Linking International Production Network and Productivity Growth: The Case of The Malaysian Manufacturing Sector.

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Abstract

Malaysia has been hosting FDI since the 1970s and has been heavily involved in global production networks (international production fragmentation) since the mid 1980s. In the 1990s, Malaysia along with other East Asian countries has achieved rapid economic growth rates which has led to the "*East Asian Miracle*", an adage coined by the World Bank. Literature has yet to ascertain whether this rapid economic growth can be due to the development of global production networks. The main objective of the paper is to bridge these two significant fields of economic interest: *the productivity debate* and *international production fragmentation*. This paper examines the performance of the manufacturing sector from 2000 to 2008 to obtain a current understanding on these relationships. The general conclusion from this study stems from various views paved by *Fundamentalists* and *Assimilationists* in the productivity literature. First, Malaysia is still very dependent on input driven growth. However, productivity has improved under certain conditions with international fragmentation. The best response for a local firm is to engage in export activities that are within the production fragmentation network. Benefits from international fragmentation are best extracted when firms invest in competitive and high knowledge intensive sectors. Regression results also show that the existing production network and its developments have only marginally improved Malaysian productivity growth from 2000 to 2008. Spillovers from foreign to local industries within the international production fragmentation network are not evident in the model. Finally the study highlighted some additional issues pertinent to the productivity debate in Malaysia for future studies.

JEL Classification: D24, O19, O47

Keywords: International Production Fragmentation, Total Factor Productivity, Spillovers

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1.0 Introduction

Since early 1970s, Malaysia has been an important production base for foreign MNCs. With ample governmental support (such as Export Processing Zones), political stability and abundant cheap local and foreign labour, Malaysia fits the description of an attractive location for international production fragmentation[2]. Since the 1980s, most of Malaysian export oriented industries have been involved in trade in parts and components, an outcome of the international production fragmentation process (fragmentation trade), which mostly consists of low-skilled assembly and labour intensive goods (Menon, 1998). The irony of this is that although the manufacturing sector is highly involved in this seemingly low–value process of the production chain, Malaysia is also part of a group of very fast growing developing economies in the '90s. Its rapid economic growth started a string of growth debates inaugurated by World Bank's *East Asian Miracle* thesis. However, the link between this productivity debate and Malaysia's heavy involvement in international production fragmentation network has been given marginal attention in growth literature.

Literature has shown that in early stages, FDIs are more interested in utilizing cheap inputs in host countries to produce goods for fragmentation trade, hence locking the manufacturing sector in a low value added spiral. As the Malaysian manufacturing sector continues to participate heavily in this new form of production specialization[3], the rhetoric on East Asian productivity growth at the same time evolved from the debate of "miraculous" to the intensively debated "*perspiration versus inspiration*" discourse (Krugman 1994). The union between the literature of production fragmentation and the productivity debate has yet to be studied intensively. In the case of Malaysia, there is yet to be a study of a similar kind that questions whether Malaysia's intensive involvement in the production network has provided productivity gains to its manufacturing industry. The *long- run hypothesis* is that input driven growth will come to a standstill due to the Law of diminishing returns; therefore there is a need to focus on total productivity (TFP) for sustainable growth. In the long run, productivity growth is also supported by linkages formed through technological diffusion

[2] Cross border relocation of production plant based on comparative advantages of host. Other similar terms includes *vertical specialization* (Hummels, Yi, & Ishii, 2001) and *global production sharing/ network* (Athukorala & Menon, 2010)

[3] In 2006, almost 50 percent of total trade in the Malaysian manufacturing sectors is in fragmentation-trade products. Within machinery and transport equipment, 70 percent of ICT exports are intermediate parts and components (Athukorala & Menon, 2010).

between local and foreign firms in. Along with various supportive government initiatives[4], *a priori* here is to assume that international fragmentation could lead to an improvement in technical progress and productivity gains in the manufacturing sector.

Based on the above hypothesis, the main objective of this paper is to study the somewhat neglected but important aspect of international production fragmentation and its impact on productivity. This study will track productivity growth variations for different industries of the manufacturing sector and identify the source of its growth. These sources will be tested under different economic characteristics to simulate the effect of different economic conditions on changes in productivity gains. In addressing the *long-run hypothesis*, this study will use disaggregated manufacturing survey data from 2000 to 2008 to empirically test the hypothesis in the context of Malaysia's manufacturing sector in the later years of international production fragmentation development and its productivity discourse. This paper is an addition to the scarce literature of international production fragmentation-productivity growth nexus, and has strong implications on the "*perspiration versus inspiration*" or *"inspiration by perspiration"* debate. In line with on-going research interests in vertical (efficiency seeking) FDI in developing hosts countries, this paper also adds to this literature by analyzing the impact of a specific form FDI's involvement (through production fragmentation network and fragmentation trade) and its impact on productivity growth.

The following is the structure of the paper: Section 2 will give an overview of the concept and literature surveys on international production fragmentation and the productivity growth debate. Section 3 will provide background on the Malaysian industrialization process. Section 4 surveys some of the measurements on international production fragmentation and the productivity, as well as their limitations. Section 5 will theoretically explain the links between international production fragmentation and productivity growth. This section discusses some of the hypotheses for further analysis in Section 6. Section 7 proposes a regression model and discusses the findings. Finally, section 8 offers the conclusions and policy implications.

[4] Such as the Heavy Industries Initiative (1985), Industrial Masterplan 2 and the Multimedia Super Corridor (1996 - 2005), New Economic Model (2010), etc.

2.0 International Production Fragmentation.

International production fragmentation is a production strategy in which production processes are separated of into "fragments" and dispersed into various strategic (cross-border) locations for efficiency gains. This phenomenon runs parallel to other definitions such as *outsourcing, vertical specialization, global production network/sharing* and *slicing up the value chain*; and is commonly measured by trade in intermediate goods (or parts and components) (Athukorala, 2003; Ng & Yeats, 2001; Hummels, Yi, & Ishii, 2001). The impact of production fragmentation on global trade in intermediate goods (fragmentation trade) has been well documented. Goods travel through different locations for different stages of the production process, before arriving at the final consumer market. The general mechanism of production fragmentation is summarized in Figure 1. It is important to understand this phenomenon because fragmentation trade has grown up to 40 percent over the past quarter of century. Athukorala & Menon (2010) have also found that world fragmentation trade in parts and components have increased from 19 percent to 22 percent from 1992 to 2005[5]. This form of trade is also more intensive in East Asian regions, and has surpassed the growth rates of trade in final goods (Athukorala & Yamashita, 2006).

Given the significance of this phenomenon, there is a considerable amount of research devoted to understanding the determinants and consequences of this new form of production specialization and trade. The typology of research topics in this area can be analyzed from labels **A, B, C,** and **D** in figure 1:

- **A: Studies on the push factors of International Production Fragmentation.**

Production fragmentation was made possible through improvement in production technology which enables the production process to be separated and dispersed into different locations. The reduction in service link costs[6] and differences in fixed and variable production costs in potential host countries also plays an important role in production re-location decisions. External competition has motivated firms to outsource and search abroad for better cost-efficient factors. The international production fragmentation network also enables MNCs to take advantage on the international division of labour. Supportive outward Foreign Direct

[5] Although both studies have methodological differences, the underlying focus on the increase in fragmentation trade remained.
[6] Coordination costs that link production locations to final assembly. Usually, it involves transportation costs, telecommunication costs, quality control costs etc.

Investment (FDI) policies, infrastructural incentives and political (in)stability in host and home countries are important considerations as well.

- **B: Studies on Fragmentation trade patterns**

Some studies on fragmentation trade patterns have been discussed earlier. Trade literature has shown that there is a need to study fragmentation trade and trade in final goods separately when analyzing international trade patterns. Athukorala & Yamashita (2006) argued that trade costs and distance affects fragmentation trade more than final goods, due to the tendency for multiple border-crossings of intermediate goods. Compared to trade in final goods, international production fragmentation has intensified intra-regional dependence through both channels of trade and FDI. However, both goods are complementary to each other. The growth in fragmentation trade also depends highly on the growth of extra-regional trade in final goods.

- **C: Impact of Production Fragmentation on home economy.**

This area of research concentrated more on firms engaging in production fragmentation network and the implications on the *home* economy. Studies concentrate mainly on the impact of production fragmentation on labour and firm productivity (Feenstra & Hanson, 2001; Hijzen, Grog, & Hine, 2005; Egger & Egger, 2006). There is a general consensus that production fragmentation has shifted the demands for low-skilled to higher-skilled labour within manufacturing sectors of the *home* country. Consequently, this improved the wages of skilled workers and resulted in an improvement of productivity. In the long run, by relocating lower skilled production abroad, more *home* resources are reallocated into specializing higher value added activities; hence forcing the upgrade of firms in technical competencies. There are also cost-efficiency gains where firms can now choose higher quality input at lower costs from an extended selection of intermediate goods that were previously unavailable at *home*.

- **D: Impact of Production Fragmentation on host country.**

Finally, research focuses on *host* countries (Country Y and Z) are commonly encapsulated into FDI-related literatures. This is understandable as production fragmentation in host countries is very much channeled by incoming FDIs. Research in this area usually revolves around linkage-generating activities between local input suppliers and MNCs. The primary focus of host country research is to identify positive spillovers from inward-FDI to domestic industries, be it on hard technical skills or soft managerial expertise (Driffield & Noor, 1999;

McCann, 1997; Turok, 1993; Stewart, 1976). Studies on FDI involvement in international production fragmentation are important because different types of FDI activities affect the host economy differently[7]. Menon (1998) explained that foreign firms engaging in intermediate inputs for simple processing and assembly have yet to provide technological spillovers that benefit domestic firms. This may imply that production fragmentation may not contribute to productivity growth in the host economy. Therefore, this area of research is of utmost interest for this paper.

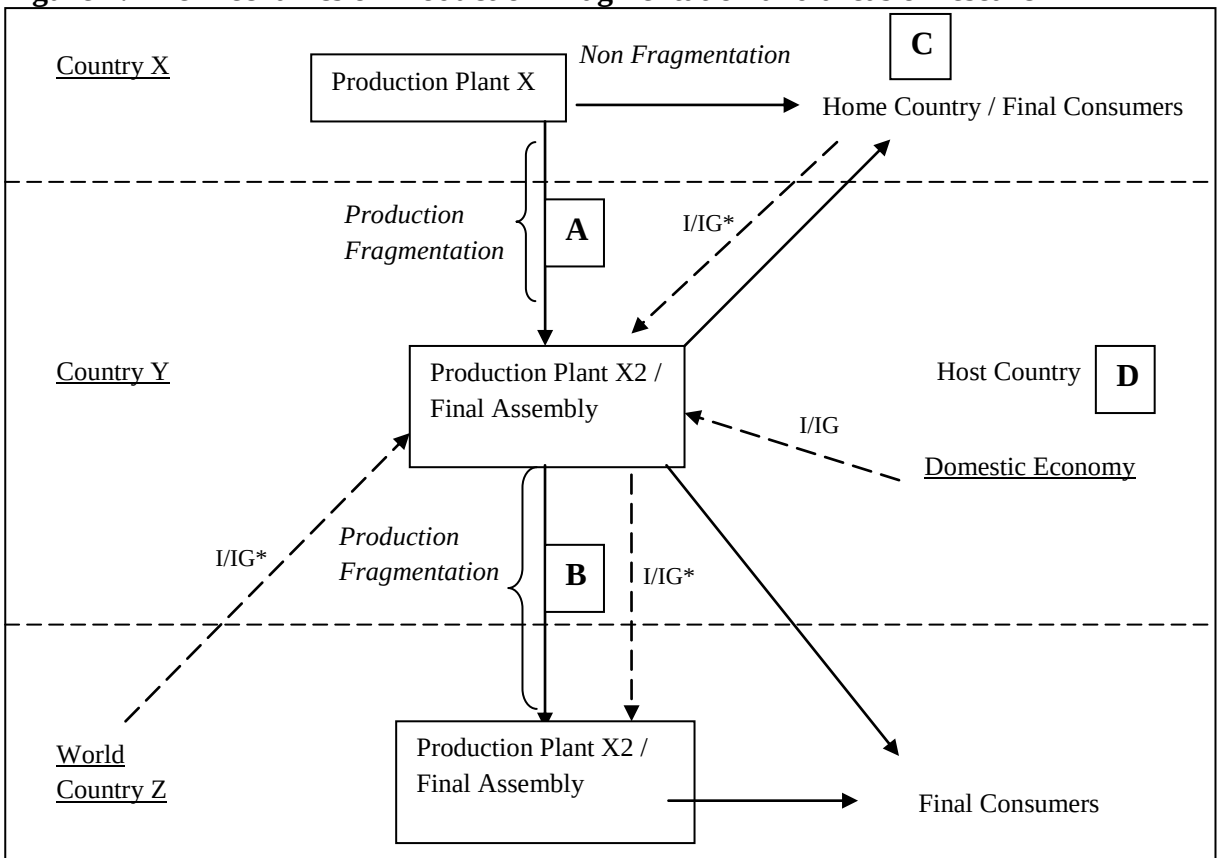
The short review above raises a few questions. Since literature on **C** has argued that in order to improve their (*home*) productivity growth, firms from *home* have to outsource low-skilled and labour intensive activities to *host* (Country Y). The question raised here regards whether "lower-end activities" have detrimental effects to the productivity of the *host* country. Studies hypothesised that *host* economies hold comparative advantage in these lower value activities, therefore the influx of FDI into host countries (may) have a positive impact on employment generation as well as positive externalities in terms of technology spillovers and learning effect. In the long run, as surplus of cheap labour decreases in the *host* country, they will develop their own indigenous technology and gradually progress to a higher-skilled and technology intensive production niche. The *host* country will then emulate the *home* country's model and outsource low-skill activities abroad *a'la* the "flying geese[8]" paradigm. As development in the *host* country moves to a higher value chain, the cycle continues with host country relocating the low value added and labour intensive activities to other countries.

However, it is uncertain whether the production fragmentation network has played a role in facilitating this transformation in Malaysia. If indeed production fragmentation develops along the similar path of this "paradigm", the few proposed research questions are as follows: In the long run, do industries in host country experience higher returns and productivity gains from the production fragmentation phenomenon? Has international production fragmentation moved Malaysia away from the lower end of the value hierarchy into higher-skilled activities in the value chain?

[7] In line with the argument that different FDI motives (market-, resource- and efficiency-seeking) affect the local economy differently (Sadik & Bolbol, 2001).

[8] In this model, Akamatsu (1962) explains that the catching-up process of industrialization of latecomer economies can be attributed to three aspects: intra-industry aspect, inter-industry aspect and international aspect. It is the rhetoric on the international aspect: *relocation process of industries from advanced to developing countries during the latter's catching-up process* that is being discussed in this context.

Figure 1: The Mechanics of Production Fragmentation and areas of research



Note: I/IG – Inputs / Intermediate Goods,
I/IG* - Fragmentation Trade

Description

Production plant X has relocated some "fragments" of the total manufacturing process into Plant X2 in Country Y. If Plant X2 is the final assembly destination, then country Y will be its distribution platform for final consumer goods in the global market. If Plant X2 serves as another processing platform, it will export back to Country X or to another location (Country Z) for further processing or final assembly. The movement of intermediate goods across borders therefore enhances trade (fragmentation trade). Production networks created from international fragmentation have also provided larger opportunity for Plant X2 to use both foreign and local intermediate goods for production. Usually, the total value of fragmentation traded goods substantially exceeds their total value (UNCTAD, 2002).

Source: Author

2.1 The Productivity and Growth Debate

The seminal contributions of Solow and Swan (1956) to economic growth literature opened a plethora of research interests in understanding the sources of economic growth. Research debates in this discipline range from understanding the determinants that affect the differences in economic growth rates between countries (which includes the role of public policies and trade orientation) to decomposing growth into components such as factor accumulation and productivity gains. The first part of this study is a modest attempt to understand the components of economic growth; a the debate which is very similar to studies done by Young (1992); the World Bank (1993); Krugman (1994); Okamoto (1994); Menon (1998); Alvi (1996); Mahadevan (2007); Hal and Aswicahyono (2010),

Studies on the sources of economic growth intensified in the 1990s due to the "*growth miracle*" adage advocated by the World Bank in its 1993 publication *The East Asian Miracle*[9]. The debate inaugurated by the World Bank generated contested views on the fundamental drivers of growth of the region. Under the influence of Kim and Lau (1994), the polemic was further fanned by Krugman (1994) when he associated East Asian's rapid economic growth with the 1950s Soviet Union model:

> "This achievement seems to be a kind of economic miracle. But the miracle turns out to have been based on perspiration rather than inspiration: Singapore grew through a mobilization of resources that would have done Stalin proud" (Krugman, 1994)."

Krugman (1994) argued that there was no *miracle* behind East Asian growth, only capital accumulation. Using neoclassical reasoning, input-driven economic growth is subjected to law of diminishing returns, where output growth is driven purely by putting extra units of labour and capital goods. The contribution of each added input to the production of output decreases in the long run. Holding other inputs fixed, this source of growth is considered unsustainable in the long run. This is where the emphasis of productivity enters the debate circle. In the Neoclassical growth model, the output of a country is a function of its resource endowment and the productivity of its inputs. Since it has been determined that the country's resources will eventually adhere to the laws of diminishing returns, growth in the productivity of production factors or Total Factor Productivity Growth (TFPG) has been viewed as the

[9] The productivity debate in East Asian was initially triggered by Young's (1992) claim that growth in the EA region was input-driven rather than productivity driven.

source for long-term growth. Over the years, this issue has been debated using three schools of thoughts: the *Fundamentalists*, the *Assimilationists* and the *Pessimists* (Filipe, 1997)[10].

Although Kurgman's proposition is argued along the lines of *Fundamentalists* discourse, the negative implications presented in his productivity debate have been argued in a softer tone by other *Fundamentalists* such as La Croix and Lee (1995). Rather than viewing input-driven growth as a perverse form of development path, they argue that many developing countries are content to achieve Singapore's level of rapid economic growth through perspiration alone. They also concede that "*Perspiration*" serves as an "*Inspiration*" for many developing countries.

However, *Assimilationists* such as Drysdale and Huang (1997) disagreed with Kurgman's proposition. They concurred that:

> ... in[an] attempt to identify factors contributing to the East Asian Miracle... A set of frequent[ly] cited factors includes outward-looking development strategy, high domestic saving rates and strong inflows of FDI, technological catch-up..[The] co-existence of rapid accumulation of capital, stagnant technology and fast economic growth may be possible for a certain period of time in a centrally planned economy, such as in the former Soviet Union.. but is unlikely to last for several decades in the market economy of East Asia

Krugman's hypothesis was based entirely on Total Factor Productivity (TFP), a neoclassical tool that came under heavy scrutiny by *Pessimists* such as Chen (1997) and Felipe (1997). The former argued that the different views on the importance of TFP stem largely from differences in the methods in measuring TFP. The latter however, argued that the notion of TFP itself needs to be analysed with caution.

Although these *schools of thought* are heterogeneous in their views, the underlying consensus on the importance of productivity-driven growth (TFPG) is unanimous. In explaining TFPG, this paper will encapsulate the different viewpoints that have been raised above. While input-driven growth is considered important for obtaining resources for economic development, highly open economies such as Malaysia also embraces spillovers from foreign partners as a source for technological progress and managerial expertise. This paper would like to assume that although TFP may be a less-than-perfect measurement of

[10] Fundamentalist argue that East Asian countries growth were attributed to input accumulation and not TFP. Assimilationists believed that productivity of East Asian economies grew by learning from foreign partners (through FDI). Pessimists however believed that the productivity debate has been misplaced due to the questionable methods in measuring TFP.

productivity, it provides a standard yardstick to measure productivity influences on the economy. For example, intergovernmental organizations such as the Asian Productivity Organization (APO) have been established since 1961 to improve the socioeconomic development of Asia and the Pacific through productivity enhancement. Even if measurement techniques are questionable, TFP values obtained using a standardized method can be an important tool for comparative inter-country studies. A number of studies have used this approach to identify productivity growth in both the country and the industry settings (see Mahadeven 2007; Alvi 1996; Menon 1998; Hill & Aswicahyono 2010). The next section will identify the literature on productivity growth in Malaysia and attempt to understand the reasons for the longevity of this debate.

2.2 TFP literature on Malaysia: A literature survey

In general, there are three different types of TFPG studies on Malaysia. The most common is the cross-country analysis. In this type of study, Malaysia is sampled along with other countries with similar characteristics and analysed at the aggregated economic level (Ikemoto, 1986; World Bank, 1993; Drysdale & Huang, 1997; APO survey report 2004). Literature has shown that even before the East Asian *Miracle* debate, Ikemoto (1986) studied the relationship between productivity and economic growth for Asian countries using the fundamentals of "Verdoorn's Law"[11] ie, a faster growth of output induces productivity through increasing returns. He concluded that this relationship exists and is only made possible through available technological innovations. Most studies built on this growth-productivity relationship, with variations only in the time-frame of analysis and computational methodology. Since these studies were all implemented at the country-level, TFPG in different sectors of the economy were not captured. There are concerns raised on the credibility of country level studies. Mahadevan (2002) argued that labour move from less productive sectors to more productive ones, and therefore artificially increases country TFPG without any real changes in sectoral TFPG. This concern is valid in the case of Malaysia due to its structural shift[12] from an agro-based to a manufacturing intensive country since the 1980s

[11] The paper also advocated the possibility of Gerschenkorn's "borrowed technology" hypothesis where developing economies will grow faster due to technology "borrowed" from early movers.
[12] However, since the focus is only on the manufacturing sector, this problem is negligible.

The second form of TFPG literature is case studies analysed at industry and firm-level. The common structure of this form begins with the analysis of variations in TFPG rates, followed by the identification of the determinants that influenced them. As disaggregated industry-level data are becoming more available, these studies have further taken into research considerations industrial characteristics such as the ownership differences (Menon 1998; Oguchi *et. al.* 2002) and trade regime (Okamoto 1994; Alavi 1996; Tham 1997). These literatures unanimously show that the Malaysian economic growth is very input-dependent. Positive TFPG varies across different sectors and differs accordingly to the timeline that is being used. Case-studies deepened the understanding of the links between firm characteristics and TFPG. For example, Menon (1998) showed that from 1988 to 1992, the TFPG of foreign-owned firms is lower than that of Malaysian owned firms. This finding challenges the *Assimilationist's* argument because if foreign firms are less technology intensive than the locals firms, the presence of technology spillovers from foreign firms is dubious. Technology diffusion between foreign and local firms is insignificant because foreign firms are merely engaging in labour intensive assembly and processing activities, which is a 'fragment' of the lower value process in the international production network[13]. Although not specifically explaining the links between international production fragmentation and productivity, this is considered one of the earliest known studies that may have (implicitly) bridged the productivity and international production fragmentation literature on Malaysia.

Other literature reviewed in this section also implicitly carry elements that are crucial to the understanding of the productivity-fragmentation nexus examined later in this study. One important element is the foreign involvement in the Malaysian manufacturing sector. In addition to Menon (1998), Oguchi *et. al.* (2002) have analyzed firms from 1992 to 1996 and showed that in aggregate terms, the TFPG difference between foreign and local manufacturing firms are negligible. Only foreign firms in electronics, petroleum and transport equipment sectors have shown TFPG improvements. Other widely discussed elements involve the impact of economic policies on TFPG. Two contrasting studies, Okamoto (1994) and Alavi (1996), both analysed the impact economic openness and the impact of different trade regimes on productivity growth. The former has found complementary effects between economic openness (ie, increase in trade from FDI liberalization policies) and productivity

[13] His study complements Tham's (1997) proposal that human capital formation is important for productivity gains especially during high-growth periods.

growth. Foreign firms entering the *host* market have brought along substantial productivity and efficiency improvements to local firms. On the contrary, the second study showed that TFPG is unaffected under different industrial regimes (be it import-substitution or export-orientation). For example, industrial protection (along the tariff-driven infant-industry line of argument) has no significant effect on TFPG.

The final strand of TFP study involves technical decomposition of the productivity indicator. Kim & Shafi'i (2009) decomposed Malaysian TFP into four elements: technical efficiency change, technical progress, scale efficiency change, and allocative efficiency change. They observed firm level data and decomposed TFPG of the manufacturing sector[14]. Their study concluded that the first two elements are crucial in determining TFPG. The quality of employees is the most significant determinant for technical efficiency. Other determinants such as the impact of firm imports and exports only affect electronics and transport equipment industries. Table 1 summarizes estimated TFP figures of the Malaysian economy from previous studies. The caveat here is the need to understand that different studies use different measures; therefore results vary and should only be taken with a grain of salt.

Table 1: TFPG studies and estimates for Malaysia

Source	Year	Research period	TFPG (%)	
			Economy Aggregate	Manufacturing Sector/ notes
Ikemoto	1986	1970-1975	1.4	
		1970-1980	1.7	
		1975-1980	1.8	
World Bank	1993	1960-1989	1.1	
Kawai	1994	1970-1990	1.6	
Okamoto	1994	1981-1985	-1.9	
		1986-1990	0.3	
Drysdale & Huang	1995	1950-1990	-0.5	
Tham	1997	1986-1991		Overall Manufacturing = 0.003
Menon	1998	1988-1992	0.2	• Malaysian Owned = 0.67 • Non –Malaysian owned = -0.21
Mahadevan[a]*	2001	1981-1984		0.11(TE = 0.03, TP = 0.08)
		1987-1990		-0.54(TE = 1.17, TP = -1.71)
		1991-1996		-0.99(TE = -1.42, TP = 0.43)

[14] Correspondence with Shafi'i revealed that firm level data are not published by the Malaysian Department of Statistics. However as Shafi'i is a researcher in the Malaysian Productivity Corporation, her study had access to firm level data through government-to-government departmental agreement.

	2007	1971-1979		0.94(TE = -0.31, TP = 1.25)
		1980-1989		1.37(TE = -0.57, TP = 1.94)
		1990-1999		0.88(TE = -0.28, TP = 1.16)
		2000-2002		0.61(TE = -0.36, TP = 0.97)
		1971-2002		1.01(TE = -0.40, TP = 1.41)
APO survey	2004	1981-2001 (time series data)	Highest value = 3.9 in 2009 Lowest value = -8.4 in 1998	
Kim & Shafi'i*	2009	2000-2004		• Electronics = -0.032 (TE = -0.046, TP = 0.045) • Textiles = -0.028 (TE = -0.037, TP = 0.045) • Transport Equipment = 0.046 (TE = -0.012, TP = 0.036) • Chemicals = 0.165 (TE = -0.012, TP = 0.036) • Food = -0.112(TE = -0.105, TP = 0.033)
Malaysian Productivity Corporation report	2009	2000-2009		0.57

Note: 1) TE = technical efficiency, TP = Technical progress
2) * represents frontier approach
3) [a] This study uses industry level data for the frontier approach. However, the previous section questioned the implementation of this technique at the industry level.

3.0 Malaysian Industrialisation experience.

3.1 Overview: Malaysian Industrialisation Background and Challenges.

- **First Phase (1957-70): Import Substitution Industrialization Strategy (Round 1)**

On the 31st of August 1957, Malaysia (or Malaya pre-1964) achieved its independence from the British colonial rule. Despite having a dominantly plural society fusion with different political views, culture and ethnic identity, the transition into independence was peaceful, smooth and relatively well prepared compared to other colonies (Hill, 2005; Menon, 2009). In general, the Malaysian economy inherited the same characteristics that were introduced by the British[15], namely, an export-oriented regime, well developed infrastructure system, minimal state interventions and a well-organized government administration. After independence, structural changes in the Malaysian economy followed the similar pattern experienced by most developing countries- a shift out of the agriculture and into the industrial sector. Malaysia's general industrialization progress

[15] Some scholars attribute the early success of the Malaysian economy to the impact of colonialism before independence (B. Higgins, 1976). This was echoed by the "inherited institutions" argument that contributed to Malaysia's high growth success story (Hill. H, 2005)

and strategies are summarized in Table 1. Following the steps of many early developing countries, import-substitution (I-S) industrialization was the earliest adopted strategy. The promotion of infant industries began upon suggestions from the World Bank after their trade mission visit in 1963. The use of tariffs and non-tariff protection at that time were aimed at reducing the dependency on imported foreign consumer goods, as well as encouraging domestic players to participate in the market. Initially the policy was successful in diversifying the economy, reducing import dependency, creating employment and improving economic growth. Contribution of the manufacturing sector to GDP expanded four percent from 1957 to 1969 (*First Malaysian Plan* 1965-1970). In the '60s, manufacturing sector increased by 10.2 per cent per year (*Second Malaysian Plan* 1971-1975).

However, the success of I-S policy was impeded by the limited size of the domestic market. Industrial growth stagnated due to several reasons. First, balance-of-payments problems were exacerbated by heavy imports of capital and intermediate goods. Second, surplus production under the I-S strategy was unable to spill over into the export market (Alvi, 1996). Towards the end of the '60s, the I-S strategy was deemed unsustainable. The switch from an I-S to an export-oriented (E-O) strategy was due to both external and internal pressures. The "*Flying Geese*[16]" paradigm of the early '60s elucidated the opportunities and benefits for developing countries in opening their markets. Internal factors, however, were strongly driven by social and political issues. The mix of different ethnic groups in Malaysia handed an early challenge for the then-ruling party to perform balancing acts between economic growth and income redistribution. However, the non-improving economic status of the largest ethnic group (the Malays, or *Bumiputera*[17]), the rise in urban employment and the dissatisfaction among the non-Malays about their education and language rights (Menon, 2008) highlighted the fragile social fabric *circa* the 1960s. The growing discontentment ultimately erupted in a form of bloody riot on the 13th of May 1969. The switch to the E-O strategy was therefore done in anticipation that high economic growth would reduce unemployment and correct social economic misalignments by providing wealth generating opportunities to *Bumiputeras.*

[16] In this model, Akamatsu (1962) explains that the catching-up process of industrialization of latecomer economies are attributed to three aspects: intra-industry aspect, inter-industry aspect and international aspect. It is the rhetoric on the international with *relocation process of industries from advanced to developing countries during the latter's catching-up process*, that is being discussed in this context.

[17] Literally translated as "sons-of-soil". It is a widely used Malaysian term embracing ethnic Malays and other indigenous ethnic groups.

- **<u>Second Phase (1970 – 1980)</u>: Export Orientation Industrialization Strategy (Round 1)**

The introduction of the Investment Incentives Act 1968 initiated a new phase in the export promotion era. The Act offered various incentives such as company tax exemption, duty exemptions for procuring imported inputs, investment tax credits, and accelerated depreciation allowances on investment and tariff protection (Menon, 2008). Again, in resemblance to the *flying-geese* process, it is within the government's aim to prepare an attractive economic environment to host incoming FDIs. Also, upon realizing the need to attain higher technological competencies and capital accumulation, efforts in promoting exports and attracting foreign FDIs were further augmented by the development of Export Processing Zones (EPZs) and Licensed Manufacturing Warehouses (LMWs) in the early 70s. These EPZs and LMWs provide appealing domains for foreign investors to relocate their production bases into Malaysia for export-oriented activities. This created an *agglomeration effect*[18] in the manufacturing industry. Foreign investors utilize the subsidised facilities and infrastructures as well as the incentives provided within the EPZs (such as tariff exemption for imported intermediate goods, Labour Utilisation Relief and Export Credit Financing).

The LMW program extends beyond the proximity of the EPZs. Firms with the LMW status extended similar duty-free imports of raw materials, tax incentives measures and minimised custom's "red tape". However, since they are not located within the EPZs, they were unable to utilise the facilities provided within zones[19]. Under these development initiatives, the manufacturing sector itself underwent a structural change in the concentration of manufactured exports: from food, wood, chemicals and metal industries (in the '60s) to electrical and textile industries. Electronics and electrical (E&E) industries benefitted most from EPZs. Warr (1985) showed that 89 percent of Malaysian exports in E&E goods are produced from EPZs. In comparison with those in EPZs, firms with LMW status are smaller in size, and are better established in labour-intensive textiles and garment industries (Cho, 1990). Since 1970, both industries have been the fastest growing industries in manufacturing exports. (Bank Negara, 1990). By 1980 the share of E&E in total manufacturing exports increased 41 percent while textiles and apparel increased 8 percent.

[18] Firms located in clusters benefit from economies of scale (input cost competition between firms) and network effect (specialization and greater division of labour). A concept related closely to international production fragmentation network.

[19] LMWs however, have added incentives if firms are being located in development areas (Cho, 1990).

While economic growth in that period was impressive, there were discourses that held that international competitiveness in the 1970s had been artificially created through export-orientated industrial enclaves such as EPZs (Alvi, 1996). Although attractive to foreign investors, EPZs were generally isolated and lacking in terms of deepening linkages with the local economy. Not discounting the EPZs contributions in terms of employment creation, concerns were mainly targeted at the ability of EPZs to integrate with the local economy; be it through purchase of domestic raw materials or capital equipment investments[20]. Another observation is the lack of policy initiative and enforcement in transforming inefficient I-S industries into competitive E-O producers. The FTZs and LMWs have created an export intensive (and exclusive) industrial cluster catering specifically for the international markets, leaving most industries outside of the enclaves to produce for the domestic market. Some of these industries are still heavily protected under the I-S strategy. Previous tariff protection practices continued under the infant-industry protection argument i.e. to protect until they are capable of competing internationally[21]. The dichotomy of development strategies operating in parallel has created a "dualistic industrial structure[22]" in the Malaysian economy (Cho, 1990; Alvi, 1996).

The lack of linkages between the "dualistic" enclaves posed a problem as Malaysia moved toward the 1980s. Export-oriented industries were limited to a small range of manufacturing products and local resources were underutilized due to the duty-free incentives targeted on intermediate imports in the EPZs. The world economic recession in 1980 reduced the Malaysian current account balance per GDP to a negative value for the first time in five years and a year later, it fell another 8 percent. A reduction in export prices and excessive imports of capital goods has led to a further deterioration of the balance-of-payment. Therefore in an effort to expand the variety of exported products, strong backward and forward linkages were created to diversify the manufacturing sector (Malaysian Government, 1993). This subsequently moved Malaysia into its next industrialization phase.

[20] To be fair, Warr (1987) explains that the lack of linkages was not due to the unwillingness of foreign firms in EPZ to use domestically produced intermediate goods, but rather the inability to obtain them domestically at the desired standards.

[21] However, the protection criteria gradually became more selective and reviews on the justification for protection were more frequent as development progressed (Second and Third Malaysian plan, 1971, 1976).

[22] Cho (1990) explained that this industrial structure is undesirable because it creates a divide in terms of the distribution in geographical development in Malaysia. Government allocations for development in the West Coast states (where EPZs were located) are higher, leaving less for other areas. Second, industrial dualism also affects economic efficiency where misalignment of prices from producers between EPZs and local economy has occurred in the textile industry (Shepard, 1980). Finally, the issue raised by Warr (1987) on the weak linkage creation between MNCs in EPZs and local economy applies in this context.

- **<u>Third Phase (1980 – 1985)</u>: I-S Strategy (Round 2)**

With a surplus of oil revenue, and infused with inspirations gathered from the successes of Korea and Japan iwith their heavy industrialisation strategy (under the "*Look East Policy*"), the government invested heavily in capital-intensive industries as a move to diversify the manufacturing sector. In the early 1980s, initiatives to develop heavy industries were supported primarily through public sector investment (Alvi, 1996). A public-sector holding company (Heavy Industries Corporation of Malaysia, HICOM) was formed in 1981 to forge partnerships with foreign companies in setting up heavy industries in selected areas such as petrochemicals, iron and steel; and transport equipment. These industries served as a base for developing indigenous technology as well as an avenue for upgrading labour skills. Projects such as the national car industry PROTON (The National Automobile Enterprise) have created extensive backward (parts and components suppliers) and forward linkages (car distribution services), hence generating employment and entrepreneurial opportunities for local entrepreneurs. With such high "*national interests*" at stake, these industries were promoted through heavy protective measures such as tariff protection, price control, government procurement provisions, import restrictions and subsidised credit.

Even with the implementation of a protectionist strategy, the success of these heavy industries has been insignificant. Apart from heavy financial losses, they were also unable to compete in the international markets despite being heavily supported by the government (Malaysian Government, 1989). Scholars argued that the failure of the heavy industry program was attributed to the over-protective state led industrialization strategies that have distorted market competitiveness and which in turn has shaped firms into operating in highly inefficient conditions. Consequently, in 1982, the budget and current account deficits had widened by 13 and 16 percent respectively. High operational costs forced the government to spend excessively. As a result, in 1985, Malaysia's GDP growth was, for the first time, reduced to a 1.1% contraction. The government realised that public-owned industries were underperforming, so it re-strategized its industrialization policy. Subsequent strategies were formalized to move away from the I-S framework. While certain industries were still being protected, government focused its efforts on attracting foreign investments in non-protected industries. The initial step was to liberalise the restrictions on foreign ownership through the

Promotions of Investment Act of 1986[23]. This inevitably started the second phase of E-O industrialization in Malaysia. The difference between this phase of the E-O strategy and the previous one lies in the government's greater emphasis on learning from the FDIs in the economy.

- **<u>Fourth Phase (1986 and beyond)</u>: E-S Strategy (Round 2) with Industrial Upgrading strategy (I-U) Round 1 (1996) and I-U Round 2 (2010).**

In a move to increase foreign investments, the Investment Incentives Act 1968 was replaced by the Promotion of Investments Act 1986. Additional incentives have been allocated to small and medium-scale industries that exhibit linkage-creation potentials. Further liberalization efforts include the relaxation of foreign equity guidelines, where foreign investors were able to own up to 100 % equity, subjected to their export targets. Parts of The Industrial Co-ordination Act 1975 were liberalized after 1985 to promote the growth of local small and medium industries (SMIs)[24] to create competition in the suppliers' market. Apart from various tax-exemption incentives, financial support such as the Export Credit Refinancing (ECR) scheme was also made available. Industrial development was guided by a ten-year Industrial Master Plan (IMP), which provided a framework for developmental direction for the industry. Since 1980, three IMPs have been implemented. The first IMP (1986-1995) gave priority to 12 sectors which demonstrated high comparative-advantage in resource and non-resource based industries. To address inefficiency issues, government restructured state-owned enterprises and privatized them under the Privatization Masterplan (1991). At this phase, the Malaysian government planned to shift Malaysia into a "developed country status" by the year 2020 through the *Vision 2020* proposal. One method to realise this long-term vision is to move the manufacturing sector away from labour intensive into higher value added and knowledge-based production niches.

- ***Industrial Upgrading 1***

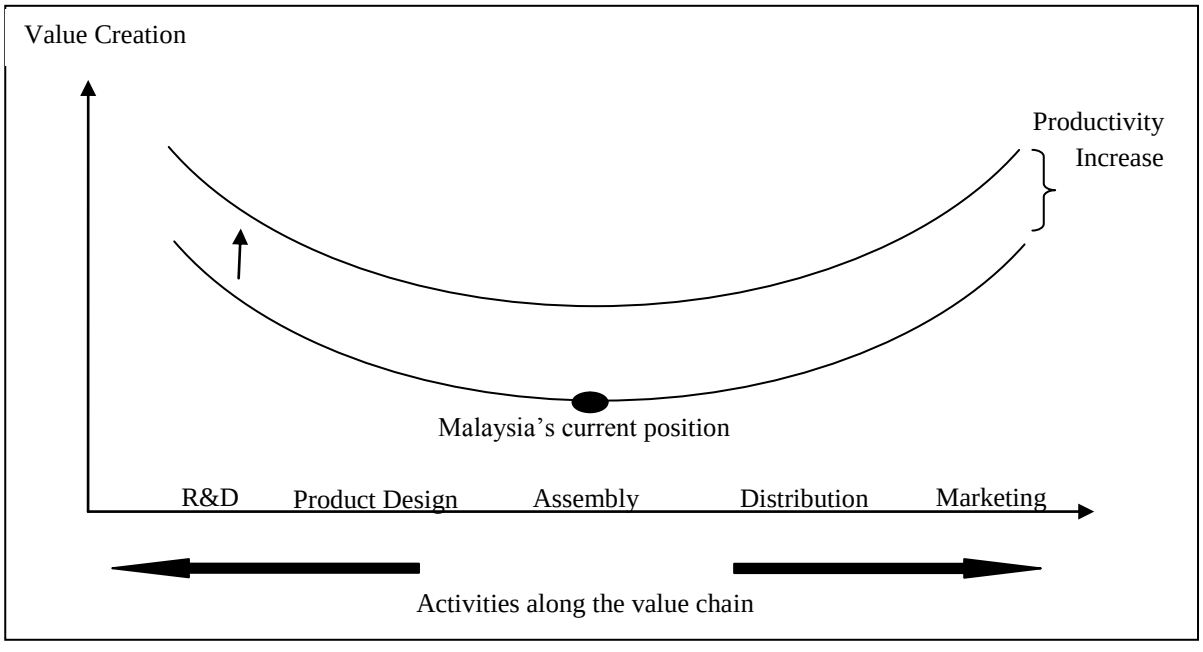
The second IMP (1996–2005) was formulated to upgrade the Malaysian manufacturing sector from a generally labour-intensive sector into a knowledge-based sector

[23] Under this Act, 100 percent foreign equity is permissible if the foreign enterprise exports at least 50 percent of its product(s) that does not compete with local industry, or if it exports 80 percent of its products regardless of competition with locals.

[24] Initially, companies with RM 250,000 shareholder funds or 25 workers are subjected to operating licenses but the amendment relaxed the requirement to RM 2.5 million and 74 full time workers.

with higher value added activities. The plan was seen as a response to Krugman's critical (*Fundamentalists*) comments that growth in Asian countries based on input-driven initiatives rather than productivity driven output (Krugman, 1994). In addition, the growing importance Malaysia's involvement in the international production fragmentation phenomenon has raised awareness among policymakers of the importance of intensifying participation into these production networks. The policy proposed the Manufacturing ++ (plus plus) and 'cluster-based' approach. The Manufacturing ++ strategy focuses on two issues shown in Figure 1. First, domestic industry expansion will focus on higher value added activities along the value chain (such as R&D, Product Design, Distribution and Marketing). The second strategy is to lift the value chain by improving productivity. The IMP2 proposed eight industrial clusters to drive industrial development: E&E, transportation, chemical, textile and apparels, resource-based, materials and advance materials, agro-based, and machinery and equipment. These clusters, in return, will enhance the participation of SMIs, upgrade human resource technical skills and strengthen the value chain. However, the success of IMP2 is vague due to lack of proper reviews on its implementation. R&D remains low (0.5 percent of GDP) and participation in high value added activities of the global supply chain is still low (Ohno, 2006). The uninvited 1997 Asian Financial Crisis also shifted some of the government development agenda into recovery purposes. Therefore, some development programmes were halted and brought to the next (third) IMP.

Figure 1: Industrial-Upgrading strategy, IMP2 – Manufacturing "plus plus" strategy



Source: Re-illustrated from IMP3 concept and Ohno (2009)

The Third IMP (2006-2020) marked the government's extended effort to address global competitiveness. Efforts to strengthen industrial clusters in IMP2 are forwarded into the plan- with addition elements such as inter-cluster linkage creation. Quantitative targets have been imposed selectively within various clusters. Along with the specific performance targets, 10 strategic thrusts are proposed to steer Malaysia into a developed nation by the year 2020. Relevant to this study, two of the strategic thrusts: Enhancing Malaysia's position as a major trading nation and Integrating Malaysian companies into regional and global network shows that Malaysia has kept its export orientation strategy. These thrusts also imply that international production fragmentation activities will be the driving force of Malaysia's economic growth and development.

- ***Industrial Upgrading 2 – New Economic Model (NEM)***

The New Economic Model is a development plan crafted to move the country out of the middle-income trap through different Economic Transformation Programme (ETP). The focus on moving Malaysia to being an advanced nation by year 2020 has evolved. Now, instead of getting out of the "*middle income trap*" has become the new catchphrase in policymaking discourse. This model is a combination of economic growth initiatives with efforts for social inclusiveness and development sustainability. Some of the *"new approaches"* for upgrading include the stronger focus on productivity-driven growth, retaining and attracting skilled professionals and supporting technologically capable industries and firms. The ETP is supported by seven Strategic Reform Initiatives (SRIs) which also include the importance of building knowledge-based infrastructures and the development of a quality workforce. While some of the suggestions were merely extensions from previous development plans, the model sets a clear tone for local inclusiveness and needs-based development strategy. SRI such as the development of a transparent and market friendly needs-based affirmative action program has long been overdue. The plan acknowledges the importance of the manufacturing sector and foreign investments in shaping Malaysian industrialization development:

> "We have established a world-class manufacturing base…Manufacturing was primarily focussed on the E&E sector by attracting large inward investment by multinational firms…. Malaysia's strategic location will serve to attract investment to build transportation and logistics hubs. Malaysia's rich endowments will help to attract foreign direct investment (FDI) and foreign portfolio investment (FPI)"… (NEM executive summary, pp.8)

After reviewing some of the Malaysian industrialization strategies, Malaysia's strengths seems to lie in its economic openness to trade, its supportive policy initiatives for FDI and industrial upgrading, and its active participation in the international production fragmentation network. The following sections will test whether all these government initiatives have affected current TFPG in the manufacturing sector between 2000 and 2008. An interesting research gap here is to understand how all these development strategies and upgrading initiatives bridge the missing links between the TFP debate and international production fragmentation. The subsequent sections will attempt to tie these fragments together.

Table 1: Industrial strategies, development stages and trade policies in Malaysia, 1957 – 2009

Industrial phases	Trade / industrialization Policies	Policy instruments and emphasis in Manufacturing production
Phase 0 • **After independence in 1957**	Inherited export-oriented strategy. (pre-1957)	• Agriculture – Rubber, black pepper. Manufacturing – tin mines • Divide and rule policy
Phase 1 • **Arrival of Manufacturing FDI**	Implemented Import – Substitution Strategy (1957 -1970)	• Domestic market focus • Substituting simple imported consumer goods • Investment Incentives Act, 1968 – moving into export orientation
Phase 2 • **Agglomeration effect**	Export orientation Strategy (1970 – 1980)	• Establishment of Free-Trade Zones • Electronics & textiles for exports
Phase 3- • **Technology absorption**	Import Substitution II (1980-1985)	• Selected Heavy industry program - HICOM • Look East Policy (1981) – learn from Japan and Korea
Phase 4 • **Upgrading 1**	Export orientation II (1985 – 2005)	• Industrial Master Plan 1 & 2 • Promotion of Investment Act and ICA guideline relaxed. • Action Plan for Industrial Technology Development • Resource-based industries • Manufacturing ++ **(industrial upgrading initiative round 1)** • Cluster approach – Internationally linked and policy driven • Vision 2020 (1991)
Phase 5 • **On-going, New Economic Model**	Continuation on Export orientation strategy (2005 – present)	• Industrial Master Plan 3** • Various "Strategic Thrusts" and policy measures for specific areas of External trade; Investments; Development of SMEs; Branding; Growth areas in the manufacturing sector; Growth areas in the services sector; Development of the *halal* industry; Enhancing domestic capabilities; Human resource requirements; ICT and other technology developments; and logistics. • New Economic Model **(industrial upgrading initiative round 2)**

Note: ** The plan extends from 2006 to 2020

4.0 Measuring International Production Fragmentation

Studies on quantifying the international fragmentation network are limited. Thus far, there is no an official indicator that represents that phenomenon. Here, I highlight most of the unofficial measurements of international production fragmentation. In general, researchers manipulate trade data to characterize the development and intensity of the international fragmentation process. Production Fragmentation is defined similarly to *vertical specialization* (Hummels, Yi, & Ishii, 2001), a condition where the level of imported intermediate parts and components being utilised to produce goods for further exports. With reference to Figure 1, Country X produces intermediate goods and exports them to Country Y. Country Y uses these intermediate inputs and combines them with domestically produced inputs. Country Y will then export to country Z, either in the form of final goods or as another form of intermediate good for further processing. Based on these descriptions, the most ideal measurement here would be to use data from the Input-Output (I/O) structure of trading nations. However, the low frequency on these datasets complicates time series analysis and the high industrial aggregation in I/O reports hinders detailed analysis.

The second possible method is to use data on trade in parts and components (fragmentation trade) to proxy for the cross-border development in fragmentation trade (Ng & Yeats, 2001; Athukorala, 2003). Information on parts and components is extracted from United Nations Commodity Trade Statistics Database (UNComtrade). This method provides consistent data points and enables analysis on a wide range of products up to 5-digit *Standard International Trade Classification* (SITC). While it is an ideal method, it suffers from selection bias problems, meaning the reported parts and components are more focused in SITC-7 and SITC-8 product groups. Since this study is focused on the manufacturing sector, this problem is trivial. The only problem with this method is the concordance between trade and industrial data. This research uses the *Malaysian Annual Survey of Manufacturing* where industries are coded, based on the year 2000 Malaysian Standard Industrial Classification (MSIC). Combining trade classifications with the MSIC is complex and will result to measurement errors if codes were incorrectly matched.

An alternative is to apply the vertical-specialization definition proposed by Hummels et. al (2001):

$$FR = \left(\frac{M_F}{Q} \right) * X \qquad \text{..... (1)}$$

where F indicates the production fragmentation index[25], while M_F represents imported intermediate goods and Q is gross output (which embeds both domestic and foreign intermediate goods). The share of intermediate goods in gross output $\left(\frac{M_F}{Q}\right)$ is used as a weight to represent the portion where imported intermediate goods are being processed into exported output X. This method is justified under three conditions that summarized the definition of international production fragmentation (or vertical specialization as noted by Hummels in their paper):

- First, goods are produced in different sequential stages. Each stage requires different inputs either obtained locally or internationally.
- Second, more than one country specializes in one "fragment" of the production process. This represents the relocation strategy based on comparative advantage.
- Finally, the products produced in the host country are exported as final goods or as parts and components for further processing in another stage.

The flow of all three conditions are easily identified in Figure 1 (refer Section 2). First, Country X, Y and Z represent different stages of the production processes. Label **A** represents the second condition on the production relocation process. The ratio between imported intermediate goods and gross output shows both first and second conditions. Gross output highlights the use mix of local and foreign intermediate goods while the imported input (I/G and I/G* from country X and Z) shows the global links and network of the production fragmentation process. Finally, label **B** represents the third "export requirements"condition. The ratio is finally multiplied with exports to indicate how the entire process is embodied in the host country's exports.

The third condition warrants further discussion. Similar to "outward processing trade", "offshore assembly programs" or "Mexican Maquiladoras", Hummels' definition on international production fragmentation hinges closely to a specific type of production fragmentation process where parts and components produced in host countries are being (re)exported to other production bases after being processed in host countries. However, some production networks only cater primarily to the domestic (host) market (e.g the

[25] Hummels, Yi, & Ishii (2001) pg 76 has mentioned that their indicator is similar to "fragmentation" studies. Therefore instead the original name *"*vertical specialization*"*, this study renames the indicator to Fragmentation (FR) to match the relevance used in this study.

automobile industry in Malaysia *à la* market seeking FDIs). Nevertheless, this study focuses on the former group for a few reasons. First, by addressing the export component, the characteristics of international production fragmentation in Malaysia are better accentuated as the largest manufacturing sector (the ICT sector) is both network- and export intensive. Second, the survey database used in this study, *Annual Survey of Manufacturing Industries,* shows that locally or foreign owned industries[26] engage in trade activities (be it imports of intermediate goods or exports). Hence imposing Hummel's third condition does not seem overly restrictive.

4.1 Measuring Productivity

4.1.1 Background

Productivity growth is defined by the increase in the ratio of output per input. An increase in productivity is interpreted as an increase in output using the same amount of inputs. Similarly, it means input-saving techniques that produce the same or higher amount of output. Both definitions relate closely to the notion of efficiency in using inputs or technological improvements in production techniques and management. Measuring the productivity of one input (partial productivity measurement) is common. For example, labour productivity (measured in terms of output per unit of labour), is a familiar indicator used by the International Labour Organization (ILO) to identify levels of human capital and skills. Measuring the productivity of multiple inputs becomes, however more complicated because of the difficulty in identifying the intensity of various input contributions to output. To capture "total" productivity of factors, one has to turn to the neoclassical concept of Total Factor Productivity (TFP). As mentioned in Section 2.1, using the neoclassical framework, economic growth is separated into two sources: factor accumulation (e.g capital and labour) and TFP. One can combine the ratio of output to input with the production function to derive a measure for "total" productivity.

The general form of 'total' productivity ratio (input per output measure, assuming inputs consist of labour, L, capital, K and intermediate goods, M):

$$\Omega = \frac{Y}{L^{\alpha} . K^{\beta}} \text{ (assuming geometric representation)} \quad (2)$$

[26] Locally owned = majority of shareholders / owners are local. Ditto foreign

where Y represents gross output, and α and β are the contribution 'weights' of the respective inputs and Ω represents the efficient level of all inputs (K, L) used to produce Y. To solve the weighing problems, neoclassical economists utilise the production function and transform the function it into a ratio form:

$$Y_t = F\{K_t, L_t, t\} \quad \text{.....(3)}$$

Where t represent the time factor that measures technical progress and productivity. By assuming t is separable (disembodied) from K and L over time, the production function is as follows:

$$Y_t = A_t F\{K_t, L_t, M_t,\} \quad \text{.....(4)}$$

transforming the expression into ratio form,

$$A_t = \frac{Yt}{F\{Kt,Lt,Mt\}} \quad \text{..... (5)}$$

Equation (5) ≈ Equation (2) where A_t is an index that measures change in output with input being held constant. Change in A_t does not affect the optimal level inputs, thus is defined as *Hicks-neutral* technical progress. Therefore, it measures factors beyond labour and capital that contribute to output. These factors can be managerial capabilities and organization competence, research and development, policy and technology diffusion from the MNCs (Filipe, 1997). Equation (5) is a static index that shows the level of TFP at one point in time. Therefore it is problematic to directly use TFP values in levels for comparative studies between economies or industries due to measurement heterogeneity in the data on input between countries (Mahadevan R. , 2002). One method to avoid this is to express TFP in growth rates ($\frac{\partial At}{\partial t}$). Here, TFP growth (TFPG) measures changes such as learning-by-doing, technical progress, improvements in organization structure and worker-management relations (*see* Solow, 1956; Farrel, 1957 (on productivity efficiency); Abromwitz, 1956).

4.1.2 Growth accounting Method[27].

The *neoclassical* growth accounting (Solow Residual) method decomposes output into input growth and TFP growth (TFPG). Based on Equation (4), assume A_t to be Hicks-Neutral and

[27] E-mail correspondence with a senior consultant from the Malaysian Productivity Corporation revealed that the Malaysian official TFP figure uses this method as well. However this study augments the official method by introducing adjustments to capital and labour (further explanation in later section).

F is a function homogenous of degree one (constant returns to scale), therefore TFPG can be obtained by differentiating it with respect to time:

With

$$Y' = \frac{\partial Y}{\partial t} = \frac{\partial A}{\partial t}.\, F\{K_t, L_t, M_t\} + A_t \frac{\partial F}{\partial K}.\frac{\partial K}{\partial t} + A_t \frac{\partial F}{\partial L}.\frac{\partial L}{\partial t} + A_t \frac{\partial F}{\partial M}.\frac{\partial M}{\partial t} \quad \text{.....(6)}$$

To obtain proportionate change in output ($\frac{Y'}{Y_t}$), divide (5) by Y_t,

$$\frac{Y'}{Y_t} = \frac{A'}{Y_t} F\{K_t, L_t, M_t\} + A_t \frac{\partial F}{\partial K}.\frac{K'}{Yt} + A_t \frac{\partial F}{\partial L}.\frac{L'}{Yt} + A_t \frac{\partial F}{\partial M}.\frac{M'}{Yt} \quad \text{.....(7)}$$

Converting inputs into proportionate change for input by simple manipulation,

$$\frac{Y'}{Y_t} = \frac{A'}{A_t} + \frac{\partial F}{\partial K}.\frac{K'}{F\{K,L,M\}}.\left(\frac{K}{K}\right) + \frac{\partial F}{\partial L}.\frac{L}{F\{K,L.M\}}.\left(\frac{L}{L}\right) + \frac{\partial F}{\partial M}.\frac{M}{F\{K,L.M\}}.\left(\frac{M}{M}\right) \text{..... (8)}$$

Rearranging the expression,

$$\frac{Y'}{Y_t} = \frac{A'}{A_t} + \frac{\partial F}{\partial K}.\frac{K}{F\{K,L,M\}}.\left(\frac{K'}{K}\right) + \frac{\partial F}{\partial L}.\frac{L}{F\{K,L,M\}}.\left(\frac{L'}{L}\right) + \frac{\partial F}{\partial L}.\frac{L}{F\{K,L,M\}}\left(\frac{M'}{M}\right) \text{..... (8b)}$$

$\frac{Y'}{Y_t}$, $\frac{K'}{K}$, $\frac{L'}{L}$ and $\frac{M'}{M}$ are the growth rate of output (Q_{tg}), capital (K_{tg}), labour (L_{tg}) and intermediate goods (M_{tg}) over time. $\frac{A'}{A_t}$ is TFPG, while $\left(\frac{\partial F}{\partial K}.\frac{K}{F\{K,L,M\}}\right)$,$\left(\frac{\partial F}{\partial L}.\frac{L}{F\{K,L,M\}}\right)$ and $\left(\frac{\partial F}{\partial M}.\frac{M}{F\{K,L,M\}}\right)$ are output elasticities of capital, labour and intermediate goods,

The growth accounting model assumes perfect competition, therefore factors are being paid according to their marginal products:

$\frac{\partial F}{\partial L}$ = w, wages, $\frac{\partial F}{\partial K}$ = r, price of capital, $\frac{\partial F}{\partial M}$ = p_m, price of intermediates.

Put all expressions into Equation (7b).

$$Q_{tg} = TFPG + \frac{rK}{F\{K,L,M\}}.K_{tg} + \frac{wL}{F\{K,L,M\}}.L_{tg} + \frac{PmM}{F\{K,L,M\}}.M_{tg} \quad \text{..... (9)}$$

$\frac{rK}{F\{K,L,M\}}$, $\frac{wL}{F\{K,L,M\}}$ and $\frac{PmM}{F\{K,L,M\}}$ are value shares of capital, labour and intermediate goods in output, (S_K, S_L and S_M).

Output Growth (Q_{tg}) = TFPG + $S_K K_{tg}$+ (S_L)L_{tg} + (S_M)M_{tg} ..... (10)

Equations (9) and (10) are derived using differential calculus. To convert them into instantaneous rate of change for discrete time, I use the Tornqvist Index as an approximation (Chambers, 1988).

$$\text{TFPG} = \frac{\Delta Q}{Q} - S_{Kg^{**}}\frac{\Delta K}{K} - S_{Lg^{**}}\frac{\Delta L}{L} - S_{Mg^{**}}\frac{\Delta M}{M} \quad \text{..... (11)}$$

$$S_{Kg^{**}} = \frac{1}{2}\left(S_{K,t} + S_{K,t-1}\right), \text{ average value share of capital}$$

$$S_{Lg^{**}} = \frac{1}{2}\left(S_{L,t} + S_{L,t-1}\right), \text{ average value share of labour}$$

$$S_{mg^{**}} = \frac{1}{2}\left(S_{M,t} + S_{L,t-1}\right), \text{ average value share of labour}$$

4.2 Limitations of the TFP measurement.

There are two assumptions that warrant concern. First, on the notion that all industries function under perfect competition assumption; second, the assumption that the production function shows characteristics of constant returns to scale. By relaxing the first assumption, factors are no longer being paid based on their marginal product. For example, monopolistic industries tend to have higher investments in capital goods; hence profits are determined by returns to capital. In this scenario, income shares of capital tend to overstate the elasticity of output to capital. This could lead to an inaccurate and biased estimation of TFPG. However, based on Young (1994), physical capital accumulation has contributed little to the growth process in developing countries such as the Asian NICs (and Malaysia). As a result, estimation bias under the first assumption may be low or negligible (Menon, 1998).

If the second assumption is relaxed, the TFPG residual will understate (overstate) the magnitude of productivity growth if the production function is specified as decreasing (increasing) returns to scale. Menon (1998) argued that it is in the nature of manufacturing activities in Malaysia to have linear technologies since they are distinguished by low-skilled

labor-intensive assembly operations[28]. Moreover, Malaysia is heavily involved in production network where the number of outputs is proportionally fixed contractually with either local or foreign manufacturers. To increase output, a proportional increase in input is most likely required. Thus, the assumption of a constant return to scale production technology is plausible. Formal institutions such as the Asian Productivity Organization and the Malaysian Productivity Corporation have also imposed these assumptions in generating official figures of TFPG. The key argument here is not to dispose the existence of other forms of technology progress, however, by applying a standardized assumption this study will be beneficial to future comparative TFPG studies.

Critics also hinged their arguments heavily on the assumptions imposed on the estimation methods. On conceptual issues, *Pessimists* questioned whether technical progress can be assumed as exogenous, disembodied and Hicks-neutral in nature. The model assumes technology as "manna from heaven" where it is costless. This may not be true as technology created through R&D involves research costs and risks. Rewards for new technologies will allow firms to take price-making positions, thus challenges the perfect-competition assumption. The *disembodied-technology* argument assumes technology as being separated from the process of investment and capital accumulation. *Pessimists* view this assumption as highly unlikely if not impossible (Kaldor 1957; Filipe 1997). It has been argued that new investment in capital (e.g new machines) itself already represents technology progress since it may improve efficiency. Other conflicting issues are debated on the basis choice of variables for the model. For example, different output measures (gross output vs value added) produce different estimation results. The same line of argument applies when different time periods or capital indicators (stock vs service flows) are used in a study. Data specification bias contributed to the varying findings in much of the TFPG literature; hence comparative implications have been constantly challenged.

Other conceptual and measurement concerns were directed to both inputs. For capital, the utilization rate of capital is one issue that warrants attention. Capital inputs are subjected to cyclical factors such as recessions and economic booms (Mahadeven, 2007), therefore they are not used at a constant rate. Business fluctuations will artificially improve (decrease) growth rates through sudden the increase (decrease) of productive capital during an economic

[28] Taking the opposite scenario as an example: For the case of skilled workers (e.g plant Manager), one manager is able to oversee multiple production plants, therefore, an increase of one skilled worker may exhibit output higher than a factor one (increasing returns to scale). But this is not the case for Malaysian manufacturing sector.

boom (bust). These conditions mask the real change in technical progress. Therefore, to separate the effect of productivity change due to business fluctuations from simple TFP growth, an adjustment to capital utilization rate is required. On labour inputs, concerns center on the labour-quality discourse. The growth accounting method assumes that workers have the same sets of skills and productivity. This may be inaccurate because changes in labor input in terms of quality may also affect the value of the TFP residual (in parametric estimation this refers to endogeneity problems). Researchers argue that failure to identify labour quality differentials in estimating TFPG for developing countries may induce measurement bias due to the profound differences in the pool of expertise among industries (Mahadevan, 2007, Oguchi 2004).

4.2.1 Addressing the issues and adjusting the measurements

Taking into account various concerns highlighted above, this study will now use two different approaches to address them:

1) Proceed with estimating TFP but impose assumptions and caveats on the findings.

In view of the fact that TFP is conceptually far from being perfect the *Pessimists* themselves have yet to produce an alternative solution to this neoclassical tool in measuring productivity. In absence of a more consistent theoretical framework for measuring productivity, the "second best" neoclassical approach is considered the best response to existing studies on productivity. Issues on variable choices and timeframe of the study will be discussed in later sections; much of the debate on the assumptions (exogenous, disembodied and Hicks-Neutral) imposed on technological progress was primarily due to the complexity of measuring and defining technology itself. While Kaldor (1957) pointed out that it is meaningless to distinguish between investment in capital goods and technical change (or between shifts in production function and movements along it), it does not imply that understanding the impact of both of these factors to economic growth is meaningless[29].

The main challenge here is to legitimatise TFPG as an indicator which measures technological progress as there are others that can be used to measure technology progress.

[29] Investing in new machines (capital input) may be seen as a form of technological improvement. However, it is the disembodied technology progress such as an improvement in production techniques, marketing and managerial know-how and institutional changes that may not necessarily depend on the new inputs.

Measurements using the cost of technologies such as R&D expenditure and the number of researchers are widespread but unfortunately not available, based on the correspondence with the Malaysian Department of Statistics. Since other proxies are unavailable, the TFPG indicator is the closest measurable technology indicator that is suitable for this study[30]. One thing is certain, the TFPG indicator is a 'standard blackbox' even to policy researchers in official organizations such as the Malaysian Productivity Coorporation and the Asian Productivity Organization. Since both institutions also assume constant returns to scale technology for consistency purposes, this research will proceed with the *Solow Residual* method with a caveat on the methodology.

2) Modification of TFPG measurement in capturing the effect of business fluctuations and labour quality changes.

The first modification is done through adjusting for capital utilization. To address the changes in labour quality, an adjustment will be made to account for a different marginal productivity of labour. Both methods are as follows:

i) Adjusting for Business Fluctuations

There are several methods used to adjust for capital stock movements caused by business fluctuations (*refer* APO survey 2004), one of which is the *Wharton Method* introduced by Klein and Summers (1966). In this method, the capital-output peak represents capacity utilization level and a fluctuation between this level and the lowest point of capital-output function depicts a deviation in output away from its "potential" output level. Capital is adjusted using the ratio between the potential and actual output (capital utilization rate). Econometrically, this method is modified by estimating a fitted trend using capital and output ratio (COR) against time to represent potential output line. A parallel line is then created through the lowest point of the COR to represent the deviation from potential output. Capital utilization series is therefore the ratio between actual and potential output series. (*see* **Appendix 1** for steps taken to make the adjustments).

ii) Adjusting for Labour Quality

[30] Studies using the stochastic-frontier method are able to decompose TFPG into "technical progress" and "technical efficiency". However Coelli et al (2005) suggests that this method is more suitable for firm-level studies. It is conceptually difficult to interpret the benchmark that defines a "technical efficient" industry since industry-level data is aggregated from different sectors and firms with different capacities and production functions.

Assume labour is divided into skilled and non-skilled categories. For brevity, I leave out intermediate goods in the derivation. Therefore:

$$\text{TFPG} = \frac{\Delta Q}{Q} - S_{Kg}\frac{\Delta K}{K} - S_{Lg}\frac{\Delta L^*}{L^*} \quad \text{..... (12)}$$

L* = Ls + Ln, (Ls and Ln respectively represents skilled and non-skilled labour). Hence,

$$\text{SLgL}^* = \frac{1}{2}\left(S_{Ls,t} + S_{Ls,t-1}\right)\Delta Ls + \frac{1}{2}\left(S_{Ln,t} + S_{Ln,t-1}\right)\Delta Ln \quad \text{……..…..…..……} \quad (13)$$

Oguchi (2004) suggests an adjustment to labour if wage data is available. Assuming ws and wn as skilled and non-skilled wages, using wage data the derivation is as follows:

$$\text{SLgL}^* = \frac{wsLs + wnLn}{Y}\left(\left(\frac{wsLs}{wsLs + wnLn}\right)\left(\frac{\Delta Ls}{Ls}\right) + \left(\frac{wnLn}{wsLs + wnLn}\right)\left(\frac{\Delta Ln}{Ln}\right)\right)$$

$$= \frac{w^*(Ls + Ln)}{Y}\left(\frac{\frac{ws}{w^*}\Delta Ls + \frac{wn}{w^*}\Delta Ln}{Ls + Ln}\right) \quad \text{…….} \quad (14)$$

with $w^* = \frac{wsLs + wnLn}{Ls + Ln}$ as the average wage rate and $\left(\frac{\frac{ws}{w^*}\Delta Ls + \frac{wn}{w^*}\Delta Ln}{Ls + Ln}\right)$ is the growth of labour efficiency unit. The term $\left(\frac{ws}{w^*}\Delta Ls + \frac{wn}{w^*}\Delta Ln\right)$ represents the efficiency weighted increase in labour.

5.0 Channels that Link Production Fragmentation and Productivity Growth

Various theories point out that production fragmentation and its impact on productivity growth in host country can be hypothetically linked by two economic channels: FDI and International trade. The first channel focuses on the *entry effect* of MNCs on the local manufacturing sector. The second channel reflects the impact of increasing varieties of intermediate goods through cross-border trade within the production fragmentation framework. This section explains how these two channels affect manufacturing productivity.

- **Foreign Direct Investment (FDI) Effect**

FDI is an important element in international production fragmentation. Studies in this discipline have been closely related to arguments proposed in various Vertical-FDI literatures. Foreign players affect productivity through three common methods: i) Entry and Competition, ii) Knowledge Spillovers and iii) Linkage Creation Effect. First, the entry of foreign competitors itself (in theory) brings in new technology and managerial know-how to host countries (Ng T. H., 2006; Findalay, 1978). In short, foreign entrants collectively contribute to the overall increase in industrial productivity of host country. In the long term, positive knowledge spillovers may occur when local industries acquire expertise and best-practices from them. In the production fragmentation literature, technology transfers from MNCs to contracted suppliers (vertical spillovers) are more apparent because MNCs prefer to internalize technology exclusively within its production network (Buckley & Casson 1976). Therefore, domestic suppliers have to compete by improving the quality and the variety of their products and services in order to 'enter' the international production networks created by MNCs'. Implicitly, these practices will drive local suppliers to be cost efficient and be innovative in production process and management.

An increase in the variety of inputs will often result in quality variations of input production. Higher quality of inputs will also result in increased production through shifts in firm's technological frontier (McCann F. , 2010). Intensive use of local intermediate goods (generated by the production fragmentation network) will also increase the linkage effect between multinationals and the economic agents in host country. If communications costs are high and product variety is similar to home and host economy, MNCs will prefer local suppliers to foreign (Rodriguez-Clare, 1996). Linkage formation may induce foreign firms to transfer technology to locals[31], resulting in productivity improvements to ensure the qualities of suppliers are satisfactory to MNC's standards.

- **Trade Effect**

Fragmentation trade can affect productivity through i) classical comparative advantage gains, ii) technological learning-through-imports, and iii) trade competition. First,

[31] However, there are different types of linkages created between MNCs and domestic firms. Some linkages are created based solely on the need to produce low-skilled labour intensive parts assembly, while others engaged in higher-skilled products. In Malaysia, the former linkage is more apparent.

production fragmentation has encouraged local plants to reallocate resources according to their comparative advantages and specialise in specific areas of production. Although in the short-run this form of specialization yields significant efficiency and productivity gains, it is not necessarily sustainable. Continuation in productivity growth stems from learning-by-doing (Keller, 2004), learning-by-exporting (Clerides et. al, 1998) and innovation. The second argument points out that international production fragmentation opened an opportunity for greater accessibility to world class input (Amiti & Wei, 2006). A wider range of input selection will provide better, more efficient mix of inputs to available technology, hence improving efficiency gains (this is similar to the "*market thickness*" argument proposed by (Grossman & Helpman, (2005)).

In addition, imported intermediate goods (given imperfect substitution) may also contain embedded foreign new technology (Halpern et. al. 2009; Caseli & Wilson, 2004, McCann 2010). This in return will improve producers' technical knowledge through learning effects such as import imitations and product adaptations. Finally, another important link between fragmentation trade and productivity is related to trade *competitiveness*. Trade competition improves productivity in firm management by forcing them to reduce X-inefficiencies[32] and force unproductive firms to exit the market (Horn et. al 1995, Melitz 2003). Market competitors will push firms to increase output through efficient use of inputs and force product and process innovations to be competitive, thus, increases overall industrial productivity.

6.0 Findings and Analysis

6.1 Data

All variables in this study are obtained from an unpublished dataset based on the *Annual Survey of Manufacturing Industries* (2000 – 2008) by the Malaysian Department of Statistics (DOS). Under the Malaysian Statistics Act 1965, it is not possible to get firm-level data, hence this paper is conducted on the industry-level of the manufacturing sector. DOS has provided two datasets separated by ownership, available only at 2-digit level of the Malaysian Standard Industrial Classification (MSIC) 2000[33]. The sampling ratio of the survey is approximately 1:13 (foreign to local firms). The database consists of 23 industries and

[32]The situation where firms with lack of competitive pressures use inputs inefficiently (technical-inefficiencies) when producing output.

[33] Data for year 2008 is based on MSIC 2008 but has been crudely matched with the classification from MSIC 2000.

forms a panel of 352 observations (with an estimated average of 25,000 firms surveyed per year). Information on intermediate imports, exports and local intermediate goods are only available from year 2000 onwards, limiting the focus of on the manufacturing sector to the current economic setting (from 2000 to 2008). Since the theoretical model takes into account the use of intermediate goods, gross output measure will be used instead of value added. This is to minimize distortions in technology effects when estimating the TFPG due to omitted measures of input (Mahadevan R. , 2002).

In calculating the growth rates, the gross output series were deflated using the producer price index at the 2-digit level[34] to eliminate the effects of price changes over time. The ideal measure for capital and labour input is machine hours and number of hours worked based on labour skills. Capital input should capture the productivity of capital (e.g in machine hours) adjusted for the exact life-cycle of the capital stock. However, such data is unavailable. Instead, this study uses fixed assets[35] as a proxy for capital input. Labour input is proxied by the number of employees. Wages and salaries per employee (cost of labour input) is the ratio of total salaries to total number of employment. Adjustments for both inputs have been discussed in Section 4.2.1. Data on the price deflator (producer price indexes) were taken from DOS time series database. For intermediate goods, this study will use item 17 of the *Annual Survey of Manufacturing Industries* which consists of both direct raw materials and packing materials sourced from local or foreign markets. The growth accounting measure is used to obtain the adjusted-TFPG indicator and Equation 1 will be used as the indicator of international production fragmentation.

This study uses the producer price index as the deflator for transport equipment and machinery sector data, and for the intermediate input series, the "double-deflator" method is employed. Using the 2000 Malaysian Input-Output (I-O) table, inter-industry input shares are obtained. However, since the classifications of the I-O table are different from the *Annual Survey of Manufacturing*, activities from the I-O are first mapped to the MSIC 2000 industry classifications from the survey (using classifications shown in Appendix 2). These input shares serve as "intermediate input weights" to the PPI for local production and imports.

[34] At constant price (year 2000) obtained from the Department of Statistics Malaysia. All price deflators in this study uses constant year 2000.
[35] Includes all goods (land, building, machinery, equipment and vehicles, computers, etc.), new or used, that have a productive life of more than one year and are intended for use by the establishment (DOS, Survey Questionnaire)

These input-weighted price deflators are then matched again to all the specific PPI of 23 industries in the MSIC 2000 classifications purchased from DOS. The procedures are explained below:

Calculations for Price of *imported* intermediate goods

1. (Inter-industry input shares from I-O table) **x** (PPI of *imported* goods published from DOS, 2-digit SITC classification, aggregated economy) = Weighted price for *imported* intermediate goods for the economy, (A_{import})
2. (A_{import}) **x** (industry-specific (unpublished) PPI at 2-digit level purchased from DOS)
3. Price for imported intermediate goods (deflator)

(The steps are repeated for *local* intermediate goods)

In adjusting for labour skills, wages are deflated using consumer price index (Bank Negara, *Quarterly Bulletin*) to obtain real wages. The value of exports is deflated using the export deflator indicator derived from Bank Negara Malaysia Annual report and rebased to the year 2000 to maintain consistency with other data. Sales values are deflated using the CPI. Prices are commonly reported usind the SITC classification, therefore mapping between prices and industrial classifications may have measurement error. However, without the availability other indicators, this study will embark on this method.

6.2 An overview: Perspiration vs Inspiration (15 years later)

Figure 5 shows the trend of annual real output growth (averaged from locally and foreign owned enterprises) and the contribution of inputs to output of the manufacturing sector from 2000 to 2008. The general overview of the figure solidifies the *Fundamentalists'* assertion that growth in Asian developing countries such as Malaysia is still primarily input-driven. It is noteworthy that the growth in intermediate inputs to manufacturing output is staggering. Although growths in labour and capital inputs vary, growths in intermediate inputs are consistently high. There are signs of "*inspiration*" when the TFPG is positive in 2004/05 and 2007/08; however in general, the dominance of an input-driven trend is prevalent. An interesting pattern here is the opposing trends between TFPG and real output. Growth in manufacturing output did not follow the pattern postulated in Verdoorn's Law. Due to the input-intensive nature of the manufacturing sector, resources gained from output growth may have not been allocated to productivity-driven activities such as R&D.

Table 1 confirms this occurrence by showing that in aggregate, output growth of the manufacturing sector has been very input-driven. This finding however, is not absolute. A closer look at Table 2 shows that at the industry level this phenomenon varies by industry. High input-driven growth can be seen regardless of the level of an industry's involvement in international production fragmentation. For example, industries such as Manufacture of Office, Accounting and Computing Machinery (MSIC 30) and Manufacture of Radio, Television and Communication Equipment and Apparatus (MSIC 32) (which represents the ICT industry in Malaysia), are heavily involved in the international production network. While MSIC 32 is experiencing an average decline in growth rates, the positive growth in MSIC 30 is driven primarily by capital and imported intermediate inputs. Output growths in industries with low involvement (F-rank above 11) in international production fragmentation such as the transportation industry (MSIC 34 and 35) are highly driven by local intermediate inputs. Although not explicitly shown in Table 1, the adjusted-TFPG from 2000-2008 is generally positive in 22 industries in the manufacturing sector.

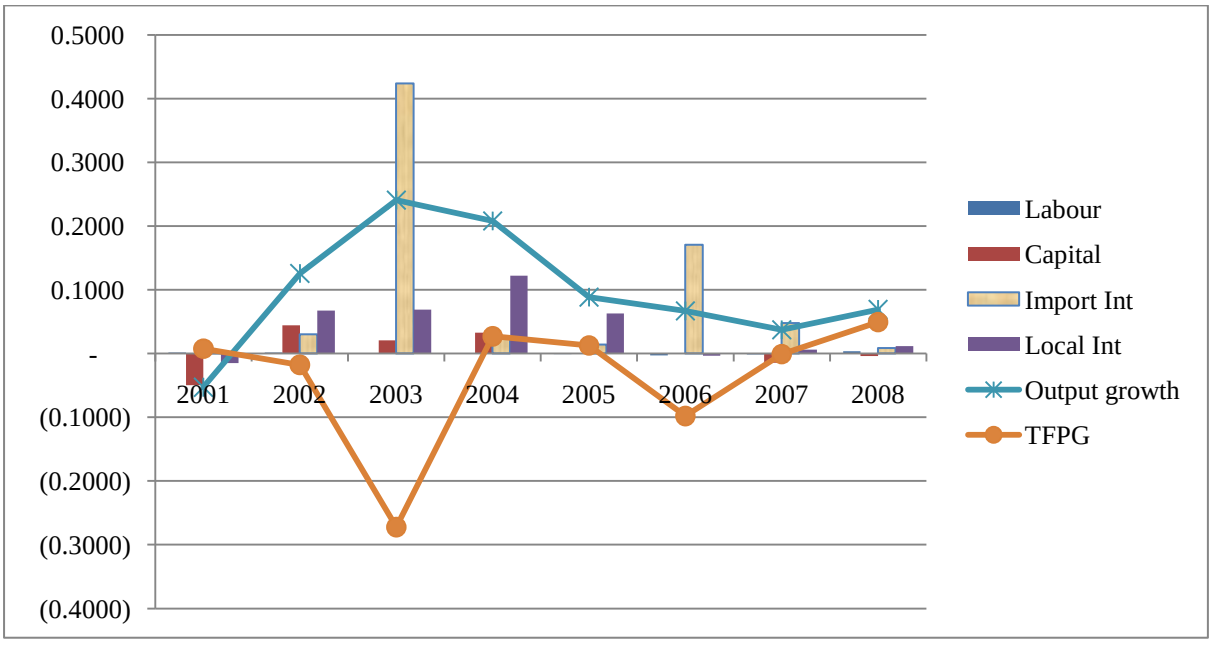
Tables 3 and 4 extends the *Perspiration vs Inspiration* debate by further incorporating ownership characteristics into the analysis. Table 3 shows that output growth in foreign owned industries stem from the intensive use of imported intermediate goods while locally owned industries use local intermediate goods more intensively. This shows that integration of foreign firms into the domestic industries has yet to fully materialize. This also shows that and there are unexplored opportunities for further linkage creation between foreign and local industries. Two other important observations on foreign industries are the declining contribution of capital and the increasing share of labor to manufacturing output. Although data shows that employment creation by foreign industries has increased, it indicates that foreign industries' commitment to production expansion in Malaysia has only focused on labour intensive activities.

In general, ownership status does not contribute significantly to the differences in TFPG since both local and foreign industries on average, have positive TFPG. However, the overall average TFPG of local industries is higher. Table 4 shows that foreign TFPG is skewed more to the lower half of the distribution. There are two possible explanations. One may argue along the lines of Section 5.0 that foreign presence (may) have pushed local industries to be more productive. The second explanation is that the base TFP values of foreign industries are

already high when they enter the Malaysian markets. These firms may have already been operating on the technological frontier, therefore further development and improvements in technical progress may seems smaller when compared to local industries which have lower initial technological competencies. The regressions model in Section 7.0 provides further analysis of this issue. In reference to the *Fundamentalist's* claims, contributions of intermediate inputs are high in both foreign and local industries

At this juncture, we are still unable to test the claims from the *Assimilationists* as to whether domestic productivity growth can be attributed to the spillover effects from foreign industries. The results have thus far supported the *Fundamentalists'* conditions. More than 15 years after the infamous article, the drivers of output growth in the manufacturing sector remain heavily reliant on inputs (especially growth in intermediate goods). However, disaggregated data shows that this case varies by industry. There have been improvements in productivity, efficiency and technological capabilities for certain industries. Also, the study has yet to establish a link between TFPG and international production fragmentation. Analysis on industry characteristics in the next section will further shed light into this productivity debate.

Figure 5: Average Output Growth rates, Contributions of Real Input to Real Output Growth and Average TFPG in the Malaysian Manufacturing Sector (2000-2008).



Source: Calculated by the author based on DOS data

Table 2: International Production Fragmentation, Contributions to output growth and TFPG for 2000 to 2008 (Industry-Level Analysis)

Manufacturing Industries			Shares of inputs in real output						
Industry*	Fragmentation Index (F)	F Rank	Adjusted Labour	Adjusted Capital	Imported intermediate goods	Local intermediate goods	Input growth	Output growth	TFPG
15	1642844	6	3.5E-04	0.1176	(0.0105)	0.1006	0.2081	0.45	0.242
16	95231	20	-1.1E-04	(0.1548)	(0.1615)	0.2113	(0.1051)	- 0.13	- 0.028
17	735253	12	-1.4E-03	(0.3243)	(0.1270)	0.0217	(0.4311)	- 0.18	0.247
18	661639	14	-1.2E-03	(0.0535)	(0.1279)	(0.0812)	(0.2639)	- 0.19	0.077
19	30488	22	4.9E-03	(0.0936)	0.0576	0.0860	0.0548	0.62	0.563
20	220416	18	3.6E-04	(0.0916)	(0.0051)	(0.0644)	(0.1607)	0.15	0.311
21	237516	17	-3.8E-04	(0.3677)	(0.0451)	0.0132	(0.4001)	0.14	0.541
22	69904	21	2.8E-04	0.0836	0.0586	0.1472	0.2897	0.55	0.256
23	2335530	4	2.6E-05	0.0198	(0.0838)	(0.1164)	(0.1803)	0.39	0.574
24	2860864	3	9.1E-05	(0.0921)	0.0867	0.0063	0.0010	0.64	0.640
25	1942326	5	1.2E-03	0.0968	0.0823	0.1800	**0.3604**	0.65	0.287
26	306653	16	-2.4E-04	(0.1985)	(0.0064)	0.2348	0.0297	0.68	0.648
27	1425559	8	-1.1E-03	(0.0622)	0.1660	0.1078	**0.2104**	0.76	0.552
28	840318	11	7.0E-04	0.0056	(0.0624)	0.0414	(0.0147)	0.25	0.268
29	1273204	9	-1.0E-04	0.0306	0.0779	0.2336	0.3421	0.61	0.267
30	19488086	2	**-4.8E-05**	**0.4133**	**0.2922**	(0.0751)	**0.6304**	0.53	-0.098
31	1572916	7	6.4E-05	(0.1276)	0.0123	0.0194	(0.0959)	0.07	0.169
32	34164345	1	-3.3E-04	(0.0783)	(0.0808)	(0.1213)	(0.2807)	-0.15	0.128
33	1229913	10	9.3E-04	0.0213	**0.3604**	0.0267	0.4094	0.74	0.329
34	343390	15	8.2E-05	0.0580	0.0920	0.3154	0.4655	0.81	0.347
35	175787	19	3.2E-04	0.0166	0.1924	0.5650	0.7744	1.88	1.103
36	680618	13	1.9E-03	0.0408	0.0517	0.1891	0.2835	0.41	0.124
Mean		11					0.097	0.440	0.343
Median							0.04225	0.49	0.278

note: *Industrial codes are in Appendix 5, Source: Calculated by the author based on DOS data

Table 3: Analysis by Ownership (2000-2008).

	Locally Owned	Foreign Owned
Average Growth (%)		
Labour	3.0	-0.3
Capital	0.6	-3.4
Import intermediate	1.7	0.8
Local intermediate	2.4	-3.2
Output-weighted (Average Contributions to Real Output growth)		
Labour	0.0008	0.00024
Capital	0.0076	-0.06155
Import intermediate	0.0080	0.00852
Local intermediate	0.0661	-0.07286
Total input	0.0826	-0.12565
Average TFPG	**0.3751**	**0.257**

Table 4: TFPG Distribution in Majority Local – Foreign Owned industries (2000-2008)

		No of Sectors	
Percentiles	TFPG range	Locally Owned	Foreign Owned
Lowest 25%	< 0.055	4	6
25-50%	0.055 < x < 0.260	5	6
20-75%	0.260 < x < 0.455	7	4
Top 25%	0.455 < x < 1.50	7	6

6.3 Analysis on the Determinants of TFPG

This section will examine the variations of TFPG under different industry characteristics and economic conditions. The selection criteria for the tests were based on the theoretical explanations outlined in Section 5.0. With reference to the links between international production fragmentation (FR) on TFPG (technology progress), this study introduces the export and FDI channel for the first two conditions, followed by two other simulations based on firm heterogeneity. The list of variables and their definitions are explained in Table 5 (variables not listed are self explanatory). Some indicators will be selected as independent variables for the model in the next section[36]. All variables are taken from the *Annual Survey of Manufacturing Industries* and all values are averaged from 2000 to 2008.

a) <u>Condition[37] 1:</u> *Ownership status and export intensity*

	Low Export	High Export
Local	0.245 (1.135)	0.349 (1.031)
Foreign	0.121 (1.163)	0.481 (1.121)

Both foreign and locally owned industries have higher average TFPG when they are more export intensive ("high" exports growth from 2000 to 2008). Local industries serving

[36] It is not appropriate to assume that the results in this section are similar to the results in econometric modelling because results here have only taken average values of TFPG under certain economic conditions while econometric results control more variables and fit the data based on the actual trend of the data. For this reason, I term the experiments here as "conditions tests"

[37] Methods for condition tests are as follows: First, the variables are sorted into different sample sets based on the selected characteristics. Next, the sets are separated from their median values. Values above the median are labelled "high" and values below median as "low" The payoff values are the average TFPG values from 2000 to 2008. Values in the parentheses are the average TFP values at levels. This is to indicate the average initial values of TFPG. Analysis on all conditions is done with the assumption of holding other variable constant.

domestic markets have make greater technological progress compared to their foreign counterpart. Foreign industries that serve local markets ("low" exports) have fewer TFPGs compared to export oriented foreign industries. This extends the arguments in Table 3, that MNC operations (especially the ones focusing on domestic market penetration) in Malaysia have been concentrating mostly on low-skilled manufacturing activities that do not require a high technical expertise. Also, this result highlights *Assimilationists*' theory that foreign involvement in the Malaysian manufacturing sector will generate productivity gains. While it shows that while foreign participation in local markets does generate positive TFPG, the effect depends on an industry's export intensity. Outcome from this test shows learning-by-exporting as an important vehicle for technology upgrading that should be complemented with the dependency on spillover effects from foreign partners.

Outcomes of Conditions 1:

TFPG export oriented local firms (LocX1) > TFPG export oriented local firms (ForX1) > TFPG non-export oriented local firms (LocX2) > TFPG non-export oriented foreign firms (ForX2)

b) Condition 2: *Ownership status and International Production Fragmentation (FR)*

	Low FR	High FR
Local	0.271 (1.16)	0.324 (1.005)
Foreign	0.116 (1.202)	0.486 (1.081)

Condition 2 has similar results to Condition 1 due to the "exports" criteria estimated in the FR index. Firms in local and foreign industries involved in the global production network have higher productivity growth compared to industries with less involvement. Consistent with the proposed theory on t*rade effect* (refer section 5.0), the FR index shows that the larger the international network of intermediate inputs, the higher the opportunity for local firms to procure better quality input (with higher technological content) that will improve existing efficiency. Local suppliers in the global production network who compete to provide high quality goods to foreign markets also have to improve their technology in order to enhance efficiency, hence a higher TFPG value. As for foreign firms involved in the international production network, their technological progress is higher compared to their local counterparts. This shows that foreign firms are in control of the changes in technology

within the production network. Further implication suggests that foreign firms are the drivers of innovation in the international production fragmentation network.

Outcomes of Conditions 2:

TFPG of foreign firms engaging in international production fragmentation (ForF1) > TFPG of local firms engaging in international production fragmentation (LocF1) > TFPG of local firms engaging in low international production fragmentation (LocF2) > TFPG of foreign firms not engaging in low international production fragmentation (ForF2)

c) Conditions 3: *Foreign Competition and FR*

	High Foreign Competition	Low Foreign Competition
Low FR	0.24 (1.08)	0.17 (1.19)
High FR	0.58 (1.07)	0.32 (1.05)

The condition 3 test shows the impact of competition and the firms' participation in *FR*. Results show that local firms facing high foreign competition have higher productivity gains if they are highly involved in the international production network. Local firms in industries with high foreign competition are more efficient or more technologically inclined due to the competition effect. Competitive pressures from foreign firms have coerced locals to operate using higher technology and efficiency, as compared with firms without foreign competition. Although low FR firms with less foreign competition have lower TFPG, the high average TFP value (1.19), shows that competition among themselves forces them to operate with higher productivity and technology competencies. With international production fragmentation, local firms exhibit higher than average TFPG from 2000 to 2008. The push for technological upgrading is stronger for local firms participating in the international production network. When faced with competition from foreign firms, local low FR industries have lower TFPG because they are less exposed to the spillover and learning gains from the network. such as opportunities for expertise exchange, transfers of tacit knowledge and managerial skills in terms of incorporating best practices from foreign affiliates.

Outcomes of Conditions 3:

The TFPG of local firms facing high competition from foreign firms in international production fragmentation activities ($F1C_{high}$) > TFPG of local firms with lower foreign competition and highly involved in FR activities ($F1C_{low}$) > TFPG of local firms facing having high foreign competition in low involvement international production fragmentation

network ($F2C_{high}$) > TFPG of local firms facing low foreign competition with low involvement international production fragmentation network ($F2C_{low}$)

d) <u>Condition 4:</u> *Knowledge Intensity and FR*

	High Knowledge	Low Knowledge
High FR	0.55 (1.165)	0.33 (1.175)
Low FR	0.25 (1.217)	0.12 (1.104)

The final test examines whether knowledge intensity in an industry plays any role in generating TFPG when tested under different international fragmentation conditions. Industries that have more skilled workers are able to raise technical efficiency (Mahadevan 2002), while skilled workers in high FR industries are able to learn new technology and absorb technical spillovers from international sources. With FR, the average TFPG in industries with more skilled workers is higher than in low-skill intensive industries. This once again invokes the *Assimilationists'* argument that productivity growth in developing countries such as Malaysia depends on the need for interaction between local and foreign industries since FR is closely related to foreign-local linkages in global production network. Industries with High FR and Low Knowledge (such as the ICT industries in Malaysia) seem to have higher TFPG than industries with High Knowledge content but Low FR (e.g government controlled heavy-industries such as the automobile industry). This can be explained through the *X-inefficiency* argument.

<u>Outcomes of Conditions 4:</u>

TFPG of industries in international production fragmentation network, industries that require high technical skills for operations (F1H1) > TFPG of industries with international production fragmentation, industries that require lower technical skills for operations (F1H2) > TFPG of industries with low FR participation but with high-skills requirement (F2H1) > TFPG of industries with low FR and industries with low-skills requirement (F2H2)

- **Summary: Best outcome for firms in Malaysian manufacturing sector.**

The strategic conditions and determinants for TFPG from four conditions tests above can be extended assuming these conditions follow the simple *transitivity* rule:

If $x \in A$, and $y \in x$, then $y \in A$, or, equivalently

Condition test 1: *LocX1 > ForX1 > LocX2 > ForX2*

Condition test 2: $ForF1 > LocF1 > LocF > ForF2$

Condition test 3: $F1C_{high} > F1C_{low} > F2C_{high} > F2C_{low}$

Condition test 4: $F1H1 > F1H2 > F2H1 > F2H2$

Therefore, based on the transitivity rule:

A: Best response for local firms:

$$Loc\ (X1, F1\{C_{high}, H1\}) > Loc\ (X2, F2\{C_{low}, H1\})$$

B: Best response for foreign firms:

$$For\ (X1, F2\{C_{high}, H1\}) > For\ (X2, F2\{C_{high}, H2\})^{38}$$

For A, TFPG is highest for local firms engaging in exporting activities. International production fragmentation has improved TFPG of these industries when competition from a foreign counterpart is substantial in a competitive market. Local industries with the highest share of skilled workers will benefit most from international production fragmentation. Foreign firms in Malaysia exhibit highest TFPG when they are less competitive with local firms. Having a niche on their own, their TFPG is highest when they are export oriented and have invested in high tech industries. Since they control the technology flows of the international production fragmentation network, any increase or decrease in this phenomenon matters marginally.

Table 5: Definition of Variables.

No.	Variable name	Definitions and measurement methods.
1.	Ownership status	• Local firms (proxy by dummy variable = 0 and Foreign firms = 1). This FDI-related variable represents the impact of foreign presence in the economy.
2.	Export growth	• Growth in exports from 2000 to 2008.
3.	Competition	• A proxy for crowding out effect. High foreign competition is represented by foreign firms' sales growth > local firms' sales growth. • This method departs from the commonly used methods for measuring competition such as *Concentration Ratio* or *Herfindahl Index* because these two indicators require firm-level data. As mentioned earlier, these data are unavailable.
4.	Knowledge intensity	• Industries with high share of skilled workers (managers, professionals, executives and technicians) in producing output. This is a proxy for the level of technology usage in an industry. Proxy by the growth in skilled workers. Based on DOS database, skilled workers are managers, professionals, supervisors and technicians

7.0 Regression Model and results

This section will propose a model to identify the determinants of TFPG and empirically test the impact of international production fragmentation on productivity and technological gains from foreign industries in the Malaysian manufacturing sector from 2000 to 2008. The proposed models are as follows:

$$TFPG_{it} = \alpha + \beta_1 \underset{(+)}{Sale_{it}} + \beta_2 \underset{(+)}{Ex_{it}} + \beta_3 \underset{(+/-)}{Comp} + \beta_4 \underset{(+)}{Pol} + \beta_5 \underset{(+)}{ICT_t} + \beta_6 \underset{(+)}{Own_{it}} + \beta_7 \underset{(+)}{Skill} + \beta_8 \underset{(+/-)}{FR*_{it}} + \varepsilon_{it}. \quad \text{..... (25)}$$

$$TFPG_{it} = \alpha + \beta_1 \underset{(+)}{Sale_{it}} + \beta_2 \underset{(+)}{Ex_{it}} + \beta_3 \underset{(+/-)}{Comp} + \beta_4 \underset{(+)}{Pol} + \beta_5 \underset{(+)}{ICT_t} + \beta_6 \underset{(+)}{Own_{it}} + \beta_7 \underset{(+/-)}{Absorb_{it}} + \varepsilon_{it}. \quad \text{.... (26)}$$

$$TFPG_{it} = \alpha + \beta_1 \underset{(+)}{Sale_{it}} + \beta_2 \underset{(+)}{Ex_{it}} + \beta_3 \underset{(+/-)}{Comp} + \beta_4 \underset{(+)}{Pol} + \beta_5 \underset{(+)}{ICT_t} + \beta_6 \underset{(+)}{Skill_{it}} + \beta_7 \underset{(+/-)}{FR*Own_{it}} + \varepsilon_{it}. \quad \text{.... (27)}$$

Subscripts *i,t* represent industry and time period respectively. Signs in the parentheses show the *a priori* relationships with TFPG. Equation 25 is the general model without the interaction terms on *FR*. To remove problems of multicollinearity, the skilled variable has been removed from Equation 26, however, the skill dimension has been embedded into the *Absorb* variable. The same reason applies for the removal of *Own* in Equation 27

In addition to the models above, two additional models are introduced to address *"Assimilationists's"* proposal to identify evidence of productivity spillovers from foreign to local firms. In setting up the model, real output from foreign industries (*Foropt*) and the FR index of foreign industries (*ForFR*) will be proxies for channel of spillovers.

$$TFPG_{Loc,it} = \alpha + \beta_1 \underset{(+)}{Sale_{Loc,it}} + \beta_2 \underset{(+)}{Ex_{Loc,it}} + \beta_3 \underset{(+/-)}{Comp} + \beta_4 \underset{(+)}{Pol} + \beta_5 \underset{(+)}{ICT_t} + \beta_6 \underset{(+)}{Skill_{Loc,it}} + \beta_7 \underset{(+/-)}{Foropt} + \varepsilon_{it}. \quad \text{... (28)}$$

$$TFPG_{Loc,it} = \alpha + \beta_1 \underset{(+)}{Sale_{Loc,it}} + \beta_2 \underset{(+)}{Ex_{Loc,it}} + \beta_3 \underset{(+/-)}{Comp} + \beta_4 \underset{(+)}{Pol} + \beta_5 \underset{(+)}{Skill_{Loc,it}} + \beta_6 \underset{(+/-)}{ForFR} + \varepsilon_{it}.$$

... (29)

Subscript *Loc* represents local industry data. With exception to *Foropt* and *ForFR* other variables in Equations 28 and 29 use data from domestic firms only. The ICT term in Equation 29 has been removed to prevent a multicollinearity problem with *ForFR*. Table 2 has shown that the ICT industry has high FR indexes. MNCs in this industry (especially semiconductor producers) generally operate using networks spread across international borders. The Malaysian electronics industry experience in the global production network has been highlighted in Section 3 of this study.

Some of the variables have been explained in Table 4. Table 5 summarizes the rest of the variables used for the model.

- Verdoon's Law suggests that higher growth in output positively affects growth in productivity due to increasing returns (Verdoon, 1949). To test this proposition and at the same time safeguard against simultaneity between output and TFP, this study uses growth in sales (*Sale*) as a proxy for gross output. This variable also represents economies of scale for a particular industry. Firms in industries with a larger market share of the economy have higher efficiency. Earlier trends (refer *Figure 5*) showed that this law does not hold; however, this section will statistically test its validity.

- Export (*Ex*) is expected to improve TFPG through learning-bay-exporting and market competition. Growth in export represents growth in the production capability to increase output, which is also a signal for improvement in production techniques and efficiency. The justification for this variable is based on Condition Tests 1 and 2 in the previous section. Export expansion impacts positively on productivity growth due to the "pro-competitive" effect, where producers for foreign markets are more efficient due to the wider array of competitive pressures. Export intensive firm also have the ability to benefit from economies of scale by producing for a larger international market.

- Competition will encourage better use of resources and bring sufficient improvement in production techniques, and hence prevent problems of X-inefficiency. This has been highlighted in Conditions test 3.

- It is particularly difficult to obtain an indicator for macroeconomic policy in a short period of time from 2000 to 2008. However, the government's decision to liberalize foreign equity policy (*Pol*) in 2003 may further enhance FDI, and hence intensify the channel for foreign technology spillover in the manufacturing sector. FDI is expected to have a positive sign on TFPG as capital investment from FDI usually embodies higher technological capability.

- The Malaysian ICT industry (ICT_{ind}) is heavily involved in the international production fragmentation network. The electronics sector is the leading contributor to manufacturing output, employment generation and exports (MIDA, 2009). ICT share in fragmentation trade in total Manufacturing trade is 70 percent in 2005/06 (Athukorala & Menon, 2010).This variable implicitly determines whether the expansion of the ICT industry has brought TFPG to the total manufacturing sector

- Ownership (*Own*) variable also takes the X-efficiency argument and demonstrates that foreign owners are technically more efficient. Foreign owners have comparative advantage over local firms in areas such as state-of-art knowledge, innovation, financing and marketing strategies which enable them to experience higher growth than locals.

- Technology diffusion is not an automatic process. The capability of the local industry in learning these new technologies lies in the pool of available skilled labour (*Skill*). For example, higher skilled workers have the ability to interpret codified knowledge, and modify their tacit knowledge to further improve efficiency. Industries that require higher skilled labour for operation also have greater innovation, be it methodology improvements or invention of new technology to achieve greater efficiencies.

- The impact of international production fragmentation (FR*) on TFPG has been discussed in Section 3.3. However, interaction terms have been added to further identify the best conditions that affect the influence of FR on productivity growth. The two additional terms are:

    1. **FR x Skilled**. I label this term as the "Absorptive Capacity" (*Absorb*) of firms in industries that are active in the international production fragmentation network.

Industries with more skilled labour are able to move to a higher value added stage of the production process such as research, design and development. Apart from learning and adapting foreign technologies, industries with high human capital are able to create specialised in-house production technology to create a niche in the production network.

2. **FR x Own** (*ownFR*). This variable is introduced to statistically test Condition 2. In a way, this is also to test the *Assimilationists'* assertion that foreign firms' involvement in international production fragmentation has helped to improve the TFPG of the Malaysian manufacturing sector. A positive sign from this variable shows that foreign involvements in FR activities are not entirely resource intensive but has exerted some form of technology upgrade in the industry as well.

- **Spillover proxy variables** – Foreign output (*Foropt)* and Foreign firms in FR network (*ForFR)*[39]. The first variable is to test the hypothesis that outputs generated by foreign industries, in general, have positive effect on the domestic industry's productivity growth. The second variable tests the same hypothesis but specifically focuses on high FR foreign industries in Malaysia. A positive coefficient will also strengthen the *Assimilationists'* argument that TFPG of local industries are generated by business interactions and linkages with foreign industries. This variable is based on the assumption that with higher output, MNCs have the capacity to invest in higher knowledge-related assets and conduct R&D, as well as having available resources to train and develop human capital. Being part of *FR*, MNCs are embedded in the business structure of host countries. Management experiences can be transferred directly (vertical spillover) and indirectly (horizontal spillover) to local firms. *ForFR* postulates that spillover from MNCs in *FR* can be in the form of training of local employees (who either set up their own production firms later in their careers or are employed in domestic firms); local firms engaged in reverse engineering, and product and management imitation; and also market-strategic effects such business partnerships and

[39] *ownFR* and *ForFR* have the same values but they measure different effects. The former is an interaction dummy that measures whether ownership status matters in *FR* and whether foreign industries in FR network will have positive effect on TFPG of the general economy. *ForFR* measures specifically the impact of foreign owned firms in FR networks on the TFPG locally owned industries. *OwnFR* and *Foropt* should have similarities in statistical significance and economic signs because when foreign owned firms in *FR* networks exhibit positive TFPG, only then positive externalities are able to spillover to the locally owned industries in the manufacturing sector.

contract manufacturers. This variable however, can also be insignificant if MNCs only focus on the less knowledge intensive production part of the production line.

Table 5: Summary on the Additional Variables for the Model.

1.	Sales growth	Sale	• Scale of operation (Athukorala & Chand, 2000) • This variable relates to Verdoon's Law (productivity growth is due to output growth). Instead of using output, this variable uses growth of sales growth to represent the dollar value of output. The use of this variable is to prevent simultaneity issues between output and TFPG - since the regression imposes TFPG as dependent variable
2.	Investment Liberalization	Policy	• In June 2003, the Malaysian Industrial Development Authority (MIDA) relaxed the equity policy on foreign investors. Foreign investors can hold 100% of the equity in all new and expansion projects. Since this policy only affect foreign owners, it is proxied by year dummy for foreign firms from 2004-2008 (assuming the impact of the policy is only evident a year later).
3.	ICT Industry	ICT_{ind}	• Dummy variable (MSIC 30 and 32) to control for the most dynamic manufacturing industry in Malaysia, the electronics industry. This industry is highly involved in international production fragmentation trade since the 1980s. • PNC exports and imports both account to almost 50% of total trade in Malaysian Machinery and Transport equipment.
4.	Absorptive capacity	Absorb	• The interaction term between the number of skilled workers and fragmentation will provide a representation on the importance of skilled workers in "absorbing" potential technology created through the international production fragmentation process.
5.	Spillover	*Foropt* and *ForFR*	• Variables from foreign industries that will be regressed on local industries database. These variables represents agents that will provide evidence of productivity spillover effects from foreign to local • *Foropt* the real output values of foreign firms while *ForFR* is the *FR* index for foreign industries.

*Appendix 3 shows that all the proposed variables have a low correlation with one another, hence ruling out multicollinearity issues.

7.1 Estimation Method

This study uses a panel of industry over time. There are three standard panel estimation methods: Pooled-OLS (Pool), Fixed-effect (FE) and Random Effect (RE). The Pool estimator assumes no unobserved heterogeneity in time (years) and space (industry). To relax this restriction, either the panel fixed-effect (FE) or random-effect (RE) estimation method is employed[40]. In choosing between the Pool, RE or the FE model, the standard Hausman test is first applied to examine whether unique errors are correlated with the regressors. If they are not correlated, the RE model will be selected. If the RE model is selected, the Breusch-Pagan Lagrange Multiplier (LM) test will be used to determine whether

[40] FE assumes correlation between industry's error term and predictor variables while RE assumes otherwise.

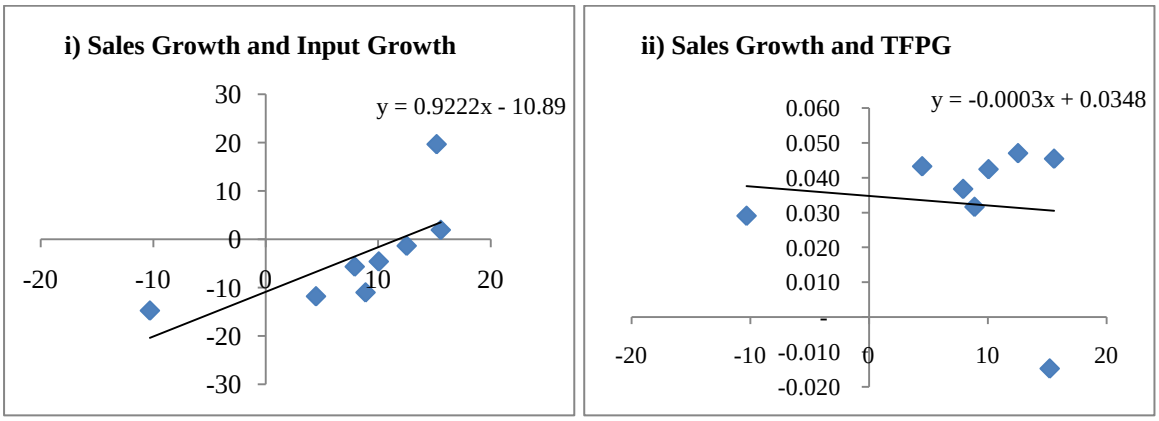
RE is also preferred over the Pool estimation methods. If there is no significance difference in variances across entities, the Pool regression will be used. If the Hausman test shows that the FE model is a better model, the Chow F parameter test will be used to determine whether FE is preferred over Pool model. The "*selected*" estimation method should be analysed with some caveats in mind: the Pool method imposes strong homogeneity assumptions among industries. The FE method eliminates the time-invariant variables which are variables of interests to the study. Finally, the RE model adopts a strong assumption that neglects the possible correlation between unobserved effects in errors and the explanatory variables, which may produce inconsistent estimators if they are otherwise.

To control for heteroskedasticity, the estimation is done using heteroskedasticity-robust standard errors. Since the time-series component is only from 2000 to 2008, unit root problems should be insignificant. The Levin-Lu-Chu test confirms that the panel is stationary. Mean VIF is lesser than 10, therefore, there are no serious multicollinerity problems.

7.2 Estimation results

Table 6 shows that the Pooled-OLS estimator is preferred in all models. All models show that contrary to Verdoorn's Law, growth in output (through sales) did not increase TFPG. The *a priori* understanding is as follows: as sale performance increases, firms will engage in product differentiation as well as quality improvements, hence improving technological intensity of industries. However, this is not the case for the Malaysian manufacturing sector. The negative relationship between sales growth and TFPG can be explained Figure 6 which shows that the growth in sales coincides with growth in intermediate inputs. Sales growth allows the manufacturing sector to realize economies of scale which may serve as a catalyst for further input accumulation. Figure 6(ii) shows that in general, returns generated from growth in output are not channeled into productivity driven activities. Although the sales performance of an industry can be affected by demand shocks and market fluctuations, TFPG figures in this study have been adjusted for business fluctuations. Therefore, market shocks are generally controlled. This further justifies the *Fundamentalist's* assertion that Malaysia's economic growth is still primarily input-driven.

Figure 6: Relationship between Sales Growth (SG) and i) Input Growth and ii) TFPG



The positive relationship between export growth and TFPG in all three models is consistent with the results shown Condition test 1. Complementary to the regression result, Condition Test 1 shows that exporters are more productive than non-exporters and firms that are more productive enter the exports markets. Industries with higher exports growth will lead to higher firm entry (in a competitive market). This leads to possible economies of scale, exploited through international trade, agglomeration effect and competition effect which in return produces higher productivity growth. Having emphasis on the importance of 'market competition pressures', the competition dummy (*Comp*) yielded the expected positive and significant sign in all three models. Market competition is important in forcing firms to employ cost-efficient methods by using newer technology or by innovating on existing production techniques.

FDI enhancing policies such as the equity liberalization dummy (*Pol*) have a positive effect on TFPG. An over-protected industry impedes productivity growth by shielding inefficient firms from market competition. Therefore, market liberalization policy has increased firms' productivity by decreasing X-inefficiencies. An open market policy has facilitated foreign entry and created greater opportunities to attract Malaysian manufacturing sector FDIs with frontier knowledge in areas such as marketing, innovation and competitiveness. While increases in FDI supported TFPG, Models 1 and 2 show that ownership differences (*Own*) do not affect TFPG. Results also challenged the *a piori* assumption that foreign firms have higher technology growth (due to resource advantages for input augmenting technology). Findings from Condition Test 1 and 2 showed that under

certain conditions[41], this assumption is challenged as TFPG for local can be higher than foreign industries. In Model 3, the effect of ownership status is only significant when foreign industries in Malaysia are involved in international production fragmentation (*ownFR*). Based on the coefficient value of *ownFR*, TFPG will increase by less than 1 per cent for every increased involvement of foreign firms in *FR*. The significant value of *ownFR* also confirmed that FDI (explained in Section 5.0) is one of the channels that links international production fragmentation to productivity gains.

The insignificant (Model 1) and perverse (Model 2 and Model 3) results of the ICT coefficient show that the leading industry in Malaysia is not leading in terms of new innovations and technical progress in the manufacturing sector. One reason is the over-dependency of the sector on labour-intensive activities (Menon, 1998, Rasiah, 2009), which has limited research and upgrading efforts. Even though the ICT industry (MSIC 30 and 32) are the top two ranked industries in the FR index, this is in no way infers that international production fragmentation is detrimental to TFPG of the local economy. Results in Model 1 show that after controlling for various other factors, international production fragmentation (*FR*) has marginally improved the TFPG of the manufacturing. Also, as discussed previously, foreign industries' involvement in international production fragmentation *ownFR* has shown positive TFPG in their business operations. Finally, firms invested in human capital will yield higher productivity gains in FR networks. Model 2 shows that for industries involved in the international production network, the increase in the number of skilled workers will increase productivity growth[42]. To reap the benefits of technology spillovers from the global production network, sufficient levels of human capital are required to receive new approaches to production and management. Results shows that the higher the absorptive capacity (*Absorb*) of a firm, the higher the productivity gained through the global production network. At this point however, the paper has yet to establish whether technology spillovers from foreign to local industries have occurred in the manufacturing sector. This will be discussed next.

[41]Two examples: (1) Local Firms with High exports > Local firms with Low Exports > Foreign firms with Low Exports and results from conditions test (2) Local firms with High FR > Local firms with Low FR > Foreign firms with low FR.

[42] The impact of *Skill* is insignificant for model 1 and 3. This is because changes in skill accumulation have been factored into the estimation of TFPG values, thus muting the effect of labour quality changes on productivity growth for all industries.

The significant and positive value of *Foropt*[43] in Model 4 strengthens the *Assimilationists'* theory that local industries do exhibit a certain amount of dependency on foreign technology for productivity growth. In general, foreign participation in the economy is not entirely driven by input accumulation as argued at the extreme end of the *Fundamentalists'* discourse. Although foreign participation (in terms of output) has positive spillovers on local TFPG, the negative sign for the ICT variable imply that these spillovers are constrained by the types of industry and MNC characteristics. For the case of Malaysia, the insignificant *ForFR* shows that the incidence of positive spillovers was not evident from foreign firms in industries which produce mainly for the global production network (such as the ICT industry).

There are a few explanations as to why spillovers are not evident from foreign firms in the FR network to local industries. First, there are copyright issues or exclusivity in accessing the technology. Technology spillovers only happen in a vertical structure. For example, imports of high tech specialized parts and components along with the embedded technology are only exclusively made available for contracted partners' production bases in host country. Therefore, the impact of spillovers was not shown in the aggregated manufacturing data. Second, since the late 1970s, foreign firms have been taking advantage of the cheap labour costs in Malaysia and investing extensively in the labour intensive section of the production network. This trend persisted for almost three decades (Athukorala & Menon, 1996; Menon 1998); the lack of skilled labour (Tham S. , 1995) as well as weak policy implementations (Rasiah, 2006) are among the constraints for foreign MNCs to shift their operations to knowledge-based and higher value added activities in the manufacturing sector.

In general, all coefficients related to international production fragmentation have very small coefficient values. Although results show that international production fragmentation has brought productivity gains to the manufacturing sector, the impact however, is questionably small. Menon (1998) stressed that *"there has not been much TFPG to spill*" between foreign and local industries. Low value-added assembly activities favored by some MNCs do not require intermediate goods with high technology content. Reflecting on his statement, then there is not much technology to be absorbed either. This also explains the

[43] This also shows that the model is consistent as *ownFR* in model 3 is also significant and positive.

reason why the coefficient value of *Absorb* is diminutive. Findings have showed that firms have benefitted from the international production fragmentation network. However, these gains are more prevalent in terms of better choices in input procurement, rather than in terms of productivity and technological gains.

Table 6: Estimation results (TFPG as independent variable)

					Spillover Model	
	Model 1	Model 2	Model 3		Model 4	Model 5
	TFPG	**TFPG**	**TFPG**		**$TFPG_{Local}$**	**$TFPG_{Local}$**
Sales	-0.00615***	-0.00637***	-0.00617***		-0.00707***	-0.00725***
	(-4.71)	(-4.52)	(-4.66)		(-6.92)	(-6.51)
Ex	0.00141^	0.00129^	0.00137^		0.00209^	0.00219^
	(1.68)	(1.69)	(1.72)		(1.84)	(1.88)
Comp	0.130*	0.120*	0.129*		0.0772	0.0753
	(2.36)	(2.43)	(2.32)		(0.82)	(0.80)
Pol	0.113*	0.101^	0.112		0.101	0.119
	(1.97)	(1.79)	(1.96)		(0.89)	(1.11)
ICT	-0.151	-0.159^	-0.163^		-0.805*	
	(-1.05)	(-1.88)	(-1.65)		(-2.23)	
Own	0.0863	0.0769				
	(1.17)	(1.33)				
Skill	187.2		173.1		355.2	328.9
	(1.46)		(1.46)		(1.54)	(1.45)
FR	8.76e-09^					
	(1.70)					
Absorb		1.29e-13^				
		(1.86)				
ownFR			1.05e-08**			
			(3.25)			
ForOpt					1.07e-08^	
					(1.95)	
ForFR						-5.84e-10
						(-0.09)
cons	-0.295	-0.119	-0.238		-0.464	-0.400
	(-1.55)	(-1.57)	(-1.56)		(-1.49)	(-1.29)
N	352	352	352		176	176
1.Hausmann Test:	Prob > χ^2 = 0.27	Prob > χ^2 = 0.02	Prob > χ^2 = 0.31		Prob> χ^2 = 0.42	Prob>> χ^2 = 0.32
2.Chow-F-test		Prob > F = 0.09				
3. LM test	Prob > χ^2 = 0.74		Prob > χ^2 = 0.53		Prob > χ^2 = 0.69	Prob > χ^2 = 0.90
Model Selection	Pool OLS	Pool OLS	Pool OLS		Pool OLS	Pool OLS
Mean VIF	1.42	1.24	1.29		1.42	1.24

t-statistics in parentheses, * p<0.05** p<0.01*** p<0.001^p<0.10

8.0 Conclusion

Malaysia has been hosting FDI since the 1970s and has been heavily involved in the global production network since the mid 1980s. In the 1990s, Malaysia along with other East Asian countries has achieved economic growth rates so rapid that the World Bank coined the phrase "*East Asian Miracle*". Yet, the links between the development of international production fragmentation and Malaysia's productivity growth has not been formally tested. This paper is a modest attempt to find the links between international production fragmentation and TFPG. This paper also re-visits the famous *"inspiration vs perspiration"* proposition by Krugman (1994) and has identified the determinants of the variations of TFPG. After analysing various industrial upgrading initiatives since 1990s, this paper next lookes at the performance of the manufacturing sector from 2000 to 2008 in order to obtain a current understanding of these issues and, indirectly provide an implicit picture on the effectiveness of these policies. In search for the determinants of TFPG, this paper also runs some conditions tests to identify various economic conditions and firm characteristics in supporting TFPG. Along these conditions, this paper proposes other controlled variables to fit into the final part of the analysis - the econometric modeling.

The general conclusion from this study stems from various views paved by *Fundamentalists* and *Assimilationists* in the TFPG literature. First, Malaysia is still very dependent on input driven growth even after going through various industrial upgrade initiatives. However, TFPG has improved under certain conditions with international production fragmentation. The best response for a local firm is to engage in exporting activities that are within the production fragmentation network. Benefits from international fragmentation are also best extracted when firms invest in competitive and high knowledge intensive sectors. This study therefore advocates for further industrial liberalization and an increase in pro-market competition efforts between local and foreign industries. Results from Conditions Test 4 show that further initiatives in providing incentives for training and skills-upgrading are effective in increasing TFPG. This shows that some of the past policy plans were on the ideal track, which leaves the implementation efforts now a "black box" for further studies.

Regression results also showed that the existing production network and its developments have only marginally improved Malaysian manufacturing TFPG from 2000 to

2008. In comparison with other variables, international production fragmentation is neither the absolute nor the most significant determinant of productivity growth. The model shows that market competition represents the most significant driving factor for productivity growth in the manufacturing sector. There is also a need to appropriate sales profit away from labour and input intensive activities and move into knowledge and technical-based operations. This is in parallel reference to the ICT sector in Malaysia. The lack of technological upgrading activities is among the reasons ICT firms in Malaysia are losing competitiveness to other Asian countries (Rasiah, 2009). The increase in competition between foreign and local firms, market liberalization efforts such as openness to trade and FDI facilitating policies are also all complementary to TFPG.

The learning-from-foreign technology paradigm suggested by *Assimilationists* is conditional to MNCs' characteristics. Positive spillovers from foreign to local industries within the international production fragmentation network are not evident in the model. This study suggests that it is the 'types of industrial activities' rather than the 'type of ownership' *per se* that is important in driving TFPG in Malaysia. While some MNCs indeed own high technology, policy focus should also extend beyond equity liberalization and focus on aspects such as human capital development and linkage creation through *FR* to set a facilitating environment for firms to upgrade their production frontier**.** Therefore, this paper proposes higher investment in human capital for firms involved in international production fragmentation. This can be done by providing incentives for training activities rather than the ongoing incentive focus on capital expenditure[44]. Investment in human capital development such as training programmes between local suppliers and foreign affiliates within the vertical structure of the production network is one example of a linkage creation channel. Training centers such as the Penang Skills Development Centre could be emulated nationwide to provide an industry-savvy labour force as well as cultivate local entrepreneurs. Other forms of industrial backward-linkages are business partnerships stemming from symbiotic relationships between locals and foreign firms. Although these relationships are spontaneous and require longer time to cultivate, additional support from the government in terms of improving the competitiveness of local industries will function as a catalyst for the linkage creation process.

[44] The main incentives for R&D in Malaysia since the Promotion of Investments Act 1986- *Pioneer status* and *Investment Tax Allowance* - both focused mainly on capital expenditure and capital absorption. Although incentives for training are available, the successes were less documented

An important caveat to the conclusion is that the arguments on the lag in upgrading initiatives, shortage of human capital and dependency on input-driven growth were all debated based entirely on the model and the framework proposed by different productivity schools of thought. This study has provided the base for understanding the conditions for these issues. However, there are other issues pertinent to the Malaysian manufacturing sector that are not highlighted in this study due the unavailability of data. These issues are considered the limitations of this study. For completeness, I will highlight some of these "unseen" issues that warrants further studies.

8.1 Limitations of study, further studies and policy suggestions.

There are various other reasons why TFPG may have remained low in Malaysia despite various upgrade initiatives and policy support for FDI and trade. Woo (2009) explained that the social-political structure in Malaysia prevents the full potential of TFPG. The affirmative action policy (New Economic Policy) has overstayed its purposes. Research direction on this issue has been limited and discouraged due to sensitive issues related to ethnic-based policies. There are concerns about the Industrial Coordination Act (ICA) 1975[45] which has loopholes in the ICA. One is the exemption on *Bumiputra* ownership requirement given to firms exporting over 80 percent of their output. With this exception, manufactured export industries (mostly foreign owned) in Kuala Lumpur and Penang (and firms in FTZs) were unaffected by this ownership requirement. Therefore, loca*l non-Bumiputera* small and light industries (non-exporting industries) remain small so that their paid-up capital stays just below the threshold that requires a company to offer 30 % of its equity to Bumiputera shareholders. Some even moved away from the manufacturing sector (Chin, 2007). This severely suppresses the full potential of local industries and further creates a divide between foreign and local industries in terms of firm expansion. Results from this study show that the local contribution to TFPG is significant in the presence of an international production fragmentation setting. Therefore, by relaxing this ethnic-based restriction, it releases the full

[45] Manufacturers are subjected to operation licensing consistent with the 'national social agenda - meaning enterprises with equity over a certain limit have to sell 30% of their shares to *Bumiputeras*. The Foreign Investment and Capital Issues Committee have similar regulatory control over large firms' investments and equity issues, enforcing the 30 % redistribution to the Malays. Indirectly, the aim of the act is to improve the relative position of the *Bumiputeras* in the modern sector of the economy (Menon. J, 2008). Other ethnic-based measures included preferential access for transport and timber licenses, 25% quotas for government contracts and so on (Lim. M.H, 1985; Tan. J, 2008). There are many criticisms for this interventionist policy because it is a form of competitive market distortion masked under the aim of distributional agenda.

potential of indigenous talents. More local industries are able to increase the overall TFPG of the manufacturing sector

The second issue is related to the dualistic nature of the economy as explained in Section 2. This study has highlighted the weakness of this economic structure. Ownership status is not significant in improving productivity and technology intensity in local industries. Even the best performing sector – electronics industries, which is highly export oriented and embedded into the international production fragmentation network - is not driving productivity growth in Malaysia. These electronics firms are located primarily in export processing zones (EPZ), clustered within special enclaves separated from local firms. The EPZs are considered "second best" policy for trade liberalization because the high concentration of foreign industries may force locals into smaller market niches. Therefore, technology transferred by the MNCs are insignificant to drive overall local TFPG (Kokko, 1994; Athukorala & Chand, 2000). This line of argument re-questions Malaysia's export-orientation argument. Have the priorities been misplaced? Have foreign-local business relationships in Malaysia provided positive externalities to the manufacturing sector?

The unexplored issue in Malaysia however goes beyond the dualistic nature of industrialization. Instead of "dualistic", studies should examine the manufacturing sector as a "tripod" that supports the Malaysian economy. The tripod structure here includes foreign-, government- and private locally–owned industries. The dichotomy between the foreign-local spillover nexus are well documented, however, studies on spillovers between privately owned small industries and large government links corporations (GLCs) are limited[46]. This issue warrants concern because industries with large government share (automotive, chemical, steel and oil and gas) are very technology- and skills-intensive. Ideally, with international production fragmentation, the TFPG in industries that GLCs are involved in supposed to outperform other local small industries and even generate horizontal externalities. However, this has not been the case for Malaysia. This puzzle is yet to be addressed.

Nevertheless, on a positive note, results from the model show that there are potential economic opportunities in areas such as technology and technical advancements along the international production fragmentation network that have yet to be explored in the Malaysian manufacturing sector. If Malaysia is able to address its above-mentioned constraints, perhaps

[46] I have requested for data on GLCs from DOS. Although data is available, it's inaccessible.

moving up the value chain and breaking away from the "middle-income trap" (World Bank 2009) will seems possible in the near future.

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Appendix1

Steps in adjusting capital utilization rate based on Oguchi (2004).

Wharton Method

1. Create a capital/output (K/Y) series using the capital stock and GDP data used for the analysis.
2. Fit a linear trend to this K/Y series.
3. Draw a line parallel to this trend line, passing through the lowest points on the K/Y series.
4. The potential or capacity K*/Y* ratio is given by points on the lower line.
5. Potential output is given by Y* = K/(K*/Y*).
6. Y/Y* gives capacity utilization.
7. The product of K and Y/Y* represents the adjusted capital stock series.

Appendix 2: Matching of codes, I-O to MSIC 2000

I-O	Description	MSIC (2000)
12	Meat and meat production	15
13	Dairy production	15
14	Preservation of fruits and vegetables	15
15	Preservation of seafood	15
16	Manufacture of oils and fats	15
17	Grain mills	15
18	Bakeries	15
19	Manufacture of confectionery	15
20	Manufacture of ice	15
21	Manufacture of other foods	15
22	Manufacture of animal feeds	15
23	Production of wine and spirits	15
24	Production of soft drinks	15
25	Manufacture of tobacco	16
26	Manufacture of yarns and cloth	17
27	Manufacture of knitted fabrics	17

28	Manufacture of other textiles	17
29	Manufacture of wearing apparels	18
30	Leather industries	19
31	Manufacture of footwear	19
32	Sawmills	20
33	Manufacture of other wooden products	20
34	Manufacture of furniture	36
35	Paper and board industries	21
36	Printing	22
37	Manufacture of industries chemical	24
38	Manufacture of paints and lacquers	24
39	Manufacture of drugs and medicines	24
40	Manufacture of soap etc.	24
41	Other chemical industries	24
42	Petrol and coal industries	23
43	Rubber processing	25
44	Rubber industries	25
45	Manufacture of plastic products	25
46	China and glass industries	26
47	Manufacture of clay products	26
48	Manufacture of cement etc.	26
49	Other non-metallic manufacture	26
50	Iron and steel industries	27
51	Manufacture of non-ferrous metals	27
52	Manufacture of other fabricated metal and fixture	28
53	Structural metal industries	28
54	Other metal industries	28
55	Manufacture of industries machinery	29
56	Manufacture of household machinery	29,30
57	Manufacture of radio, television etc.	32
58	Manufacture of electric appliances etc.	29
59	Manufacture of other electric machinery	31
60	Ship and boat building	35
61	Manufacture of motor vehicle	34
62	Manufacture of cycles, motorcycles	35
63	Manufacture of other transport equipment	35
64	Manufacture of instruments and clocks	33
65	Other manufacturing	36

Appendix 3: Correlation table

	TFPG	Sales	Export	Compete	Pol	ICT	Own	Skill	FR	Absorp	ownFR
TFPG	1.0000										
Sales	-0.4388	1.0000									
Export	-0.0249	0.3436	1.0000								
Compete	0.0595	0.1064	0.0903	1.0000							
Pol	0.0776	0.0312	0.0751	-0.0270	1.0000						
ICT	-0.0678	0.0255	-0.0212	-0.0110	0.0000	1.0000					
Own	0.0842	-0.0342	-0.0602	0.0000	0.0000	0.0000	1.0000				
Skill	0.1588	-0.1678	-0.1541	-0.0907	-0.0797	-0.2488	-0.1225	1.0000			
FR	0.0226	-0.0384	-0.0140	-0.0163	-0.0126	0.7301	0.2134	-0.2223	1.0000		
Absorp	0.0220	-0.0392	-0.0298	-0.0282	-0.0039	0.6067	0.1668	-0.1361	0.9164*	1.0000	
ownFR	0.0291	-0.0459	-0.0282	-0.0074	-0.0140	0.6519	0.2699	-0.2105	0.9809*	0.9108*	1.0000

* Terms not entered in the same equation

Appendix 4: Correlation table, evidence of linkages

	VS	VSfor	Elec
VS	1		
VSfor	0.6697	1	
Elec	0.612	0.9581	1

Appendix 5- Industry Code

Code	
15	Manufacture of Food Products and Beverages
16	Manufacture of Tobacco Products
17	Manufacture of Textiles
18	Manufacture of Wearing Apparel; Dressing and Dyeing of Fur
19	Tanning and Dressing of Leather; Manufacture of Luggage, Handbags, Saddlery, Harness and Footwear
20	Manufacture of Wood and Products of Wood and Cork, Except Furniture; Manufacture of Articles of Straw and Plaiting Materials
21	Manufacture of Paper and Paper Products
22	Publishing, Printing and Reproduction of Recorded Media
23	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel
24	Manufacture of Chemicals and Chemical Products
25	Manufacture of Rubber and Plastic Products
26	Manufacture of Other Non-metallic Mineral Products
27	Manufacture of Basic Metals
28	Manufacture of Fabricated Metal Products, Except Machinery and Equipment
29	Manufacture of Machinery and Equipment n.e.c.
30	Manufacture of Office, Accounting and Computing Machinery
31	Manufacture of Electrical Machinery and Apparatus n.e.c.
32	Manufacture of Radio, Television and Communication Equipment and Apparatus
33	Manufacture of Medical, Precision and Optical Instruments,Watches and Clocks
34	Manufacture of Motor Vehicles, Trailers and Semi-trailers
35	Manufacture of Other Transport Equipment
36	Manufacture of Furniture; Manufacturing n.e.c.