 1.5% of GDP and to have at least 60 R&D personnel per 10,000 people in the labour force. Neither objective was met; in 2010, R&D expenditure was 1.07% of GDP, while the number of R&D personnel per 10,000 people in the labour force was 14.7. Fifty-five initiatives were listed to support the following priority areas: research and technological capacity, research commercialisation, human resource capacity, promotion of a culture for innovation, institutional framework, technology diffusion, and building competence for specialisation.

5.3.4 National Policy on Science, Technology and Innovation, 2013–2020

The National Policy on Science, Technology and Innovation stands on five foundations. The most important is to ensure all stakeholders, including ministries, agencies, universities, and private industry, accept and implement the policy. The second is to provide support by building STI capacity and capabilities in terms of institutions, mandates, management, personnel, and funding, and through transmitting and diffusing STI knowledge. The third seeks to strengthen private sector STI capabilities through various incentives and measures and to increase private–public research collaborations. The fourth is to adopt principles of good public sector governance to ensure a sound institutional and regulatory framework for the STI system. The fifth is to instil the belief that STI is essential for a stable, peaceful, prosperous, cohesive, and resilient society. The five foundations support six strategic thrusts: advancing scientific and social research, development, and commercialisation; developing, harnessing, and intensifying talent; energising industries; transforming STI governance; promoting and sensitising STI; and enhancing strategic international alliances.

The policy measures under these thrusts include increasing R&D expenditure to at least 2% of GDP, and the ratio of researchers per 10,000 workforce to at least 70 by 2020; facilitating knowledge transfer from research by public sector stakeholders to industry; providing greater autonomy to public institutions of higher learning and research institutes to spur industry collaboration and entrepreneurship; raising the level of awareness on ethics and humanities in society; and establishing clear guidelines and standards to enhance the commercialisation of products from homegrown innovation.

5.3.5 Science, technology, and innovation sector policies

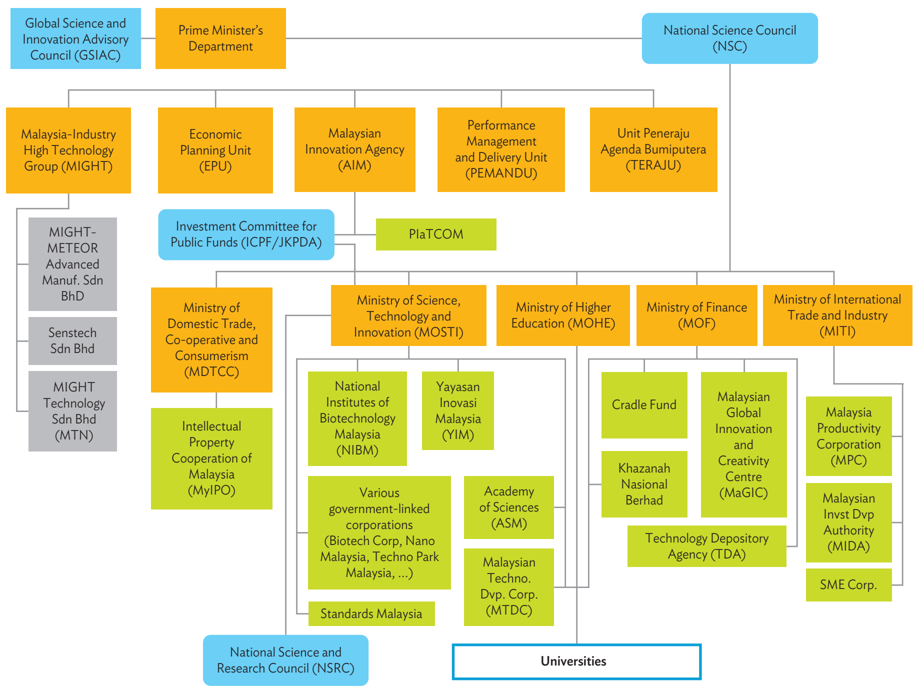
Several STI sectoral policies have been implemented since 2005. These include the National Biotechnology Policy (2005–2020), the Intellectual Property Commercialisation Policy for Research and Development Projects Funded by the Government of Malaysia (2009), and the Malaysia National Green Technology Policy (2009).

The National Biotechnology Policy is the most important. Its objective is to make the biotechnology sector into a key driver of economic growth, contributing 5% of GDP by 2020. Initiatives have been undertaken to focus on agriculture, healthcare, industrial biotechnology development, R&D and technology acquisition, human capital and financial infrastructure development, sound legislative and regulatory framework, the strategic positioning of Malaysia as a centre of excellence for biotechnology, and the establishment of an effective government agency for implementation. The policy is to be implemented in three phases: a capacity-building phase (2005–2010) concentrating on the establishment of advisory and implementation councils, the development of knowledge workers, and business development; a science-to-business phase (2011–2015) focusing on the development of local expertise and new products; and a global presence phase (2016–2020) that aims to take Malaysian companies to the global stage.

5.3.6 Malaysia's national innovation system

The concept of a national innovation system (NIS) rests on the premise that understanding the linkages among actors involved in innovation is the key to improving technology performance (OECD, 1997). Innovation and the technical progress of a country depend on the relationships among the actors or agents involved in producing, distributing, and applying various kinds of knowledge. The actors are people, private enterprises, universities, and research institutes. The flow of technology and information among them takes numerous forms, such as joint research, personnel exchanges, cross-patenting, and the purchase of equipment.

Figure 5.4: Key Public Actors in the National Innovation System, 2015



Source: Organisation for Economic Co-operation and Development (2016, p. 159).

Malaysia's NIS has evolved gradually. The main actors are the government sector (including the ministries and public research institutes), the business sector (including private enterprises and government-linked companies), and institutions of higher learning (both public and private) (Figure 5.4).

The main government ministries involved in innovation are MOSTI and the Ministry of Higher Education (MOHE). MOSTI spearheads the development of STI in the country. It oversees more than 20 departments, agencies, and companies clustered into five focus areas: biotechnology, information and communication technology (ICT) policy, industry, sea to space, and science and technology core (Day and Amran, 2011). MOSTI provides most research grants through specialised schemes and established MASTIC to compile the national STI statistics and indicators. MOHE, on the other hand, seeks to establish Malaysia as a hub of excellence for higher education. It aims to develop at least 20 centres of excellence that are internationally recognised for research output, copyright, publications, and research collaborations.

Other publicly created institutions include the Malaysian Institute of Microelectronic Systems (MIMOS), which was set up in 1985 to sponsor basic and applied research in microelectronics. In 1993, the Human Resource Development Council was established to address the lack of skilled human resources. The Malaysia Technology Development Corporation was formed in 1992 to promote and commercialise local research and to introduce new technologies from abroad. In 1993, the Malaysian Industry–Government Group for High Technology was formed to coordinate industry–government partnerships in high technology. The Small and Medium Industries Development Corporation (renamed the SME Corp) was also established in 1996 to oversee the needs of SMEs and to include them in the initiatives.

In 1997, the Multimedia Development Corporation, a government-owned company, was formed to create an attractive environment for Malaysian and global firms in the ICT industry. It also oversees MSC Malaysia (formerly the Multimedia Super Corridor), which offers facilities and tax breaks to firms located in the multimedia corridor near the Kuala Lumpur International Airport.

Public research institutes also contribute to innovation and technology diffusion, especially in agriculture, health, forestry, and electronics. In 2011, there were 29 public research institutes, including statutory bodies, Cess-funded organisations, and a MOSTI-owned company; the rest were attached to ministries. The Malaysian Agricultural Research and Development Institute, the Malaysian Palm Oil Board, the Malaysian Rubber Board, the Malaysian Cocoa Board, and the Forest Research Institute Malaysia are key public research institutes in the primary commodities sector.

Public higher education institutions play a vital role in the Malaysia's innovation system. In 2012, they provided 80% of the country's research personnel and accounted for 29% of its total R&D expenditure (OECD, 2016). Private universities, hampered by the lack of funding and specialised staff, have not yet contributed significantly to the NIS.

In the business sector, there are several MNCs conducting high-end R&D. They are mainly in the electronics industry and include Intel, Motorola, Hewlett Packard, and Altera, which have all moved from labour-intensive assembly to R&D activities, including design and product development. In addition, numerous projects aimed at fostering high-tech clusters have been established. Among the government-linked companies, Petronas is by far the largest and best known. Besides engaging in intense R&D activities in the oil and gas industry, it also plays a strong role in supporting domestic R&D.

Besides the high-profile MSC Malaysia, which is the national ICT initiative designed to attract world-class technology companies, several science parks have been set up across the country. These include the Kulim High-Tech Park in 1993, targeting high-tech production, and Technology Park Malaysia in 1996, which is targeted more towards R&D-based businesses. The third-largest park is the ICT-focused cluster of Cyberjaya – located within MSC Malaysia – which has attracted MNCs such as Dell, Hewlett Packard, Motorola, and Ericsson.

5.3.7 Public funding for innovation

Government initiatives in support of R&D and innovation seek to address the public-good nature of innovation. Left to the market, investments in innovation would be below the socially optimum level because private gains from innovation fail to capture its spillover benefits to society. Several studies have shown the significant difference between private and social returns to R&D (Griffith, 2000; Dias and Dias, 2006). Dias and Dias (2006), for example, computed the social rate of return to R&D investment in Malaysia (54%), Thailand (57%), Singapore (58%), and Indonesia (64%). The high social rate of return in relation to the private return justifies the implementation of policies that reduce the gap between the actual and socially optimal levels of investments in innovation. Financial incentives, subsidies, and grants are commonly provided to encourage R&D in the business sector.

In Malaysia, several types of fund are available for the creation, research, development, and commercialisation stages of R&D (MOSTI, 2014b). Most of them are managed by MOSTI, although grants are also provided by other ministries. MOHE, for instance, provides different types of grants for research activities in universities. Under the Ministry of International Trade and Industry, the SME Corporation administers subsidy schemes for SMEs, while the Malaysian Investment Development Authority manages R&D investment incentives. Other ministries with financing schemes for R&D include the Ministry of Energy, Green Technology and Water, the Ministry of Agriculture and Agro-based Industry, and the Ministry of Finance. Many public agencies also provide funds for R&D and commercialisation, such as the Multimedia Development Corporation, the Malaysia Technology Development Corporation, and the Malaysian Biotechnology Corporation.

In addition to public funding, various assistance and training schemes are implemented by government agencies to facilitate innovation. The Malaysia Commercialisation Assistance Programme under MOSTI, for example, assists biotechnology companies in commercialising technologies, products, and services (Day and Amran, 2011). The SME Corporation, together with the Malaysia Innovation Agency, provides technical assistance, market intelligence, incubation and testing facilities, and other services (SME Corporation, 2015). The Human Resources Development Fund (HRDF), established in 1993, aims to catalyse the development of a competent local workforce. Manufacturing firms with 50 or more workers, or 10–50 workers but RM2.5 million or more in paid-up capital, have a human resources development levy imposed of 1% of the monthly wages of each employee, which can then be claimed back through any of 11 different approved training programmes for skills upgrading. The HRDF helped almost 18,000 companies during 1993–2016 (HRDF, 2016).

5.3.8 Case examples

Besides providing funds, the public sector has initiated several schemes to encourage innovation. This section reviews a few examples of direct public sector initiatives.

The BioValley project

The BioValley project was initiated under the National Biotechnology Policy to spearhead the biotechnology industry. It was launched in 2003 at a cost of US$160 million and aimed to attract large biotech companies to a centralised hub by offering cheap rent, good telecommunications infrastructure, and access to the country's rich biodiversity. It was envisioned as a potential source of innovation for new drugs and other products (Cyranosk, 2005).

Initially, three research institutes on genomics and molecular biology, pharmaceutical and neutraceutical biotechnology, and agro-biotechnology were planned. Although the project was to be completed by 2009 with hundreds of labs researching into different areas of biotechnology, it never really got off the ground. It was eventually replaced by the far less ambitious BioNexus scheme, which evolved around existing labs specialising in agricultural biotechnology, genomics, and molecular biology. BioNexus remains a part of the National Biotechnology Policy and is managed by the Malaysian Biotechnology Corporation. Qualified biotechnology companies are given fiscal incentives, grants, and access to capacity-building programmes and research facilities. The scheme has seen some progress, with the number of companies growing from 7 in 2006 to 210 in 2011. However, more than 90% of these companies are small companies that have little impact in the industry (MOSTI, 2014b).

The failure of the BioValley project was not entirely unexpected given the weak foundations in biotechnology research and the lack of skilled manpower. In contrast, the Biopolis biomedical research hub in Singapore, established at about the same time, has grown into an excellent biomedical park, hosting renowned companies such as Merck, Novartis, Procter & Gamble, Pfizer, and GlaxoSmithKline (A-STAR, 2013).

Science and technology parks

It is argued that locating firms in a science park will foster innovation by encouraging networking and collaboration among themselves and with external entities, such as universities and other research agencies (Malairaja and Zawdie, 2008).

The most prominent science and technology park in Malaysia is MSC Malaysia, set up in 1996. It offers tax breaks, financial assistance, business networking, and easy access to government projects for both foreign and local firms located in the multimedia corridor near Kuala Lumpur International Airport. One of the main objectives is to use the park to incubate local SMEs in an information technology industry that is currently dominated by MNCs (Suhaimi and Yusof, 2006). Other science parks have also been established across the country, including two high-tech parks. The Kulim High-Tech Park, established in 1993, houses firms engaged in clean, high-value-added activities; while the Senai High-Tech Park, established in 2011, attracts firms active in green technology and offers them incubator and laboratory facilities. Other science parks include Technology Park Malaysia (TPM), established in 1996, which encourages R&D in knowledge-based industries and R&D clusters of industries located within MSC Malaysia that focus on ICT.

Despite strong government support in terms of funding for infrastructure and the provision of tax incentives and grants, the science and technology parks have so far played only a minor role in knowledge transfer and establishing links with universities and other research agencies. A study of TPM showed that there is no significant difference in university links with firms in the science park and those located outside the park. Moreover, the limited links forged among firms in the park, universities, and other R&D agencies have not been effective in helping the science park firms upgrade their technological capabilities (Malairaja and Zawdie, 2008). The study also reported that most firms did not view university links as an important factor in their decision to locate in TPM. Another study on knowledge transfer in TPM and the Kulim High-Tech Park, found only a moderate level of knowledge transfer from foreign firms to local firms; and such transfers produced very few outputs, such as patents (Awang et al., 2013).

University–industry collaboration in research and development

All government policies on innovation have stressed the need for university–industry collaboration, and there have been many initiatives to foster greater links between the two. For universities, links with industry are important as the latter are a source of funding, knowledge, and information on the latest technology developments. For industry, links with universities are important as they can tap scientists and researchers to expand their innovation initiatives. However, establishing collaboration and links between the two parties has remained a major challenge, although some progress has been made. Table 5.13 shows the scores and rankings for university–industry R&D collaboration for Malaysia given in the GII and GCI.

Table 5.13: University–Industry Research and Development Collaboration, 2011–2016

	Score			Rank		
Index, Pillar	2011	2014	2016	2011	2014	2016
GII, Business sophistication (score 0–100)	61.7	67.0	72.1	21	15	12
GCI, Innovation (score 1–7)	4.9	5.3	5.2	21	12	11

GCI = Global Competitiveness Index, GII = Global Innovation Index.

Sources: INSEAD (2011); Cornell University, INSEAD, and World Intellectual Property Organization (2014, 2016); World Economic Forum, *The Global Competitiveness Report*, various years.

The university–industry R&D collaboration rankings of both indices are remarkably similar and show that the rankings have moved up a few rungs, from 21 in 2011 to 11 (in the GCI) and 12 (in the GII) in 2016. The improvement, however, does not mean that collaborative research between universities and industries is widespread. During 2006–2011, on average, 90% of university collaborative research funding went to collaborative work with government research institutions and agencies (Chandran, Sundram, and Santhidran, 2014); collaboration with industry accounted for just 3.7%–8.7% of total university collaborative funding (Table 5.14). Despite the slight improvement in collaborative funding, it remains low compared to other developing countries, such as China, where nearly 35% of innovative firms reported having R&D collaboration with universities (Fu and Li, 2011).

The low level of collaborative efforts between universities and industry can be attributed to the research gaps between both parties (Chandran, Sundram, and Santhidran, 2014). Universities are mainly involved in basic and fundamental research, which are relevant to only a few industries such as the pharmaceuticals, biotechnology, and chemicals industries. Most industries are focused on incremental product and process innovation, which requires close links between firms and buyers and suppliers of technology, but not universities.

Table 5.14: Collaborative Research and Development Funding, 2006–2011 (%)

Year	Government	Industry	International
2006	93.5	5.0	1.4
2007	95.3	3.7	1.0
2008	90.1	6.9	3.1
2009	84.8	8.7	6.5
2010	88.4	7.7	3.9
2011	90.0	7.2	2.8

Source: Chandran, Sundram, and Santhidran (2014).

Industrial clusters

In theory, clusters facilitate the exchange of knowledge on markets and new innovations because competitors, suppliers, supporting industries, and public R&D agencies are located in the same region or district. This approach was emphasised in the Tenth (2011–2015) and Eleventh (2016–2020) Malaysia Plans, as well as the Second (1996–2005) and Third (2006–2020) Industrial Master Plans. Several industrial clusters have developed, such as the electrical and electronics (E&E) clusters in Penang and Negeri Sembilan; the information technology, creative content, and technologies clusters in MSC Malaysia; the palm oil industrial clusters in Sabah; and the automotive clusters in Perak and Selangor.

Only the E&E cluster in Penang has achieved some measure of success. Excellent infrastructure, a skilled workforce, and good supporting industries have helped build the core competencies of several SMEs. A few of them have become global suppliers to MNCs (UNDP, 1994; Ariff, 2008; Athukorala, 2014). It has also been found that being in Penang was positively and significantly associated with innovation among SMEs (Hosseini, 2015). But this has not been the case with other clusters. Many MNCs concentrate on manufacturing and assembly by utilising technology from their parent companies with little R&D of their own. Thus, there is little technology transfer or spillover benefits to local SMEs in the cluster. SMEs, on the other hand, lack the core technological competence to benefit from links, even when such opportunities arise. Furthermore, they lack skilled personnel and links with universities that could help them tap the expertise in these institutions. Few of them invest in R&D, despite the availability of incentives (UNDP, 1994; Narayanan and Lai, 2000). Another constraint that impedes R&D among them is their dependence on foreign firms (Abad et al., 2015).

Similar to the manufacturing sector, the ICT cluster in MSC Malaysia is dominated by MNCs. One of the main objectives of MSC Malaysia is to help local SMEs gain the benefits of knowledge spillovers from MNCs. With the adaptation of this knowledge through innovation, it is hoped that the SMEs can eventually produce indigenous ICT products and services. However, it is evident that there is little knowledge transfer between ICT MNCs and local SMEs (Sarif and Ismail, 2006). As usual, the problem lies in the low absorptive capability of the SMEs and their reluctance to engage in learning-by-doing.

Direct government participation

To upgrade technological capability, the government participates directly in high-tech industries in the E&E sector by providing training and support services as well as by directly manufacturing high-tech E&E products. The Malaysian Institute of Microelectronic Systems (MIMOS) was set up in 1985 to pursue research, development, and commercialisation activities in microelectronics. MIMOS currently has two subsidiaries: MIMOS Semiconductor, which provides integrated and advanced shared facilities for the E&E sector; and MIMOS Technology Solutions, which generates new technology ventures through innovation, investment, and the transfer of technology. MIMOS Wafer Fab, under MIMOS Semiconductor, provides a wide range of services, such as wafer fabrication, partial processing, failure analysis, wafer testing, and semiconductor wafer fabrication training. It has two R&D facilities, the first of which commenced operations in 1997. MIMOS Technology Solutions is involved in investing MIMOS' technologies into ventures, incubating technology companies, and developing and deploying MIMOS' products and solutions. It also transfers MIMOS' technologies to Malaysian companies for commercialisation.

Khazanah Nasional, the Government of Malaysia's investment arm, was set up in 1994 to manage the government's commercial assets and invest in strategic and high-tech sectors. Its subsidiary, Silterra Malaysia, established in 1995, began wafer fabrication in 2000. Silterra offers circuit design, layout, and simulation, and a broad range of fabrication processes for integrated chips. Although in terms of revenue the company was one of the top 20 foundries in the world, it has been making losses consistently (Lee, 2014). To increase its competitiveness, Silterra entered into a partnership with MIMOS to produce power management integrated circuit wafers for its global market in 2012.

5.4 | Future Innovation Policies

Future innovation policy initiatives should address the weaknesses in existing structures and policies rather than introduce new ones. The following areas need attention.

5.4.1 Consolidating agencies and institutions in the national innovation system

Too many public agencies, ministries, and institutions are involved in the NIS (Figure 5.4). They implement a large variety of schemes, grants, and initiatives, the interconnectedness of which is not always clear. A recent survey by the Organisation for Economic Co-operation and Development (OECD, 2016) cites sources to suggest that no less than 44 agencies and 10 ministries are engaged in supporting STI. If a narrower perspective is adopted, this number is reduced to 14 agencies and 8 ministries. Regardless of the preferred perspective, there are redundancies and overlapping functions, resulting in a lack of direction in priority setting and the disbursal of research funds. Having too many actors, guided by the interests of their individual ministries, results in the fragmented implementation of policy measures, poor results, and a lack of direction in the national research agenda.

The governance structures of STI policies need to be rationalised to better integrate the agencies and ministries implementing the various schemes and incentives for innovation. Continuous monitoring and evaluation of implementation should be emphasised. It is not uncommon to observe frequent policy changes or new policy initiatives that have no regard for the outcomes of existing policies. The lack of a formal mechanism to systematically monitor and evaluate the outcomes of policies and agents tasked with implementing them is widely acknowledged. Efforts are underway to attempt to address these weaknesses.

5.4.2 Making research and development incentives work

Incentives and grants for R&D are certainly not lacking, but the level of awareness among industries regarding these incentives is either low, or, where awareness exists, the onerous bureaucratic requirements act as major disincentives to apply for them. In 2012, about one-third of manufacturing (and service) companies claimed that they were unaware of such government support, while another 13% found the process of getting assistance too complicated and time-consuming (MOSTI, 2014a).[11] As early as 1994, E&E firms in Penang cited the same issues with regard to the government assistance schemes on technology transfer (UNDP, 1994; Narayanan and Lai, 2000).

The dissemination efforts for subsidy schemes from various ministries and agencies need to be coordinated through a central agency in MOSTI, such as MASTIC. Online applications could ease access to available schemes. The complaint of bureaucratic application procedures could be resolved by simplifying procedures in consultation with industries.

5.4.3 Strengthening links

The issue of inadequate university links and ineffective knowledge transfer despite strong government support should be addressed urgently. To strengthen the links, universities must be permitted to operate in a more liberal environment with minimal government intervention. With liberal regulations, universities should prioritise research with commercialisation value. Universities should also be proactive in disseminating information through regular workshops, seminars, and the like to science park firms on the types of market-driven research and facilities available that can assist in their innovation efforts.

Universities must play an active role in identifying and encouraging opportunities for knowledge spillover, as this is extremely important as part of the network of institutions that build bridges between universities and industries located in both science parks and non-science parks. Public research agencies, including universities, should be allowed to operate freely without external interference; they should focus on research with commercialisation potential and must be provided with a platform to disseminate information quickly and efficiently.

11 The vision of transforming the economy to one driven by innovation is a key element in the National Innovation Model (MOSTI, 2007). Yet, more than 60% of manufacturing and services companies surveyed in 2012 had neither heard of, nor understood, this model (MOSTI, 2014a).

To attract major investments from innovative MNCs is not an easy task, given the intense competition from other science and technology parks in the region. Nevertheless, the country must pursue an aggressive strategy to target foreign R&D investments that complement the country's research priorities, and focus on increasing the innovation capacity of local firms, particularly SMEs.

5.4.4 Improving the contribution of patents and intellectual property

The number of patent applications remains at a low level, despite some improvement in recent years (Table 5.4). A contributory factor is the lack of patent comprehension by public agencies. These agencies approve the government-subsidised projects of local manufacturers without requiring intellectual property (IP) creation (MOSTI, 2014c), even though IP creation is a government requirement for approval (MOSTI, 2009). Local firms, thus, do not see the urgency of applying for IP rights unless they are needed to obtain government research funds in the first place. A second factor is the inordinately long time taken to approve applications. Sometimes, inventions become dated by the time approval is granted.[12]

Besides the policy on IP commercialisation, there are many others, including the National Intellectual Property Policy (2007), the Patent Act (1983), and the Trade Marks Act (1976), that seek to protect innovation outcomes. However, strengthening the legal and operational aspects of the national IP system and efficient administration by the Intellectual Property Corporation of Malaysia have not resulted in widespread use of the system or stimulation of the innovation agenda (OECD, 2015).

To improve the contribution of the IP system, including patents, it is necessary to build a governance structure that ensures the coordination of programmes to support IP so that there is no duplication among the initiatives of the various stakeholders and that applications are quickly processed. In recent years, research in public agencies has improved significantly, particularly in universities, where they are evaluated based on performance in research output (publications and patents). The incentive programmes have been effective in creating a pool of researchers engaged in securing patents and other IP. Incentives have also helped create a network of industry partners that did

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12 Patent applications take, on average, about three years to process and approve. There have been cases of patents being granted after seven years, sometimes rendering the patent useless as new ideas have replaced the patented idea.

not exist previously. The incentive programmes should be further refined to focus on the quality rather than the quantity of IPs and patents. This will ensure a higher rate of successful commercialisation.

Collaborative research is the best avenue for SMEs to increase their absorptive capacities and innovation output (Table 5.4). Yet, only 16.5% of firms received technological support from outside institutions in 2005–2006 (Hosseini, 2015). The policy delivery system should be fine-tuned so that they engage SMEs and foster their links with universities and outside institutions. Policies would include providing advice on seeking IP protection for inventions, sourcing IP developed from elsewhere, and commercialising IP. As many SMEs do not have the capacity to create patents, other IP titles, such as trademarks, rights to designs, and utility models, may be more relevant. Policies should thus be broadened beyond the pursuit of patents to improve the innovation performance of SMEs.

5.4.5 Establishing a competitive business environment

Besides increasing resource allocation efficiency and decreasing the distortion in market prices, market competition stimulates invention and innovation as competitors strive to produce new and better products. This was corroborated in the Malaysian context by the PIC-2 study data, which showed that firms in competitive sectors were more likely to engage in innovation (Table 5.5). Creating a flexible, transparent, and secure business environment is also a means of attracting MNCs to relocate their R&D. The implementation of the Competition Act in 2012 was a step in the right direction.

5.4.6 Building the talent pool

A key factor accounting for the limited benefits reaped by SMEs from the advantages of clustering or collaborative research is their inability to absorb new technology. This is directly linked to the lack of skilled talent. Although this aspect has not been discussed in this chapter, the shortage of talent must be addressed. Countries such as Australia, Canada, China, and Singapore have opened their doors to worldwide talent (Zeufack and Lim, 2013); Malaysia should consider doing the same as a short-term measure to ease the talent constraint. In the longer term, the curricula of tertiary education in science and engineering must be reviewed regularly to meet the nation's needs. The enrolment of science and engineering students must also be increased without sacrificing content or quality.

5.5 | Conclusion

Emphasis on innovation received a late start, becoming evident in the late 1980s. Surveys suggest that the incidence of firm-level innovation rose from 21% in 1997 to about 64% in 2006, which is encouraging. However, the lack of maturity of innovation is evident from the fact that the largest concentrations of innovating firms (both large firms and SMEs) were in rubber and plastics and food processing. These are relatively low-tech industries (UNDP and World Bank, 1995). Furthermore, most firms were engaged in adaptation, not creation. There was also a negligible presence of innovating SMEs in the more sophisticated E&E subsector. Most firms in the sector remain as parts suppliers to MNCs, leaving little room for independent innovation.

Patent counts were low, although they have been rising. Even so, the patent counts fail to recognise the differences in technologies underlying these patents (Gayle, 2001). Product differentiation leads to numerous patents of minor changes to existing technologies or products. These become patents for product differentiation rather than for new ideas.

Firm-level innovation was largely through collaborative research and technology from the parent establishment; access to technology through SME links with MNCs was not widespread. In addition, although horizontal and vertical (backward) spillovers from foreign firms exist, forward spillovers were not detected.

Macro indicators of innovation also showed improvements over time, although they still lag China, a relative latecomer. These improvements, however, did not bolster Malaysia's global standing, as measured by innovation indices. During 2014–2016, Malaysia's rankings in both the GII and the GCI fell.

Several weaknesses in the implementation, monitoring, and application procedures with respect to innovation policies and schemes have undermined their effectiveness. The NIS, too, has developed in an ad hoc manner and needs urgent rationalisation. Addressing these weaknesses can help Malaysia increase its momentum in innovation.

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