1. Introduction

The electronics and automobile industries have been among the strategic industries promoted by the Malaysian government. The former contributed around a quarter of manufacturing output and employment, and 67.5 per cent of manufactured exports in 1996.[1] The microelectronics sub-sector forms one key component of the electronics industry. The automobile industry contributed 5.0 per cent of manufacturing value added in 1995.[2]When the government launched its heavy industry drive from 1981 the selection of the particular industries included emphasis on the development of backward-forward linkages and the expansion of local personnel participation in management roles. Proton and later Perodua became the prime companies earmarked by the government to achieve success in placing Malaysia eventually as a leading automobile producer. The supplier base examined here is fairly common to the needs of both industries, i.e. machine tools. Machine tool supplies accessed by microelectronics industries range from simple tooling to robotics machinery, while the automobile industry in Malaysia rely primarily on jigs, dies, molds and fixtures. A whole range of other supplies such as car air conditioners, seats, tires, ceramics, lead

[1] Computed from Malaysia (1998).
[2] Computed from Bank Negara (1998: P-83).

frames, acids and resins have been excluded from the report for comparative purposes.

Both industries have been the key target of government efforts to stimulate linkages since the 1980s. While spin-offs were part of the original plan to move the critical automobile chains to the technology frontier, the electronics industry received similar official concerns only from the late 1980s. Specific instruments have been introduced to promote the development of suppliers in the country. Indeed, suppliers involving the automobile industry still rely heavily on government support – both direct and indirect to sustain their operations. However, support for electronics suppliers have been far less forthcoming. Hence, the momentum achieved through multinational support in Penang, which enjoys complementary state coordination, has helped create far stronger linkages than in locations without such clear networking bonds.

Given the significance of these industries – electronics dominated by private foreign ownership and passenger cars by strong state control – they present useful cases for testing current arguments on the development of subcontracting links.

2. Analytic Framework

The two industries examined in this paper demonstrate characteristics distinctly manifest in a number of industries. The microelectronics industry is characterized by high technology, short product cycles, substantial intermediate-industry customization and scale. Passenger car assembly is characterized by large scale, moderate product cycles and considerable end-user customization. However, microchips form the brain in other electronics products, while the car is an end-customer product. Also, with exception of Carsem, Unisem and Globetronics, microelectronics firms in Malaysia are foreign controlled and access their key technologies from abroad. National cars in Malaysia still depend on key foreign technologies such as engine design, and therefore are located significantly behind the technology frontier. The microelectronics industry also does not face significant tariffs (less than 5 per cent), while the automobile industry is heavily protected. Foreign assemblers in Malaysia operate with much more modest logistics due to the constraints (e.g. tariffs) imposed by efforts to protect national companies.

Efforts to understand the nature and function of supplier networks inevitably require assessment of the origin and basis underlying inter-firm links. Given inherent information asymmetry, scale economies and dynamic gains accruing to learning experiences and innovations, purely market determined outcomes cannot generate a competitive mix of suppliers (Richardson, 1960; 1972; North and Thomas, 1970;

Rasiah, 1997). Even when complementary support services are involved, scale economies and uncertainty associated with dissimilar activities present serious problems. Institutions governed by trust and command often assist markets resolve collective action problems more efficiently. Instead of internalizing to avoid market failure, firms can extend the technical division of labor across the industry to generate better economic outcomes through trust.

New growth economists generally accept such market failures but contend that non-market interventions can only be auxiliary and supportive or generate inferior outcomes if not dictated by markets (see Helpman and Krugman, 1989; Lucas, 1988). Transaction cost theorists such as Coase (1937) and Williamson (1990) argue that markets allow supporting roles for command and trust when involving asset specificity, frequency and information asymmetry. Transaction costs are considered minimized when the market determines the parameters of the hierarchy and trust. However, Rasiah (1995; 1997; 1998) contends that the market will be ill-equipped to rationally allocate functions to other coordination modes due to:-

- lack of information.
- conflicting and competing interests that embody markets.
- inherent learning deficiencies that restrict coordination of production organization.

If left to the government alone, inferior economic outcomes often arise due to information asymmetries and principal-agent problems. It is because of these problems, Richardson (1960; 1972) and North and Thomas (1970) have argued that allocative problems can be better resolved through effective coordination between markets and institutions through arrangements that allow the equally important

coordination roles for command and trust as relative price signals. Hence, Cooperation (through trust and loyalty) becomes an important complementary coordinating force (see also Wilkinson and You, 1992; Rasiah, 1995).

Experience plays a critical role involving industries demonstrating substantial accumulation of knowledge. While codifiable knowledge can be accessed through books, manuals and lectures, production capabilities also require learning endowments that can only be acquired through experience. Such indivisible and unquantifiable attributes are located in social organizations (see Penrose, 1959). The machine tool makers lacked such experience when they entered the supplier networks and hence faced tremendous technological barriers. A major aspect of the problem was resolved by the presence of scattered bundles of experience developed in machinery workshops within the electronics multinationals, and from one machinery American multinational. The state-supported automobile firms have not accessed the capabilities developed in foreign-local joint-ventures developed since 1967, and hence seriously lacked experience when they started. Nevertheless, the supplier firms have had a mixture of experienced (including foreign controlled) and inexperienced human capital.

The capacity of inter-firm networks to generate optimal allocative and coordination solutions is often conditioned by broader political economy factors. Statist explanations have viewed strong states as independent of societal pressures equipped with technically sound -equipped bureaucrats to extract resources, offer public goods and order, reconcile conflicting interests and support productive firms (Haggard, 1990; Khan, 1989; Mardon, 1990). For rapid growth, however, a proactive state committed to development - has also been important. Hence, Evans

(1992) has offered a broader but static and vague reference to states, *viz*. strong states, weak states, soft states and predatory states. Much more, can however, be theorized to tailor various configurations of governance capacities and their effect on conduct and performance of individuals, firms and institutions in particular, and economies in general. The real differences explaining why firms in some localities develop and fail in others are far more complex than the simple schema provided by Evans. Detailed cases often unravel a combination of factors without any relative order of significance that interact to distinguish successes from failures. Local regulatory environments and the specific institutional coordination mechanisms nevertheless, are important in understanding the development of economic activities. The report, thus, examines the impact of two different industries on machine tool subcontracting links in Malaysia.

3. The Regulatory Environment

Small firms *inter alia* play vital roles in the quantitative and qualitative plans of large corporations. Governments have either directly or indirectly supported the initiatives of small firms not just due to their infancy, electoral muscle and special advantages offered by the economics of scope, flexibility, lower capacities, but also as critical suppliers for large firms. As argued earlier, the regulatory environment is one of the critical variables that explain the evolution of subcontracting links.

Contrasting state policy measures have characterized the two industries. The microelectronics industry has enjoyed similarities in federal policies, but distinct differences locally between Penang and other states. Suppliers involving the electronics industry faced virtually no direct state support until the late 1980s. Federal policy initiatives from the late 1980s nevertheless appear generally unsuccessful, while the efforts of the local Penang state have proved quite successful. The passenger car industry has faced uniform policies across the country, but enormous differences differentiate state-supported Proton and Perodua, and joint-venture firms assembling foreign cars. Suppliers involving the multinational assemblers before the 1980s have generally been small and confined to simple substitutable components. Government policy has helped expand the number and size of suppliers since Proton began rolling out its first car in 1985.

3.1 Microelectronics Firms

Much of the initial federal support for the evolution of subcontractors involving the microelectronics industry came indirectly, and in some sense fortuitously. There were no clear efforts to attract microelectronics firms with the purpose of spawning local machine tool firms when the government first launched its export-oriented industrialization policy following the Investment Incentives Act in 1968. Micro-electronics multinationals only began relocating in Malaysia after the Free Trade Zone Act was enacted in 1971 and the subsequent opening of the zones in 1972. National Semiconductor — the first semiconductor firm to commence operations in Malaysia — built its factory in Bayan Lepas in 1971 and started production in 1972. Rasiah (1998) identified at least four important areas in which government support was instrumental in stimulating the relocation of microelectronics multinationals in Malaysia.

While the potential for the development of local machine tool firms emerged through the redeployment of multinationals, the regulatory environment generally disadvantaged their development until the late 1980s. Being generally ethnic Chinese controlled, official policy under National Economic Policy (NEP) considerations have since the promulgation of Industrial Coordination Act (ICA) in 1975 discriminated them. Firms with an employment size of 25 and above and a paid up capital of 250,000 were required to obtain licensing which often necessitated compliance with national ethnic restructuring conditions. Also, local non-*Bumiputera* firms also hardly enjoyed access to incentives.

Regulations seriously restricted local enterprises from supplying multinationals located in FTZs and LMWs. Until the 1990s government legislation defined sales and purchases to and from FTZs and LMWs as exports and imports respectively and therefore subjected such transactions to the normal customs duties (see Rasiah, 1992). Also, multinationals preferred imports to service their inputs rather than acquiring them from firms located in the principal customs area to avoid cumbersome customs procedures. Machine tool firms operating in the principal customs area have generally relied on imports of metals and machinery, which have generally been subjected to tariffs. Multinationals, thus, had the option of purchasing machine tool supplies from local manufacturers relying on tariff-imposed imports against tariff-free imports from abroad. Under such circumstances, *ceteris paribus*, multinationals for long preferred sourcing their supplies from abroad than from local suppliers. Hence, official government policy generally erected enormous obstacles to the development of local machine tool firms.

Being small and largely owned by local Chinese capital, machine tool firms generally enjoyed little federal support. In fact, the machine tool industry received strong impetus only following its classification among the promoted industries in the Industrial Master Plan of 1986. Being complementary to the operations of the strategic industries such as electronics, the industry enjoyed similar incentives, though, the extent of foreign direct investment was extremely small. The Promotion of Investment Act of 1986 offered the industry duty exemptions if located in free trade zones (FTZs) or licensed manufacturing warehouses (LMWs) and export incentives such as the double tax deduction on exports and export credit refinancing. The extent of take up was, however, small due to information asymmetry involving the tooling

industry which is largely characterized by small and medium firms, and the lack of multinational deployment of machine tool production due to the smallness of the Malaysian market.

Under such circumstances, the machine tool industry did not develop as fast as the industries it was expected to service, especially the electronics and automobile industries. Imports have consistently exceeded output over the years 1984-94.[3] The widening gap between sharply rising demand from user industries and slow growth in domestic production capabilities has continued to aggravate the trade deficits involving the industry. Demand slowed in 1985 due to a fall in GDP, but imports still grew. Unlike Taiwan where domestic production capabilities rose to reverse imports so that the trade balance began improving strongly since the 1970s (see Fransman, 1985), it has consistently shown high deficits in Malaysia (see Table 1). The share of imports in machine tool domestic demand gradually rose between 1984-90 before falling slightly in 1994.

Thus, federal policy instruments generally discouraged the growth of local machine tool sales to microelectronics multinationals. Against this general trend nationally, Penang firms managed to increase sales and deepen technologically to service multinationals. Kelang Valley machine tool firms, however, generally failed to achieve similar success. The relative success of Penang firms over Kelang valley firms suggests the effective harmonization of relative prices, firm-level command and

[3] A longer time series was not possible due to the aggregation of the industry with other industries in the preceding years. The available industrial production index is that of all machinery industries, including electronics, which significantly distorts the actual growth of the industry.

cooperation as well as effective institutional coordination in the former and its lack of coherence in the latter two locations.

Table 1: Machine tool industry in Malaysia, Selected statistics, 1984-94

	1984	1985	1990	1994
Gross Output ('RMmillion)[3]	358.0	226.1	566.5	1337.3
Import ('RMmillion)[3]	256.8	267.3	1191.2	2537.3
Export ('RMmillion)[3]	10.3	20.6	54.8	172.7
Imports in domestic demand*	59.2	56.5	70.0	68.5
Export share in output #	4.0	9.1	9.7	12.9
Trade Balance •	-94.4	-85.7	-91.2	-87.3
Mean Employment º	24.9	25.8	36.5	43.0

Note: [3] - figures in current prices; * - percentage of Imports in domestic demand measured as output+imports-exports; # - percentage of exports in output; • - percentage of net exports in total machine tool trade measured as exports plus imports; º - employment per establishment.

Source: Malaysia, External Trade Statistics, various issues; Malaysia, Industrial Surveys, various issues.

Institutions play important roles to solve collective action problems and enhance coordination between firms and between firms and government. In Malaysia, ethnic-based political economy conditions has strongly underpinned the nature of institutional development. When states are dictated by sectional interests - which in the case of Malaysia by ethno-class politics - it affects the nature of institutional development. Hence, small and medium-size non-*Bumiputera* ethnic businessmen have often faced difficulties accessing benefits offered by the federal government.

Favorable ethnic and class similarities locally offered stronger state-firm networking in Penang. The lack of federal support and the pressure from two alternative ethnic parties, one largely led by bourgeois Chinese within the ruling government (i.e. the Malaysian Chinese Association), and the other by a popular opposition party (i.e. the Democratic Action Party) offered the checks and balances to reduce the potential for cooperation to result in unproductive collusion.

The structural differences between Penang and Kelang Valley produced two distinct sets of local machine tool development experiences in Malaysia. Machine tool firms located in Penang have experienced rapid growth from the early 1980s, while firms in the Kelang Valley have generally performed poorly. The official regulatory environment that faced Penang firms can be said to have emerged only indirectly and has largely been similar to that faced by Kelang Valley firms. Government policy stimulated the redeployment of microelectronics multinationals to Malaysia. Microelectronics multinationals have become the prime technology suppliers and output purchasers of machine tool firms in Penang. These firms, emerged as a direct response to the federal and local state governments' efforts to woo foreign direct investment. The intermediary role by the local state government and its development corporation were critical in the establishment of initial links with foreign multinationals and subsequently effective supply of infrastructure and other facilities, including federally coordinated incentives from 1989. Like Kelang Valley firms, Penang's machine tool firms' production technology and markets were simple and small until microelectronics multinationals fostered their expansion. The initial period of emergence and expansion of output was also characterized by little federal government support, including anti-linkage biases generated by cumbersome customs

regulations associated with FTZ coordination. The local state, embodied by strong ethno-political relationship with microelectronics firms and machine tool firms' management played a critical role in the establishment of buyer-supplier ties between them in Penang. The lack of similar conditions and relationships restricted such developments in the Kelang Valley.

Local structures differentiated the extent of support in resolving collective action problems and enhancing the role of markets between Penang and the Kelang Valley, thereby creating the specific conditions necessary to sustain effective coordination between the state, institutions and traditionally established small and medium businessmen in the two areas. Socio-political factors in Malaysia have restricted effective coordination in the Kelang Valley, while enhancing it in Penang (Rasiah, 1997). There has been greater collaboration between the small and medium scale Chinese businesses and the Gerakan-led Penang state government than between them and the UMNO-led Selangor state government. Support for the historically dominating ethnic Chinese in medium and small scale businesses has helped greater institutional coordination in the former than in the latter. Unlike large businesses where the politically connected ethnic *Bumiputeras* have often been important partners of the ethnic Chinese, inter-ethnic business collaboration among small and medium scale enterprises has generally been very thin. The Penang government, thus, has played a more important role in the development of the absorptive capacity of the entrepreneurially better equipped Chinese in Penang than its counterparts in the Kelang Valley.

The local state government and its Penang development corporation (PDC) worked closely with multinationals to stimulate export-oriented processing, assembly

and testing activities. The state got involved actively to reduce information asymmetry linking multinationals with capable local firms. The multinationals also identified potential local suppliers to meet their self-expansion plans. Where multinationals were led by local employees, the room for seeking local supplies tended to be larger. Local private employees working for multinationals enjoyed greater ability to identify potential suppliers state officials. Local firms not already engaged in high precision machine tool niches did not initially involve in the multinationals quantitative and qualitative plans. The multinationals obtained state support to attract participation from potentially capable local suppliers. The initial networks formed around past suppliers in lower order sourcing, business associations, old boys associations and past employment contacts offered the original sources of information to scan potentially capable local firms. To expand local businesses in the economy, the state leadership began to encourage strongly the formation of consultation committees to assist their development. Hence, when developments in microelectronics multinationals stimulated proximate machine tool sourcing, the channels for matching local SMIs with them had emerged.

Institutions were created or strengthened in Penang. The Chinese chamber of commerce worked closely with the state leadership and the PDC. The chief minister also actively promoted spin off relationships between local businessmen and multinationals. The chief minister himself increasingly advised the PDC to promote local sourcing of components by multinationals.[4] Especially in the 1980s, systemic relations within intra-ethnic networks became fairly strong. Multinationals reliance on the PDC to coordinate effectively security, infrastructural support and quell labor

unrest helped strengthen the relationship between the local state and the multinationals. All the 8 microelectronics multinationals in Penang - irrespective of ownership - considered the state government as pro-active in stimulating machine tool spin-offs (Rasiah, 1987). The PDC compiled a list of local suppliers in metal, plastics and packaging industries from 1985, which has been upgraded annually since showing detailed information on their productive capacities. The PDC has also actively organized meetings, visits and promotions to match and strengthen links between foreign multinationals and local firms. Given serious information asymmetry problems associated with backward small and medium firms, PDC's role here has been critical in effecting linkage coordination. Business council meetings between state officials and local management of microelectronics multinationals have also been important in the promotion of local machine tool sourcing. Intel's strong support for local machine tool sourcing owes much to its former managing director, Lai Pin Yong's, active promotion of local vendors. The ethnic Chinese background of the state leadership that feared increased federal efforts to raise *Bumiputera* participation in the economy, local suppliers and purchasing officers in multinational firms helped strengthen intra-ethnic networking (Khong, 1991).

The development of local machine tool firms in Penang received a strong fillip following the opening of Micro Machining in the 1970s by National Semiconductor – an American microelectronics subsidiary located in Penang. Micro Machining later changed its name to Micro Components Technology before it was sold to Japanese controlled Towam in the 1990s. This machine tool firm acted as the prime training

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[4] Interviews with PDC officials conducted by the author in 1986.

ground for cutting edge hardware machine tool activities and developed the founders of BI, BG and BJ.

Socio-political complementarily in Penang - particularly the small and medium scale business community aligned with Gerakan party - enabled relatively strong political support and direct matching efforts linking microelectronics multinationals with local machine tool firms. This along with the state leadership's relative autonomy from the federal government allowed strong efforts to stimulate local machine tool sourcing by microelectronics multinationals. The smooth coordination role played by the Penang state government and the Penang Development corporation has created strong cooperative relations between them and the multinationals. Hence, despite starting with backward capacities, pro-active support for the local firms helped tap the spin-off potential that has emerged from growing flexibilization of production in electronics multinationals. Local machine tool sourcing received a boost when the federal government introduced incentives for firms meeting a 30 per cent local sourcing condition in 1991. A further stimulus came when big *Bumiputera* enterprises began to capitalize successful Chinese firms involved in supplying electronics multinationals, and support of the state government helped three of Penang’s local machine tool firms to attain tax benefits in the period 1989-98.

Like Penang, Kelang Valley had been a major center for colonial economic activities. Unlike Penang, however, its importance rose following independence. Kuala Lumpur remained the administrative and commercial capital of Malaysia. Port Klang replaced Penang as its chief port. While Subang became the site of its biggest international airport. In addition, like the ministries, the Malaysia’s prime industrial promotion agency, the Malaysian Industrial Development Auhority (MIDA) and other

industrial parastatals are also mainly located in the Kelang Valley. The synergy associated with good infrastructure and administrative and commercial centers obviously attracted many multinationals. Unlike Penang, however, the Kelang Valley socio-political structure offered little active support to start and strengthen machine tool subcontracting with microelectronics multinationals. The state not only did little to increase information about local suppliers engaged in machine tool activities, they also did little to attract the trust of local machine tool firms. The microelectronics multinationals often linked well with federal institutions to maintain customs and administrative coordination. The local state not only involved little and thus bypassed.

Politically, federal ethnic power relations have been reproduced at the level of the local state. Bumiputera-dominated UMNO has ruled Selangor since Malaysia's independence. The ethnic Chinese dominated DAP has dominated only in Chinese-dominated urban constituencies. Given the proxities of federal institutions, multinationals generally coordinated with federal institutions their security, infrastructural support and labor relations operations. The local state institutions have generally been bypassed by the microelectronics multinationals as a consequence. Dominated by *Bumiputera* employees, the SEDC have hardly enjoyed ethnic-based networking potential with multinationals as the purchasing officers in the latter have generally been ethnic Chinese. The Selangor state economic development corporation's (SEDC) role has been limited to infrastructure development and the leasing of industrial land. In fact, its function stops once the premises reach the firms. It has played no formal role in the promotion of local sourcing. Given the political and economic congruence of ethnic interests both at the national and state levels,

there has been no political pressure on the local state to assume a direct role to promote local sourcing involving non-*Bumiputera* firms.

Under such circumstances, the small and medium scale firms that have had a long entrepreneurial experience and show potential linkage development effects - dominated by ethnic Chinese ownership - have enjoyed little state support. The lack of state support has left them facing severe market failure problems - though ethnic congruence with the generally ethnic Chinese purchasing officers in the multinationals have encouraged some amount of local sourcing. Not only are microelectronics multinationals badly positioned to identify small and medium scale firms' potential capabilities as it would require detailed scrutiny and monitoring, they themselves have received little encouragement to participate in such developments which are risky and uncertain. Hence, both the microelectronics multinationals and the local machine tool firms have been reluctant to engage actively in upgrading the technological capabilities of the latter. They not only face finance problems - including accessing subsidized loans and technical assistance from the credit guarantee schemes and the industrial technical assistance fund (ITAF) - but are also hardly prominent to attract the attention of potential multinational clients. Indeed, interviews show that the list of small and medium scale firms promoted by the government include relatively few machine tool firms operating in the Kelang Valley. Where it has involved active state promotion, such as those by the *Bumiputera* venture trust, Permodalan Usahawan Nasional Berhad (PUNB) stringent ethnic-based conditions apply.

The lack of political support has restricted the establishment and strengthening of sourcing relationships between microelectronics multinationals and local machine

tool firms. The intermediary coordination role played by the PDC in Penang has been missing in the Kelang Valley. Lacking state efforts through institutionalization of risks and other support services, microelectronics multinationals in the Kelang Valley reported lacking motivation to develop local machine tool capabilities. Unlike in Penang where a proactive state leadership has played a critical role in stimulating links between local firms and microelectronics multinationals, state leadership in the Kelang Valley has generally avoided such a role (see Rasiah, 1998a). Since the federal state, *de facto* has generally been the active governance agent in the Kelang Valley, national considerations embedded in the NEP and its successor, the national development plan, have dictated the promotion of local sourcing. *Inter alia*, ethno-class has differences restricted the effectiveness of the nationally coordinated subcontract exchange program (SEP) - originally launched in 1986 - to stimulate local sourcing. Its success in stimulating subcontract relations between ethnic Chinese firms and microelectronics multinationals have been modest even after the enactment of the 30 per cent local sourcing condition in 1991 for firms applying to enjoy financial incentives. Yet 2763 firms had registered under the SEP by 1993 (Malaysia, 1994: 260).

The federal state has been relatively more successful in its promotion of the special vendor development program (VDP) involving the electric/electronics industry which was launched in 1992. Anchor companies began to support small and medium firms with an equity of not less than RM100 thousand that show *Bumiputera* participation in equity and employment of 70 per cent and 55 per cent, however, respectively. Participation in this program within the electronics industry has so far largely involved consumer and industrial electronics firms. Few of them, however,

has established links with microelectronics firms. Sapura and Sharp were the initial anchor firms. This program has helped create *Bumiputera* controlled suppliers from scratch within a short time in the electronics industry. The government planned to create 80 new vendors over the sixth and seventh Malaysia plans (Vijaya Letchumy, 1993: 14). Subsidized loans and technical assistance offered through ITAF and Permodalan Nasional Berhad (PNB) have been critical in their development. Information asymmetry and other imperfections has combined to hamper local machine tool suppliers access to such productive rent in the Kelang Valley.

3.2 Local Passenger Car Firms

Unlike the microelectronics industry, which began and relies almost completely on foreign markets, passenger car assembly in the Malaysia began and relies almost completely on the domestic market. Hence, local equity conditions under the ICA of 1975 has required at least 70 per cent domestic equity to assemble in Malaysia. Despite the ICA conditions, the government involved little to promote a supplier base for the automobile industry. Efforts to increase localization began in 1979 but until the late 1980s most supplies were imported. Given Malaysia's relatively small market, completely knocked down (CKD) assembly activities in Malaysia used little machine tool support. The picture changed when the government launched Proton in 1983 following the incorporation of Heavy Industry Corporation of Malaysia (HICOM) in 1981. Unlike the foreign assemblers, accessing their key technologies and supplier networks abroad, the government started to promote a whole new base to support Proton locally. The initial tie-up with Mitsubishi and later Citroen and acquisitions

from Lotus were seen as major steps towards the expansion of a whole value-added chain in Malaysia (see Machado, 1997; Rasiah, 1997). Hence, the government began involving directly to stimulate the growth of supplier firms.

Through parliamentary decree Proton enjoyed a massive loan with subsidized interest rates from Bank Bumiputera Malaysia in the 1980s, and through majority equity, control over the operations. However, Mitsubishi controlled the technology and therefore enjoyed considerable say over manufacturing decisions and access to profits. Hence, when it was felt that technology transfer was taking place too slowly, the government struck a further tie-up with Citroen. The export drive benefited considerably from new agreements with Mitsubishi in the 1990s which raised control over value added over the Iswara models in the 1990s (see also Machado, 1997). The sharply fallen demand for Wira since the 1997 crisis has reduced further proton's access to profits.[5] The government also raised tariffs over car imports. In addition to restrictive import licenses – which is generally offered to companies with *Bumiputera* ownership – import tariffs on CBUs ranged between 140-300 per cent in 1998 (Nagata, 1998). CKD assemblers faced a tariffs ranging from 42-80 per cent in 1998. However, Proton was exempted from import tariffs on CKDs initially while foreign assemblers experienced a rise in tariffs from 15 per cent in 1979 to 25 per cent in 1983 and 40 per cent in 1984 (Fujita, 1998: 156-157). Localization requirements, which was introduced in 1979, was revised in the 1990s. Thereafter localization – measured as displacement volumes) – was raised from 30 and 20 per cent respectively for engine capacities of 1850 cc or less and 1850-2850cc to 60 and 45 per cent respectively in 1996 (Fujita, 1998: Table 1).

Spin-off effects involving foreign brand assemblers continued to be feeble and confined to low value added CKD activities. Serious efforts to create local supplier base involving machine tools only emerged after Proton was launched. Local suppliers engaged in machine tool manufacture were either local owned or generally jointly owned between local and foreign capital. It is the relative absence of a competitive supplier base in the country that led the government to introduce pro-active policies to develop them. However, its promotion followed closely the nationalistic conditions contained under the ICA that required eventual majority control by *Bumiputeras*.

The umbrella concept has been in place since 1984. Unlike the Subcontract Exchange Scheme started in 1988 where government efforts were confined to the identification of a group of potential vendors for promotion to multinationals, the Proton Component Scheme (PCS) involving Proton tied the suppliers to identified fostering firms and required that they met local equity conditions gradually. The Vendor Development Program (VDP – launched in 1993 – complemented the PCS, though its coverage extended to several industries. Hence, Proton's suppliers under the PCS and VDP enjoyed a captive market. The two complementary programs helped Proton generate 138 vendors, which in addition to in-house production, supplying with 3,511 components in 1995 (Rasiah, 1996). Proton manufactured itself 394 components in 1995.

Local suppliers got a massive boost from the falling exchange rates experienced by Malaysia from 1985. A combination of appreciating Northeast Asian and Singaporean currencies following the Plaza Accord and the ringgit devaluation

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[5] Author's interviews in 1998.

pushed the real effective exchange rate down, making imports progressively more expensive from 1985 until the mid-1990s. The government raised tariffs on components imported by Proton by 13 per cent in 1992 to stimulate import-substitution (Fujita, 1998: 158). Rising input costs from imports from Japan forced Proton to stimulate more aggressively the development of its suppliers. The Yen effect also drew a number of Japanese suppliers to joint-venture with local companies in Malaysia. The massive rents generated from shielded sales in the domestic market offered considerable scale potential for foreign suppliers.

Unlike the microelectronics multinationals where ownership is dominated by American and Japanese capital, the biggest passenger car manufacturer in Malaysia is Malaysian owned. Proton is also the biggest car assembler in Southeast Asia (Rasiah, 1998b). By 1997 the second national car, i.e. Perodua – which enjoys a technology tie-up with Daihatsu of Japan - had become the second biggest car seller in the Malaysian market. The problems associated with the specific ethno-political structure involving machine tool makers linked to microelectronics multinationals being Chinese-dominated did not occur in the case of a number of Proton's suppliers as they were required to meet majority *Bumiputera* equity ownership gradually. While the government's policy instruments directed at non-*Bumiputera* firms were less attractive, the microelectronics multinationals supplier selection criteria did not discriminate that way. With the exception of a few critical foreign suppliers such as Nippon Denso (Japanese owned air conditioner supplier) and Robert Bosch (German owned car-stereo supplier), which refused to give away majority equity to local capital and still enjoy supplier status, most other suppliers had to meet such equity conditions. Hence, most machine tool suppliers to Proton are either fully

Bumiputera-owned or show majority *Bumiputera* equity control. Hence, a number of competitive machine tool makers have avoided from such tie-ups with Proton to prevent excessive encroachment into their operations. Indeed, four of Penang's leading machine tool makers linked to microelectronics multinationals reported avoiding Proton's lucrative captive market due to ownership considerations.

Socio-political factors have played an important role in influencing the economic outcomes of machine tool subcontracting links with the microelectronics and passenger car industries in Malaysia. Proactive and complementary socio-political elements enabled strong links between local machine tool firms and microelectronics multinationals in Penang. Its divergence in the Kelang Valley blocked the deepening of such relationships. With weak inter-ethnic relations at the small and medium scale level, the Chinese business community involved in metal, tooling, foundry, rubber and plastic works enjoyed little support to access microelectronics multinationals. Federal financial incentives associated with local sourcing too failed to generate local sourcing levels comparable to Penang. Hence, much of the domestic machine tool sourcing in the Kelang Valley has been met by foreign subsidiaries attracted to Malaysia or local suppliers from Penang. Despite enjoying far stronger support from the government and a captive market, Proton's suppliers have not moved much up the technology ladder due to weak technical support from Proton as well as a lack of competition and institutional coordination. Strong ethnic ownership considerations also constrained the participation of Penang's cutting edge machine tool makers in the quantitative and qualitative plans of Proton. Hence, Proton's supplier firms in the Kelang Valley and Negeri Sembilan have not

matched the service support Penang’s microelectronics multinationals have been getting in Penang.

4. Machine Tool Subcontracting

The study examined selected machine tool firms from Penang, the Kelang Valley and Negeri Sembilan to examine their growth and subcontracting experience with microelectronics multinationals and passenger car assemblers. Given their small size and lack of information, they were selected from information provided by microelectronics multinationals operating in Penang and the Kelang Valley as well as Proton. As the suppliers were drawn from the purchaser firms, the technique excluded firms outside the latter's operations.[6]

The methodology used required careful cultivation of relationship with the suppliers which in the case of the machine tool suppliers of microelectronics multinationals involved 12 years. Given the length of study involving the microelectronics multinationals, the information presented here is considerably more than that of Proton's suppliers. Nevertheless, interviews with 9 majority local owned suppliers are examined in this section.

4.1 Suppliers of Microelectronics Multinationals

The microelectronics multinationals utilize state-of-the-art technologies in Malaysia, albeit confined primarily to assembly and test activities. The technological

[6] See Rasiah (1998) for an explication of the snowballing research technique.

relationships with local machine tool firms reflect considerably transfer of know-how to local firms in machine tool technology. The pattern and depth of supplier relationships emerging demonstrate considerable governance variances between Penang and the Kelang Valley. Stronger private-public coordination in the build up of institutional support activities Penang has created considerable room for systems integration so that synergy have expanded from the outsourcing of human capital, materials, components as well as a number of other infrastructural support services. Machine tool suppliers have thus evolved considerably in Penang. A lack of effective coordination has stifled similar development of machine tool firms in the Kelang Valley.

As shown in Table 2, Penang's machine tool firms are not only greater in number, they also show a wider and more sophisticated range of products and process technologies. Also, all of Penang's suppliers interviewed regarded microelectronics multinationals as key to their development. Substantial inflow of technology involving American microelectronics multinationals, and gradual two-way interfacing with software and hardware has helped upgrade local firms technological capabilities. Only BO among the four Kelang Valley supplier firms considered microelectronics multi-nationals as an important agent for its growth.

The technology trajectory of local machine tool firms servicing microelectronics multinationals in Malaysia has involved five stages of development. Stage one has typically characterized production of simple crude parts which has then been fabricated into final components by more developed suppliers or the microelectronics multi-nationals themselves in-house. The second stage has involved the manufacture of jigs, fixtures, molds and dies with low precision levels. Stage

three is characterized by high precision engineering of small batch components. Stage four either involves the production of small batches with high precision requirements or the manufacture of semi-automated machinery, or both. The former has involved a range of products using similar horizontal technologies, while the latter has generally involved the microelectronics industry. Although microelectronics multinationals have been the main initiators, consumer electronics and disk drive firms have started acquiring high precision parts from machine tool firms. In stage five, firms either undertake large volume precision engineering of components or small batch fully automated machinery, or both. Disk drive multinationals have become major purchasers of large batch parts from selected machine tool firms. Firms in stage five generally enjoy original equipment manufacturing (OEM) capability, i.e., they enjoy the capacity to supply orders using their own production capabilities. Given the cumulative and complementary nature of these stages, firms specializing in the higher stages in the technology trajectory also often perform the lower operations. It is only when firms pass through stage five, original design manufacturing(ODM) and original brand manufacturing(OBM) stages emerge. The transition through these stages is not discrete as firms enjoying OBM facilities also perform manufacturing activities of the lower production stages.

None of the local machine tool firms studied here have participated in ODM and OBM activities, though, six firms in Penang - reported enjoying designing capabilities. The prime cutting edge machinery used in production is still imported by the microelectronics firms in the sample as none of the local supplier firms have managed to move up to ODM and OBM activities. Nevertheless, within the limited range of machinery and component markets entered by local firms, suppliers in

Penang tend to enjoy production capabilities superior to supplier firms in the Kelang Valley. Penang firms, using the proxies - share of precision production and testing machinery indices, engineer and technician/machinist indices, and level of precision tolerance - tend to show higher productive capabilities. Also, BF from Penang has started plans to locate a machine tool plant in China to service microelectronics and disk drive firms.

Penang and Kelang Valley machine tool firms also demonstrate considerable differences in their technological relationships involving microelectronics multinationals. Machine tool firms in both Penang and the Kelang Valley were backward in the 1970s. From simple fabrication, several of Penang's local machine tool firms have gradually moved up the technology trajectory while those of Kelang Valley have generally remained entrenched in stages one and two activities. Technological deepening in the former has involved substantial technology transfer from microelectronics multi-nationals. In addition to upfront capital and guaranteed markets, microelectronics firms have also developed prototypes and subcontracted them out to local machine tool firms. Process and product know-how was transferred and the development of local firms was monitored by the principal buyers. As the local firms participated actively in the quantitative and qualitative needs of the microelectronics multinationals, the latter's own self-expansion efforts saw swift technological deepening in the former (Rasiah, 1994). As the local firms passed through the learning cycle, the relationships changed to involve increasing in-house participation in technology development. BF, BI, BK and BM subsequently managed to gain sufficient synergy to participate actively in the development of their own capabilities. Increased in-house development capabilities enabled BF and BK to attain

relative freedom from their foster multinationals in the 1990s. Local machine tool firms hardly enjoyed similar technology transfer from microelectronics multinationals in the Kelang valley despite the dominance of American ownership. Relying strongly on in-house technology development both in the 1970s and the 1980s, local machine tool firms in the Kelang Valley failed to achieve similar levels of technological deepening.

The lack of consequent development in supplier networks has resulted in increased in-house workshop machine tool production in Kelang Valley micro-electronics multinationals. Some microelectronics multinationals in addition, have also began purchasing machinery from Penang's machine tool firms. For example, AC bought four automated wire bounders from BF. AA acquired six wire bounders from BK in Penang in 1990, while its subsidiary in Seremban acquired 8 wire bounders from BK in 1992. The growing reputation of Penang firms led to micro-electronics firms in the Kelang Valley to woo them to start subsidiary operations in the Kelang Valley. As a result, BF, BI and BK considered starting subsidiary plants in the Kelang Valley in 1996.[7] Such plans were, however, abandoned after a careful study due to a lack of state support, rising costs of production resulting from rising wages from the late 1980s, intermediate inputs, utilities and an appreciating exchange rate until the financial crash of 1997.

Overall backward sourcing by microelectronics multinationals in Malaysia has been very small due largely to the overwhelming composition of imported wafers. The share of local production inputs in microelectronics multinationals in 1993

[7] Interviews in 1993 and 1998.

ranged from 0.5 per cent in AC to 7.5 per cent in AE.[8] Although the pecuniary share of machine tool inputs sourced by most microelectronics firms has been relatively small - ranging from 2.5 per cent by AC to 33.7 per cent by AE in 1993. It has risen steadily in Penang firms. The average share over the period 1988 to 1993 ranged from 1.2 per cent in AC to 18.5 per cent in AE.[9] When AE is excluded, the next best figures come from AG which sourced 8.3 per cent of its machine tools local firms on average over the same period. As noted earlier local machine tool firms have yet to break into ODM and OBM activities. Overall sales of local machine tool firms linked to microelectronics multinationals have, however, expanded considerably. From virtually scratch operations at inception, local machine tool sales rose to millions of ringgits in 1993. BF recorded gross sales of RM20 million in 1993 (see Table 3). Here again, Penang firms show a superior performance record over Kelang Valley firms. All five firms that achieved gross sales figures of at least RM10 million in 1993 are located in Penang.

Whatever the classifications used, it can be seen that Penang's local machine tool suppliers generally show higher growth and technological deepening than their counterparts in the Kelang Valley. Yet local firms in both regions enjoyed similar productive capabilities in the 1970s. Both sets of microelectronics firms have been dominated by American ownership, and local firms have been dominated by ethnic Chinese ownership. Given their similar initial capabilities and the latent demand generated by the microelectronics firms, this contrasting experience within the same

[8] These figures exclude building and service expenses.

[9] Among other things, the average figure takes into account large machinery purchases during major upgrading exercises.

national polity distinguishes the influence of local structural specificity on the development of institutional coordination.

4.2 Suppliers of Passenger Car Firms

The technological capabilities – both product and process - of Proton is significantly behind that of the microelectronics multinationals examined above vis-à-vis frontier firms. While specializing primarily on assembly and test activities, foreign micro-electronics firms in Malaysia are generally engaged in state-of-the-art process and product technologies.[10] Proton was the only firm chosen here. Proton is not only attempting to achieve technology transfer from foreign firms, it also still relies on foreign suppliers for its engines. The firm launched efforts to introduce just in time in early 1995, but abandoned it by the end of that year following a change in management. Nevertheless, some staff members have continued with such efforts, albeit in a small scale. Nine of Proton's machine tool suppliers suppliers were interviewed.

Comparisons between Proton's purchases and of the microelectronics multinationals must treated with caution as they are characterized by substantial structural and classification differences. Firstly, Proton is an essentially domestic-oriented import-substituting firm while the microelectronics multinationals are predominantly export-oriented. Secondly, Proton's localization – displacement volume – is not measured in value added terms. It is instead presented as volume of

[10] Malaysian owned subcontract assembly and test firms such as Unisem, Carsem and Globetronix are engaged in low value added products, but the suppliers studied here have little links with such firms.

components sourced locally. Hence, the 80 per cent localization reported by Proton in 1996 should actually be much less if measured in value added terms.

Majority local suppliers to Proton demonstrated four types of ownership patterns (see Table 3). The first involving CA is totally owned by *Bumiputera* capital. CB, CC, CD, CE and CF are jointly owned by *Bumiputera* capital and local Chinese capital. CG and CH are owned jointly by *Bumiputera* capital, local Chinese capital and Japanese capital. CI is owned by *Bumiputera* and Japanese capital. All nine suppliers supplied Proton with machine too services ranging from exhaust pipes, jigs, fixtures, molds and tool sets.[11] At the time of the study, few firms offered themselves to be interviewed. Some of the officials interviewed had already resigned from their firms. Most firms did not keep records of their past production statistics. Nevertheless, some productive capability statistics were gathered for analysis here.

CA is a subsidiary of a holding company which has its core business in tele-communications and electronics products. CB, CC and CD were subsidiaries of Chinese firms who registered separate firms with joint-venture deals with Bumiputera capital to meet Proton's ownership requirement criteria. CE and CF were originally Chinese owned but eventually absorbed *Bumiputera* capital to meet the same conditions. CI had 30 per cent Japanese capital and was started following recommendations from Mitsubishi.

Although less informative than Table 2, Table 3 shows selected productive characteristics of Proton's suppliers. If viewed comparatively with local suppliers of the microelectronics multinationals in Table 2, Proton's suppliers are primarily

[11] The financial crisis made the study extremely difficult as firms were facing retrenchment as well as uncertainty associated with production orders.

confined to stage 2 of the 5 stage trajectory. Only two firms reported moving towards the third stage of high precision tooling services with the assistance of Japanese technology. Also, while all the 9 firms studied reported enjoying OEM status, they

Table 3: Local machine tool firms linked to Proton, 1998

Firm	Ownership (equity %)	Location	Process techniques	Employment	Products
CA	$L_B(100)$	Kelang Valley	TMs, QCC	84	Precision dies, molds, jigs, fixtures and components
CB	$L_B(51)_C(49)$	Kelang Valley	TMs, JIC, QCC	28	Exhaust pipes
CC	$L_B(55)L_C(45)$	Kelang Valley	TMs, JIC, Codified instructions	65	Precision fabrication
CD	$L_B(51)L_C(49)$	Kelang Valley	QCC, JIC	92	Precision components
CE	$L_B(51)L_C(49)$	Kelang Valley	TMs, JIC, Codified instructions	17	Precision parts
CF	$L_B(45)L_C(55)$	Kelang Valley	JIC, Codified instructions	16	Fabrication
CG	$L_B(51)L_C(39)$ J(10)	Negeri Sembilan	QCC, SPC	36	Precision components, molds and dies
CH	$L_B(40)L_C(30)$ J(30)	Negeri Sembilan	JIC, QCC	42	Precision components
CI	$L_B(70)$J(30)	Kelang Valley	QCC, TMs	55	High precision parts.

reported a lack of designing ability. The inability to meet delivery schedules has meant that all suppliers carry large amounts of inventories. The exhaust pipe supplier, i.e. CB, keeps inventories piled up at Proton's in-coming inventory warehouse using the just in case (JIC) inventory supply framework Interviews with Proton officials show that substantial amounts of inventories involving most of their suppliers are kept at Proton due to poor delivery schedules. It was also reported that uncertainty associated with traffic jams has also affected some suppliers ability to meet demand schedules. The Proton City project at Tanjung Malim is expected to reduce such

problems, but the current downturn has resulted in the project being shelved for the moment.

Like the supplier firms of microelectronics firms in the Kelang Valley, Proton's suppliers appear to be embedded in a space ineffectively organized. Institutions to support Proton and its suppliers have been created without explicit input from the firms, demonstrating elements of systems integration made famous by Intel. The synergy associated with effective institutional support has not been developed adequately. Thus, although Proton and its suppliers in the Kelang Valley and Negeri Sembilan enjoy privileged support from the government, Penang's machine tool firms have significantly out-grown them.

It can be seen that the microelectronics multinationals' suppliers in the Kelang Valley appear to be of similar productive capabilities as Proton's suppliers. Interviews suggest that the variance in capabilities is largely a result of differences in institutional coordination. Effective private-public coordination in Penang involving firms, state authorities and institutions with the firms playing a lead role has been critical in the creation and coordination of institutional support. Institutions in the Kelang Valley and Negeri Sembilan have emerged through state directives without taking cognizance of firms' interests. Planning seems to be orchestrated by the government here with the hope that firms inevitably would use the institutions that have been created.

5. Conclusion

This paper broached the development of machine tool firms linked to microelectronics and passenger car firms, focusing on the impact of the regulatory environment and in-firm changes in production reorganization and their effect on the development of subcontracting links in Penang, Kelang Valley and Negeri Sembilan. Machine tool suppliers in Penang have clearly achieved rapid growth and technical change than those located in the Kelang Valley and Negeri Sembilan. The similarities in technologies used by microelectronics multinationals in Penang and the Kelang Valley suggests that the critical explanatory variable distinguishing such a variance is largely due to external attributes rather than in-firm strategies.

The different ethno-class specificity in Penang and the Kelang Valley have set the structural limits to the development of machine tool links involving microelectronics multinationals. The massive state support offered have failed to generate competitive machine suppliers for Proton in the Kelang Valley and Negeri Sembilan. The competitive nature of microelectronics products manufactured has forced the adoption of cutting edge flexible manufacturing systems across the country. A significant part of the trajectory of technology transfer was passed to sustain competitive operations in Penang. A similar supplier base did not emerge in the Kelang Valley due to weak institutional coordination. Heavy protection without the

stick as well as weak institutional coordination has denied the gales of creative destruction to push Proton's suppliers to the technology frontier.

Relatively complementary local socio-political structures helped enhance effective coordination between markets, institutions and firms to enhance the development of small and medium scale machine tool firms in Penang. The specific nature of local politics in Penang, and the local political leadership's relative autonomy over the federal government helped the local state to support ethnic Chinese small and medium scale businesses more actively. The special intermediary role of the Penang Development Corporation has been instrumental in forging strong state-business-multinational coordination. Thus, markets, trust and in-house command worked complementarily to coordinate the expansion and deepening of machine tool subcontracting firms in Penang.

Although similar proximate machine tool demand also emerged in the Kelang Valley, constraints imposed by stifling local socio-political structure restricted the expansion of significant machine tool relationships between microelectronics multinationals and local small and medium scale firms. The local state offered little proactive support to forge links between microelectronics multinationals and local small and medium scale machine tool firms in the Kelang Valley. Unlike its counterpart in Penang, the Selangor Economic Development Corporation has hardly played any coordinating role to link microelectronics multinationals with local firms in the Kelang Valley. The SEP and VDP promoted by the federal governments have remained under-utilized.

Despite strong state support, machine tool suppliers linked to the passenger car industry have not made significant technological strides. While foreign assemblers

have lacked the initiative due to the small domestic market and the lack of dynamic state support instruments, Proton has enjoyed considerable state support, but have failed to generate competitive suppliers due to a combination of coordination and technological support problems. Local car assemblers are not only still far from the technology frontier, but face little pressure to move down the isoquants. Hence, even Proton has not effectively employed just-in-time techniques made famous by Toyota. As noted earlier, it was the quantitative and qualitative demands of the microelectronics multinationals and better coordination that helped local suppliers in Penang upgrade themselves to move up the machine tool technology ladder. The lack of both in the passenger car industry has left machine tool suppliers in the Kelang Valley and Negeri Sembilan weak.

It can also be seen that the microelectronics multinationals' suppliers in the Kelang Valley appear to be of similar productive capabilities as Proton's suppliers there and Negeri Sembilan. The divergence in capabilities seems largely a consequence of differences in institutional coordination. Effective coordination in Penang involving firms, state authorities and institutions, with the firms playing lead roles, has been critical in the creation and coordination of institutional support. Institutions that emerged in the Kelang Valley and Negeri Sembilan seem to be driven primarily by government directives without sufficient cognizance of firms' interests. Hence, firms have not figured strongly directly in the formulation of institutions and their supporting roles in the Kelang Valley and Negeri Sembilan.

References

Alt J.E. and Chrystal K.A. (1983), *Politic Economics*, Berkeley: University of California Press.

Bank Negara (1998), *Quarterly Economic Bulletin*, Kuala Lumpur: Bank Negara.

Best M. (1990), *The New Competition*, Cambridge: Harvard University Press.

Coase R.H. (1937), "The Nature of the Firm", *Economica*, 16(4): 386-405.

Doner R. (1991), "Approaches to the Politics of Economic Growth in Southeast Asia", *Journal of Asian Studies*, 50(4): 818-49.

Evans P. (1992), "The State as Problem and Solution: Predation, Embedded Autonomy, and Structural Change", Haggard S. and Kaufman R.R. (eds*), The Politics of Economic Adjustment*, Princeton: Princeton University Press.

Fujita K. (1998), "Industrial Policies and Trade Liberalization: The Automotive Indus- try in Thailand and Malaysia", Omura K. (eds*), The Deepening Economic Inde- pendence in the APEC Region*, Tokyo: Institute of developing Economies.

Haggard S. (1990), *Pathways from the Periphery: The Politics of Growth in the Newly Industrializing Countries*, Ithaca: Cornell University Press.

Helpman E. and Krugman P.R. (1989), *Trade Policy and Market Structure*, Cambridge: MIT Press.

Hirst P. and Zeitlin J. (1991), "Flexible Specialization Versus Post-Fordism Theory: Evidence and Policy Implications", *Economy and Society*, 20(1).

Hua W.Y. (1983), *Class and Communal Politics in Malaysia*, London: Zed Press.

Jomo K.S. (1986), *A Question of Class*, Kuala Lumpur: Oxford University Press.

Kaldor N. (1979), "Equilibrium Theory and Growth Theory", Boskin M.J. (ed), *Economics of Human Welfare: Essays in Honour of Tobor Scitovsky*, New York: Academic Press, pp 271-91.

Kamal S. and Young M.L. (1985), " Penang's Industrialization: Where do we go from here", Paper presented at the "Future of Penang Conference", Penang.

Khan M. (1989), "Corruption, Clientelism and the Capitalist State", Unpublished doc- toral thesis, Cambridge University, Cambridge.

Khong S.M. (1991), "The Service Sector in Malaysia: Structure and Change", Unpublished doctoral; thesis, Cambridge: Cambridge University.

Lim L.Y.C. (1978), "Multinational Firms and Manufacturing for Export in Less Developed Countries: The Case of the Electronics Industry in Malaysia and Singapore", Unpublished doctoral thesis, Ann Arbor: Michigan University.

Lucas R.E. (1988), "On the Machanics of Economic Development", *Journal of Monetary Economics*, 22: 3-22.

Machado K.G. (1995), "Proton and Malaysia's Motorvehicle Industry", Jomo K.S. (ed) *Japan and Malaysian Development: In the Shadow of the Rising Sun*, London: Routledge.

Malaysia (1971), *The Second Malaysia Plan 1971-1975*, Kuala Lumpur: Government Printers.

Malaysia (1976), The Third Malaysia Plan 1976-1980, Kuala Lumpur: Government Printers.

MIDA (1988), *Investment in the Manufacturing Sector: Policies, Incentives and Procedures*, Kuala Lumpur: Malaysian Industrial Development Authority.

Malaysia (1994), *Ministry of International Trade and Industry Report*: Kuala Lumpur: Government Printers.

Malaysia (1998), *External Trade Statistics*, Kuala Lumpur: Statistics Department.

Mardon R. (1990), "The State and Effective Control of Foreign Capital: The Case of South Korea", *World Politics*, 43(1): 111-38.

Munro (1964), "Untitled mimeo" Penang.

Nagata O. (1998) "Automotive Industry and Toyota's Operations within Southeast Asia", paper prepared for the Symposium on Industrial Networks in Asian Economies – Present and Future Perspectives, Tokyo.

North D.C. and Thomas R.P. (1970), "An Economic Theory of the Growth of the Western World", *The Economic History Review*, 22(1): 1-17.

PDC (1971*), Annual Report*, Penang: Penang Development Corporation

Rasiah R. (1987*), International Division of Labor (*translated from Malay), Master's thesis, Universiti Sains Malaysia (Published in 1993 by Malaysian Social Science Association)

Rasiah R. (1988), "The Semiconductor Industry in Penang: Implications for NIDL Theories", *Journal of Contemporary Asia*, 18(2).

Rasiah R.(1994), "Flexible Production Systems and Local Machine Tool Subcontracting: Electronics Component Multinationals in Malaysia", *Cambridge Journal of Economics*, 18(3): 279-98.

Rasiah R. (1995), *Foreign Capital and Industrialization in Malaysia*, New York and London: St Martin's and Macmillan.

Rasiah R. (1996), “Industrialization as Engine of Growth and Industrial Policy in Malaysia”, *Managerial Finance*, 9(2).

Rasiah R. (1996a), “Changing Organisation of Work in the Electronics Industry in Malaysia”, *Asia Pacific Viewpoint*, 37(1): 21-38.

Rasiah R. (1996b), “Innovations and Institutions: Moving Towards the Technological Frontier in the Electronics Industry in Malaysia”, *Industry and Innovation*, 3(2): 79-102.

Rasiah R. (1997), “Class, Ethnicity and Economic Development in Malaysia”, Rodan G, Hewisen K. and Robison R. (eds), *Political Economy of South-East Asia*, Melbourne: Oxford University Press.

Rasiah R. (1997a), “Rent Management in Proton”, *IKMAS working papers*, No. 2, UKM, Bangi.

Rasiah R. (1998a), “From a Backyard Workshop to a Modern Machine Tool Factory: Eng Hardware”, Jomo K.S, Felker G. and Rasiah R. (eds), *Looking Inside the Black Box: Industry Technology Development in Malaysia*, London: Routledge.

Rasiah R. (1998a), “Politics, Institutions and Flexibility: Microelectronics Trans-nationals and Local Machine Tool Linkages”, Doner R. and Deyo F. (eds*), Flexible Specialization in Asia*, Ithaca: Cornell University Press.

Richardson G.B. (1960), *Information and Investment*, Oxford: Oxford University Press.

Richardson G.B. (1972),“The Organisation of Industry”, *Economic Journal*, 82(3): 883-96.

Sabel C. (1986), “Changing Models of Economic Efficiency and their Implications for Industrialization in the Third World”, Alejandro C.F.D. et al (eds),

Development, Democracy and the Art of Trespassing, Notre Dame: Notre Dame University Press.

Saham J. (1980), *British Industrial Investment in Malaysia 1963-1971*, Kuala Lumpur: Oxford University Press.

Sengenberger W. and Pyke F. (1991), "Small Firm Industrial Districts and Local Economic Regeneration: Research and Policy Issues", *Labour and Society*, 16(1).

Vijaya Letchumi (1993), "SMI Development Programmes", paper presented at MITI/MIDA/FMM seminar, "Domestic Investment in the Manufacturing Sector", Penang.

Wilkinson F. and You J.I. (1992), "Competition and Cooperation: Towards an Understanding of the Industrial District", Small Business Research Centre, Working Paper No. 88, Cambridge University, Cambridge.

Williamson O.E. (1985), *Markets, Hierarchies and Relational Contracting*, New York: Free Press.

Firm	Ownership (equity %)	Location	Inception year	Process techniques	Employ-ment	Sales (RM million)	Products
BA	L_C(100)	Penang	1979	TMs, JIT, QCC	45	2.5	Precision components
BB	L_C(100)	Penang	1983	TMs, JIT, TQM QCC, SPC	22	1.4	Precision parts, automated machinery
BC	L_B(60) L_C(40)	Penang	1988	TMs, Codified instructions	15	0.3	Precision fabrication
BD	L_C(100)	Penang	1987	QCC and SPC	34	1.5	Precision parts, automated machinery
BE	L_C(100)	Penang	1991	TMs, Codified instructions	17	0.3	Precision parts
BF	L_C(100)	Penang	1976	JIT, TQM, TMs, TPM, QCC, SPC	200	20.0	Precision components, automated machinery
BG	L_I(100)	Penang	1978	Codified instructions	22	2.6	Precision parts, molds and dies
BH	L_C(100)	Penang	1984	JIT, SPC, QCC	85	10.0	Precision components
BI	L_C(100)	Penang	1980	JIT, TPM, QCC, TMs	68	15.0	Precision parts. Automated machinery
BJ	L_C(100)	Penang	1984	JIT, TPM, QCC, TMs	40	2.5	Precision parts
BK	L_C(100)	Penang	1950	JIT, TQM, TPM, QCC, TMs	120	10.0	Precision parts, automated machinery
BL	L_C(100)	Penang	1980	JIT, TQM, TPM, QCC, SPC	40	1.7	Automated machinery
BM	L_C(100)	Penang	1982	JIT, TQM, TPM, QCC, SPC	128	12.0	Simple parts fabrication, jigs, fixtures, molds and dies
BN	L_C(100)	Kelang Valley	1988	Codified instructions	18	0.15	Molds, dies, jigs and fixtures
BO	L_C(100)	Kelang Valley	1988	Codified instructions	14	0.36	Jigs, fixtures, molds and dies
BP	L_C(100)	Kelang Valley	1984	Codified instructions, QCCs	32	0.56	Simple parts fabrication, molds, dies, jigs and fixtures
BQ	L_C(100)	Kelang Valley	1975	TQM, QCC	69	2.5	Parts fabrication, jigs, fixtures, molds, dies

Table 2: Local machine tool firms linked to microelectronics multinationals, 1993

Notes: L_C – Local Chinese; L_B – Local *Bumiputera*; L_I – Local Indian; T – Taiwanese.

Source: Author's Interviews (1993)