A STUDY OF FIRM LEVEL INNOVATION IN MALAYSIAN MANUFACTURING

by

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TABLE OF CONTENTS **Page**

CHAPTER FOUR : DEFINITIONS, METHODOLOGY AND DATA

CHAPTER FIVE : FACTORS AFFECTING THE DECISION TO INNOVATE

CHAPTER SIX : FACTORS THAT DRIVE AND ENABLE DIFFERENT TYPES OF INNOVATION

CHAPTER SEVEN : MAIN FINDINGS AND POLICY IMPLICATIONS

LIST OF TABLES **Page**

LIST OF FIGURES **Page**

KAJIAN INOVASI DI PERINGKAT FIRMA DALAM SEKTOR PEMBUATAN DI MALAYSIA

ABSTRAK

Kajian ini telah mengkaji lima aspek inovasi di peringkat firma dalam sektor pembuatan di Malaysia, iaitu: (1) faktor-faktor yang menentukan keputusan untuk melakukan inovasi; (2) sejauh mana inovasi dilakukan; (3) ciri-ciri firma yang melakukan inovasi; (4) jenis-jenis inovasi yang dijalankan, dan (5) faktor-faktor yang mendorong dan membolehkan pelbagai jenis inovasi dilakukan. Sebuah model konseptual dan rangka kerja kos-faedah telah dicipta untuk menerangkan keputusan sesebuah firma untuk melakukan inovasi. Data yang diperolehi daripada satu tinjauan besar yang dijalankan oleh Bank Dunia telah dianalisis untuk menjawab empat aspek inovasi yang baki. Kajian ini mendapati bahawa 64 peratus firma terlibat dalam inovasi. Peratus ini adalah lebih tinggi daripada apa yang dilaporkan oleh kajian-kajian sebelum ini. Faktor-faktor yang mempunyai kaitan positif dengan inovasi di kalangan firma-firma kecil dan sederhana (atau SMEs) adalah: persekitaran persaingan yang tinggi, lokasi firma di Pulau Pinang, mempunyai ketua pegawai eksekutif yang berpendidikan tinggi, dan mempunyai keupayaan untuk membeli teknologi. Bagi kes firma-firma besar, umur firma, mempunyai ketua pegawai eksekutif yang berpendidikan tinggi dan mempunyai keupayaan untuk membeli teknologi didapati berhubung secara positif dengan inovasi. Inovasi seterusnya telah dibahagikan kepada empat jenis: tiada-inovasi, penerima-pakaian (adoption), adaptasi atau penyesuaian dan penciptaan. Sebahagian besar daripada SME didapati terlibat dalam ‘adaptasi’, manakala firma-firma besar pula sebahagian besarnya melakukan‘penciptaan’. Semua firma, tanpa mengira saiz, yang mengambil bahagian dalam penyelidikan usaha sama, telah memperolehi teknologi daripada syarikat

induk, atau menerima sokongan penyelidikan/teknologi daripada luar mempunyai kebarangkalian yang lebih rendah untuk menerimapakai teknologi yang sedia ada. Selain daripada faktor-faktor ini, SME yang mempunyai hubungan pembekal dengan syarikat-syarikat multinasional (MNC), didapati berorientasikan eksport, mempunyai keupayaan untuk membeli teknologi, telah menerima insentif R&D atau mempunyai kakitangan R&D telah menunjukkan kecenderungan untuk melakukan adaptasi yang tinggi. Sebagai bandingan, penciptaan dalam semua firma menunjukkan hubungan positif dengan penyelidikan usaha sama, penerimaan teknologi dari syarikat induk, penerimaan sokongan peyelidikan/teknologi daripada luar dan mempunyai kakitangan R&D. Firma-firma besar yang lebih tua mempuyai kebarangkalian yang rendah untuk menerimapakai teknologi yang sedia ada dan kebarangkalian yang lebih tinggi untuk melakukan penciptaan. Walau bagaimanapun, kebarangkalian untuk menjadi pencipta adalah rendah bagi SME yang mempunyai struktur membuat keputusan yang berpusat. Sebaliknya, SME yang menjadi pembekal kepada MNC dan yang berorientasikan eksport mempunyai kebarangkalian yang tinggi untuk menjadi pencipta. Penemuan seterusnya menunjukkan SME dalam subsektor elektronik mempunyai kebarangkalian yang lebih rendah untuk terlibat dalam adaptasi dan penciptaan dan mempunyai kebarangkalian yang lebih tinggi untuk menjadi firma tanpa inovasi, berbanding dengan subsektor automotif. Begitu juga didapati, firma-firma besar dalam perusahaan kayu dan produk-produk kayu mempunyai kebarangkalian yang lebih tinggi untuk menjadi firma yang bukan pelaku inovasi dan hanya sebagai penerimapakai teknologi yang sedia ada, dan mempunyai kebarangkalian yang rendah untuk menjadi pengadaptasi dan pencipta teknologi. Implikasi-implikasi daripada penemuan-penemuan kajian untuk meningkatkan kadar innovasi turut dibincangkan

A STUDY OF FIRM LEVEL INNOVATION IN MALAYSIAN MANUFACTURING SECTOR

ABSTRACT

This study investigated five aspects of firm level innovation in Malaysian manufacturing, namely: (1) factors that determine the decision to innovate; (2) the extent of innovation; (3) characteristics of an innovating firm; (4) types of innovation undertaken, and (5) the factors that drive and enable different types of innovation. A conceptual model and a cost-benefit framework were developed to explain a firm's decision to innovate. Data obtained from a large survey conducted by the World Bank were analysed to answer the other four aspects. The study found that 64 percent of firms were engaged in innovation. This is higher than figures reported by previous studies. The factors associated with innovation among small and medium-sized enterprises (SMEs) were: a strong competitive environment, being located in Penang, having CEOs with higher education, and the ability to purchase technology. In the case of large firms, the age of firm, having CEO's with higher education and the ability to purchase technology were positively related to innovation. Innovation was further divided into four types: no-innovation, adoption, adaption and creation. Proportionally more SMEs were engaged in 'adaption' while a larger proportion of large firms were involved in 'creation'. All firms, regardless of size, which participated in collaborative research, obtained technology from parent plants, or received research/technological support from outside, had a lower probability of adoption. Apart from these factors, SMEs that had a supplier relationship with multi-nationals (MNCs), were export oriented, had the capacity to purchase technology, obtained R&D incentives or had R&D staff also showed a higher propensity to be

doing adaption. In contrast, creation in all firms was positively associated with collaborative research, obtaining technology from parent plants, getting research/technology support from outside and having R&D staff. Older, large firms had a lower probability of adoption and higher probability of creation. However, the probability of being creators was low for SMEs with centralized decision making structures. On the other hand, SMEs that were suppliers to MNCs and were export oriented had a higher probability of being creators. Further results showed that SMEs in electronics had a lower probability of engaging in adaption and creation and a higher probability of being non-innovators, relative to the automotive subsector. Similarly, large firms in wood and wood products had a higher probability of being non-innovators and mere adopters, and a lower probability of being adapters or creators. The implications of the findings of the study for increasing the pace of innovation are also discussed.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The role of innovation in development has long been of interest to economists (Hagerstrand, 1968; Teece, 1986; Acs & Audretsch, 1987; Dosi, 1988; Mytelka, 1993; Nelson, 1993). Innovation activities not only result in higher production but also create technology that is transferable (Griffith et al., 2006).

In Malaysia, the emphasis on innovation was late in coming. Industrialization began in 1958 and went through two main phases: imports substitution and export expansion (Osman-Rani, 1982; Narayanan & Rasiah, 1992). The focus was on producing local substitutes for imported goods and employment generation during the first phase. The subsequent export expansion phase continued the emphasis on employment creation but shifted production from catering almost exclusively for the domestic market to producing manufactured goods for exports as well. Export expansion was led by foreign firms that had been attracted through generous incentives. They were largely engaged in labour intensive manufacturing and were happy to take advantage of Malaysia's cheap labour. The operations they were involved in required no research and development (R&D) and official attitude regarding innovation was, at best, laissez faire (Narayanan & Lai, 2000).

With the rise of other cheap labour economies in the region like China, India, Vietnam and Indonesia, Malaysia's advantage in cheap labour began eroding. It was only then that it was forced to seriously consider innovation to protect its competitiveness in manufacturing. The launch of the First Industrial Master Plan in

1986 marked the efforts to develop domestic technological capabilities, address shortages in skilled human resources and encourage R&D. Many policy measures, incentives and institutions were introduced in the subsequent periods towards this objective. The Second Industrial Master Plan (1996-2005) intensified these efforts and the Action Plan for Industrial Technology Development (APITD), launched in 1990, marked a further step in stimulating innovation and technological development.

The role of innovation in the Malaysian economy received new emphasis with the launch of the New Economic Model (NEM) in March 2010. The NEM document (NEM, 2010: 34) pointed out that although Malaysian economic growth equaled that of South Korea and Taiwan in the earlier periods (1950-1976), the pace has not been sustained. In fact, Malaysia had been one of only 13 countries in the world to have recorded growth in excess of seven per cent for more than 25 years since the Second World War but growth faltered in the aftermath of the 1997-1998 Asian financial crises. The share of 'high-tech' products[1] in total manufactured exports of Malaysia rose in the 2000s, and averaged at 59.56 percent, which was unique in the region and perhaps in the world, but this trend too could not be maintained after 2003 (World Bank, 2005) [See Figure 1.1].

Malaysia is currently a middle-income country that has not yet attained the status of a high-income economy. Malaysia has been described as a middle-income country that is "squeezed by the competition from low-wage economies on the one hand, and more innovative advanced economies on the other" (Flaaen, Ghani & Mishra, 2013)[2].

[1] According to World Bank, (2005) high tech products are defined as products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Available at : http://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS/countries/MX-BR?display=graph

[2] The World Bank coined the term "middle income trap" to describe countries like Malaysia that enjoyed high growth by exploiting resources and cheap labour but are now unable to compete with newly emerging low cost producers because of rising

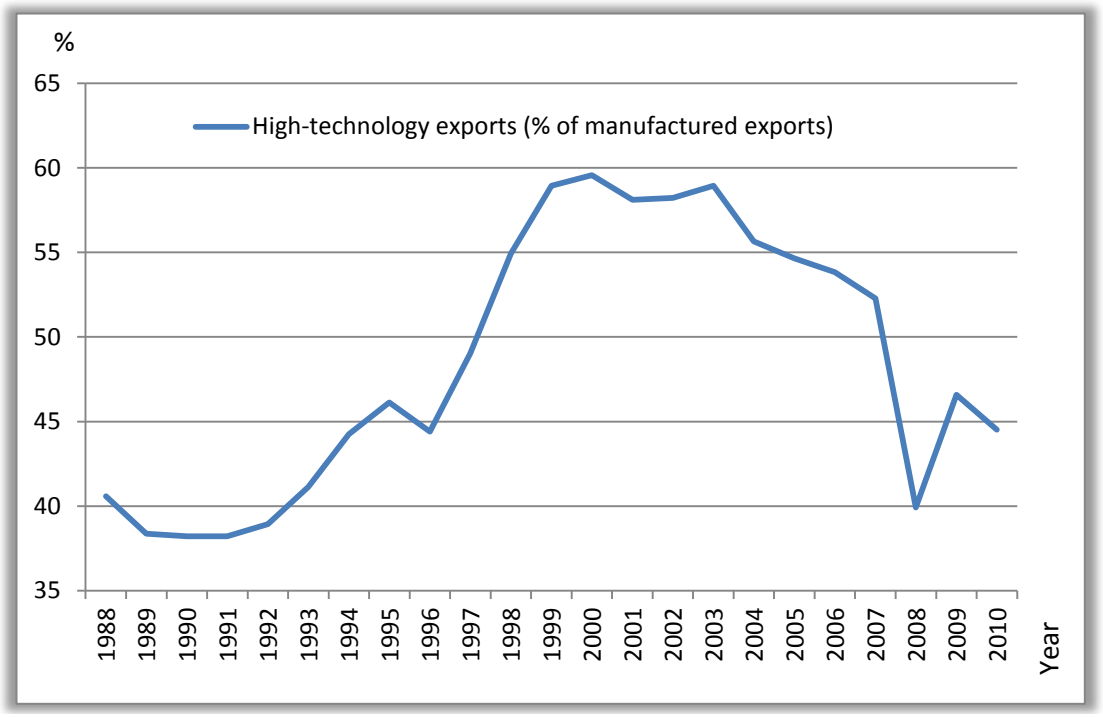

Figure 1.1 Trend of High Technology Exports as a Percentage of Malaysian Manufacturing Exports
Source: Graphed using World Development Indicators, available at: http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?page=1

Both the NEM and the Tenth Malaysia Plan (2011-2015) that was launched soon after, envisioned Malaysia as a knowledge-based and innovation driven economy. Both documents emphasized the need for Malaysia to aggressively promote innovation activities in the private sector. A robust manufacturing sector, grounded on independent innovative capabilities, is therefore critical if the sector is to spearhead the drive up the value chain in a sustained and sustainable fashion (Narayanan & Lai, 2000; NEM, 2010; Zeufack et al., 2011).

The emphasis on innovation is well placed because Malaysia compares poorly with other countries in the region, with respect to several key *macro-indicators* of innovation. For example, R&D expenditure as a percentage of GDP in Malaysia was

domestic wage levels, on the one hand, and with more advanced economies, because they lack the expertise to produce higher value products, on the other. Despite its widespread use, De Micheaux (2014) has argued that the term has neither a theoretical nor an intellectual basis.

just 1.07 in 2011, lagging behind Japan (3.26 per cent), South Korea (3.74 per cent), Singapore (2.09 per cent) and China (1.76 per cent)[3] [See Figure 1.2].

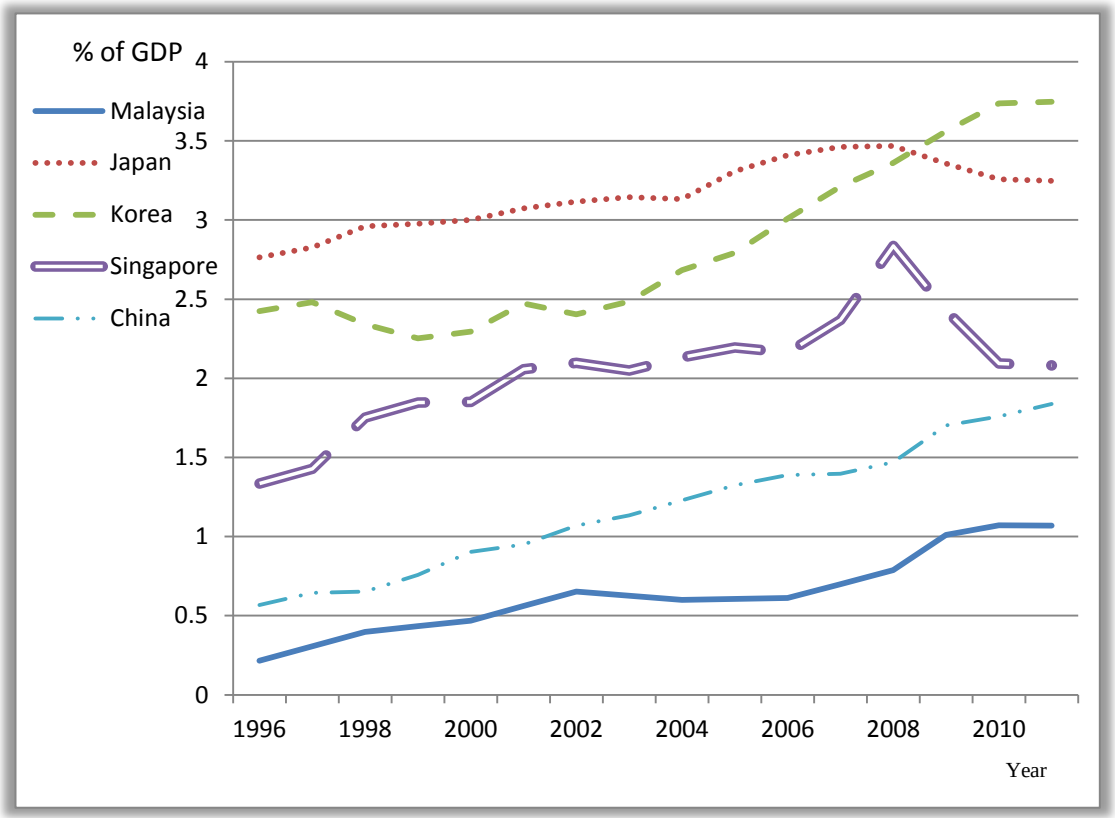

Figure 1.2 Research and Development Expenditure (% of GDP)
Source: Graphed using World Development Indicators available at:
Fhttp://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?page=1

Malaysia was also behind with respect to R&D personnel per million persons in 2006: its figure of 365 compared unfavourably with that of Singapore (5677), Japan (5416), South Korea (4321) and China (931)[4]. Innovation often translates to patenting. The data on patents granted by the US Patent and Trademark Office (UPTO) for 2007 showed that only 158 accrued to Malaysia as opposed 33,354 that accrued to Japan, 6295 to South Korea, 6128 to Taiwan, 772 to China and 393 to

[3] http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?page=1
[4] http://data.worldbank.org/country

Singapore[5]. It was also noted that 90 per cent of patent applications and awards handled by the Malaysian Patent Office involved foreign, not local residents (Zeufack, et al., 2011: 6). Finally, in rankings based on the 2012 Global Innovation Index (GII), Malaysia was placed in 32nd position out of 144 countries evaluated. It was well behind Singapore (3), South Korea (21) and Japan (25), and only slightly ahead of China (34), a late-comer.[6] The GII is widely regarded as a broader measure that indicates the extent to which countries and businesses integrate innovation into their political, business and social spheres.

More recently, the interest has shifted from the macro impact of innovation on the economy to factors that motivate innovation at the firm level (Crepon et.al 1998; Lööf & Heshmati, 2002; Kremp & Marissa, 2004). Hobday (2005) defines firm level innovation as the successful introduction of a new or improved product, process or service to the marketplace. In order to capture incremental innovation that occurs outside formal R&D activities and from 'behind the technology frontier' defined by firms in advanced countries, he broadened his definition to include any product, process or service new to the firm, and not confined only to those new to the world or marketplace .

In recognising the importance of innovation, Lall, (2001) pointed out that in the fast changing global market, successful manufacturing companies that are able to sustain their competitive advantage are the ones with faster technology adoption abilities and those involved in successful research and development that enables them to produces a flow of innovative new products over time. Firms that do not adopt these methods will fall behind competitors who do. Firms are increasingly dependent

[5] http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm
[6] http://www.globalinnovationindex.org/gii/main/analysis/rankings.cfm?vno=&viewall=true#CGI.SCRIPT_NAME#

on innovation to meet greater customer requirements, to provide better service, and to face increased competitive pressures.

Innovation needs new technology and technology development takes time and requires continuous investments by firms in themselves (De Cubas, 1974). However, there are firm level attributes and institutions outside the firm that can nurture the process of technology development and its conversion to innovation. Institutions outside the firm can provide important support by strengthening the science base and producing adequately trained human resources. In Asia, South Korea and Taiwan stand out as examples of countries where factors within the firms and institutions outside it have come together to foster firm level innovation that has allowed them to catch up with firms in advanced economies (Hobday, 2005; Skerlavaj, Song & Lee, 2010; Huang & Yang, 2010).

In Malaysia, the heightened concern regarding firm level innovation initially saw researchers focusing on issues of technology transfer rather than whether or not firms were innovating. There was therefore interest in determining if technology was being transferred within the manufacturing sector dominated by multinationals (MNCs) (Yamashita, 1991a, 1991b; UNDP, 1994; Rasiah, 1995a, 1995b; Narayanan, 1999; Narayanan & Lai, 2000) and the modes of transfer and the linkages that have been built up between MNCs and local supporting firms (Rasiah, 1994a, 1994b; UNDP, 1994; Batra & Tan, 2003; Giroud, 2003).

When interest in innovation within firms emerged, the Malaysian Science and Information Technology Centre (MASTICI) started collecting data on innovation through periodic surveys of firms and the first survey was completed in 1994. Since

then, five surveys have been carried out with two to four year intervals[7]. However, the published reports only show aggregate data on some key aspects of innovation. It is unclear if detailed analyses of the firm level data have been undertaken. In any case, no published studies have been available.

The low level of innovation at the firm level has now been recognized in Malaysia (MIDA, 1983; WB/UNDP, 1995; NEM, 2010); a report prepared by the World Bank and the United Nations Development Programme (WB/UNDP, 1995) noted that expenditures on R&D were low, relative to other newly industrializing economies (NICs) like Singapore, Taiwan, Korea and Japan. In addition, when R&D spending occurred, it was confined largely to foreign-owned firms within the electronics and electrical (EE) subsectors (WB/UNDP, 1995: 13-16; NSI-5, 2008).

This led to some Malaysian studies attempting to identify the characteristics of firms that innovate. Most were concerned with small and medium-sized enterprises (SMEs) or firms in specific manufacturing subsectors. For example, Lee and Lee (2007) found that among smaller SMEs the probability of innovation increased with firms having more employees but decreased with the age of firms. In contrast, among medium-sized firms, age was positively related to innovation— as was higher market concentration and production for the domestic market. However, medium-sized firms that were public limited companies were less likely to innovate. Finally, foreign ownership was not significantly associated with innovation among SMEs. Another study, Yahya et al (2011) confined itself to process innovation among SME's but their small sample-size cast doubts on their findings. Other small subsectoral studies include Ng and Thiruchelvam (2010) who looked at innovation among smaller wooden furniture manufacturers, Salim and Sulaiman (2011) who examined SMEs in

[7] The usefulness of these surveys are discussed in Chapter 2.

the ICT subsector and Seng and Mohtar (2012) who concentrated on innovation in the heavy construction sector.

Innovation related studies on Malaysian manufacturing as a whole are fewer still. Lee (2004) was the only study to examine the characteristics of innovating firms in manufacturing as a whole using representative national level data drawn from the Third National Survey of Innovation (NSI-3), covering the period 2000-2001. Based on 749 firms, the study found that the likelihood of innovation increased with firm size, market concentration and ownership structure (with private and public limited firms twice more likely to innovate than sole proprietorships). Curiously, a negative relationship was found between the likelihood of innovation and export orientation (measured by the share of total sales exported). No difference in the propensity to innovate was found between foreign and domestically owned firms. A study by Tasmin and Woods (2008) looked at knowledge management (often regarded as an enabler of innovation) in a sample of 149 large Malaysian manufacturing firms. Of the demographic elements of the firm they found that only the number of employees and receipt of ISO certification were positively associated with knowledge management. Idris and Tey, (2011) examined a small sample of firms to establish whether or not international joint-ventures in Malaysia were a source of knowledge transfer and innovation and concluded that they were not.

More recently, Lim and Nagaraj (2012) and Lim, Lee and Nagaraj (2012) looked directly at factors impeding innovation among Malaysian manufacturing firms. Based on self-reported responses given by firms in the course of the National Survey of Innovation (2000-2001), factors such as innovations costs, perceived risks, the lack of finance, and the lack of information regarding markets were identified as obstacles faced by both innovators and non-innovators.

This brief survey highlights the fact that very few studies examining innovation at firm level and the factors that motivate it exist in the Malaysian context. The existing studies are not only narrowly focused (either on SMEs or on specific manufacturing subsectors) but also relied on samples of firms that caution against generalizations. The exception is Lee (2004) but his analysis only sought to establish the characteristics of firms that were innovating, without reporting explicitly what constituted innovation. Moreover, the study did not go on to identify the type (or level) of innovative activities being carried out at the firm level. By treating all types of innovation alike, the study was unable to distinguish if the correlates of innovation differ with different kinds of innovative activity. There were also methodological problems; the study relied on a simple Logit model but failed to correct for heteroscedasticity. One implication of this oversight is that the standard errors are suspect and this will make inferences drawn from the data unreliable. Furthermore, no tests for multicollinearity were reported. Multicollinearity, if present, leads to large standard errors and identifies variables as insignificant predictors when in fact they are.

1.2 Problem Statement

Innovation in manufacturing has been given a central role in helping Malaysia transit from a middle-income economy to a high-income one. However, macro-indicators of innovation and the limited data gathered from firm level innovation surveys strongly suggest that Malaysia is still lagging behind other NICs in the level of innovative activities in manufacturing. Furthermore, very little is known about the extent and types of innovation that occur at the firm level and the factors that enable it. Yet, this kind of knowledge is critically needed to devise public policies to nurture and strengthen the pace of innovation in the manufacturing sector.

More specifically, there are gaps in existing knowledge with respect to at least three important aspects of firm level innovation in the manufacturing sector: one, the prevalence of innovative activities in firms; two, the types of innovation that firms engage in; and three, the factors that drive and enable firm level innovation.

1.3 Research Questions

The study focused on the following research questions:

1. What are the underlying factors that influence a firm's decision to invest in innovation?
2. Is firm level innovation occurring in the Malaysian manufacturing sector and if it is how prevalent is it?
3. What are the key characteristics (if any) that separates an innovating firm from a non-innovator?
4. What are the types of innovation that firms engage in?
5. Do the factors that drive and enable innovation differ by the type of innovation?

1.4 Objectives of the Study

The objectives of the study were therefore as follows.

1. To develop a conceptual model and a corresponding analytical framework to explain how a firm decides on how much to invest in innovation.
2. To analyse the extent of firm level innovation by key firm characteristics like firm size (SMEs versus large firms), firm ownership (foreign owned versus local owned) and subsector of activity (eight subsectors).

3. To identify the key characteristics that separate innovating firms from non-innovating ones.
4. To identify the types of innovation that firms are engaged in, by key firm characteristics.
5. To analyse the factors that drive and enable each type of innovation

1.5 Contribution of Study

This study makes several contributions in the area of innovation studies: First, it is the first study to employ a large and representative sample of firms in Malaysian manufacturing to examine firm level innovation. This suggests that the findings of the study can be generalized.

Second, it goes beyond most studies that merely identify the correlates of firm level innovation by developing a conceptual model and a corresponding analytical framework to explain how a firm decides on how much to invest in innovation. The conceptual model separated these correlates into drivers and enablers; the enablers were divided into those that facilitate innovation, those that lower the cost of innovation and public policy initiatives. The advantage of this is that it helps identify factors favouring innovation that are outside the control of the firm (drivers) and those within the control of the firm (the first two sets) and factors that are the outcome of joint-efforts by the firm and the government (the third set of enablers). This will help clarify policies that can be initiated by the firm and those that need the intervention of the authorities. This framework may also be useful in analyzing innovation in other countries.

Third, while various methodologies have been used in the study of firm level correlates of innovation, to my knowledge this is the first time *Ordered Probit*

analysis has been used for this purpose. The advantage of this methodology is that it isolates the direction and strength of the marginal impact of each driver or enabler on the different types of innovation in an uncomplicated way. Policymakers and firm level managers can therefore interpret the results in a direct manner and be guided on the initiatives they have to undertake to nurture various types of innovation. Again, the results may offer useful insights when analyzing innovation in the manufacturing sector in other countries in the region.

1.6 Organisation of Study

The study is organised as follows: Chapter 1 provides the background motivating the study, explains the problems that is being studied and lays out the objectives of the study. It also outlines the contributions the study hopes to make. Chapter 2 traces the developments that led to an emphasis on innovation in Malaysian manufacturing. It also discusses the usefulness of the various National Surveys of Innovation (NSI) in evaluating the progress of innovation in the manufacturing sector. Chapter 3 surveys the literature regarding the definition of innovation, innovation models and the correlates of innovation. The conceptual model and the analytical framework underlying the study are also developed. Chapter 4 discusses the definitions, methodology and data used in this study. Chapter 5 presents the analyses on the factors that motivate firm level innovation while Chapter 6 examines the factors that motivate different types of innovation in firms. The final Chapter highlights the policy implications of the findings and points out the limitations of the study.

CHAPTER TWO

OVERVIEW OF INNOVATION ACTIVITIES IN MALAYSIA

2.1 Introduction

The first section of the chapter outlines the phases of the development of a coherent policy to foster, sustain and increase the level of innovation in the country. It subsequently reviews innovation in the manufacturing sector, based on the main findings drawn from all the National Surveys of Innovation (NSI) that have been carried out so far.

2.2 The Early Phase: No Emphasis on Innovation

Malaysian industrialisation first went through the import substitution phase (1958-1968); both foreign and domestic manufacturing companies were encouraged to produce domestic substitutes for imported goods behind protective tariff walls. The primary emphasis was to reduce import dependence for consumer goods and to generate employment (Osman-Rani, 1982).

Subsequently, the country moved on to the export expansion phase (1968-1990)[8] with the Investment Incentives Act of 1968 and the establishment of the Free Trade Zone Act of 1972. This also coincided with the introduction of the New Economic Policy (NEP) that sought to generate opportunities for Malays and other *Bumiputeras* in modern, urban based activities that included manufacturing. Since most of the domestic firms were controlled by ethnic Chinese, the government sought

[8] In reality Malaysia went into a second phase of import substitution (1980-85) and export expansion (1985-2010). But these phases are not really important when tracing the broad development of innovation policy in the country because they represent a deepening of emphasis but not shifts in the industrialisation policy.

an alliance with foreign capital, wooing them with attractive tax and other incentives (that included pioneer status and investment credit) in return for employment opportunities for Malays (Narayanan, 1996). This phase saw a rapid expansion of employment opportunities for Malays and especially females as production operators and assembly line workers in foreign owned firms set up in specially created free trade zones focusing primarily on export markets (Narayanan & Rasiah, 1992). The objective of attracting foreign capital was to diversify the economic base of the country and generating employment opportunities in the manufacturing sector. This saw the relocation of labour intensive assembly operations from US, Europe, Taiwan and Japan to Malaysia but these activities required no R&D. Neither was there any official concern about ensuring technology transfer nor encouraging innovation at the firm level (Narayanan & Lai, 2000). Foreign firms locked in FTZ enclaves had little links with domestic small or medium sized firms either as suppliers of inputs or in any other ancillary role. Local affiliates of foreign firms remained competitive in foreign markets through cost cutting measures allowed by cheap labour rather than in-house innovation (NEM, 2010).

Early studies of the period reported the natural transfer of lower level skills meant to operate and maintain the technology transferred to local affiliates of MNCs. The progress of the transfer varied widely between manufacturing subsectors but appeared to progress more rapidly in the export oriented, more competitive electronics and electrical (EE) subsector (Yamashita, 1991; UNDP, 1994; Narayanan & Lai, 2000). Even in this subsector, more progress was reported in Penang than in the Klang Valley due to unique political differences and circumstances (Rasiah, 1996; Narayanan, 1999).

Whatever technology transferred that occurred was dictated by the needs of the MNCs and not the outcome of a well-conceived policy or framework. It was reported that technology transfer proceeded at a faster pace in US owned electronics firms and the local supplier firms they had linked up with, as compared to Japanese or Taiwanese owned firms (Narayanan & Lai, 1998). And regardless of ownership, R&D expertise was being transferred at a very slow pace (Yamashita, 1991; Narayanan & Lai, 2000). Technology was also being transferred at an irregular pace through the diffusion of knowledge caused by staff turnover (UNDP, 1994).

The advantages of cheap labour began to fade in the mid-1990s as new locations of cheap labour like China, India, Vietnam and Indonesia emerged. These countries too were able to offer export processing zones, infrastructure and even cheaper labour than Malaysia could. Malaysia had to turn to other measures to maintain its competitiveness in manufacturing.

2.3 Towards a Pro-Innovation Environment[9]

This potential threat from emerging cheap labour economies was already recognised in the late 1980s though not fully appreciated. In 1986, therefore, Malaysia launched its First Industrial Master Plan that officially appreciated the need to build up domestic technological capabilities, address shortages in human capital resources, and encourage R&D. Specific incentives were announced towards achieving these objectives. More specifically, incentives were announced for new technology intensive firms, for technology acquisition and domestic sourcing of inputs.

To enhance the environment for research and innovation several organisations were created during this period. The Malaysian Institute of Microelectronic Systems

[9] This section draws largely from Rasiah (2011), Govindaraju and Rasiah (2011) and Rasiah (2012).

(MIMOS) was set up in 1985 to sponsor basic and applied research in micro-electronics. In 1993 the Human Resource Development Council (HDRC) was established to address the lack of skilled human resources. In a marked shift in the education policy, the setting up of private universities was permitted and the enrolment in public universities was increased. 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 (MIGHT) was formed to coordinate industry-government partnerships in high technology. Small and Medium sized enterprises (SMEs) were not neglected; the Small and Medium Industries Development Corporation[10] took shape in 1996 to oversee the needs of the SMEs.

The Second Industrial Master Plan (1996-2005) intensified these efforts and widened its scope to include firms in the service sector as well. The plan introduced the idea of clustering to promote industrial linkages, productivity and technology development. It was hoped that technological learning and acquisition will develop through the close contacts of domestic firms with MNCs by way of subcontracting or parts supplier links. The results were significant but not widespread and appeared to confine itself to specific subsectors (like the EE subsector) and locations (Penang). It was also unclear the extent to which these policies or the changing demands of the MNC affiliates motivated these linkages.

The Action Plan for Industrial Technology Development (APITD), launched in 1990, marked a further step in stimulating innovation and technological development. The strategies included measures to strengthen the capabilities of local firms in adopting process technologies and enhancing R&D.

[10] Later renamed as SME Corp.

The formation of more organisations to support innovation continued. In 1997, a government–owned company called the Multimedia Development Corporation (MIDeC) was formed to create an environment that was attractive for both Malaysian and global firms in the information and communications technology industry. It also oversees Multimedia Super Corridor (MSC) Malaysia (1996) that offers facilities and tax breaks to firms located in the multimedia corridor near the Kuala Lumpur International Airport.

Several High Tech Parks were also established around the country, with the first being located in Kulim, Kedah, in the north and the second being located in Senai, Johor in the south. The former focuses on attracting local and world class firms involved in clean, high value added activities. The latter emphasises on firms active in green technology and offers incubator and lab facilities for domestic and foreign companies working in these areas.

While it is certain that many firms have benefitted from the activities of these organisations[11], it is unclear how widespread or deeply rooted these benefits have been. No study has been done to evaluate their reach or effectiveness. Commenting on them, Rasiah (2012: 207) asserted that these "organisations suffered from the lack of a clearly defined mandate and were not subject to formal mechanisms to vet, monitor and appraise their performance." They also lacked leaders with industry level experience and suffered cutbacks in funding after the 1997-98 financial crisis.

[11] Earlier agencies that preceded the organization mentioned here include SIRIM, a solution-provider in quality and technology; Malaysian Agricultural Research and Development Institute (MARDI) that does research in agriculture, food, and agro-based activities; and the Rubber Research Institute of Malaysia (RRIM), specialising in rubber and rubber-related products. Many firms in the sample used in the study, particularly those involved in food and resource based activities, reported benefitting from links with these bodies.

In an attempt to evaluate the state of innovation in the country, the National Survey of Innovation was launched in 1995. The results of the survey would indicate whether or not the resources poured into creating an environment that was favourable to innovation was justified.

2.4 The National Surveys of Innovation (NSI)

In Europe, national innovation surveys have been carried out almost every 4 or 5 years. They have been conducted by individual countries since the 1980s and were known as Community Innovation Surveys. Eventually, the member states of the European Union decided to coordinate their efforts, and they laid down a common methodological approach to measure innovation in what has come to be known as the Oslo Manual (OECD, 1996; 2002; 2005).

In Malaysia, the first National Innovation Survey (NSI-1) was conducted in 1995 by the Malaysian Science & Technology Information Centre (MASTIC). The aim was to provide information on the state of technological development in the country. The Malaysian methodology was based on the recommendations of the Oslo Manual and the Community Innovation Surveys (MASTIC, 2008). Since then, the surveys have been conducted on a fairly regular basis; so far five surveys have been completed as described below.

2.4.1 (1990-1994) National Survey of Innovation in Industry (NSI-1)

The first NSI was labeled as the National Survey of Innovation (NSI-1) and was conducted in 1995, covering a five-year period from 1990 to 1994. The survey covered 815 companies in manufacturing and services that were identified as possible innovators from various sources. A total of 412 companies responded with 268 firms reporting some form of innovation. Innovation in companies was rated as low,

medium or highly innovative. Following the Oslo Manual, the NS1-1 considered innovation as 'low' if firms purchased rather than developed new technologies. On the other hand, innovation level was considered as 'medium' in firms that developed or introduced new or improved products and/or processes. Finally, firms were considered as being 'highly innovative' if they carried out their own R&D and/or applied for patents; and/or sold or transferred technologies out of the business. However, these classifications were ignored in subsequent surveys.

It should be noted that Chapter 3 of the survey report concedes that the sample was biased in favour of companies likely to be carrying out innovation; thus the high proportion of firms (65 percent) engaged in some form of innovation should be considered with care.

2.4.2 (1997-1999) National Survey of Innovation in Industry (NSI-2)

The second survey (NSI-2) covered a period of four years from 1997 to 2000. It differed from the first in several aspects. First, in line with the recommendation in the Oslo Manual, the NSI-2 adopted a stratified random sampling method. The sampling frame was obtained from the Department of Statistics of Malaysia (DOS). This was a departure from the earlier method of selecting from a list a total of 815 companies that were identified as possible innovators. Second, again following the Oslo Manual, the survey was conducted in two stages. In the first stage, questionnaires were sent to 4,000 randomly selected respondents (as compared to the 412 firms covered under the NSI-1). In the second stage, of the 1,044 firms that responded, a more detailed questionnaire was sent out and 219 firms indicated that they conducted some form of innovative activities. The detailed questionnaire used was based on the Community Innovation Survey 2 (CIS-2). Third, instead of a five-year reference period, the survey used a three-year reference period. Also, it focused entirely on the

manufacturing sector leaving out services as it was assumed to be at a nascent stage. The overall incidence of innovation reported in NSI-2 fell substantially (21 per cent) relative to the higher but biased figure reported in the first.

2.4.3 (2000-2001) National Survey of Innovation in Industry (NSI-3)

The reference period for the NSI-3 was a two year period covering the years 2000-2001. The survey itself was carried out between August 2002 and May 2003. As in the case of the NSI-2, a total of 4,000 questionnaires were sent to manufacturing firms drawn from the list obtained the DOS. However, unlike the NSI-2, the NSI-3 relied on a single stage survey approach and attracted responses from 749 firms; of this, 263 firms (35 percent) indicated that they had been engaged in innovation. This was an increase over the figure reported in NSI-2.

The questionnaire used was based on the CIS-3 Survey. Again, the survey concentrated only on firms in the manufacturing sector. However, on the advice of the DOS, the sizes of the establishments were defined based on number of employees, rather than value of revenue as was the case in NSI-2.

2.4.4 (2002-2004) National Survey of Innovation in Industry (NSI-4)

The NSI-4 covered the period from 2002-2004. The survey reverted to the two-stage method. A total of 4,000 manufacturing firms were canvassed, using the same techniques as in the previous surveys. Two major differences should be noted between NSI-3 and NSI-4. First, an inclusion criterion was used in the latter survey; only firms with five or more employees (in 2002) were included. This is similar to the approach taken in the Oslo Manual (OECD, 2005), where a minimum firm size of 10 employees was adopted. The 4,000 firms with five or more employees accounted for 28.2 percent of all manufacturing firms with five or more employees. Second, a

longer time frame (of three years) was used in the NSI-4 compared to the NSI-3 (two years). The NSI-4 reported that 54 percent of the firms were engaged in innovation, a substantial increase over the figure in the previous survey.

2.4.5 (2005-2008) National Survey of Innovation (NSI-5)

The NSI-5 covered the period from 2005 to 2008. The methodology and design of the questionnaire were based on the Oslo Manual and CIS-4 harmonized questionnaire. A one-stage survey method was adopted. The questionnaire was distributed among 4,000 firms in manufacturing and 1,000 firms in the service sector. A combination of postal surveys and personal visits were used to obtain the maximum response rate.

The NSI-5 is considered the most reliable and representative; it reported that 51 percent of the sample was engaged in innovation, although this was a marginal decrease from the figure in the previous survey.

In summary, it should be noted that the sample size of the survey in each period differed and the surveys were carried out as a single stage effort in some years and as a two stages process in others. Also, the NSI-1 and NSI-5 covered firms in both manufacturing and services while the rest covered only the manufacturing sector. Based on these considerations the data are not comparable and it is difficult to draw reliable conclusions regarding the trends in innovation across the five surveys. This also suggests that apart from the scattered pieces of information emerging from these surveys and other small-sample based studies, little is known regarding factors that motivate firm level innovation and the nature of these activities.

2.5 Summary and Discussion

Even after Malaysian industrialization shifted focus from import substitution to export expansion, depending on foreign direct investment to drive the process, the policy towards innovation remained ambivalent until 1986. Whatever technology that was transferred and diffused was primarily based on the self-interests of the local affiliates of foreign MNCs. The Industrial Master Plans that came afterward developed, in stages, a more coherent policy to develop indigenous innovative capabilities as well as drawing on the strengths of foreign MNCs. Numerous organisations were set up or sponsored by the government towards this end. There is evidence from the survey data used in the study (to be discussed later) that these outside agencies and organisations helped foster collaborative research and provided technological support. However, the reach and effectiveness of these organisations, relative to the resources allocated to them, have never been properly evaluated. The initiation of the National Surveys of Innovation by MASTIC in 1996 was an attempt to assess the success of these efforts. Unfortunately, the different methodologies and coverage of the NSIs do not allow a reliable analysis of innovation trends over the periods they cover. Thus, the progress made in innovation in the manufacturing sector cannot be reliably assessed.

CHAPTER THREE

LITERATURE REVIEW AND ANALYTICAL FRAMEWORK

3.1 Introduction

This chapter is divided into three sections. The first section reviews the literature with respect to the definitions and main models of innovation. It shows that the existing models do not provide much insight into the factors motivating and sustaining firm level innovation. The second section surveys the empirical literature on firm level innovation and identifies the main correlates of innovation. The survey reveals that in most cases the correlates have been introduced into econometric estimation models in an ad hoc way without explaining how they might fit into a coherent framework that would deepen the understanding of firm level innovation. The final section addresses this lack by suggesting a conceptual model into which the key correlates can be fitted. This model is then used as the basis for the analytical framework underlying the empirical part of this study. The final section therefore meets the first objective of this study of developing a conceptual model and a corresponding framework to explain how a firm decides on whether or not to invest in innovation.

3.2 Defining Innovation

The work of Joseph Schumpeter (1934) has greatly influenced modern ideas of innovation. He viewed innovation as a dynamic process in which new technologies replace the old, a process he labeled “creative destruction”. He divided innovation into two types, incremental and radical. For Schumpeter, radical innovations created major disruptive changes, whereas incremental innovations continuously advanced the process of change.

Since then various definitions of innovation have appeared in the literature (see, for example, Drucker, 1984; Leonard & Swap, 1999; Li & Atuahene-Gima, 2001; Zhao, 2005; Massa & Testa , 2008) but over time the definitions given in the *Oslo Manual* (OECD, 2005) has become a standard point of reference. The Manual classified innovation into four types: product, process, marketing and organisation.

i. **Product innovation** refers to new knowledge or technology used to introduce new or improved products or services. An improved product (or service) is an existing product (or service) whose performance has been significantly enhanced or upgraded.
ii. **Process innovation** is the implementation of new or significantly improved production or delivery method to generally increase productivity.
iii. **Marketing innovation** covers all new marketing methods, product designs, packaging, product placements, product promotions and/or or pricing.
iv. **Organisation innovation** refers to the implementation of new organisational methods in the firm's business practices, work place organisation or external relations.

It was emphasized that the innovation should be new to the firm though not necessarily new to the market. It was also immaterial whether the innovation was developed by the main firm or by another enterprise. However, changes of a solely aesthetic nature and the mere selling of innovations produced and developed entirely by other firms were not counted as innovation.

Shumpeter's concepts of incremental and radical innovation have also been further refined in the broader literature (Utterback & Abernathy, 1975; Ettlie & Bridges & Keefe, 1984; Dewar & Dutton, 1986; Ettlie & Reza, 1992). The former refers to small improvements in the areas of product, process, marketing or