FOSTERING CLUSTERS IN THE MALAYSIAN ELECTRONICS INDUSTRY

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1. Introduction

Development policy on regional development has undergone considerable changes since the introduction of growth poles in the 1960s. For a number of years - both international organizations (e.g. UNIDO and World Bank) and national governments - promoted location-based industrialization ranging from industrial estates to export processing zones. The arguments then ranged from simply attracting industries (both foreign and local) to generate employment and later also exports, to the promotion of lead sectors and linkages. Whatever the instruments - whether through an emphasis on basic infrastructure and security in export processing zones or in addition, fiscal instruments to promote linkages – government hardly attempted to create or promote instruments (both government-led such as training institutions and privately coordinated such as chambers of commerce) to address inter-firm and firm-institution connectivity and coordination. As development planners sought new instruments to revive industrial estates and export processing zones clusters became a useful instrument owing to its dynamic role in driving differentiation and division of labor in Italy, Silicon Valley, Route 128 and Taipei,China. Government efforts in Malaysia to seek clustering as the major steering instrument of industrialization since 1996 is thus no exception to these developments.

Although clustering as a formal strategy was adopted by the Malaysian government in 1996, industrial clusters in Malaysia were already rooting in varying forms for several decades. Given that it contributed around a quarter of manufacturing employment, investment and value added, and around 80 percent of manufactured exports in 2003, the paper focuses on the impact of institutional and systemic effects of clustering and its consequences on upgrading and differentiation and division of labor in the electronics industry in Malaysia. The comparison is confined to the two leading electronics conurbation in the country – i.e. Penang and the Kelang Valley - to obtain a more informed policy assessment. The rest of the paper is organized as follows. Section 2 discusses the analytic framework. Section 3 presents government instruments involved in the development of electronics clusters in Malaysia. Section 4 compares and analyses clustering effects in the electronics industry in Penang and the Kelang Valley. Section 5 finishes with the conclusions.

2. Analytic Framework

Any attempt to examine clusters empirically in developing economies would require an assessment of other instruments used to promote regional development. Malaysia is no different given that industrial estates and export processing zones dominated early industrialization initiatives until clustering was adopted formally in 1995 as the main strategy. Three critical concepts have dominated region-centered industrial promotion, viz., industrial districts, growth pole and agglomeration economies and clusters. Marshall

(1890) provided the earliest known elements that constituted regionally defined set of firms by referring to industrial districts. Young (1928) articulated the advantages industry offers from its differentiating and division of labor potential. In addition to markets and command, Brusco (1982), Sabel (1982), Piore and Sabel (1984), Becatini (1982), Wilkinson and You (1995), Rasiah (1994), Pyke and Sengenberger (1988) and Rasiah and Lin (2005) showed how a systemic framework with a blend of influence from markets and trust-loyalty (social capital) have been instrumental in driving productive networks of industrial synergies.[1] Piore and Sabel (1984), Hirst and Zeitlin (1988) and Sengenberger, Loveman and Piore (1990) provided a dynamic and coherent account of inter- and intra-firm on how horizontally evolving relationships provide the impetus for the transition to a high road to industrialization. Best (2001) developed this further by examining the conditions that drove entrepreneurship and new species of industries regionally. Rasiah (2002) discussed the synergistic advantages the Silicon Valley and Route 128 have introduced to the continuous reinvention of old firms and the birth of new firms in clusters where there exists ease of movement of human capital – tacit to start new firms and new to galvanize old firms. Guerreri , Iammarino and Pietrobelli (2003) summarized the three dominant types of industrial clusters that have emerged to compete at the global frontier, viz., one, the atomized Marshallian small firms that typify Italy and Taipei,China, two, a handful of large firms defining the roles of suppliers in Detroit, and three, the single large mother firm defining the roles of suppliers in Japan.

There has been a parallel but converging development of the theory of agglomeration economies. Theories of state power and regional organizations have focused on the role development organizations play in stimulating industrial activities by concentration of infrastructure in particular locations. Early work from geographers and development economists examined the advantages of developing growth-pole strategies (see Perroux, 1949, 1961; Boudeville, 1966; Hirschman, 1958, 1977; Myrdal, 1958) on regional development. Unlike the concept of clusters which examines the regional dynamics as a network, growth pole was referred to by Perroux (1949) as an industry or a group of firms that drove the growth of other firms and economic activities most in the region: polarization arising from the propulsive development of a firm or industry. Growth poles eventually assumed the meaning of growth polarization stimulated external economies and linkages. The synergy effects of agglomeration economies have been documented lucidly subsequently by Cooke and Morgan (1998), Garofoli (1992), Porter (2001), Scott (1988) and Storper (1997). Work on agglomeration economies show that regions endowed with a dynamic set of economic agents connected and effectively coordinated – firms and institutions (e.g. provision of utilities such as power, water, telecommunications, education and training institutions and R&D labs) drive innovation and competitiveness through flows of circular and cumulative causation. UNCTAD and UNIDO saw such regional development initiatives through strong government intervention – either through supporting import-substitution in industrial estates or export-orientation in free trade zones – as a major instrument to improve the terms of trade and balance of payments of developing economies. Hirschman (1958; 1970) canvassed strongly for export-orientation to attract the discipline and scale effects of markets to promote competition and backward linkages.

In economies with successful upgrading the role of government shifted from the a focus on simply basic infrastructure to in addition the provision of high tech infrastructure. The discipline, and scale and scope effects of markets and the role of government in guiding

[1] The significance of trust in raising economic performance was earlier noted by Mill (1844).

markets and providing public goods were important in all rapid industrializers (see Chang, 2003). In addition, trust-loyalty (social capital) was also argued by Richardson (1960; 1973), North (1972), Sabel (1982), Piore and Sabel (1984), Burchell and Wilkinson (1997), Rasiah (1994), and Rasiah and Lin (2005) to have been critical. The simultaneous and often overlapping role of trust alongside markets and government helped synergize clusters in successful regions. Hence, networking among human capital based firms and institutions have been vital to stimulate cluster synergies.

Human capital has also been a critical pillar to drive dynamic clustering (especially upgrading) (see Rasiah, 2002). Modern industrialization requires the employment of human capital with at least communication skills so that conception, organization, coordination and execution of tasks are carried out smoothly. Primary and secondary schools offer the initial mass of labour for large scale but low value added mass production operations. Export-oriented TNCs relocated simple assembly operations in economies that offered large reserves of cheap but educated (trainable) labour. American, Japanese and European TNCs relocated in Jamaica, Barbados, Malaysia, Mexico, Singapore, Taipei,China and the Republic of Korea in the late 1960s and 1970s to access cheap literate labour (Scibberas, 1977; Lim, 1978; Rasiah, 1988).[2] Political instability and restrictive policies discouraged similar relocations in the People's Republic of China (henceforth PRC) and India in the 1970s. PRC only became a major manufacturing target of TNCs from the 1980s (*World Bank Institute*, 2001). TNCs did not figure strongly in the economies of the Republic of Korea and Taipei,China (see Lall, 1996; Hamilton, 1983). Singapore and Malaysia relied heavily on TNCs to generate clustering with ramifications for human capital synergies.

From basic and secondary schooling, the demand for technical and professional skills rises as firms move up the technology ladder (Pavitt, 1984). TNC-driven regions – e.g. Ireland and Singapore - have typically managed to stimulate spillovers and industrial upgrading by matching demand conditions with the supply of technical, tertiary and scientific and engineering human capital. Institutions associated with education often face collective action problems. Private agents are unlikely to participate in market-driven activities when the risks involved are not matched by returns. R&D scientists and engineers have increasingly become important to support innovative activities. Arrow (1962) had noted that interventions in markets are necessary when social returns exceed private returns. Schumpeter (1934) had argued that rents are necessary to motivate innovators. Kaldor (1957; 1962) had contended that markets generate sub-optimal outcomes when addressing investments that generate dynamic increasing returns and structural interdependence.[3] The production of technical personnel, scientists and engineers involve considerable acquisition of knowledge. Because knowledge is a public good - its consumption by one does not exclude that by others – the synergies associated with it clearly fits Arrow's distinction of social returns exceeding private returns. Hence, learning institutions such as universities, R&D labs and technical schools that generate high tech human capital fall under the category of public goods. Intermediary organizations such as development corporations and chambers of commerce play a critical role to coordinate information and knowledge flows between government and markets (see Aoki, 2001; Rasiah, 1999; Doner, 2001). The Republic of

[2] In fact the US customs items of 806.7 and 807 specifically offered generous exemptions to stimulate the relocation of low value added manufacturing activities to developing economies (see Scibberas, 1977).

[3] Abramovitz (1956) produced a similar argument about increasing returns. New growth economists such as Romer (1986) and Lucas (1988) demonstrated these ideas using elegant models. See Scherer (1992; 1999) for a lucid account

Korea and Taipei,China shortened the experience of the Western economies and Japan with strong government focus on human capital development (see Amsden, 1989; Wade, 1990).

The second channel of human capital development –tacit and experiential knowledge – is produced through learning by doing. While domestic institutions are necessary to increase the supply of high tech human capital, tacit and experiential knowledge is critical to run even innovating firms. Penrose (1959) and Polanyi (1997) made distinctive contributions to the understanding and significance of experiential and tacit knowledge respectively – which overlap and are specific to individuals. Rosenberg (1982) had established the peculiar characteristics of human capital where coordination and extraction of performance cannot be bounded. Schumpeter (1934) and Hirschman (1958) had discussed extensively the role of entrepreneurs in economic development. However, conventional economic theory tended to confine the term entrepreneurship to a black box (see Rasiah, 2002). Given the tacit and spontaneous nature of a number of human capital actions, formal contracts can never be exhaustive and hence will always involve moral hazard problems (see Rosenberg, 1982; Rasiah, 1995). Hence, trust has become a critical mode of governance to stimulate entrepreneurial synergies. Business theory helped define and differentiate entrepreneurs, with the focus largely on the evaluation and management of entrepreneurship. Management courses equip entrepreneurs with technical and professional knowledge so that they become better managers. Critical elements of the theory of entrepreneurship could be traced to Mills (1848), Marshall (1890), Penrose (1959) and Chandler (1962).

Whereas growth pole and agglomeration strategies had focused on the provision and appropriation of economic synergies from the provision of infrastructure and firms' proximate locations, clusters in addition emphasized inter-firm and firm-institution connectivity and coordination. The application of theory to the creation and growth of entrepreneurs became more dynamic with the works of Saxenian (1994; 1999) and Best (2001) as clusters enjoying open system frameworks and cohesive integration stimulated the flow of tacit knowledge for new firm creation. The term clustering itself refers to a network of inter-connected firms, institutions and other organizations whose synergy strength depends on strong systemic coordination and network cohesion. Clusters of firms and institutions enjoying strong network cohesion are likely to offer greater flexibility, and generate technological and market synergies than those characterized by truncated operations of individual firms. Causation involving the propellants of synergies in clusters is complex and is not uni-directional (Young, 1928; Best, 2001). Porter (1990) had discussed clustering alongside the four diamonds that drive competitiveness, but offered vague reference to systemic instruments and network cohesion. Marshall (1890), Brusco (1976), Wilkinson and You (1992), Piore and Sabel (1984), Sabel (1995), Sengenberger and Pyke (1988) and Hirst and Zeitlin (1991), Rasiah (1994) and Best (2001) offered a much more dynamic feel of the synergies associated with clustering when discussing the dynamics of industrial districts.[4]

Inter-firm pecuniary relations through sales and purchases is only one channel of inter-firm interactions (Rasiah, 1995). Knowledge flows –rubbing off effects from the interaction between workers (Marshall, 1890), and the movement of tacit and

[4] Variants of these arguments related to transactions costs to explain the existence of firms was advanced by Coase (1937) and Williamson (1990), and the relevance of non-market modes of coordination by Richardson (1960; 1972) and North (1991).

experiential skills embodied in human capital – produce systems synergies (Penrose, 1959). Open integrated clusters encourage inter-firm movement of tacit and experiential knowledge embodied in human capital, which, *inter alia*, distinguishes dynamic from truncated clusters (see Best 2001; Rasiah, 2001). New firms benefited from gaining managerial and technical personnel from older firms in the Silicon Valley irrespective of national ownership. American owned Intel, Dell and Solectron, and Japanese owned Sun Micro Systems hired technical and managerial personnel from old firms in the Silicon Valley.[5] Mature firms gain new ideas and processes to ensure continuous organizational change as some old employees are replaced to make way for fresh ones with new ideas, while new firms benefit from the entrepreneurial and technical – tacit and experiential – knowledge to start new firms (Rasiah, 2001).[6] Saxenian (1994; 1999) offered an impressive documentation of inter-firm movement of human capital, which helped support new firm creation capabilities in the Silicon Valley.

While the prime propellants of cluster dynamics in the successful industrial districts of Emelia Romagna and Silicon Valley are local firms, five important developments have made this approach applicable even to TNC-driven clusters. First, host government investments in basic infrastructure and bureaucratic coordination helped resolve customs, security and labour problems. Second, TNCs have increasingly integrated production at selected host-sites (e.g. Ireland and Singapore). Third, production reorganizations in electronics value chains has encouraged TNCs to subcontract out dissimilar activities to suppliers and contract manufacturers. Fourth, growing horizontal integration has diffused synergies to several layers of firms at host sites (e.g. Israel and Singapore). Fifth, TNCs increasingly rely on host-site institutions to access scarce high tech human capital – through relocation and immigration (e.g. software in India).

Evolutionary economists introduced the concept of national innovation systems (NIS) to explain systemic effects on innovations (Freeman, 1988; Lundvall, 1992; Nelson, 1993).[7] The NIS framework posits the role of a range of economic agents - institutions and firms – which are critical for stimulating innovation synergies. Where national systems fail to meet human capital demand-supply conditions, dynamic clusters such as the Silicon Valley, Ireland and Singapore introduced selective immigration policies (Best, 2001). Some TNCs have also relocated abroad to access human capital where large-scale immigration was difficult (e.g. software companies in India). Although existing work has hardly dealt with the construction of emerging systems, which is necessary for underdeveloped locations, its focus on the necessary links between economic agents is similar to the cluster concept where a mix of firms and institutions is viewed as critical to stimulate innovative activities. The application of the NIS approach to clusters have led to the integration of the development of critical high tech institutions alongside clustering effects that expand inter-firm and firm-institution connectivity and coordination (see Mytelka, 2002; Rasiah, 2004). The use of the cluster approach in NIS amplifies the systemic synergies that arise from dynamic inter-firm and institutional links. Given the strongly overlapping and complementary nature of the two approaches, this paper integrates systemic coordination and network cohesion and examines the NIS from the lenses of firms.

[5] Author Interviews (1995).
[6] Author Interviews (1995; 1999).
[7] Elements of the NIS can be traced to Smith (1776), Hamilton (1791) and List (1885).

Five important propositions are identified here to examine clustering First, effective systemic coordination and network cohesion is necessary to stimulate demand-supply conditions for the creation and appropriation of knowledge both through formal educational institutions as well as firms. Integrated clusters enjoying network cohesion – connectivity and cohesion - is important to ensure the continuous growth of supplier chains intersecting global value chains with domestic production dynamics. Third, dynamic clusters take advantage of tacit and experiential knowledge to intensify differentiation and division of labour. Fourth, a critical mass of technical personnel and R&D engineers and scientists are essential to enable firms' strong participation in innovative activities. Fifth, clusters benefit from open national frameworks so that human capital deficiencies can be overcome through selective immigration as experienced by the United States, Singapore, Israel and Ireland.

The Malaysian electronics industry is characterized by three major regional agglomerations, and moribund operations in Sarawak and Sabah. Penang is the largest of them in terms of firm numbers, employment and value added, followed by the Kelang Valley and Johor. Penang's electronics industry employed over 90,000, followed by the Klang Valley with over 85,000 in 1995 (MITI 1996: 38). Penang and Kelang Valley are also the oldest electronics manufacturing locations in Malaysia. Matsushita Electric started Malaysia's first electronics manufacturing operations in 1965 in Shah Alam (Kelang Valley), while Penang Electronics (1970) and Clarion (1971) were the earliest electronics firms in Penang.

3. Government Instruments

Before an assessment of the impact of clustering is carried out it will be useful to examine government policies implemented to drive regional development in Malaysia. Clusters as a formal government tool was adopted in Malaysia following the introduction of the Second Industrial Master Plan (IMP2) in 1996. However, the electronics clusters that can be traced in Malaysia were rooted much earlier, especially since the opening of the export processing zones in 1972. Unlike what is contained in the term cluster – which has no industry borders and its expansion through differentiation and division of labour as firms continue to specialize in smaller segments of activities in the value chains – government promotion in Malaysia is driven under industry lines. Where the promoted industry cluster had originally evolved in export-processing zones as is the case with electronics, promotional instruments in the country has targeted them as the nucleus of cluster activity. Hence, the discussion of fostering instruments in this section examines emergence and expansion of geographically defined electronics clusters in Malaysia. The section is divided into the pre-IMP2 phase and the IMP2 phase.

3.1 Pre-IMP2 Phase: Employment Generation and Export-Orientation

The origins of government emphasis on clusters in Malaysia can be traced to the opening of industrial estates in the 1960s. Although the term cluster or initiatives targeting inter-firm links with a view toward launching and strengthening institutions to drive differentiation and division of labour was not part of Malaysian industrial policy, the provision of basic infrastructure to import-substituting firms attracted the relocation of several firms into designated locations. The agglomeration effect from such targeting since the promulgation of the Pioneer Industry Ordinance of 1958 however was minimal owing to the application of narrow import-substitution that simply relied on tariffs imposed on final consumption goods. Such a policy offered neither the impetus for learning and innovation, nor the opportunities for the production of inputs domestically (see Rasiah, 1995).

The inability of the industrial estates to attract or create new firms led to the adoption of export-oriented manufacturing following the Investment Incentives Act of 1968. However, it was not until the introduction of export processing zones following the FTZ Act of 1971 and the formal opening of these zones since 1972 that export-oriented firms began to relocate in large numbers in Malaysia. In addition to the small domestic market, the promotional role of UNIDO and World Bank to encourage developing economies to take advantage of the dispersal efforts of multinationals were also important. In addition to promotional tours to developed economies (including special visits to flagship firms such as Intel, Motorola, National Semiconductor, AMD, HP and Hitachi), generous financial incentives became an important carrot that the government used to attract multinationals (see Appendix 1). Using the clause of pioneering industries the government also refused unionization of workers in the industry until 1989. Where the creation of a larger free trade zone was neither desirable nor feasible the government simply opened licensed manufacturing warehouses (LMW) to house large individual firms. Both types of export processing instruments enjoyed the same privileges, including the provision and coordination of basic infrastructure support.

After an initial surge in FDI inflows in the period 1971-74, the export processing zones began to face a slowdown owing to a global slowdown in FDI outflows, problems of government coordination of firms located in EPZs and in the principal customs area (PCA), and lack of policy instruments to promote differentiation and division of labour. Following the Industrial Coordination Act (ICA) of 1975 by requiring firms to export and import most of their outputs and inputs respectively government policy discouraged outsourcing domestically. Until the 1980s the government administered the EPZs largely in a laissez faire manner so that neither the critical institutions nor the systemic networks were created to drive the learning and innovation necessary to stimulate upgrading.

It was the circumstances of increasing leakage from the truncated operations of multinationals that led to the government to seek strategies to expand linkages domestically in the 1980s. Convinced that the Japanese and Korean models built around large industries were working the government promoted strongly the heavy industries of steel, cement and cars following the Look East Policy of 1981 as a means to develop domestic firms as well as intensify linkages domestically. It was only since 1986 when the first Industrial Master Plan (IMP) was launched that the export processing zones regained active promotion from the government. A severe slowdown in GDP in the mid-1980s led the government to take advantage of a new wave of multinationals relocating from Japan, the Republic of Korea, Taipei,China and Singapore (largely American multinationals) by reviving incentives and the opening of new export processing zones in other parts of the Western corridor of Peninsular Malaysia.

The Ministry of International Trade and Industry's *First Industrial Master Plan 1986-95* (IMP) had three broad objectives (MITI 1996: 7):

- To ensure the continued expansion of the economy through the accelerated growth of the manufacturing sector,
- To promote the optimal and efficient use of the nation's natural resources through value-added manufacturing, and

- To lay the foundation for the development of indigenous technological capabilities.

A combination of overheating and a tightening of the labour market and the competitive threat posed by PRC, the Philippines, Indonesia and Thailand following political stabilization and increased marketization led the government to launch high tech institutions to stimulate upgrading following the introduction of the Action Plan for Industrial Technology Development (APITD) in 1990. The APITD identified institutional pillars to stimulate upgrading in the manufacturing sector. The Human Resource Development Fund (HRDF) was started in 1993 after the act in 1992, the Malaysian Technology Development Corporation (MTDC) was launched in 1992, and the Malaysia Industry Government High Technology (MIGHT) platform was opened in 1993. The National Electricity Board, the Telecommunications Corporation and the Malaysian Microelectronics Systems (MIMOS) were corporatized in the early 1990s with the purported claim their increased market-orientation would allow them to support firms more effectively. The Private Universities Bill was enacted in 1995 so as to enable the development of human resource with greater role for markets.

3.2 IMP2: Clustering as the Engine of Manufacturing Synergies

As the first IMP reached its expiry date in 1995, the government began seeking strategies to fuse upgrading with the creation of greater differentiation and division of labour. Hence, clustering and the manufacturing ++ approach became the core of the second Industrial Plan of 1996. The *Second Industrial Master Plan 1996-2005* (IMP2) confirms the Government of Malaysia's goal for the nation to become an advanced industrialised nation by the year 2020. IMP2 was designed to build on the successes of the IMP. It aims to address the issues and challenges that have been identified in order to sustain and enhance the momentum of growth in the manufacturing sector.

The IMP2 recognised four key elements to a cluster based industrial development approach (MITI 1996: 25-30). They are

- Clusters
  In accordance with the IMP2, the government would like to direct local industries within the concept of cluster development in order to develop greater linkages and complementarities. The local electronics industry is a suitable candidate for this development. Many subsidiary industries are either directly or indirectly linked and complement the electronics industry. The Malaysian electronics industry has the diversity in various product groups to create the critical mass of networking and linkages crucial to the eventual development of clusters.

- Value added and Value chain.
  The key to the clustering process as proposed in the IMP2 is to increase the value added activities from R&D to design and prototyping to product development to basic processes to conventional assembly to distribution and logistics to marketing (MITI 1996: 10).

  It is perceived that the local electronics industry has the potential to expand extensively along the value-added chain. The various segments of the electronics industry are expected to continue to develop depth as their supply chains and links expand across a wide variety of activities. These activities are expected to form an additional segment in the electronics cluster, namely the information technology segment. Thus, while the TNCs expand their value-chain and supply networks, the local supporting and ancillary industries as well as the second tier electronics industry are envisaged to enhance their status from simple subcontractors, to Original Equipment Manufacturers (OEM), to Original Design Manufacturers (ODM), and eventually to Original Brand Manufacturers (OBM). Some local electronics companies are already moving in this direction but a critical mass of such firms needs to be nurtured in order to develop an eventual self-sustaining movement.

- Key suppliers
  Large and small firms are out-sourcing their sub-assemblies and services. This allows both firms to focus on their core competencies but rely on their extensive network of suppliers. The IMP2 has identified nine key supplier categories that require development in order for the clustering process to be carried out efficiently. They are

  - Parts and components
  - Critical business support services
  - Logistic services
  - Technical business services
  - Electronic commerce
  - R&D
  - Manufacturing materials
  - Machinery, and
  - Packaging

- Requisite economic foundations.

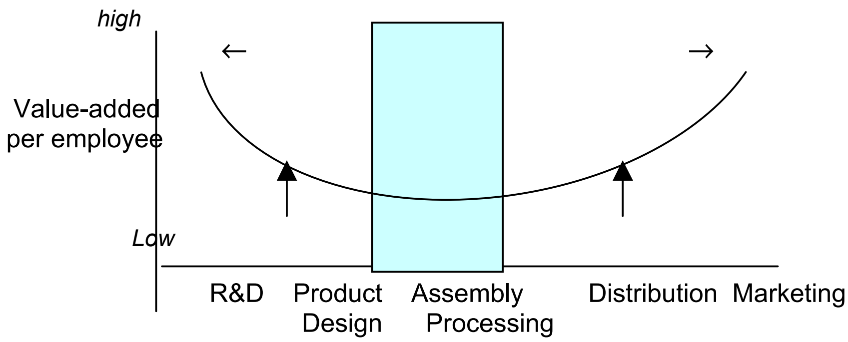
  There are four factors to be considered under these requisites.
  - The generation of the human resources required as well as the ability to advance and renew the skills required fulfilling the demands of specific clusters.
  - To assist the degree to which industries are able to acquire new technology and develop and commercialise applications.
  - The right policies, incentives, and business friendly services to allow for a conducive environment for trade and investment
  - The provision of advanced transportation, telecommunication, information, power and environment protection systems, as well as industrial parks that facilitate the efficient operations of the clusters

The basis for the official promotion of clustering under the IMP2 was to drive value addition upwards through directly raising efficiency levels and participating in higher value added products, and through integrated operations (see Figure 1). As the IMP_2 (*1996-2005*) posited:

> The *Manufacturing ++ strategy* for Malaysia entails not only moving along the value chain but more importantly will place emphasis on productivity-driven

growth, such that value-added per employee improves to a higher plane at all levels of the value chain (MITI 1996: 31).

Figure 1: Manufacturing ++ Strategy



IMP$_2$ emphasised moving beyond manufacturing operations to include R&D and design capability, development of integrated supporting industries, packaging, distribution, and marketing activities (MITI 1996: 3). This strategy entails not only the move along the value chain but also to place emphasis on productivity-driven growth, so that the value-added chain will shift to a higher plane.

The IMP2 focused on the following series of strategic thrusts (MITI 1986: 11):

- Global Orientation.

  The IMP2 was designed to reorient the local industry from being purely export driven, to an industry based on global orientation. This is to be achieved through:
  - The development of indigenous companies to become world scale and world class manufacturers by
    - Developing their global marketing capabilities and
    - Developing their ability to compete internationally while not relying only on cost advantages.

- Enhancing Competitiveness.

  The IMP2 was expected to foster competitiveness in industries through a
  - focus on clusters through the deepening and broadening of industrial linkages and
  - productivity enhancement

- Improving the requisite economic foundation.

  The IMP2 stressed the need for the development of a strong base in the requisite economic foundation. This is to be achieved through the development and management of

- Human resources
- Technology acquisitions
- Enhanced absorptive capacities
- Physical infrastructure
- Supportive administrative rules/procedures
- Fiscal and non-fiscal incentives
- Business support services

- Malaysian owned manufacturing companies.

The IMP2 underlined the role foreign TNCs have contributed towards the electric and electronics industry's success. However the IMP2 posits that Malaysian indigenous firms must assume greater importance and become larger companies. The intended result is a higher percentage of the electronics income being retained within Malaysia and an increase in the domestic share of the value added activities. This is to be achieved by

- Increasing participation of indigenous companies in a broad range of manufacturing activities, especially in cluster based activities and
- The development of indigenous firms into large companies geared towards regional and global markets

- Information-intensive and knowledge-driven processes.

This is to be achieved through a concentration on

- R&D,
- Product design,
- Marketing,
- Distribution and procurement and
- Electronic commerce

Whereas the value addition thrust of IMP1 and the APITD was strengthened further, clustering became the focal point of IMP2. The cluster as a concept was used in IMP2 as:

> The defining characteristic of a cluster is the high degree of connectivity… A cluster is an agglomeration of inter-linked or related activities comprising industries, suppliers, critical supporting business services, requisite infrastructure and institutions (MITI 1996: 23)...The existence of a mature cluster requires the development of ancillary industries and economic foundations in support of the core industry (25).

The IMP2 emphasized clustering as an important strategy to move the electronics industry upward. The term cluster focuses on connectivity amongst electronics companies, supplier firms, R&D organisations, electronics associated service facilities, training and HRD institutions, infrastructure and amenities, and relevant government agencies. All these would work together complimenting and linking with one another to drive the electronics industry ahead to greater innovation, R&D, competitiveness, and new product development along the value-added chain.

The IMP2 identified two antecedents to be considered in the process of developing clusters in the electronics and electrical industry:

- Finding the missing links and promoting investment in these areas. The missing links are the core activities currently absent in the local industry that are required for the industry to have control over the complete value added chain and
- Creating a cluster that is closely knit through information networks that possess flexible manufacturing capabilities.

Three broad but potentially strong Industry Clusters were identified in the IMP2 on the basis of international linkages, resource depth and policy focus, *viz*.,

- Internationally linked clusters. These are clusters that are based and driven by foreign TNCs. The electric and electronics industry cluster is placed under this category. It has a high concentration of foreign TNCs whose products are for the global market. It has been noted by the EPU that "…the primary source of technology will continue to be foreign enterprises…"[8] in the electronics sector. This sector is dependent on global factors for growth and sustainability
- Resource-based clusters. These are industries that are based on Malaysia's natural resources. These industries have a high degree of indigenous firm involvement.
- Policy-driven clusters. These are industries that are technology-driven and identified through government policy initiatives. It is these industries that are believed to be critical for the development of particular capabilities.

The IMP2 categorised eight Malaysian industrial groups into clusters (MITI 1996: 32-3). Some of these groups are well defined and noticeable as clusters already while others have the potential to become clusters. These groups are the

- Electrical and Electronics Industry Group
- Transportation Industry Group
- Chemicals Industry Group
- Textiles and Apparel Industry Group
- Resource-Based Industry Groups
- Materials and Advanced Materials Industry Group
- Agro-Based and Food Products Industry Group
- Machinery and Equipment Industry Group

The cluster concept in the IMP2 looked at regional concentrations based on the premise that industries require high degrees of employment concentration, buyer/supplier linkages, specialised services, access to technology and sources of innovation. A regional Distribution Index was designed for purposes of IMP2. This index has identified Penang as possessing the largest concentration of workers in the electronics industry. Other areas of concentration are Selangor and Johor with spillovers into Kedah, Negeri Sembilan, and Melaka.

[8] EPU (1996), p. 2

Penang and the Kelang Valley became the obvious dominant electronics clusters in Malaysia. Penang has a good foundation of TNC supplier networks relative to other electronics regions within Malaysia. Many TNCs in Penang are already sourcing materials, components, services, training facilities, and other equipment from local suppliers. Further development of this supplier network will depend on how well the indigenous supplier companies are able to meet the requirements of MNCs in terms of quality, new product development, and competitiveness of products.

The umbrella concept that some TNCs have developed was expected to aid this process. The idea is for the electronic industry to follow the Proton example. Although the form and essence of the relationships is debatable, Proton's umbrella concept involves the training and nurturing of indigenous suppliers to produce certain Proton components. There are dozens of suppliers within the Proton umbrella.

With IMP2's cluster-based strategy policy-makers and industrialists will be able to work together within a focussed, integrated and comprehensive framework.

> The cluster-based industrial development framework addresses the issues of markets, linkages and requisite economic foundation and relates them to the underlying core competencies that are central to the competitiveness of industrial clusters … The cluster-based industrial development approach with its emphasis on industrial linkages, and the role of critical support industries and services, *will enable policy-makers and industrialists to operate a focused, integrated and comprehensive framework* (original in italics, MITI 1996: 22).

The IMP2 has identified six policies and strategic directions (MITI 1996: 79-85), *viz*.,

- Developing the Value Chain. The electronic and electrical industry is dominated by foreign TNCs who have located their production in Malaysia. However most of these operations are in assembly and testing operations. The IMP2 strategy is to encourage these foreign TNC's to increase the extent to which they undertake higher value added activities in Malaysia. This is to be achieved through
    - The encouragement and establishment of integrated manufacturing centres;
    - Reviewing laws governing Free Zones (FZs) and Licensed Manufacturing Warehouses (LMWs); and
    - Reviewing financial encumbrances that hinder the establishment of operational headquarters, world headquarters, and international procurement offices in Malaysia.

- Deepening the Supply Chain. The development of indigenous firms in order to develop domestic capabilities is one of the areas that the IMP2 intends to promote. This is to be carried out by
    - Strengthening supply chains vertically and horizontally,
    - Enhancing cluster linkages, and
    - Reviewing equity and export conditions.

- Move to a Higher Technology Plane. The IMP2 has stated that it intends to move value added activities both upwards as well as along the value chain. The acquisition of necessary emerging technologies and core competencies are critical for R&D, product development activities, and to enhance productivity. This it to be achieved by
    - Acquiring technology to design and fabricate wafer production,

- The development of local technological capabilities, and
- Providing specialised Technology Parks for High-Tech Industries.

- Establishing Wafer Fabrication Facilities. This goal calls for
  - At least one project of each of the main types of integrated circuits manufacturing,
  - Fabless chip companies to be established in Malaysia,
  - Technology acquisition based on the MIMOS model,
  - Promotion of wafer fabrication,
  - The conversion of silicon ingots from basic materials, and
  - Government support systems.

- Develop World-Class Malaysian Owned Companies. Due to the high involvement of foreign TNC's in the electronics and electrical industry, Malaysia has many companies which meet international quality standards. These quality standards can be used to create world class and world scale producers and suppliers. IMP2 suggests that this can be carried out by

  - Supporting indigenous subcontracting companies in order to become OEM and OBM,
  - Providing government incentives to indigenous firms to assist in developing skills in high value added activities,
  - Liberal policies to allow expatriates with technical or specialised skills to enter the country and for
  - MATRADE (see below) to organise promotional programmes for Malaysia brand name products to be sold regionally and globally.

- Develop the information technology (IT) and multimedia industry. The IMP2 expects this sector to be the next engine of growth and has stated applications for immediate development in the Multimedia Super Corridor (MSC). They are
  - Electronic government,
  - Telemedicine,
  - R&D,
  - Remote Manufacturing,
  - Borderless Marketing Centre,
  - Multimedia Funds Heaven,
  - Multipurpose Smart Card, and
  - Smart Schools.

The government introduced state of the art support institutions to drive upgrading and clustering in the manufacturing sector. In particular, emphasis was on complementing indigenous R&D, product and design innovations, and new product developments of high quality and technologies capable of competing internationally with stimulation of similar activities in multinationals.

Action Plans include the following initiatives:

- The Malaysian Industrial Development Authority (MIDA) set up a special division to assist the electronics industry in line with IMP2. This assistance is in the form of incentives, information dissemination, and special assistance to investors in respect to rapid project approval, advice on factory locations, and liaison with respective state governments.

- The government established the Multimedia Super Corridor (MSC), Cyberjaya, and several new high-tech parks, particularly the Kulim Hi-Tech Park, which will emphasise the promotion of the electronics industry. The MSC and Cyberjaya, in particular, will stress R&D in electronics and information technology (IT). To expedite these, the government has set up the Multimedia Development Corporation and has introduced a number of special incentives for firms that qualify for MSC status. To highlight the importance of the MSC, it is placed within the ambit of the Prime Minister's Department.

- MIMOS, an agency set up by the government and recently privatised, is to be an instrumental in creating various start-ups in the electronics industry. Its small wafer fabrication plant and various facilities for testing and packaging as well as initiatives for design innovation and R&D, act as a catalyst for spin-offs. MIMOS is situated in the MSC area and the government will actively co-ordinate with MIMOS on the future direction of the electronics industry in Malaysia. In particular, it is desired that MIMOS with the assistance of the Malaysian Technology Development Corporation (MTDC), will be able to create numerous start-ups among the indigenous electronics sector.

- To develop the sector more rapidly and to spearhead R&D, the government has also provided allocations for financial assistance. Some examples of these assistance funds are the Industrial Technical Assistance Fund (ITAF) and the Intensification of Research in Priority Areas (IRPA) Fund. The funding assistance can be sourced through MITI, MIDA and Small and Medium-Scale- Industry Development Corporation (SMIDEC).

- The government has made a RM100 million allocation for a Multimedia Grant Scheme. The purpose of the scheme is to help SMI companies to participate in the MSC. SMIs involved in multimedia, telecommunications, and IT are eligible for up to 50% funding if they qualify for MSC status, and also in cases of joint venture companies where Malaysians have majority equity. The funding is primarily meant for SMI electronics firms to conduct research. At the end of 1998, the Multimedia Corporation received 270 applications for MSC status of which 201 (74%) have been approved. Of the 201 applications, 136 companies are in operation. In terms of activities, 35% of the approved firms are involved in software, 19% in content development, 16% in systems integration, 10% in telecommunication, 8% in post production/animation/film, 6% in electronics, 3% in training/education, and 3% heavy users.

- The Multimedia Super Corridor (MSC) is another initiative to provide new impetus to the further development and modernisation of the electronics industry in Malaysia. It is a strategic project to attract organisations by providing the infrastructure to draw in Information Technology (IT) and electronics projects. The MSC is expected to spawn spin-off effects for research, development, IT innovations, and R&D in product development. It is also expected to provide spin-offs in the development of service industries in IT and in the electronics and electrical sectors. In effect the MSC aim is to herald the formation of a regionally compact electronics cluster with close linkages and numerous complementarities.[9]

- The development of the MSC and Cyberjaya and several high-tech industrial parks in the country with a high priority and emphasis on R&D will provide seedbeds to the efforts to create an information technology cluster.

4. Contrasting Clusters: Penang and Kelang Valley

This section examines the experience of the two leading electronics clusters in Malaysia where the consequences of federal fostering policies (both during the pre-IMP2 phase and under the IMP2 phase) and differences in state level governance and coordination initiatives produced low levels of R&D operations in both regions, but a variance in local state coordination produced different levels of upgrading in the two regions. Using extensive interviews over a period stretching from 1985 until 2004, this section attempts to evaluate the processes, dynamics and support forces that helped connect and coordinate links between TNCs and local firms in Penang and the Kelang Valley (see also Rasiah, 2002). The firms interviewed for this paper are reported in Table 1. The policy and systemic framework embedding TNCs and SME suppliers in Penang and the Kelang Valley is shown in Table 2.

It can be seen in Table 2 that Penang and Kelang Valley enjoyed high numbers of electronics TNCs, and strong institutional coordination of basic infrastructure and security, and incentives and promotional efforts to relocate in Malaysia. Penang in addition also enjoyed strong participation in state-level governance from its chambers of commerce, network cohesion, TNC-SME matching efforts by the state, coordination meetings between TNCs, SMEs and state institutions and the publication and distribution of the financial and technological capabilities of SMEs. Kelang generally faced relatively weak support in these areas with adverse technological and inter-firm synergy deficiencies as the consequence. However, both regions lacked state support in R&D (including in the construction of R&D institutions), university-industry collaboration and human capital supply.

[9] This paper does not undertake a detailed analysis of the Multimedia Super Corridor (MSC) and Cyberjaya.

Table 1: Breakdown of Interview Sample, 2004

Sub-sectors	Penang	Kelang Valley
Component electronics	**21**	**16**
Consumer electronics	**22**	**35**
Industrial and peripheral	**11**	**12**
Plastic	**18**	**9**
Machine tools	**34**	**9**
Packaging	**3**	**2**
Total	109	83

Source: Compiled by author.

Table 2: Systemic Coordination Instruments, Malaysia, 2002

Systemic Features	Penang	Kelang Valley
Chambers of Commerce	Strong	Weak
Incentives and visits to relocate in Malaysia	Strong	Strong
Density of TNCs and institutions	High	High
Network cohesion	Strong	Weak
Skills development and training	Strong	Exists but weak
Matching of supplier firms with TNCs	Strong	Weak
Basic infrastructure support	Strong	Strong
Security problems	Strong	Strong
Meetings between state, TNCs and supplier firms	Strong	Seldom
Production of high tech human capital	Low	Low
Industry-Public R&D Institution ties	Weak	Weak
Industry-University ties	Weak	Weak
R&D support institutions	Weak	Weak
Publication of documents on product and process technology of suppliers	Strong	None
Access to foreign High tech human capital	Restricted	Restricted*

Note: * IT firms in the Multimedia Super Corridor (MSC) enjoy liberal environment to import foreign engineers and scientists, but the narrow strip is still underutilized.

Source: Author

4.1 Penang: Strong Cluster Synergies

The Penang government established the Penang Development Corporation (PDC) in 1969 to “undertake and promote socio-economic development” (PDC 1974: 4), which included the extensive promotion of export-oriented TNCs. TNCs helped raise Penang’s manufacturing share in GDP from 13 percent in 1971 to 46 percent in 2000 (PDC, 2001). The Penang region built high volume production capability in electronic components, consumer appliances, hard disk drives and PC components, by inserting in TNC-driven global production chains. Changes in the dynamics of TNC production coincided with improvements in systemic coordination in Penang, which helped strengthen clustering since the 1980s.

Although Penang achieved dynamic clustering, the lack of R&D infrastructure (including serious shortage in engineers and scientists) – where governance jurisdiction is held by federal institutions headquartered in the Kelang Valley - restricted industrial upgrading. Strong systemic coordination helped the cluster generate and appropriate considerable network synergies. Integrated business networks with PDC's pivotal intermediary role fuelling cluster cohesion helped movement of tacit and experiential knowledge embodied in human capital for new firm creation, differentiation and division of labor.

Speciation Synergies

Systemic coordination was instrumental in the relocation of industrial sub-species new to Penang, which helped sustain differentiation and extended the platform for human capital development in firms. A deliberate effort to promote sub-species to strengthen inter-firm links in Penang emerged from the late 1980s when a massive influx of electronics firms offered the state the opportunity to be selective. Personal approaches by the Penang government since the early 1970s attracted TNCs. Penang Electronics – opened as a symbolic spur - was started in 1970, which was followed by the relocation of Clarion and National Semiconductor in 1971 and later by Intel, Motorola, Hewlett Packard, AMD and Hitachi by 1974. While a myriad of firms relocated, the early 1970s was dominated by the microelectronics sub-specie. These firms use cutting-edge process technologies with extensive application of flexible production techniques from the 1980s.

Consumer electronics became important from the late 1970s, but particularly since the late 1980s. Sony, Toshiba and Pensangko were some of the consumer electronics firms. Disk drive companies were actively wooed from 1989 with Maxtor, Conner Pheripherals, Seagate, Quantum, and Komag starting operations from the early 1990s. Many of them have either closed down or relocated by the late 1990s, but Quantum, Seagate and Komag were still operating in 2002. In addition to product transitions in old subsidiaries such as Komag and Osram,[10] the Penang government was promoting the opto-electronics sub-specie in 2000-2002.[11]

The development of synergies from TNC operations also drew participation from Dell, which reported relocating in Penang to integrate around its product chain and strategically customize product development for the Asia Pacific market. Dell's movement to Penang attracted contract manufacturers such as Solectron and raised demand for other local suppliers.

Sub-species of industries – not new to the universe – have also evolved domestically to stimulate differentiation and diversity in Penang. Machine tool and plastic molding species evolved from technological constraints emerging in the production dynamics of TNCs operating in Penang. The development of several tiers of firms in these industries has enabled the workforce to expand further embodied knowledge development and movement in the Penang cluster. Intel, AMD, Fairchild and Hewlett Packard subcontracted out a number of older products to Globetronics, Unisem and Carsem (the latter two located in Ipoh). TNC synergies initiated and stimulated the development of

[10] Osram was renamed from Siemens Litronix.
[11] Author interviews (2001) with Penang's Chief Minister.

precision engineering, machinery and plastic injection molding sub-species of firms in Penang – especially from the 1980s.

However, the lack of engineers, scientists and technicians has restricted Penang's capacity to stimulate horizontal integration. The Penang government is keen on a pro-active strategy to step up the supply of engineers, scientists and technicians, and complementing imports from abroad is necessary to ameliorate the problem, but the jurisdiction for adoption and application rests with the federal government. PRC has already emerged as the biggest single threat to labor-intensive industries in Penang. In fact, four TNCs reported shifting operations from Penang to PRC in 2001.[12]

Training Ground

Changes in TNC strategies from the 1980s helped widen and deepen the production of tacit and experiential knowledge in Penang. Intel's, Motorola's and AMD's progressive efforts from simple assembly to continuous improvement capabilities from the 1980s made it possible for greater technology transfer to Penang, which helped local plants to upgrade to more complex and higher value-added activities (Rasiah, 1987; Lim 1991). Intel, Motorola and AMD have been managed completely by Malaysians from 1980, the late 1980s and mid-1990s respectively. Just-in-time (JIT) and the shift towards flexible production systems took place in the 1980s, which enabled semiconductor firms in Penang to avoid massive capacity restructuring during business downswings. New firm creation – primarily by ex-TNC employees - helped TNCs to externalize dissimilar assembly and test lines to facilitate organizational and process integration and re-integration easily.

In addition, TNCs such as Motorola, Intel, AMD and Hitachi, introduced redesigning activities in Penang, but confined to adapting older technologies. Motorola Penang enjoys design leadership in Asia for the CT2 cordless telephone. The Center does new product design, product-process interface and advanced manufacturing processes. Motorola's R&D center, which started with four engineers in the 1980s, had nearly 120 in 1998 (Ngoh, 1994). However, Penang's short supply of R&D scientists and engineers made similar expansion by other TNCs difficult. Penang does not have a critical mass of scientists and engineers to support rapid product innovation, and institutional support for industrial upgrading.

Dell has developed a mass customization system to reproduce in Penang its "produce to order" model that combines the Toyota production system (cellular manufacturing, JIT, Kanban, quick changeover, continuous improvement, self-directed work teams) with the internet to integrate production and distribution into a single high-throughput process. Dell's factory is being geared to respond directly to the final customer so that all intermediary distribution links are eliminated. Its Managing Director reported that Penang stood out not only because of the smooth coordinating approach of the state government and PDC, but also because of its cultural mix that offered regional customization potential for much of Asia (Rasiah 1995). Dell's unique fusion of design, process flow and final demand facilitated by the internet has offered production and marketing flexibility. Dell's inter-firm production network has generated considerable information and knowledge synergies for stimulating differentiation and division of labor in Penang. However, Dell does not have a sufficiently large pool of engineers and scientists in

[12] Author Interviews (2001).

Penang to drive rapid product innovation and systems integration capabilities, which has constrained its efforts to achieve integrated manufacturing operations.

In addition, all electronics TNCs interviewed are engaged in cutting edge competition, which have forced them to raise skill levels of employees using a long term vision of human resource development. Company CEOs reported that the application of Total Quality Management (TQM) requires that employees continuously improve operations at all levels. National Semiconductor's subsidiaries in Penang, i.e. Dynacraft and Micro Components Technology – started to support its chip assembly subsidiary, i.e. Fairchild in Penang, trained many of Penang's engineers in precision engineering and metal working technology who now own and manage Prodelcon, Metfab and Rapid Synergy. The founders of these three firms also acquired their tacit and experiential knowledge from working in Micro Machining, which was a subsidiary of National Semiconductor until 1989. Former employees of Intel managed Shinca, Shintel, Sanmatech, Unico, Globetronics and Solectron in 1999. Former employees of Micro Machining (then a subsidiary of National Semiconductor which changed its name to Fairchild in 1989) started the local firms of Prodelcon, Polytool, Rapid Synergy and Metfab. Komag, Quantum and Seagate also benefited from absorbing managers from older TNCs in Penang.

Redesigning operations in TNCs also produced human capital synergies for other firms. Two of Motorola Penang staff joined the R&D division of Sapura, which is a local firm located in Kelang Valley in the late 1980s. Two of Intel's R&D personnel left for AMD's NVD design center in the mid-1990s. However, restrictions on immigration involving R&D personnel have restricted TNCs capacity to upgrade in Penang. Intel, Motorola, AMD, HP and Fairchild, and the supplier firms of Eng Technology, Trans Capital and Unico reported trying in vain to bring foreign experts to expand R&D activities.[13]

The creation of entrepreneurs, managers, technicians and skilled human capital has helped TNCs upgrade their own operations as the continuous movement out of older employees allowed the entry of fresh human capital with new ideas and willing to acquire new knowledge. Employees moved out to help start and support new firm creation in Penang. The increased inter-firm movement of human capital stimulated greater outsourcing of dissimilar activities while allowing TNCs to upgrade and specialize in higher value added operations. The increasing outsourcing of dissimilar products alongside inter-firm movement of employees helped increase the number of suppliers to TNCs.

Differentiation and Division of Labor

The expansion and movement of embodied knowledge in employees helped intensify differentiation and division of labor. Entrepreneurs and professionals, technical and skilled employees developed in TNCs moved to start or strengthen new firms. Employees of Intel established Globetronics, Shinca, Shintel and Unico, while Motorola started BCM. Eng Technology, Metfab, Prodelcon and Choong Engineering grew strongly from technological diffusion from Intel. Wong Engineering grew with support from Motorola. The founder of Loshta gained his tacit and experiential knowledge working in Motorola. Polytool and Rapid Synergy absorbed considerable precision

[13] Author Interviews (2002).

engineering technology from Intel and AMD. Complementary but dissimilar product lines were relocated as new firm creation expanded, which was accompanied by the emergence of a locally owned supplier base with increasing differentiation and division of labor.

Strong systemic coordination and the flow of embodied knowledge stimulated localization of inputs by TNCs. Local supporting firms in Penang sourced 46 percent of their inputs locally in 1996 (Narayanan 1997: 23). Differentiation and the development of tacit and experiential knowledge worked both ways. The economic advantages of introducing flexible production systems encouraged lead suppliers to actively differentiate and intensify the division of labor. Rasiah (1994) had reported only three stages in 1990.

> The first-tier vendors (those who had the first links with the electronics sector firms) have, in time, chose to specialize in certain functions, and passed on some of their previous tasks to second-tier machine tool firms whom they helped foster. These second-tier firms have gone on to spawn their own third-tier subcontracting firms, giving them simply tasks like parts fabrications, which were no longer sufficiently profitable for the former.

Increased differentiation and division of labor helped deepen and widen the movement of tacit and experiential knowledge embodied in employees. Most supplier firms in Penang have passed through the third and fourth stages of technology absorption and diffusion (Rasiah 1994). In the first stage, suppliers did simple grinding, machining, welding and stamping operations to supply trolleys, components and parts to TNCs, using imported machinery and designs and drawings supplied by TNCs. This stage characterized the local machine tool firms in the 1970s. In the second stage, supplier firms upgraded to assemble semi-automated machinery and precision tools using imported machinery and designs and drawings from TNCs. In the third stage, supplier firms adapted and reverse engineered imported machinery for their own use, and high precision foreign components and machinery for sale to TNCs in Malaysia and subsidiaries abroad. In the fourth stage, suppliers developed their own original equipment manufacturing capabilities to supply precision components and machinery to TNCs in Malaysia and their subsidiaries abroad. In the fifth stage, suppliers introduced original designs, though much of production is oriented towards subcontract demand operations.

Several first-tier firms – operating at stage four - evolved from simple backyard workshops to modern firms and later to TNCs themselves. Eng Technology has subsidiaries in PRC, Philippines, Malaysia and Thailand, while Atlan has subsidiaries in Malaysia and Indonesia. The network of suppliers in Penang shows generally a vertical division of labor with firms confined to all the five stages of technology utilization. Nevertheless, a handful of firms (e.g. Eng technology, BCM, Unico and SEM) show strong potential for horizontal integration. Strong technological interface between TNCs and suppliers encouraged simultaneous inter-firm engineering activities.

Firms exploited the local systemic synergies and open but integrated business network of Penang to encourage the exit and entry of entrepreneurial, technical and skilled human capital to support new firm creation. The number of plastic, machine tool and packaging firms linked directly or through first, second and third tier suppliers to electronics TNCs in Penang expanded from around 45 firms in 1989 to around 155 firms in 1993 and 455 in 2001.[14] The spread of TNC-driven synergies could not have reached high levels without the active intermediary role of PDC. The PDC also matched potentially capable local firms with TNCs in the 1980s. The PDC helped solve collective actions involving scale and scope (e.g. training) by coordinating the formation of training centers and encouraging active consultation between suppliers, institutions and TNCs. PDC's role helped translate TNC demand into the formation of the PSDC in 1989. The PDC initiated the opening of the PSDC by offering a highly subsidized building – charging a symbolic rent of RM1 a year instead of the market rate estimated at RM1 million a year.[15] The PSDC is particularly important in offering specialized and generic skills training. In addition, Intel and Motorola have specialized continuous training centers where employees could also access training and skills unrelated to their formal work. Following the demonstration effects from Intel and Motorola, local owned Atlan established its own training center in the late 1990s. The PDC was instrumental in attracting capitalization of Globetronics from Malaysian Technology Development Corporation (MTDC).

The founding of Trans Capital, Unico and Globetronics in the 1990s – all managed by former TNC employees - added a new dimension to Penang, which helped raise local demand for skills for "front-end" operations like chip design, surface mount technology (SMT), and applications engineering. In addition to offering demand for the absorption of R&D personnel from TNCs, these firms helped widen knowledge accumulation in local firms, though the lack of R&D scientists and engineers in the country has restricted horizontal integration.

Local suppliers achieved rapid process and product upgrades through in-house and simultaneous engineering links with TNCs. There are not only a larger number of local suppliers linked to electronics TNCs in Penang (see Tables 1 and 3), they have also developed stronger technological capabilities and recorded generally higher value added and labor productivity growth than supplier firms in the Kelang Valley (see Table 4). BB, BC, BD and BE – all located in Penang - enjoyed the highest annual average labor productivity growth among the machine tool supplier firms connected to electronics TNCs in the two clusters. Only BI and BL, and BV recorded negative labor productivity growth in the period 1993-2001 and 1995-2001 respectively. BV's labor productivity declined considerably because of accounting procedures as its output between 1994-96 was supported strongly by staff from BK – which is its parent firm. Penang's open cluster encouraged employees gaining tacit and experiential skills to support new firm creation.

Strong systemic coordination helped network cohesion and dynamic clustering in Penang, which stimulated inter-firm flows of embodied knowledge in Penang. The inter-firm movement of human capital - exposed to cutting edge manufacturing practices – helped the appropriation of considerable tacit knowledge embodied in employees in Penang. The systematic promotion of electronics sub-species, open integrated business network with strong employee movement to support new firm creation helped increase differentiation and division of labor. However, limitations in the coordination of human capital institutions responsible for the supply of technicians, engineers and scientists, and immigration have restricted expansion into R&D activities. Hence, rising production costs and competition from cheap cost sites such as PRC and Philippines is threatening to stall further differentiation and division of labor in Penang.

[14] Author Interviews (1995; 2001).
[15] Author Interviews (1999; 2001).

4.2 Klang Valley: Weak Cluster Synergies

Klang Valley was better endowed than Penang when the first major influx of electronics TNCs relocated in Malaysia in the early 1970s. Matsushita – Malaysia's first electric and electronics firm – relocated operations in the Kelang Valley in 1965. Matsushita has since 2004 relocated its electric division to Thailand. With Kuala Lumpur being the administrative capital until 1998, and the promotional agency of MIDA, federal support was strongest in Klang Valley. While Malaysia's capital changed to Putra Jaya in 1998, Kuala Lumpur remained the commercial hub of the country. The concentration of TNCs and institutions in the region offered considerable opportunity for the development of entrepreneurs, and professional, technical and skilled human capital for new firm creation.

However, weak systemic coordination has restricted network cohesion and hence produced less inter-firm human capital synergies for new firm creation in Kelang Valley. Support organizations such the SEDC hardly gathered and disseminated information, matched firms, intermediate technology and skills development, and R&D activities.[16] While different sub-species exist, Kelang Valley lacks network strength for the whole to exceed the sum of the parts. While in-firm development of tacit and experiential knowledge is strong, the lack of network cohesion has restricted deepening and inter-firm human capital flows. Kelang Valley had more than eight public and private universities in 2000, but faced severe demand-supply deficits involving engineers and technicians.[17]

Uncoordinated Species

The Kelang Valley enjoys a range of sub-species of electronics industries transplanted from abroad (e.g. components, consumer electronics and telecommunication products). As with Penang, the Kelang Valley shared the same federal strategy of approving FDI with incentives on the basis of employment and investment levels from the 1970s. However, the massive influx of Japanese, Taiwanese and Korean investment sought to relocate in Malaysia from the late 1980s – driven strongly by the Plaza Accord of 1985 (which led to the appreciation of the Yen, Won, New Taiwan dollar and the Singapore dollar) and the withdrawal of the Generalized System of Preferences (GSP) from the Republic of Korea, Taipei,China and Singapore – applied serious pressure on space, labor and infrastructure in Malaysia. Penang used the situation to seek a critical mass of sub-species of firms to stimulate clustering, but SEDCs in Kelang Valley only diverted highly labor-intensive firms to the neighboring states of Negeri Sembilan and Melaka. There was no systematic effort to promote dynamic clustering by the institutions approving FDI applications. As one official from the Selangor SEDC put it,

> MITI (including its promotional agency, MIDA) and officials from the government help promote Malaysia as a good place to invest. MITI even handles the investment approval process. We take potential inventors around to show what Selangor has to offer, allocate land and facilitate the starting of the factories. Our tasks end the moment firms start their factories.

[16] Author Interviews in 1990 and 1999.
[17] Author Interviews (2002).

> We do sit on coordination committees of MIDA, but do not involve in any monitoring and active appraisal of investment.[18]

Kelang Valley's closed and generally opaque business networks have restricted its capacity to generate spillovers of dissimilar activities for new firm creation to support differentiation and division of labor. Dissimilar but complementary products are either imported or produced in-house. The Selangor SEDC also did not systematically promote the development of local sub-species of supplier firms. Hence, a few supplier firms – with no strong technological interface with TNCs – have developed in the Kelang Valley. Hence, the supplier machine tool and plastic firms linked to electronics firms in Kelang Valley traced using a snowballing methodology were limited in number (see Table 1). Tables 3 and 4 also show that Kelang Valley's machine tool firms had relatively weaker technological capabilities and performance than Penang firms. Two of the firms had closed down by 2001, while BQ and BU recorded negative labor productivity growth in the period 1993-2001 and 1995-2001 respectively. With the exception of BQ, which is linked to Motorola, the remaining machine tool firms did not emerge from the cluster synergies generated by the TNCs. Apart from foreign owned BU, the others started operations to take advantage of the Supplier Exchange Program (SEP) and Vendor Development Program (VDP) - introduced in the late 1980s by the federal government to stimulate linkages. JVC, Sony Hitachi and Chungwa Picture Tubes reported that local suppliers were technologically inferior and hence only supplied low value added components.[19] These firms sourced their critical components either from abroad or from foreign companies.

While considerable technological and product diversity has emerged in Kelang Valley, sub-species of firms lack connectivity between one another. The disconnected operations of firms have impeded the creation and appropriation of cluster synergies. The bigger and more successful local firms such as OYL Electronics and Sapura operate without production links with TNCs. Hence market opportunities arising from technological constraints generated from the continuous reconstitution of production in TNCs have not been appropriated effectively. The limited TNC-local firms links are confined to licensing agreements (e.g. Sapura and Nokia and OYL and York). Sapura and OYL Electronics benefited little from sourcing links with TNCs in the Klang Valley, though TNC-trained local personnel have been instrumental in their growth. Sapura and OYL have R&D capabilities, but with the exception of the voice activated phones of the former in the early 1990s, have yet to achieve success with new products.

Weak systemic coordination restricted the orderly stimulation of new sub-species of industries for dynamic clustering. The Kelang Valley lacks strong inter-firm connections to generate systemic synergies. The lack of network integration and the weak development of industrial species from abroad and locally - reduced the Kelang Valley to a porous conurbation.

Training Ground

The in-house skill formation process is considerable in the Kelang Valley. TNCs have invested heavily in skills and technical training activities to be globally competitive.

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[18] Author interviews (1999). MITI refers to the Ministry of International Trade and Industry. MIDA refers to the Malaysian Industrial Development Authority.
[19] Author interviews (1999; 2001).

Motorola, Chip Pack, Texas Instruments, Sony, JVC, Hitachi and Western Digital also reported participation in incremental engineering activities. However the lack of systemic coordination to strengthen network cohesion has restricted the outflow of TNC-developed personnel to support new firm creation.

The lack of systemic coordination has constrained the growth and upgrading of local firms, which is necessary for TNCs to introduce simultaneous engineering and high technology activities. Weak supplier support has restricted headquarters ability to transfer advanced technology to Kelang Valley. Five TNCs interviewed in the Klang Valley contended that their operations would be upgraded if ancillary firms develop or relocate to handle stronger horizontal interface. The Managing Director of Motorola noted in 1996:

> Our production strategy is to integrate best practice process technologies in Malaysia as it will enable us to achieve continuous improvement and productive flexibility. However, we do not have a strong supplier base here to facilitate that transition. We even have a considerable machinery workshop in-house because of it.[20]

TNCs developed in-house manufacturing capabilities in the Kelang Valley that use small batch or mass production capabilities (e.g. JIT, MRP2 and TQM systems), which are best practices that expose employees to world class embodied knowledge. However, the shortage of scientists and engineers in Malaysia and restrictive immigration policies – with the exception of the MSC region where IT firms enjoy a waiver from 1998 – has undermined the capacity of the region to make the transition to innovation related activities.

The lack of network cohesion has restricted the outflow of potential entrepreneurs and skilled personnel for new firm creation. Consequently, problems of information imperfection and moral hazard reduced outsourcing activities and inter-firm links. The Federation of Malaysian Manufacturers had a handful of machine tool and plastic supplier firms from the Kelang Valley. If in Penang supplier firms enjoyed formal platforms to engage in consultative committees with intermediary and development organizations, only the more established and only a handful had access to such platforms. In addition, the managing director of one firm even mentioned that they have only participated passively in related meetings with development corporations, the Small and Medium Scale Industrial Development Corporation (SMIDEC) and other government meetings.

Some TNCs have introduced product-adaptation activities in Kelang Valley. Matsushita developed its split-level air-conditioners, using a flexible production model, approximating the Toyota multi-flow system with customization.[21] However, a lack of high tech human capital has restricted stronger participation in R&D activities. The Malaysian executive director of the firm reported that product enhancement activities would be strongly magnified if only more qualified R&D personnel were available. Shortfalls in the supply of technical and R&D personnel was reported as a major constraint by Chip Pack, Motorola, Sony, Hitachi, JVC and Texas Instruments to expand innovative activities.

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[20] Author Interviews (1996).
[21] Author Interviews (1999; 2001)

TNC participation in stimulating off-firm training has been thin in Kelang Valley. The success of PSDC in Penang encouraged the government to initiate the Selangor Human Resource Development Center (SHRDC). However, the SHRDC lacks coordination dynamism from state organizations. National organizations such as American Business Council, JACTIM, JETRO and German Malaysian Institute (GMI) started training activities in the late 1980s and early 1990s, but the limited depth and spread of their programs has produced little impact on skills development. Japanese cooperation has included training of tool and die makers, and the Germans on precision engineering, which has been important but confined to low-end activities. Hence, TNCs and local firms face considerable collective action problems.

The Multimedia Super Corridor (MSC) has not encouraged imports of high tech human capital to most TNCs – thereby restricting the potential for generating greater human capital synergies. Although the MSC offers easy access to hiring foreign high tech human capital, the TNCs involved in this study are not classified as IT-based and those that are IT-based reported being unsure about the future of their participation in Malaysia.[22] Motorola, Chip Pack, Matsushita, Sony and Texas Instruments reported restrictions in their capacity to hire foreign engineers.

Differentiation and Division of Labor

Despite the high density of TNCs, weak systemic coordination has constrained clustering in Kelang Valley. The lack of differentiation and division of labor has reduced inter-firm flow of embodied knowledge. Electronics TNCs have supplanted local supply requirements by either importing or sourcing from their own subsidiaries in Malaysia.

The first-tier supplier firms have hardly evolved contacts with second-tier suppliers. Human capital in supplier firms in Kelang Valley has not been exposed to tacit and experiential knowledge beyond the second stage of absorption. Instead of local firms appropriating synergies from an extensive division of labor as in Penang, TNCs source minimally and directly from first-tier suppliers.

Several Japanese and Taiwanese firms act as sourcing anchors - e.g. Matsushita group of air-conditioner companies, Sony Group of TV/Video companies, Motorola, Tamura Electronics, Chunghwa Picture Tubes, Formosa Prosonic Technics and Quality Technologies Opto. Local anchors in the Klang Valley include Sapura, OYL, M-SMM Electronics and Jasa Kita. Local firms - started largely with federal government support - use licensed technology. The anchors offer markets and technological support for foreign and local firms. Most local suppliers producing air-conditioner, television, video and refrigerator components are limited to low value-added activities. Key technologies such as LCD are still imported from Japan, the Republic of Korea and Taipei,China. All development work on audio and video equipment, including Discman and Internet music players is done abroad. Taiwanese owned Chunghwa Picture Tubes has its own suppliers in Shah Alam. A number of high value added components such as LCD displays and TFT screens are imported from subsidiaries or suppliers located in home-sites. Local owned Sapura and OYL electronics have not penetrated TNC markets in Klang Valley. Japanese, Taiwanese and South Korean firms accounted for the critical components sourced domestically. The inter-firm production division of labor involving

[22] Author Interviews (2000) with an NTT official.

these firms is either non-existent or generally limited to one to two first-tier supplier firms each.

A limited number of local firms supply TNCs, but are confined to non-core components. Procurement officers in four Japanese firms involved in the assembly of videos, CTVs and car air-conditioners in Bangi reported sourcing core components from Japanese suppliers. JVC in Shah Alam, and Sony Video and Nippon Denso in Bangi complained of the high defect rates involving components supplier by local firms, which to them is the reason why they source their critical components from Japanese firms.[23] Capannelli (1999: 213) reported a similar finding:

> Although the strategy of intra-group sourcing varied among the assemblers, as a general rule, the parts involving core technologies were often procured from sister companies of the same group. In contrast, the lower-end technology parts were mainly supplied by "Malaysian" firms. In several cases these input makers were joint ventures with third country firms from Singapore and Taipei,China.

Capannelli (1999: 233) reported that only about a fourth of Japanese consumer electronics firms' supplies in Kuala Lumpur were sourced from Malaysian firms. TNCs located in Southeast Asia – primarily Japanese owned - accounted for 60 percent of the supplies. Rasiah (1996) and Narayanan (1997) also reported weak production linkages between TNCs and local firms in Klang Valley.

American and European firms source far less locally in Klang Valley than in Penang. Motorola, Texas Instruments, Western Digital and Chip Pack reported sourcing between 2-20 percent of their purchases locally. Swedish owned Ericsson reported sourcing around 45 percent of its purchases from domestic firms, but primarily from TNCs. Japanese, Taiwanese and South Korean firms source most of their supplies from firms of their own nationalities – a consequence of poor network cohesion rather than national idiosyncrasies.[24] American and European firms generally sourced from other TNCs or imported. Motorola and Chip Pack[25] reported sourcing higher value added components and equipment in 1993 from Eng Technology and Loh Kim Teow located in Penang (Rasiah 1996). Texas Instruments reported importing machinery supplies from its subsidiary in Singapore.

A study of linkages between four TNCs and four local suppliers in Klang Valley found that the latter has evolved little over the years (Rasiah 2002). Only one of the four local suppliers had gained tacit and experiential knowledge from working as an employee of TNCs in Kelang Valley. Japanese, Taiwanese and Korean suppliers have stage three and four operations using technology from their parent companies abroad, but lack inter-firm links with other suppliers. Hence, differentiation and division of labor involving foreign suppliers domestically was low.

Kelang Valley not only has few suppliers linked to TNCs (see Table 1), but also firms linked to TNCs show low technological capabilities and performance levels (see Tables

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[23] Author interviews (1999).
[24] Author interviews (2002).
[25] This firm was known as Harris Semiconductor in 1993. It has since changed names to Harris Advanced Technology, Chip Pack and finally to Chip Pack.

3 and 4). Only BP recorded strong value added and labor productivity growth in the period 1993-2001. Two of the supplier firms had closed down by 2001, and the foreign owned BU recorded negative average annual growth in value added and labor productivity in the period 1995-2001. JVC, Toshiba, Sony, NEC, Fujitsu and Hitachi reported attempting to increase local sourcing following promotional efforts by the government under the subcontract exchange program (SEP) and the vendor development program (VDP) introduced in the late 1980s. Under SEP each TNC has attempted to use three to four suppliers for low-end inputs (e.g. plastic injection molding and molds and dies manufacturing). Short-termist links between anchor TNCs and local suppliers have stimulated little differentiation and division of labor.

Lacking systemic coordination to stimulate information flow, connectivity and identification of latent capabilities, TNCs in Kelang Valley have operated truncatedly. As a senior officer of Motorola put it:

> The risk of failure is just too high. Private firms generally do not individually search and canvas for greater inter-firm collaboration and sourcing when known suppliers do not exist. It was possible in Penang because of the dynamic role of PDC, which created deliberation councils and took on a proactive role of promoting and matching firms. We will be glad to assist if some reliable organization assumes such a role here. We are aware of these developments from the operations of our telecommunications components and products subsidiary in Penang.[26]

Companies such as Texas Instruments, Chip Pack, Matsushita Industrial, Sony and Toshiba have not attracted or developed world-class first-tier suppliers including contract manufacturers, owing to a lack of systemic coordination and network cohesion. Most TNCs use flexible production systems, but retain in-house a number of even dissimilar activities such as machine tool support. Where specialized components are needed, such as microchips and lead frames, they are primarily bought from firms in Penang, Singapore, Taipei,China, the Republic of Korea and Japan. The lack of a developed computer and peripherals sub-sector, and dissimilar product segments such as machine tools and plastics engineering has also restricted the production and inter-firm movement of personnel.

The pool of managers, professionals, technicians and skilled personnel from the Kelang Valley have generally either remained in old firms or left to join newly relocating TNCs. Motorola, Texas Instruments, Chip Pack, Hitachi, Sony and Matsushita Industrial reported that former personnel were hired by local firms with strong TNC-related sub-contract manufacturing activities (e.g. Unisem and Carsem).[27] Eight managers reported interest in starting their own firms after detecting considerable market potential for specialized capabilities, but have stuck with their TNCs owing to a lack of institutional support.[28] Also, no TNC in the Klang Valley reported developing local firms, with the Managing Director of Motorola stating that the environment has not been conducive.[29]

[26] Author Interviews (1999; 2001 and 2005).
[27] Author Interviews (1999, 2001, 2002, 2005).
[28] Author Interviews (1999; 2002; 2005).
[29] Author Interviews (2001; 2005).

Despite the presence of a critical mass of electronics TNCs, the lack of systemic coordination has restricted the network cohesion necessary in a nascent cluster to stimulate the production and inter-firm movement of tacit and experiential knowledge effectively. Kelang Valley has particularly lacked the movement of potential entrepreneurs and technical personnel for new firm creation. While a myriad of industries exist, four fundamental problems have undermined its capacity to engender inter-firm human capital flows. First, the lack of systemic coordination has constrained the ability of firms to resolve collective action problems associated with human capital development. Second, the lack of systemic coordination also restricted the orderly promotion of new species of industries to support inter-firm human capital synergies. Third, weak inter-firm connections have stimulated little the movement of entrepreneurs, professionals, technicians and skilled personnel to support new firm creation. Fourth, the lack of movement of embodied knowledge in human capital – tacit and experiential – has restricted differentiation and division of labor in the Kelang Valley.

Table 3: Machine Tool Firms, 1993 and 2001

Firm	Cluster	Year Open	Employment		Sales RM mn		Products (2001)
			1993	2001	1993	2001	
BA#	Penang	1979	45	NA	2.5	NA	Precision components
BB	Penang	1983	22	43	1.4	9.1	Precision parts, automated machines
BC	Penang	1988	15	34	0.3	1.6	Precision parts fabrication
BD	Penang	1987	34	78	1.5	8.7	Precision parts, automated machinery
BE	Penang	1991	17	36	0.3	1.8	Precision parts
BF	Penang	1976	200	250	20.0	45.3	Precision components, automated machines
BG	Penang	1978	22	Closed	2.6	Closed	Precision parts, moulds, dies
BH	Penang	1984	85	112	10.0	15.1	Precision components
BI	Penang	1980	68	96	15.0	18.3	Precision parts, automated machinery
BJ	Penang	1984	40	87	2.5	9.5	Precision parts and automated machinery
BK	Penang	1950	120	150	10.0	12.8	Precision parts, automated machines
BL	Penang	1980	40	85	1.7	7.5	Automated machines
BM	Penang	1982	128	266	12.0	46.2	Parts fabrication, jigs, fixtures, moulds, dies
BN	KV	1988	18	Closed	0.2	Closed	Jigs, fixtures, moulds, dies
BO	KV	1988	14	Closed	0.4	Closed	Jigs, fixtures, moulds, dies
BP	KV	1984	32	45	0.6	1.9	Parts fabrication, moulds, dies, jigs, fixtures
BQ	KV	1975	69	132	2.5	4.5	Precision parts, jigs, fixtures, moulds, dies
BR	Penang	1993	400*	1300	5.4*	42.9	Metal parts
BS	Penang	1990	NA	120	NA	NA	Automated machinery and precision engineering
BT	KV	1993	29*	52	106.0*	264.0	Precision components and sub-assemblies
BU	KV	1992	282*	332	61.6*	65.4	Aluminium components
BV	Penang	1994	30*	240	6.0*	21.6	Moulds, dies and metal components

Note: KV – Kelang Valley; * - 1995 figures; # - firm sold to different owner in 1995.

Source: Reproduced from Rasiah (2002).

Table 4:Technology Deepening and Performance, Machine Tool Firms, 1993 and 2001

Firm	Technology index								Average Annual Growth (1978 prices) ***1993-01♣***	
	Engineer		Techno-machinist		Computer-aided production machine		Computer-aided testing machine			
	1993	2001	1993	2001	1993	2001	1993	2001	VA	VA/L
BA#	0.0	NA	26.7	NA	27.6	NA	33.3	NA	NA	NA
BB	0.0	10.0	68.2	72.2	21.1	65.3	23.1	55.2	25.1	15.0
BC	0.0	1.2	40.0	54.1	15.0	45.7	30.0	44.3	22.0	10.1
BD	0.0	NA	60.0	NA	11.8	NA	40.0	NA	23.3	11.1
BE	0.0	1.9	45.2	63.2	45.0	55.5	26.5	42.4	23.8	12.7
BF	2.0	6.5	47.0	77.8	34.3	68.3	78.9	58.7	9.6	6.6
BG	0.0	Closed	40.9	Closed	38.9	Closed	33.3	Closed	NA	NA
BH	0.0	3.7	52.4	70.4	47.2	55.6	29.4	45.7	4.2	0.7
BI	1.5	2.9	54.1	77.8	55.1	NA	71.4	NA	1.5	-2.8
BJ	2.5	4.1	50.0	80.5	25.0	44.3	60.0	56.7	16.9	6.1
BK	1.7	5.0	41.7	77.2	38.9	NA	33.3	NA	2.1	-0.7
BL	2.5	4.4	62.5	66.3	33.3	44.5	60.0	52.5	19.1	8.4
BM	1.7	2.1	40.2	49.6	29.2	48.7	73.3	66.3	17.1	6.9
BN	0.0	Closed	22.3	Closed	5.6	Closed	6.7	Closed	NA	NA
BO	0.0	Closed	20.6	Closed	6.8	Closed	10.8	Closed	NA	NA
BP	0.0	0.1	27.6	36.7	12.2	24.5	11.7	22.3	14.3	9.5
BQ	0.0	0.2	35.4	44.6	6.2	25.7	21.5	32.8	6.5	-1.8
BR	NA	4.1	NA	73.5	NA	55.7	NA	75.0	28.3*	14.6*
BS	NA	0.6	NA	66.5	NA	NA	NA	NA	NA	NA
BT	NA	4.5	NA	72.5	NA	75.4	NA	72.5	11.0*	4.3*
BU	NA	1.5	NA	70.1	NA	54.5	NA	45.8	-0.2*	-2.9*
BV	NA	3.5	NA	74.2	NA	36.4	NA	43.6	16.3*	-13.6

Note: ♣ - growth rates computed after adjusting for machinery and transport equipment price inflation (computed from Bank Negara Malaysia, 2003); * - 1995-2001 figures; company was acquired by another owner in 1995; Engineer and techno-machinist (technicians and skilled machinists) indexes were calculated as shares of these employees in total employment. Machinery indexes were calculated as precision machinery shares in total machinery. Only three firms replied questions on the value of machinery and hence composition based on value was excluded.

Source: Reproduced from Rasiah (2002)

5 Conclusions

This paper examined the agglomeration-oriented initiatives of government to stimulate employment- and export-oriented industrialization initially and subsequently in addition a government focus on clustering in electronics manufacturing in Malaysia. Generous financial incentives, excellent basic infrastructure and smooth bureaucratic coordination helped attract large-scale operations of electronics assembly in Malaysia. The use of the two regions of Penang and Kelang Valley to examine policy under the same national milieu but facing two sets of state-level instruments helped identify some of the consequences of an active and passive coordination effects in the country. The empirical investigation also helped examine policy failures that allow an understanding of clusters as a concept and its development in reality.

Whereas excellent institutional coordination – especially in Penang and Kelang Valley – formed a potent influence on FDI inflows to Malaysia - serious drawbacks on the development of absorptive capacity and coordination on higher value added activities has restricted upgrading, and differentiation and division of labor in the country. Between the two regions examined, Penang managed to engender considerable cluster synergies. However, owing to a lack of human capital either from domestic institutions or from imports to participate in innovative activities – including R&D – the industry has achieved neither a strong movement toward higher value added activities nor horizontal linkages between TNCs and SMEs. Local state level institutional coordination managed to ameliorate supply chain growth problems (including training) and promote new firm creation. However, the lack of human capital and motivation for R&D activities has undermined the capacity of supplier SMEs for engaging in horizontal links with TNCs. The lack of local state level coordination in driving supply links has left most TNCs to operate truncatedly in the Kelang Valley. The electronics industry examined in the paper is a clear case in point. In addition to the need to initiate the enabling conditions for systemic coordination between officials in firms, non-government institutions and government to expand connectivity and coordination between them, governments should also develop the high tech institutions necessary to spearhead upgrading.

The comparison between two regions facing similar federal policies but somewhat different state-level strategies helped articulate the importance of effective government coordination. The local government – official and unofficial - coordination relationships between the development corporation, chambers of commerce, infrastructure and security service providers and the firms helped stimulate strong systemic links that helped support strong new firm creation and inter-firm links in Penang. The confinement of local government instruments to basic infrastructure and security coordination reduced the appropriation of such systemic synergies in the Kelang Valley.

Smaller economies with fairly good basic infrastructure and political stability such as Mauritius can also look to electronics TNCs as a possible industry to attract. These economies will have to go beyond the Malaysian experience, though, to stimulate upgrading and widening of value chains domestically. The same lessons also apply to large economies. Large economies such as PRC, India, Brazil, South Africa and Mexico obviously possess a far larger domestic market than Malaysia to leverage TNCs to encourage upgrading. Domestic markets in Malaysia (including those in Singapore, Israel, Ireland and Costa Rica) – especially in electronics – were largely unimportant both in the relocation as well as upgrading strategies of TNCs. The advantages facing large economies that offer the resources and facilities offered by these small economies will only be higher owing to their large domestic market.

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Appendix 1: Financial Incentives

Financial incentives have been pivotal to the emergence of Malaysia as a major site of electronics production. This section reviews the incentives used to promote investment, exports, R&D, inter-firm linkages and training. Incentives were the main instruments used to attract labour-intensive and large-scale investment from the late 1960s and early 1970s; they are still key instruments even though the government's emphasis on wooing electronics investment shifted to industrial upgrading and integrated manufacturing from the late 1980s. The Malaysian government

2.1 Pioneer Status and Investment Tax Allowance

Pioneer Status (PS) and the Investment Tax Allowance (ITA) are two of the most attractive incentives offered by the Malaysian government. Under the PS incentive, an approved company can obtain tax exemption from 70% of is statutory income for a period of 5 years, commencing from the date of production. However, for companies located in the states of Kelantan, Pahang, Terengganu, Sabah and Sarawak, an exemption from 85% of their statutory income is permitted for a similar period.

Under the ITA, an allowance of 60% of qualifying capital expenditure incurred within 5 years from the date of approved of incentives is allowed. The ITA can be utilised to offset 70% against statutory income in the year of assessment. However, companies located in Sabah and Sarawak can qualify for an allowance of 80% and the allowance can be utilised to offset against 85% of statutory income.

Both PS and ITA are given to projects that fall under the category of "promoted product" or "promoted activity" as determined by MITI.

The incentive differentials were designed to encourage the dispersal of industrial development to the less industrial areas, especially eastern corridor states and Sabah and Sarawak. But the differential PS and ITA incentives have not been attractive enough to entice firms to the relatively less developed areas of the country. Most still prefer to be located in the traditional and popular industrial sites in Penang, Kedah, Selangor, Negeri Sembilan and Melaka in the western corridor of peninsular Malaysia.

Some electronic firms have opted to invest in the eastern corridor states and Sabah and Sarawak as industrial land has become more scarce and expensive in the more popular states. Sabah and Sarawak have been active in promoting FDI, and have managed to attract some electronics firms to their newly created Free Industrial Zones (FIZs).

The appraisal mechanisms used since 1986 have reduced the breadth of successful applications for PS and ITA incentives. From a total tax holiday offered to electronics firms generating high levels of employment and investment in the 1970s until the mid - 1980s, the emphasis shifted to strategic and high technology industries from the late 1980s. Subsequent efforts have been taken to scale down the percentage of exemptions from 100%, depending on foreign equity participation and domestic market shares of sales. Since the 1990s, total tax holidays have only been given to high technology and strategic industries.

2.2 Reinvestment Allowance

Reinvestment allowance (RA) is granted to manufacturing companies that incur qualifying capital expenditure for the expansion of production capacity, modernisation and upgrading of plant and machinery and product diversification. It is provided in the form of an allowance of 60% of capital expenditure incurred by the companies. This allowance is utilised to offset against 70% of the statutory income in the year of assessment. Additionally, companies that reinvest and significantly increase their productivity will obtain a 100% deduction against the statutory income.

This incentive is important to the electronics industry because of its characteristics of rapidly changing technologies, shortening product cycles, and intense global competition. Reinvestments are necessary to keep in line with global technological change. An assessment of the extent of take up of RA is important to determine the allowance necessary to encourage existing manufacturing companies to reinvest considering industrial promotion by lower wage countries like PRC, India and Philippines.

The government aimed the RA to encourage reinvestment in high productivity sectors through automation, extension into new product lines and labour saving devices. However, as with incentives in general, the government needs the capability to monitor the effects on company decisions and activities.

2.3 High Technology Industries

Specific incentives are targeted to stimulate investment in high tech industries. Companies engaged in high technology industries are eligible for the following incentives:

- Pioneer Status with full tax exemption at statutory income level for a period of five years or
- Investment Tax Allowance of 60% on qualifying capital expenditure incurred within a period of five years. This allowance can be used to offset against the statutory income.

High-tech companies must meet the following conditions in order to qualify for the above incentives:

- Local R&D expenditure to gross sales should be at least 1% on an annual basis and companies are allowed a period of 3 years from date of operation to comply with this requirement or
- The percentage of science and technical graduates to total work force should be at least 7%.

2.4 Strategic Projects

Incentives are also awarded to strategic projects, including Pioneer Status and Investment Tax Allowance for manufacturing companies that are involved in strategic projects of national importance. Manufacturing companies that are involved in strategic projects of national importance are granted the following incentives:

- Pioneer Status with full tax exemption at statutory income for a period of ten years or
- Investment Tax Allowance of 100% in qualifying capital expenditure incurred within a period of five years. The allowance can be utilised to offset against the statutory income.

Strategic projects are those with heavy capital investment and high technology that can generate extensive linkages and have significant impact on the Malaysian economy. The criteria to qualify for such incentives are for projects with the following:

- Investment of more than RM100 million
- Integrated manufacturing activities
- Backward and forward linkages
- High-tech products
- Incorporation of approved R&D facilities.

2.5 R&D

The Malaysian government offers R&D grants to the following:

- Contract R&D company, a company that provides R&D services in Malaysia to companies other than its related associates,
- R&D company, a company that provides R&D services in Malaysia to other companies,
- In-house R&D, R&D activities within a company for the purpose of its own business.

In Malaysian owned electronics companies the first 2 types of R&D activities are almost non-existent. Most of the existing R&D undertaken by the electronics companies are confined to designs, packaging and processes but little, if any, on technologies and new product development. Most of the locally based MNCs undertake their new product development and technology R&D in their home bases.

R&D activities in Malaysia can qualify for a range of incentives which include the following:

- ITA of 50% on qualifying capital expenditure incurred within 10 years;
- Double deduction is allowed on revenue expenditure incurred by a person on research directly undertaken by him or on his behalf;
- Double deduction on payment for the use of services of approved research institutes, R&D companies or contract R&D companies, as well as cash contribution research institutes;
- Buildings used for purpose of approved R&D;
- Capital allowance on capital expenditure incurred in the provision of plan and machinery used for R&D; and
- Machinery/equipment, materials, raw materials/component parts and samples used for exemption from the duty/tax.

2.6 Training and Skills Development

The government provides 5 different types of training incentives. The most widely used since 1993 is the Human Resource Development Fund (HRDF). The HRDF, which is co-ordinated by the Human Resource Development Council (HRDC) requires manufacturing firms with an employment size of 50 and more to contribute 1% of their payroll, which they can then reclaim using approved expenses. This mechanism penalises firms that do not train their employees.

A similar incentive is being considered for SMIs. If approved, SMIs with less than 50 but more than 10 employees and with a paid-up capital of not more than RM 2.5 million can avail themselves of the assistance grants under the HRDF. A 1% of payroll contribution will qualify them for claims worth twice as much. The other training incentives are:

- Double deduction for expenses incurred for approved training (employment size less than 50 employees),
- A single deduction given for contribution in cash to a non-profit technical or vocational training institution,
- Exemption from import duties, sales tax and excise duties for imported machinery's, equipment's and materials used for training personnel,
- ITA for new investment to upgrade training equipment or expansion of training capacities.

The 1% payroll penalty is a strong incentive to increase training. In addition to the training requirements required by the move towards flexible production systems, the DDTI (from 1988) and the HRDF (from 1992) were reported as instrumental in pushing MNCs such as Intel and Motorola to start their own training centres as well as supporting the formation of the Penang Skills Development Centre in 1989 (see below and Appendix 6).

The surplus achieved from the difference between collections and claims goes to maintain the administration as well as subsidise training in SMIs. This mechanism actually supports MNCs indirectly as SMIs can become local suppliers. Such efforts enable the movement of SMIs to become globally competitive, meeting the need to create world-class production chains by stimulating them to make the transition to more advanced production capabilities.

Contributions to the HRDC were temporarily suspended in 1997-99 due to the financial crisis. Nevertheless, many locally based MNCs have their own in-house training programs. The indigenous electronics firms, however, are far behind in this respect. Their take up of DDTI has been low, suggesting a clear need for considering a stick similar to the 1% contribution of payroll required under the HRDF, which they can then claim twice from HRDC.

2.7 Industrial Linkages and SMIs

To promote linkages between large companies, both foreign and local, and local SMIs, the government recently granted incentives to large companies in the form of a deduction in income tax. Under the industrial linkage scheme, expenditure incurred on the training of employees, product development and testing and factory auditing to ensure quality of vendor's products can be deducted from the statutory income.

Vendors including SMIs, which produce intermediate goods in an approved scheme, will be granted pioneer status for five years with 100% exemption on the statutory income. Vendors in approved schemes who are capable of achieving world-class standard in terms of price, quality and capacity are granted pioneer status for 10 years with 100% exemption from statutory income.

2.8 International Procurement Centres

International Procurement Centres (IPC) refer to locally incorporated companies, whether local or foreign-owned, which carry out business in Malaysia to undertake procurement and sale of raw materials, components and finished products to its group of related and unrelated companies in Malaysia and abroad. These firms are deemed especially pertinent to the electronics industry that sources about 70-75% of its components but only about 25-30% from local suppliers.

To encourage the establishment of IPCs and make Malaysia a distribution centre, the government offers the following incentives:

- Approval of the number of expatriate posts to be based on the requirements of IPCs,
- IPCs will be allowed to open one or more foreign currency accounts with any licensed commercial bank to retain their export proceeds without any limit imposed,
- IPCs will be allowed to enter into foreign exchange forward contracts with any licensed commercial bank to sell forward export proceeds based on projected sales,
- IPCs will be exempted from the requirements of the Ministry of Domestic Trade and Consumer Affairs guidelines on foreign equity ownership on wholesale and retail trade,
- IPCs will be allowed to bring in raw materials, components, or finished products without any payment of custom duties into Free Industrial Zones (FIZ) or Licensed Manufacturing Warehouses (LMW) for repackaging, cargo consolidation and integration before distribution to the final consumers.

The criteria to qualify for the IPC incentives include the following:

- Locally incorporated company under the Companies Act 1965 with a minimum paid-up capital of RM 0.5 million,
- A minimum total business spending of RM 1.5 million per annum,
- A minimum annual business turnover of RM 100 million,
- Goods are to be handled directly through Malaysian ports and airports.

2.9 Promotion of Exports and Industrial Upgrading

A range of other incentives promotes manufacturing export activities in Malaysia. A number of these incentives are also used to promote training, use of environment-friendly technologies and technological deepening in firms. The most important of these incentives are the following:

- Export Credit Refinancing,
- Double Deduction for Promotion of Exports,
- Double Deduction of Export Credit Insurance Premium,
- Industrial Building Allowance,
- Incentive for Industrial Adjustment,
- Incentive for small-scale companies,
- Incentives for Computers and Information Technology Assets,
- Incentive for the Storage, Treatment and Disposal of Toxic and Hazardous Waste,
- Tariff Protection,
- Exemption from Import Duty on Direct Raw Materials/Components,
- Exemption from Import Duty and sales Tax on Machinery and equipment,
- Drawback of Excise Duty on Parts, Ingredients or Packaging Materials,
- Drawback of sale Tax on Materials used in Manufacturing, and
- Drawback of import Duty.

A number of these incentives will have to be gradually removed to meet WTO and AFTA conditions. All subsidies that can be construed to balance trade will contravene the provisions contained under the Trade Related Investment Measures (TRIM) regime. Hence, export subsidies, including those on insurance and credit will have to be gradually scaled down.