

The Local Content of Japanese Electronics

Manufacturing Operations in Asia

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1. Introduction

Foreign direct investment (FDI) may increase host country productivity through improved resource allocation, increased competition, and expansion of local capabilities through a transfer of (technological) know-how (e.g. Caves 1995; Wang and Blomstrom 1992). Expansion of local capabilities occurs if FDI introduces superior organisational practices and technologies and if this know-how spills over to and is assimilated by local suppliers and customers, the local workforce, and local rival firms. The scope for such spillovers depends on the underlying innovative capabilities of the investing firm, the degree to which this is transferred to the foreign venture, and the extent of integration of the foreign firm into the host economy. In addition, a condition for substantial spillovers is a sufficient “absorptive capacity” of the local economy, e.g. the sophistication of local suppliers and the skill level of the workforce (Cohen and Levinthal 1990; Capannelli 1997a; 1997b). Integration in this context is the degree of interaction with the local workforce, local suppliers, customers, government institutions, industry associations, educational institutions and research centres (Turok 1993; De Arcos et al. 1995; Lall 1995). Since integration is achieved through country-specific investments in building up relationships with the local economy, highly integrated foreign firms are less likely to divest in the future and the long term viability of FDI increases.

The empirical literature on the spillover and productivity effects has produced mixed evidence on the impact of FDI. Industry level studies have generally shown positive effects of FDI on labour productivity (Globerman 1978) and product and process innovations (Bertschek 1995). Firm and establishment level studies have given less support. Haddad and Harrison (1993) did not find evidence of productivity increasing technology spillovers from foreign-owned subsidiaries to local firms in Morocco¹. Aitken, Hanson, and Harrison (1997) found evidence of a -more limited-

form of spillovers of multinational investment in Mexico. The presence of exporting multinational firms was found to increase the probability that domestically owned firms start export activities, suggesting the presence spillovers in the form of informational externalities and access to overseas distribution channels. Okamoto (1997) and Chung et al. (1996) failed to find a direct impact on the productivity of North American car component suppliers from their forward linkages with Japanese assemblers.² These two studies did show substantial improvements in the productivity of US-owned components suppliers (partly as a result of inventory reductions), suggesting that Japanese FDI had an indirect positive effect on productivity by increasing competition.³ However, another recent study of the impact of Japanese FDI on productivity of locally owned Chinese firms (Kinoshita 1996) found almost opposite effects. Here the results did not support indirect spillover effect of FDI on local firms' productivity, but provided evidence that direct buyer or supplier linkages with foreign firms led to higher productivity levels.

The debate on spillovers and other benefits from FDI spillovers appears to be particularly intense where it concerns Japanese FDI in Asia, which is the subject of this paper. One reason for this is the perception that Japanese FDI is somehow less likely to generate spillovers to local economies because of the idiosyncratic behaviour of Japanese multinational firms. Another reason is the economic importance of the activities of Japanese multinational firms in South East Asian countries. As shown in Table 1, Japanese manufacturing affiliates play a principal role in East Asian economies. In the ASEAN-4 countries (Thailand, Indonesia, Philippines, Malaysia), Japanese firms are responsible for almost a third of employment in the electronics and transport machinery industries.

In the discussion on the role of Japanese FDI, two contrasting views can be discerned. The positive view of Japanese FDI holds that Japanese FDI promotes economic development in Asia as the production processes and know how transferred correspond closely with the absorptive

capacity of the Asian economies. Products and components manufactured with the most standardised and mature technologies are produced in ASEAN countries and, more recently, China where cheap and low skilled labour is relatively abundant. Goods of intermediate technology are produced in the NIEs where labour is more expensive but also more skilled. The most technologically advanced and capital intensive production takes place in Japan. In this “Flying Wild Geese” representation of Japanese FDI, Japan’s technological leadership pulls along the industrialisation of Asian economies (e.g. Yamazawa et al. 1993; Urata (1991). The specialised nature of Japanese FDI in different Asian countries in accordance with differences in comparative advantage promotes intra-regional and intra-industry trade. In this view there is an important role of the “regional core networks” established by the larger Japanese multinational firms: networks of interrelated manufacturing plants for final goods and components, with different capital, labour, and skill-intensities (Belderbos and Sleuwaegen 1996; Gold et al. 1991).

A contrasting and less benign view of Japanese FDI points out that the centralised nature of management in Japanese multinational firms and Japanese firms’ reliance on long-term dedicated supplier relationships discourages substantial integration in local economies. Japanese firms exercise strict control over overseas ventures (Mason and Encarnation 1994), are slow in appointing local staff to managerial positions (Westney 1996; Belderbos 1997), and are among the least internationalised in terms of overseas research and development activities (Patel 1995). A number of studies present evidence of relatively closed supply chains. Japanese affiliates in the United States rely more on imported components from the parent company than other foreign investors (Graham and Krugman 1990; Froot 1991; Murray, Wildt, and Kotabe 1995) and Japanese affiliates in Australia rarely use open tenders for machinery procurement but routinely buy from long-standing suppliers in Japan (in contrast with European and U.S. affiliates) (Kreinin 1992). Evidence on Japanese subsidiaries in the Malaysian electronics industry shows that

Japanese firms buy an overwhelming share of local components from Japanese-owned components suppliers, including those within the same corporate group or vertical 'keiretsu' (Capannelli 1993, 1997b).⁴ In a recent paper, Hackett and Srinivasan (1998) argue that Japanese firms face higher supplier switching costs because of their intensive use of co-operative subcontractor relationships with established Japanese suppliers, in particular suppliers within vertical keiretsu. This implies that Japanese firms are less eager to switch to local suppliers for their overseas manufacturing operations. Their empirical evidence suggesting that Japanese firms are less inclined than US firms to invest in countries which impose strict local content requirements on foreign investors are in accordance with the hypothesis of higher switching costs. However, it appears to be an open question whether differences in investment and procurement behaviour are due to the idiosyncratic organisation of Japanese multinational firms or a temporary phenomenon due to a 'vintage effect': the relatively late internationalisation of Japanese firms (Mody and Srinivasan 1997; Westney 1996; Belderbos 1997, chapter 10).

In this paper, we contribute to the discussion by examining the determinants of Japanese firms' decisions to establish vertical linkages in Asian economies. Vertical linkages, i.e. the local content of manufacturing operations, have been a focal point of host country concern. Several Asian countries have instituted formal local content requirements for foreign investors; others have made preferential investment status conditional on local content, or have put informal pressure on foreign investors to extend their vertical linkages (Japan Machinery Center for Trade and Investment 1997; Commission of the European Communities 1998). Local content rules exist because increased local content is seen to provide a number of benefits to the host economy. If increased local content is achieved by sourcing materials and components from local suppliers, it may involve transfer of know how to, and promote growth of, the local supplying industry. If local content is increased, on the other hand, through increased vertical integration of the

manufacturing operations (by producing more components in-house), it may be associated with an upgrading of employee skills, in particular if the production of components is more technology and know how intensive. In either case, increased vertical linkages are likely to enhance the local employment and trade balance effects of the investment project. In addition, the increased cost of divestment associated with greater investment and linkages to the local economy may positively affect the longevity of FDI.

In this paper we analyse procurement behaviour at the micro level, i.e. at the level of individual firms, using subsidiary-level data from MITI's 1992 survey among Japanese multinationals. We develop an empirical model that aims to explain the local content of Asian manufacturing operations by Japanese subsidiaries in the electrical and electronics industry. The model specifies determinants at the parent, subsidiary, and host country levels. Three main determinants, among others, are included: the presence of local content rules, the role of dedicated supplier linkages in vertical keiretsu, and the 'vintage' effect. The effect of local content rules is measured at the subsidiary level, by utilizing a question in the MITI survey that inquires whether such regulations were applied. The effect of supplier relationships within vertical keiretsu is measured directly by estimating for each parent firm the intensity of transactions within the vertical keiretsu in Japan. The 'vintage' effect is taken into account by including a variable for the operating experience of the subsidiary in the country of investment. The data set used contains information on 157 Asian subsidiaries in the electronics industry. The electronics industry is the largest Japanese investor in Asia and makes extensive use of subcontracting relationships outside and within vertical keiretsu. However, empirical research on Japanese subcontracting relationships to date has almost solely focussed on the automobile industry.

Our main interest in this paper are the potential benefits of Japanese FDI for host economies which are derived from extended vertical linkages. The empirical analysis therefore focuses on the

local (host country) content of the electronics manufacturing subsidiaries in Asia. Local content includes both the value added of manufacturing subsidiaries (in house production of components) and the value of components and materials sourced from local (Japanese, third country, as well as locally owned) suppliers. We chose not to focus on procurement alone because ignoring intra-subsidary value added could lead to biased results: there is conceptually little difference between in-subsidary production of components (value added) and procurements from nearby components plants from affiliated firms belonging to the same vertical keiretsu. The differences could merely be one of legal subsidiary boundaries. On the other hand, a distinction between procurements from locally-owned and related suppliers would be useful, since the former is likely to be associated with greater technology transfer and the stimulation of local entrepreneurship (e.g. Lim and Fong 1983). Unfortunately, our data does not allow us to estimate the importance of local procurement from locally owned firms.⁵

The remainder of this paper is organised as follows. The next section briefly reviews the literature on subcontracting and supplier relationships of Japanese firms and previous work on vertical linkages of foreign-owned affiliates. Section 3 develops hypotheses concerning the determinants of the local content ratio of Japanese manufacturing operations in East Asia and describes the empirical model and data. Section 4 presents the empirical results. The last section summarises our findings and offers concluding remarks.

2. Previous literature: Vertical linkages, Japanese supplier networks, and local content rules

We are not aware of any recent systematic empirical analysis of the vertical linkages of foreign-owned firms in host economies. There is a research tradition on vertical linkages of

foreign firms in the economic geography literature. O'Farrell and O'Loughlin (1981), for instance, statistically analysed local procurement levels of foreign-owned affiliates in Ireland. In a more recent study, Turok (1993) investigated local sourcing by foreign- (including Japanese) owned firms in the Scottish electronics industry ("Silicon Glenn") in 1992 and concluded that the level of vertical linkages was low.⁶ The only recent attempt to provide a more comprehensive explanation of local sourcing decisions in this tradition is Reid (1995), but this study is primarily concerned with the effect of Just In Time (JIT) delivery systems on the spatial clustering of suppliers. Reid found that the use of JIT systems by 239 Japanese-owned manufacturing plants in the US is positively associated with the proportion of material inputs procured at the county level (but not at the state or national levels).

Apart from the descriptive evidence presented in Kreinin (1992), Graham and Krugman (1990), and Froot (1991), which emphasises the reliance by Japanese overseas affiliates on component and materials imports from Japan, there are a number of (case) studies examining local procurement by Japanese firms. Hiramoto (1992) presents a case study of the subcontracting and sourcing relationships of Japanese television and VCR assemblers in Asia and Europe. He found that Japanese assemblers have often failed in their attempts to establish similar long-lasting subcontracting relationships with local parts suppliers. Major obstacles were the lack of an attitude towards continuous improvement, the emphasis on quality and reliability, the dominant position of the assembler-buyer, and the buyer's preference for the use of relatively ambiguous contracts. Belderbos (1997, chapter 8) examined aggregate data on procurement and value added of Japanese electronics subsidiaries in the EU and the US. While the local (European and North American) content of manufacturing operations was substantial (in the range of 40-60 percent), the role of locally-owned firms in the supply chain was limited. Comparable findings were obtained by Capannelli (1993; 1997b) for Malaysia. These results correspond with earlier work

by Lim and Fong (1982) for Japanese investors in Singapore.

On the other hand, there is some evidence that the reliance on in-house components and procurement from Japanese affiliates is declining. Baba and Hatashima (1995) and Chia (1995) argue that there is a recent move from the use of firm-specific components developed internally or within the vertical keiretsu towards the open purchase of standard components. Greater competitive pressures have forced Japanese firms to re-design products in order to facilitate the procurement of cheaper mass-produced components in Asia. Baba and Hatashima (1995) describe a number of cases in which Japanese electronics firms have extended local design activities in South East Asia.⁷ Chia (1995) shows that an increasing number of Japanese firms have set up regional procurement offices in Singapore to facilitate cost effective sourcing of components made in Asia.

Recent empirical work on Japanese FDI has explored the role of supplier and subcontractor linkages in the decision to invest abroad and the location of investments. Belderbos and Sleuwaegen (1996) found that vertical linkages between firms are an important factor in the decision to invest in Asia: subcontractor firms within vertical keiretsu are more likely to invest in Asia if the parent firm operates a large number of plants (a 'regional core network') in the region. Using location data on Japanese manufacturing affiliates in the United States, Head, Ries and Swenson (1995) found that Japanese plants were more likely to be set up in a state, the greater the number of existing Japanese plants in that state in the same industry. The existence of plants set up by parent firms or suppliers in the same vertical automobile keiretsu exerted an additional positive effect on the location decisions by firms in the keiretsu. Horiuchi (1989) and Cusumano and Takeishi (1991) report that Japanese automobile manufacturers actively assist their keiretsu component suppliers to set up plants near their assembly operations abroad.

Empirical work on Japanese subcontracting and buyer-supplier relationships has primarily

been concerned with establishing the role of risk sharing as well as the correlation between relationship-specific investments and the performance of suppliers and assemblers. These studies have focussed on the automobile industry. Asanuma and Kikutani (1992) and Okamuro (1995) provide evidence that the intensity of long term supply relationships is positively correlated with the stability of performance. Dyer (1995) finds evidence that automobile assemblers are more profitable the greater the proximity (spatial clustering) of their suppliers. Proximity is associated with suppliers' dedicated investments in production facilities, greater sharing of know how and more intense communication. These are found to be correlated with faster design changes, improved quality, and increased return on investment. For the consumer electronics industry, Capannelli (1997a) found that technology transfer by Japanese assembly firms to their input suppliers is positively related to specific investments to enhance respectively the former's technological capability and the latter's absorptive capacity, and negatively related to the bargaining power of suppliers. The effectiveness of technology transfer was found to be greater in case of lower-end production inputs.

Studies of components procurement and supply chain management in the strategic management literature have also focussed on the relationship between sourcing strategies and firm performance. Kotabe and Omura (1989) examine sourcing strategies of a group of foreign (including Japanese) multinational firms in the United States and found that the extent of internal sourcing of major components is positively related to US market performance of the product. Murray, Wildt and Kotabe (1995) surveyed 104 foreign-affiliated manufacturing subsidiaries in the United States in 1993 and found weak evidence that reliance on non-standardized components and internal sourcing was related to better market performance as measured by sales growth. They also reported significant differences in procurement behavior between European- and Japanese-owned subsidiaries in the United States in 1991. Japanese subsidiaries sourced a significantly

smaller share of the value of components in the United States and combined a greater reliance on non-standardized components to significantly higher levels of intra-firm sourcing.

A last research tradition has been concerned with formal analysis of the welfare and strategic effects of local content requirements (e.g. Belderbos and Sleuwaegen 1997; Jie-A-Joen, Belderbos and Sleuwaegen 1998; Richardson 1993). The effect of local content requirements is found to depend, among others, on the market power of local parts suppliers, the cost competitiveness and level of vertical integration of local competitors in the assembly industry, and whether the requirements induce FDI in components production. Despite the wealth of theoretical studies, the only empirical study of the effect of content regulations is Hackett and Srinivasan (1998). Their finding that local content regulations exert a significantly negative effect on Japanese FDI would imply that, on balance, the negative effect on FDI in assembly industries is much stronger than any positive effect on FDI by assemblers and related suppliers in local components production to satisfy the requirements. However, they also found a positive and significant effect of the stock of Japanese FDI on new investments. This is consistent with the finding of strong agglomeration economies by Head, Ries and Swenson (1995) and may in fact measure a partly offsetting positive effect on FDI by subcontractors in response to previous investments by assemblers facing local content regulations.

3. Data and Empirical Model

This section develops an empirical model explaining the extent of vertical linkages of Japanese manufacturing subsidiaries in Asia. The dependent variable is the local content ratio (LOCON), defined as sales of the subsidiary minus components and materials imported from abroad, divided

by subsidiary sales.⁸ Since the dependent variable is restricted within the interval [0,1] two-limit Tobit analysis is used to relate the local content ratio to a set of explanatory variables.

Below we will first introduce the data set and discuss the use of the dependent variable. This is followed by discussion of the explanatory variables at the parent firm and subsidiary levels. We will first estimate a set of empirical models including these variables while controlling for country characteristics through a set of country dummies. This helps us to focus on the estimates of variables at the level of the firm. Since our data set only includes nine Asian countries, the variation is not as large as to allow for inclusion of a comprehensive set of country variables. Nevertheless, in a second set of extended models we do employ a set of country variables expected to have an impact on local content. Country variables are discussed in the last part of this section.

3.1 Data

Subsidiary data are drawn from MITI's 1992 Basic Survey among Japanese multinational enterprises and account for operations in the fiscal year through March 1993. A representative number of 157 subsidiaries in the electronics industry had sufficient information on local content and a basic set of explanatory variables. Eighty-three of these were established in the four Newly Industrialised Economies (NIEs) and 67 in the ASEAN-4 (Indonesia, Thailand, Philippines, and Malaysia), and 7 subsidiaries operated in China. Further details on the data selection as well as the definition of the dependent and explanatory variables are provided in the Appendix.

Table 2 shows the origin of procurements by Asian electronics subsidiaries of Japanese firms. Japan is the most important origin of procurements (46 percent), followed by the host country (39

percent) and other Asian countries (12 percent). Asian countries other than Japan are important sources of parts and components for subsidiaries in the ASEAN-4, Singapore and Hong Kong, but less so for Taiwan, South Korea, and China.

Table 3 shows the average local content ratio by country. The local content ratio averaged 71 percent for the NIEs and was 56 percent for ASEAN-4 countries. Higher local content ratios in the NIEs are achieved both through greater local sourcing (28 percent) and higher value added (43 percent).

3.2 The Dependent Variable

Foreign-owned subsidiaries can achieve a higher local content in a number of ways: (i) increasing the value added of the assembly activity, (ii) increasing the intra-subsidary production of components, (iii) increasing procurement of components and materials from Japanese suppliers in the same keiretsu which are producing in a local plant, (iv) increasing procurement from locally established independent Japanese firms, (v) increasing procurement from local subsidiaries of third country firms, and (vi) increasing procurement from locally-owned suppliers. The local content ratio of a subsidiary measures how much value the activity creates in the local economy, i.e. to what extent the value chain is established locally. However, there is a potential measurement problem associated with the local procurement share of the local content ratio. In particular when local suppliers are foreign-owned, these suppliers in turn will source part of their sub-components and materials from abroad. The value added that is generated locally must be less than price paid for the components. Hence, our local content measure (and the figures in Table 3) overestimates the contribution to the local economy. There is evidence that this overstatement of actual local

content is not negligible. Belderbos (1997, 326) reports that the local content ratio of Japanese electronics subsidiaries is reduced from 66 to 55 percent if the non-European content of components manufactured by Japanese suppliers in the EU is deducted. Although this is an important qualification to our analysis, it is less likely to introduce a systematic bias in the empirical results concerning the determinants of local content. At the country level, the same factors that positively affect value added of final goods manufacturing will have a positive impact on the value added of locally manufactured components as well. We did not find evidence that local content of the electronic components subsidiaries in our sample is determined differently from the local content of final goods subsidiaries.⁹ Hence, there will be a strong correlation between our measured local content ratio and actual local content.

A Japanese firm's decisions concerning the sourcing of components and materials for its manufacturing operations in Asia can be subdivided into two decision problems: 1) whether to procure the components in-house (or intra-keiretsu), and 2) whether to procure the components in Japan or overseas (in Asia). The 'internalisation' decision of 1) reflects the trade-off between quality and reliability benefits of in-house production of components of proprietary design versus cost-reducing sourcing of standard components. If a firm chooses external sourcing of components to maintain a competitive cost structure, it will be more likely to choose components produced in low cost Asian locations (produced by locally owned firms or independent Japanese transplants). If a firm chooses proprietary components manufacturing, it is still possible that overseas manufacturing activities reach high local content levels. A condition is that the overseas manufacturing location allows for cost effective production of the components within the assembly plant or in a dedicated components manufacturing subsidiary established by the assembler or its related component suppliers. The local content level reached will therefore reflect both the importance of transaction costs associated with arm's length trade and the attractiveness

of Asian countries in components manufacturing.

3.3. Explanatory Variables

Parent Firm Level

We posit that the *R&D intensity* of the parent firm (R&DINT) has a negative effect on local content. R&D intensive firms make greater use of proprietary designs and in-house know-how and they possess more intangible assets related to manufacturing capabilities of high technology components. They are less likely to transfer the production of these components to external suppliers. Since production of in-house developed components is generally capital and technology intensive, it is less likely that Asian manufacturing locations provide substantial cost advantages for R&D intensive firms. There is some evidence for this assertion: Fukao et al. (1994) found that R&D intensity has a significantly negative impact on the stock of foreign direct investment in Asia by Japanese electronics firms. We hypothesise that R&DINT is negatively correlated with the local content ratio. We also test whether the effect is stronger for ASEAN-4 countries and China compared to the NIEs since the greater technological capabilities of the latter make them more attractive for R&D intensive manufacturing operations.

Japanese firms differ in the intensity of long-term co-operative subcontracting and supplier-assembler relationships (e.g. Sako 1992; Dyer 1995). In particular firms that are member of large *vertical keiretsu* with a substantial number of related components manufacturers will make intensive use of these relationships. Intra-keiretsu procurement is based on long-term relationships characterised by intensive interaction between supplier and assembler involving dedicated

investments in equipment and human resources and requires the implementation of just in time delivery and total quality control systems. There is evidence that these relationships enhance performance and reduce risk (Dyer 1995; Asanuma and Kikutani 1992; Okamuro 1995). Since the assembler-supplier system is one of the bases for competitiveness of Japanese firms, they have followed a strategy to emulate it abroad. In practice, however it has proven difficult to involve locally-owned suppliers in such relationships (Hiramoto 1992). Moreover, the supplier switching costs are higher for keiretsu firms given the sunk investments in existing relationships with Japanese suppliers (Hackett and Srinivasan 1998). Supplier networks have therefore often been replicated abroad through the establishment of overseas manufacturing plants by existing Japanese manufacturers of parts and components, in which the latter were often assisted by the 'core' firm of the keiretsu (Belderbos and Sleuwaegen 1996).

The consequences of keiretsu membership for the local content of overseas operations are not unambiguous. On the one hand, keiretsu members firms' higher switching costs may lead to a greater continuing reliance on supplies of inputs from long-standing suppliers located in Japan. On the other hand, if the supplier has followed the assembler abroad, keiretsu firms may be able to reach higher local content than independent firms. The possibility of the replication of supplier networks abroad may be a particular advantage in locations where there is a lack of local or third country component manufacturers. We therefore examine whether the effect of keiretsu intensity is stronger in countries which have a less developed indigenous electronics parts industry, such as ASEAN-4 countries and China.

Since a substantial share of investments in Asia is by the 'core' firms of the keiretsu or by member firms of these keiretsu, membership of a vertical keiretsu itself is not a distinctive characteristic. Instead, we devised a measure of *intensity* of supplier-assembler relationships. We used Toyo Keizai's publication "Nihon no Kigyō Guruupu" (Japanese corporate groups), to

establish for each Japanese investor whether it belonged to a vertical keiretsu. Then we proxied the intensity of supplier-assembler relationships for keiretsu members by taking the ratio of the size (measured by paid-in capital) of all Japanese subsidiaries and related firms in manufacturing (“kogaisha” and “kankeigaisha”) to the size of the ‘core’ firm of the keiretsu in Japan. We call this variable keiretsu intensity, KEIRINT. The values for KEIRINT corresponded well to our intuition concerning the strength of supplier networks, with, for example, the highest ratios for Matsushita and Fujitsu and the lowest for Sharp. Unfortunately, we were not able to identify the keiretsu intensity for all Japanese investors, and the inclusion of KEIRINT reduces the number of valid observations by 17.

Subsidiary Level

At the subsidiary level, the *experience* in manufacturing in a country is likely to be an important determinant of the extent of vertical linkages. Finding suitable local suppliers and establishing links with these firms is a time consuming process, in particular if the suppliers have to adapt to the demands of Japanese assemblers in terms of quality and delivery schedules. In other cases, re-design of the product is necessary to allow for the use of locally made standardised components. O’Farrell and O’Loughlin (1981) found a positive effect of operating experience on the level of local procurement by foreign-owned subsidiaries in Ireland, but Reid (1995) could not establish a similar effect for Japanese firms in the United States. One reason for the latter result may be that no distinction was made between greenfield establishments and acquisitions. In case the local subsidiary was acquired by the Japanese investor, it is natural to assume that the subsidiary is relatively deeply embedded in the local economy at the time of the acquisition; the number of years of operation under Japanese ownership is not likely to have an important

additional impact on local content. In fact, it is conceivable that under Japanese ownership, a restructuring of manufacturing activities takes place, which may involve a switch to the use of Japanese made components. In our analysis of Japanese subsidiaries in Asia, the distinction between acquisitions and greenfield plants is of very limited importance, since the role of acquisitions in Asia is marginal: only 4 subsidiaries in the sample were acquired. This small number does not allow for a test of a different effect of experience for acquired firms. We therefore use only one variable, EXPER, the number of months since operations started in the manufacturing subsidiary under Japanese control.¹⁰

As mentioned above, the *entry mode* is likely to have an impact on integration in the local economy. Acquired subsidiaries are likely to have higher local content given their local ownership and pre-acquisition operating experience. We also expect that joint ventures facilitate higher levels of local content than wholly owned subsidiaries, *ceteris paribus*. This is because the local joint venture partner or its related firms may have accumulated expertise in either electronics components manufacturing or procuring components from local suppliers. Taking the wholly owned greenfield subsidiary as the base case, we include two dummy variables in the model, ACQUIS in case the subsidiary was acquired, and JV in case the subsidiary is a joint venture with a local partner.

A feature of the operations of Japanese electronics firms in Asia is a certain dichotomy between subsidiaries producing for export markets and subsidiaries primarily selling on the local market. The *export vs. local sales strategy* may have an impact on vertical linkages of the subsidiary. If the subsidiary is focussing on the local market it is likely that 1) it produces relatively mature and low priced products for this local market and not the most sophisticated products or models, and 2) it has an incentive to adapt the products to the local tastes and circumstances. The more mature the products, the more likely it is that locally produced low-cost

standard components can be used. If products are adapted to the local market this is likely to involve re-design which allows the use of locally made components. Furthermore, subsidiaries selling price sensitive products on the local market are also more vulnerable to currency swings if they rely on procurement from Japan. In sum, we expect that subsidiaries with higher local sales ratios have higher local content. LOCSALES measures the percentage of subsidiary turnover destined for the local market. We expect this positive effect to be greatest for ASEAN countries and China where demand is less sophisticated than in the NIEs.

Industry characteristics will have an effect on the extent of vertical linkages. High local content ratios may be more difficult to achieve in high technology industries such as in telecommunications than in the more mature consumer goods sectors. Subsidiaries manufacturing products that use components with a low value to weight ratio will be more inclined to use local components because transportation costs associated with imports are relatively high. We control for such possible systematic differences by including industry dummies. We re-grouped the industry classification used in the MITI survey to four sub-classes in the electronics industry: consumer goods, semiconductors and electronics parts, telecommunication and computer equipment, and other electronics and electrical equipment. We use consumer goods as the reference case and include three dummies: TELCOMP, PARTS, and OTHERIND.

Country Level

The first country characteristic affecting local integration is the availability of locally established component suppliers. We used data from Elsevier's World Electronics Yearbook to calculate the *value of electronic parts and components production* in each country in 1992. As explanatory variable we took the natural logarithm of the production value, SUPPLIERS. The

variable SUPPLIERS measures the availability of locally owned suppliers as well as Japanese-owned suppliers. It will also generally reflect the attractiveness of a country to establish components manufacturing operations.

The extent to which *Japanese suppliers* play a role in the local components industry will also affect vertical linkages. By using long-standing suppliers from Japan established near the overseas manufacturing base, firms can avoid the switching costs and emulate best practice in Japan. There may be important economies of agglomeration once a substantial number of Japanese suppliers have set up local manufacturing subsidiaries. Reduced input costs can result from increased specialisation and training of local personnel. We used MITI survey data to establish the total turnover of Japanese electronic parts manufacturing subsidiaries in each country in 1992. We employ as indicator of the presence of Japanese suppliers, JRATIO, the log of total turnover by Japanese subsidiaries divided by SUPPLIERS. We also hypothesize that firms with extensive supplier linkages within their keiretsu in Japan are likely to benefit most from the availability of Japanese suppliers. Hence we test for the cross-effect of JRATIO and KEIRINT.

The cost advantage of using a local network of suppliers also depends on the *quality of the infrastructure*. A good infrastructure facilitates physical transport of components within the country and communication between assembler and suppliers. The perceived quality of infrastructure, as measured by a survey among US multinational firms conducted by Business International Corporation, has been found to have a significantly positive impact on inward investment (Wheeler and Mody 1992; Hackett and Srinivasan 1998). We use the rating provided by Business International Corporation (Business International 1989) in 1989 as indicator for the quality of infrastructure in 1989: INFRA measures this quality on a scale of 0 to 10. We include INFRA as a moderating factor on the effect of SUPPLIERS. Hence we include SUPPLIERS*INFRA.

An important issue is to what extent *local content rules* directed at increasing the local content of (foreign-owned) manufacturing operations are successful in enhancing vertical linkages. We examined in some detail the available information at the country level on local content regulations and import restrictions on components and materials (Japan Machinery Center for Trade and Investment 1997; Commission of the European Communities 1998). We found that there were very few formal rules specifying local content requirements applicable to the electronics industry. Most existing requirements apply to automobile and machinery manufacturing. The only country which regularly imposes local content and export performance requirements on foreign owned firms is China; often these are part of trade balancing requirements which link import restrictions to export performance. In a number of ASEAN-4 countries, preferential treatment to foreign investment projects is contingent on local content (amongst other requirements). Malaysia, for instance, grants 'Pioneer status' (entitling to tax exemptions) if investments meet a number of conditions, among which local content requirements. In Indonesia import tariff reductions can be made dependent on local content. Overall, we concluded that import requirements and local content rules in Asia, if applied, are mostly part of incentive schemes. Such schemes and the conditions vary per investment project and this introduces a degree of discretion in the application of local content rules. The schemes may link import restrictions or local content requirements to export requirements.

Based on these findings, we decided to use two alternative indicators of local content requirements: besides an indicator of local content requirements at the *country* level, we also use a measure at the level of the individual *subsidiary*. At the country level, the presence and strictness of local content regulations and import restrictions is measured by the ratings given by US multinational firms provided by Business International (1989). We averaged the ratings for the extent of component and material import restrictions and the use of local content requirements

to construct the variable REGULATION. In case local content requirements and import restrictions are made contingent on export requirements, subsidiaries with a local sales orientation will face stricter requirements than export oriented firms. To control for this characteristic, we also include the cross effect of LOCSALES and REGULATION. Both the cross effect and REGULATION are expected to have a positive effect on the local content ratio.

The subsidiary-specific indicator of local content requirements is taken from the MITI survey. Subsidiaries are asked to indicate whether local content rules affect their manufacturing operations. If they indicate yes, the dummy variable for subsidiary-specific local content requirements, REGUSUB, takes the value 1. Because REGUSUB varies per subsidiary, we also include the variable in the country dummy model. Use of the dummy variable REGUSUB has the disadvantage that it does not indicate the strictness of the requirements. Given that local content rules tend to be stricter in ASEAN4 countries and China than in the NIEs, we attempted to remedy this to an extent by including REGUSUB separately for both groups of countries. We expect a stronger positive effect of REGUSUB for ASEAN-4 countries and China. In addition, we include the cross-effect of REGUSUB and LOCSALES to test whether subsidiaries with a local sales orientation face stricter requirements.

4. Empirical results

After presenting the results of the country dummy model, we analyse the results of the model with country variables. Finally, the results of a number of tests are discussed.

Country dummy model

Table 4 shows the results of five Tobit models explaining the local content ratio of Asian manufacturing subsidiaries of Japanese electronics firms. The first two equations do not include KEIRINT and are estimates based on 157 observations. Equation 1 is used as the basic model while Equation 2 tests whether there are differences in procurement behaviour by subsidiaries located in the NIEs and those located in ASEAN-4 countries and China. Equations 3-5 include the KEIRINT variable; inclusion reduces the number of observations to 133.

In accordance with our expectations, the parent firm's R&D intensity negatively affects local content. R&D intensive firms make greater use of non-standardized and technology intensive components, often developed and produced by the firm in Japan. There is no evidence, on the other hand, that this effect is significantly stronger in ASEAN-4 countries and China. The estimated coefficients for R&DINT do not differ markedly in Equation 2, while the standard error of the separate estimates is substantially higher.

The results show a robust positive and significant effect of operating experience on the local content ratio. Operating experience in the host country increases the vertical linkages of subsidiaries in the local economy, as the switch to local suppliers and the process of adaptation to the new environment require time. However, the estimated coefficient of EXPER suggests that this effect in itself is limited: one additional year (12 months) of local operating experience increases the local content ratio by 0.6 percent points. The results can only be taken as a partial confirmation of the role of Japanese firms' relatively late internationalisation in procurement behaviour.

Our expectation that the entry mode of the subsidiary has an impact on the input sourcing strategy is partly confirmed. Both ACQUIS and JV consistently have positive signs but their significance is low. ACQUIS is significant (at the 10 percent level) in Equation 1.

The hypothesis that local content increases if sales are destined for the local market is confirmed by the positive and significant coefficient of LOCSALES in Equation 1. The results of equations 2, 3 and 5 show that this effect is largely driven by procurement behaviour of subsidiaries in ASEAN-4 countries and China: LOCSALES is significant for subsidiaries in these countries, but insignificant for subsidiaries located in the NIEs. This suggests that for countries with a relatively unsophisticated market, subsidiaries' focus on the local market helps to achieve a lower dependence on imports of technology intensive parts and components.

REGUSUB, the variable indicating local content requirements at the subsidiary level, has a positive sign but is insignificant in Equation 1. However, if the effect is split between NIEs and ASEAN-4 countries and China, it appears that these requirements have an insignificant effect on the local content ratio of subsidiaries located in the former countries but a positive and significant impact on subsidiaries' local content in the latter. This indicates that relatively strict local content requirements have changed procurement behaviour in ASEAN-4 countries and China, but that such restrictions play no role in influencing sourcing decisions of subsidiaries in the NIEs. In Equation 4, it is also tested whether local content regulations have a greater impact on subsidiaries selling on the local market. The cross effect of LOCSALES and REGUSUB is positive and significant, suggesting that local market oriented subsidiaries indeed face stricter requirements. Inclusion of the cross effect increases the standard errors of the coefficients of LOCSALES and REGUSUB, which become insignificant.

The effects of the inclusion of the keiretsu intensity variable, KEIRINT, in Equation 3 confirm that keiretsu linkages have a major impact on vertical integration and local procurement. KEIRINT has a positive sign and is highly significant. Moreover, inclusion of KEIRINT clearly improves the fit of the model: the Chi-square increases by a substantial margin. Separating the effect of KEIRINT for subsidiaries in the NIEs and subsidiaries in the ASEAN-4 countries and

China in Equation 5 shows a slightly higher coefficient for the NIEs. Hence, we do not find evidence that keiretsu firms are able to reach higher local content ratios in countries with a less developed local supply infrastructure. Perhaps investments in local manufacturing plants by keiretsu suppliers are also less viable in these countries, compared with the NIEs.

After controlling for the subsidiary and parent firm characteristics, there is not much additional variation in local content ratios across countries. Only the dummy for Taiwan is consistently significant (at the 10 percent level), indicating that Taiwanese subsidiaries reach higher ratios than subsidiaries in Hong Kong, *ceteris paribus*. The coefficient of the Indonesia dummy is positive and significant at the 10 percent level in Equation 1, but this appears to be related to the local sales orientation of Indonesian subsidiaries and stricter local content requirements. The Indonesia dummy becomes insignificant if the models include separate (and higher) estimates for local sales orientation and local content rules in the ASEAN-4 countries and China.

The industry of the subsidiary neither exerts a strong independent influence on the local content ratio. The coefficients for TELCOMP, PARTS, and OTHERIND are negatively signed, indicating that subsidiaries producing consumer goods tend to have higher local content, but the coefficients are not significant.

We conclude that the results generally confirm our hypotheses concerning the effects of parent firm and subsidiary characteristics on local content. Almost all coefficients have the predicted sign and reach conventional significance levels in most equations; for subsidiary-specific local content regulations and local sales orientation this only applies to ASEAN-4 countries and China. The only unexpected result is the lack of geographic differentiation in the effects of R&D intensity and keiretsu intensity.

Country variable model

Table 5 shows the estimated coefficients of equations 6-10 which include host country variables. A general observation is that the estimated effects for most parent and subsidiary variables do not differ markedly from the estimates of the country dummy model. R&DINT and EXPER remain significant, ACQUIS is significant at the 10 percent level in all equations, and REGUSUB (Equations 7, 9 and 10) and LOCSALES (Equations 9 and 10) remain positive and significant for ASEAN-4 countries and China.

The results on the host country variables are generally less unambiguous. In equation 6, the size of the host country's electronics parts industry, SUPPLIERS, has the expected positive sign but is far from significant. SUPPLIERS does impact local procurement conditional on a good quality of the host country infrastructure: SUPPLIERS*INFRA becomes significant in equation 7.

In Equation 8, the country specific indicator of local content regulations and import restrictions, REGULATION, is substituted for REGUSUB. In addition, the cross effect of REGULATION and LOCSALES is included. REGULATION has the expected positive sign but is insignificant, while its cross-effect with LOCSALES is insignificant with the wrong (negative) sign.¹¹ Taken together with the results for REGUSUB, this suggests that local content regulations vary considerably between foreign subsidiaries in a country and have a greater impact on procurement behaviour of specific subsidiaries (presumably those that apply for a form of favourable investment status) rather than affecting local content of all investors.

In Equation 9, the indicator for the presence of Japanese suppliers, JRATIO, is introduced. It has the expected positive sign but is not significant. The inclusion of cross-effects of KEIRINT with SUPPLIERS and JRATIO in Equation 10 neither gives significant effects.¹² In light of the strong positive effect of the KEIRINT variable, these results are puzzling. Given the higher

switching costs for firms with intensive intra-keiretsu supplier relationships, we expected the positive effect of KEIRINT to impact through the replication of keiretsu supplier networks abroad. We can think of a number of reasons why the results do not bring this out. First, the variable JRATIO may not be an accurate proxy for the strength of the local Japanese supply base. JRATIO is derived from MITI survey data with a limited response rate, and response rates may differ by country. Furthermore, JRATIO measures sales of responding components subsidiaries and hence includes exports, while export oriented subsidiaries may not have been set up to supply local manufacturers. We are not able at this point to remedy these potential problems. Second, we may not be able to estimate country variable effects with sufficient precision due to the small number of countries (seven) in our country variable model. Third, in theory we should include an indicator for the local presence of suppliers *within the same keiretsu* instead if a proxy for the presence of Japanese suppliers overall. These issues need further attention in future research.

Further Tests

We performed a number of other tests, the results of which are not shown. These do merit some discussion. We also hypothesized that the characteristics of the local market may have an impact on the local content of manufacturing operations. The more sophisticated the demand for electronic goods, the more firms will be inclined to adapt and re-design products for the local market, which may also involve a switch to higher value added components produced locally. We used as a measure of demand sophistication, MARKET, the value of electronics sales in the country in 1992 (taken from Elsevier's World Electronics Yearbook) per capita. Market sophistication may moderate the effect of LOCSALES: the more sophisticated market demand, the more the market resembles the major export markets (EU, US and Japan) and the smaller the

effect of differences in local vs. export sales strategy. The cross-effect of LOCSALES and MARKET had the expected negative sign but was not significant.

Another test involved adding a dummy variable which takes the value 1 if the investing firm is a 'core' firm in the vertical keiretsu. The results did not support the hypothesis that 'core' firms behave differently from member firms. Another consideration was that in the country dummy model, the strict regulations in China linking export and import requirements could bias the effect of LOCSALES: the regulations are likely to increase the effect of LOCSALES on the local content ratio as compared with other Asian countries. We included a cross-effect of the CHINA dummy with LOCSALES. The coefficient was positive, as expected, but not significant.

We tested whether we could find evidence that transfer-pricing issues are affecting reported local content ratios. Affiliates located in host countries with higher tax rates may have an incentive to engage in transfer pricing and report a higher value of imports from the parent firm (and hence a lower local content ratio). We calculated host countries' effective tax rates by taking the pre-tax current profit minus after tax current profit divided by pre tax current profit for all Japanese subsidiaries reporting to the 1992 MITI survey.¹³ We included this effective tax rate as an explanatory variable in an attempt to control for the effects of transfer pricing. The variable had a counter-intuitive positive sign but was not significant, while the other coefficients remained unchanged.

A last test involved substituting the local procurement ratio (local procurement divided by total procurement) for the local content ratio as the dependent variable in the model. The estimated effects were very similar to those in the local content ratio models. The one important difference was that the country-specific measure of local content rules, REGULATION, did reach conventional significance levels in the model of Equation 8. We took this result as a further confirmation that local content rules in Asia have an impact on vertical linkages.

5. Conclusions

We examined the determinants of vertical linkages, i.e. the local content (intra-subsidary value added and procurement of inputs from locally established suppliers), of 157 Asian subsidiaries of Japanese multinational firms in the electronics industry in 1992. Consistent with our theoretical considerations, we found that a number of characteristics, both at the parent firm level and at the subsidiary level, affect subsidiaries' local content ratio. The operating experience has a positive effect on the local content ratio. As subsidiaries gain operating experience in the local economy, they are able to deepen their vertical linkages. This result is consistent with the notion that an alleged lack of vertical linkages of Japanese multinational firms is the result of a 'vintage effect': Japanese firms' relatively late internationalisation. However, the magnitude of the estimated experience effect is too small to take this result as more than a partial confirmation of the 'vintage' effect explanation. The results indicated that acquired subsidiaries are more integrated into the local economy and have higher local content ratios than greenfield subsidiaries. Subsidiaries of R&D intensive parents rely more strongly on imports of (non-standardized) components designed by the parent and have lower local content ratios. Subsidiaries located in ASEAN-4 countries and China that sell a high percentage of manufactured output on the host market reach higher local content levels than export oriented subsidiaries. A local market orientation is likely to be associated with the use of mature and standardized low-cost components procured from locally established suppliers, whereas an orientation on sophisticated export markets is associated with technology intensive components which are not typically available locally.

Membership by the parent firm of a vertical keiretsu with intensive supplier-assembler relationships has a robust positive impact on local content. We ascribed this to the ability of keiretsu members to stimulate the creation of a network of keiretsu components and parts manufacturers in host economies which helps to achieve higher local content levels. Apparently, this effect offsets a possible negative effect of keiretsu relationships on local content which may be due to the higher costs involved when switching to overseas suppliers outside the keiretsu. However, we could not establish with the data available that keiretsu firms reach higher local content in countries with a greater relative presence of Japanese suppliers.

The host country's local content regulations had a positive and significant effect if measured at the subsidiary level, but not if a more general measure was used at the country level. This finding is consistent with the observation that there are few formal local content rules in Asian countries, whereas preferential investment status programs provide governments with discretionary power to demand changes in procurement behaviour on a case by case basis. It should be noted, though, that the finding that local content requirements have been capable of changing procurement behaviour does not tell us whether the benefits of these policies have outweighed their costs. Achievement of local content targets come with tax relief or investment subsidies and, perhaps more important, there is evidence that local content requirements reduce the total volume of foreign investment (Hackett and Srinivasan 1998).

In general, our attempt to establish the effects of host country characteristics on local content was less successful, which may be due to the limited number of countries represented in our sample. We did find that the size of the host country electronics parts and components manufacturing sector combined with the availability of a good local infrastructure raised the local content of Japanese subsidiaries.

This study is a first attempt to shed some light on the determinants of vertical linkages by

Japanese firms. In order to allow for a better assessment of vertical linkages and potential spillovers to the local economy as well as the role of keiretsu supplier linkages, it may be necessary in future research to distinguish between local procurement from Japanese subsidiaries and local procurement from locally owned suppliers.¹⁴ In addition, the effect of overseas supplier networks of vertical keiretsu should be analysed directly by measuring the size of these networks for each keiretsu in each country. We are planning to examine these networks by combining the available information on keiretsu membership with databases on overseas subsidiaries. We expect that this approach will provide us with more robust evidence concerning the interaction of keiretsu linkages, local supply infrastructure, and local content. We are also planning to remedy the limited variation in host country characteristics by extending the study to a larger number of countries and, possibly, by adding data on local content and host country variables in 1995. An extension to 1995 is of interest, since there is evidence that local procurement in Asia has been increasing between 1992 and 1995 (MITI 1998b).

Another avenue for further research is to change the focus from the host country level to the regional level. In order to gain insight into the role of 'regional core networks' in East Asia and their importance for Asian trade and industrial development, a perspective is needed which takes into account procurements from other Asian countries (excluding Japan). As can be seen from Table 2, procurements from other Asian countries are not unimportant.

Japanese subsidiaries appear to have been quick to adjust to the changing economic conditions after the Asian economic crisis in the summer of 1997. According to a recent MITI survey (MITI 1998a), Japan's manufacturing subsidiaries in the ASEAN-4 countries have reduced their investment in tangible fixed assets by 21 percent and increased their export to Japan by 11 percent from the last quarter of 1996 to the last quarter of 1997 (Yen-based figures). Such changes are bound to have a substantial impact on procurement behaviour. There are some indications that

the increased costs of imported components due to the depreciation of Asian currencies has spurred firms to increase local procurement.¹⁵ More insight concerning the procurement strategies of Japanese firms may be obtained by investigating changes in vertical linkages throughout the 1990s. We hope to be able to contribute to research in this area in future.

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TABLE 1. Share of Japanese manufacturing subsidiaries in host country employment in 1995: Six East Asian economies

	Electrical Machinery			Transport Machinery			All Manufacturing*
	Total employment	Employment Japanese subsidiaries	Japanese share (%)	Total employment	Employment Japanese subsidiaries	Japanese share (%)	Japanese share (%)
South Korea	436,385	12,740	2.9	314,000	7,908	2.5	1.2
Taiwan	377,877	34,780	9.2	127,764	22,825	17.9	3.6
Singapore	100,111	38,809	38.7	34,672	1,243	3.6	13.5
Indonesia	132,484	49,373	37.3	123,842	42,510	34.3	1.8
Philippines	118,560	45,106	38.0	N.A	26,515	N.A	3.6
Malaysia	452,422	127,475	28.2	45,487	14,051	30.9	8.8

* Shares in total manufacturing are for 1997

Source: Author's calculations based on UNIDO, MITI (1998b), and Asian Development Bank (1998).

TABLE 2. Distribution of procurement by Asian manufacturing subsidiaries of Japanese electronics firms in 1992 over regions of origin

	Local	Japan	Asia	Other	Subsidiaries
	%	%	%	%	#
HONG KONG	48	34	18	0	8
SOUTH KOREA	46	50	4	0	25
SINGAPORE	40	43	15	2	27
TAIWAN	50	43	6	1	38
NIEs	46	44	9	1	98
INDONESIA	63	17	20	0	5
MALAYSIA	34	44	16	6	40
PHILIPPINES	16	42	42	0	4
THAILAND	28	55	15	2	34
ASEAN-4	32	47	17	4	83
CHINA	23	72	0	5	7
ASIA-9	39	46	12	3	188

Notes: 188 subsidiaries with complete information (see Appendix). Percentages are shares of total procurement.

Source: Authors' calculations based on MITI (1994).

TABLE 3. The local content ratio of Asian manufacturing subsidiaries of Japanese electronics firms in 1992

	Local procurement / Sales (A)	Value added / Sales (B)	Local content ratio (A+B)
	%	%	%
HONG KONG	33	36	69
SOUTH KOREA	23	44	67
SINGAPORE	30	39	69
TAIWAN	29	44	73
NIEs	28	43	71
INDONESIA	44	28	72
MALAYSIA	23	34	57
PHILIPPINES	10	44	54
THAILAND	18	34	52
ASEAN-4	22	34	56
CHINA	18	36	54
ASIA-9	24	38	63

Notes: 188 subsidiaries with complete information (see Appendix)

Source: Authors' calculations based on MITI (1994)

**TABLE 4. Determinants of the local content ratio of Asian subsidiaries:
Tobit estimates with Country dummies**

	eq1	eq2	eq3	eq4	eq5
R&DINT	-1,28		-1,23	-1,32	-1,25
t-value	-2,41 **		-2,21 **	-2,40 **	-2,24 **
R&DINT*NIES		-1,23			
t-value		-1,58			
R&DINT*(1-NIES)		-1,10			
t-value		-1,54			
KEIRINT			0,17	0,19	
t-value			3,21 ** *	3,47 ** *	
KEIRINT*NIES					0,20
t-value					2,21 **
KEIRINT*(1-NIES)					0,16
t-value					2,49 **
EXPER	0,0006	0,0005	0,0006	0,0007	0,0006
t-value	2,68 ***	2,58 **	3,03 ** *	3,32 ** *	3,04 ***
ACQUIS	0,29	0,24	0,24	0,20	0,24
t-value	1,81 *	1,50	1,55	1,36	1,56
JV	0,05	0,04	0,05	0,05	0,04
t-value	1,28	1,14	1,14	1,20	1,09
LOCSALES	0,12				
t-value	2,25 **				
LOCSALES*NIES		0,01	-0,01	-0,04	-0,01
t-value		0,18	-0,16	-0,48	-0,13
LOCSALES*(1-NIES)		0,23	0,17	0,10	0,18
t-value		3,06 ***	2,20 **	1,23	2,22 **
REGUSUB	0,06				
t-value	1,37				
REGUSUB*NIEs		0,00	-0,05	-0,14	-0,05
t-value		0,01	-0,63	-1,59	-0,60
REGUSUB*(1-NIES)		0,10	0,15	0,08	0,15
t-value		1,74 *	2,69 ** *	1,31	2,61 ***

REGUSUB*LOCSALES				0,34	
t-value				2,16 **	
TELCOMP	-0,06	-0,05	-0,09	-0,07	-0,09
t-value	-0,71	-0,67	-1,12	-0,88	-1,16
PARTS	-0,05	-0,03	-0,02	-0,02	-0,02
t-value	-1,33	-0,72	-0,38	-0,44	-0,43
OTHERIND	-0,06	-0,06	-0,04	-0,05	-0,04
t-value	-1,00	-1,00	-0,57	-0,62	-0,59

TABLE 4 continued

	eq1	eq2	eq3	eq4	eq5
INDONESIA	0,24	0,14	0,13	0,15	0,14
t-value	1,78 *	0,97	0,89	1,01	0,93
SOUTH KOREA	0,12	0,11	0,14	0,13	0,14
t-value	1,13	1,04	1,23	1,16	1,22
MALAYSIA	0,11	0,00	0,00	0,01	0,01
t-value	1,02	0,01	-0,01	0,09	0,05
PHILIPPINES	0,08	-0,05	-0,03	-0,01	-0,03
t-value	0,55	-0,31	-0,21	-0,07	-0,16
SINGAPORE	0,15	0,14	0,16	0,17	0,16
t-value	1,43	1,36	1,48	1,59	1,43
THAILAND	0,06	-0,06	-0,08	-0,06	-0,07
t-value	0,55	-0,45	-0,58	-0,47	-0,50
TAIWAN	0,19	0,17	0,20	0,20	0,20
t-value	1,88 *	1,71 *	1,83 *	1,85 *	1,82 *
CHINA	0,13	0,01	0,04	0,03	0,05
t-value	0,97	0,07	0,25	0,21	0,30
CONSTANT	0,44	0,50	0,43	0,43	0,43
t-value	4,17 ***	4,65 ***	3,65 ** *	3,73 ** *	3,65 ***
no. obs. (censored)	157(6)	157(6)	140(4)	140(4)	140(4)
Log Likelihood	19,04	21,49	25,84	28,15	25,91
Chi-square	49,52	54,41	58,19	62,80	58,32

*** Significant at 10% level, ** significant at 5% level, * significant at 1% level.

**TABLE 5. Determinants of the local content ratio of Asian subsidiaries:
Tobit estimates with country variables**

	eq6	eq7	eq8	eq9	eq10
R&DINT	-1,57	-1,66	-1,77	-1,40	-1,49
t-value	-2,89 ***	-2,84 ** *	-3,06 ** *	-2,40 **	-2,56 **
KEIRINT	0,19	0,22	0,20	0,14	
t-value	3,33 ***	3,84 ** *	3,54 ** *	2,29 **	
EXPER	0,0009	0,0008	0,0008	0,0008	0,0008
t-value	4,44 ***	4,04 ** *	3,79 ** *	4,07 ** *	4,23 ** *
ACQUIS	0,29	0,26	0,31	0,24	0,24
t-value	1,93 *	1,73 *	1,91 *	1,65	1,66 *
JV	0,03	0,03	0,03	0,01	0,01
t-value	0,86	0,89	0,65	0,32	0,23
LOCSALES*NIES	0,07	0,01	0,08	0,01	0,01
t-value	0,98	0,15	0,63	0,14	0,19
LOCSALES*(1-NIES)	0,10	0,09	0,20	0,18	0,20
t-value	1,28	1,10	1,01	1,97 *	2,14 **
REGUSUB*NIES	0,00	-0,02		-0,04	-0,03
t-value	-0,06	-0,32		-0,54	-0,39
REGUSUB*(1-NIES)	0,09	0,12		0,13	0,12
t-value	1,64	2,02 **		2,30 **	2,10 **
REGULATION			0,02		
t-value			0,91		
REGULATION*LOCSALES			-0,03		
t-value			-0,68		
SUPPLIERS	0,04				
t-value	1,33				
SUPPLIERS*INFRA		0,00	0,00	0,00	0,00
t-value		2,29 **	1,92 *	3,01 ** *	2,08 **
KEIRINT*SUPPLIERS*IN					0,00

FRA					
t-value					1,58
JRATIO				0,12	0,15
t-value				0,51	0,65
KEIRINT*JRATIO					-0,14
t-value					-0,68

TABLE 5 Continued

	eq6	eq7	eq8	eq9	eq10
TELCOMP	-0,08	-0,10	-0,08	-0,08	-0,09
t-value	-1,07	-1,33	-1,04	-1,01	-1,14
PARTS	-0,03	-0,04	-0,03	-0,02	-0,02
t-value	-0,74	-0,91	-0,78	-0,54	-0,61
OTHERIND	0,03	0,03	0,02	0,03	0,04
t-value	0,36	0,37	0,26	0,28	0,41
Constant	0,19	0,29	0,27	0,09	0,14
t-value	0,83	2,73 ** *	1,65	0,37	0,60
no. obs. (censored)	140(4)	133(4)	133(4)	128 (2)	128 (2)
Log Likelihood	18,90	19,79	18,14	26,31	27,24
Chi-square	44,30	46,59	43,28	47,44	49,31

*** Significant at 10% level, ** signifi

Appendix: Data sources, selection and description of variables

Data Selection

Our data on local procurement and intra-subsidary value added of overseas manufacturing subsidiaries of Japanese electronics firms are taken from MITI's "Fifth Basic Survey of Foreign Affiliates Activity" (MITI 1994) and concern fiscal year 1992 (the year ending 31 March 1993). This MITI survey includes a total of 314 subsidiaries in East Asia. For a relatively large number of subsidiaries, the information on local procurement and procurement by region of origin was incomplete, and a first screening reduced the number of observations to 203. We further eliminated subsidiaries with less than 10 employees, and a few cases in which the data were unreliable (e.g. the value of total procurement exceeded that of total sales). This diminished the number of observations by 15, and we ended up with reliable information for a sample of 188 firms.

We matched these data with information on parent firms using fiscal year 1992 financial data from published financial reports (MOF 1993) for firms listed at the Tokyo Stock Exchange and Toyo Keizai's "Nihon no Kigyou Guruppu" (for Keiretsu membership). We could not establish the parent firms of all Asian subsidiaries and R&D and keiretsu information of parents was not available for all subsidiaries. This reduced the number of observations in to 157 in the basic country dummy model, and further to 140 in models with keiretsu variable included. The data on host country characteristics from Business International do not include information on China, which further reduced the sample to 133 in the country variable model and the presence of Japanese suppliers could no be established for 5 more observations, reducing the number of observations to 128.

Variable Definitions

Table A1 provides the definition of the variables and the data sources.

TABLE A1. Variable description and data sources

<i>variable</i>	<i>Description</i>	<i>Source</i>
LOCON	Local content ratio: (total sales - total import) / (total sales - import of finished goods)	1
R&DINT	Parent firm R&D ratio: Parent firm R&D expenditure / total sales	1, 5
KEIRINT	Intensity of supplier-assembler relationships within the vertical keiretsu in Japan: Paid-in capital of the core keiretsu firm's manufacturing related companies in Japan / paid-in capital of the core keiretsu firm. Core firms have at least 250 billion Yen in sales.	2
Entry mode: (omitted dummy)	Greenfield and 100% Japanese equity share (reference case)	1
ACQUIS	Acquisition (100% Japanese equity share) of existing firm	
JV	Joint-venture	
Industry dummies: (omitted dummy)	Consumer goods	1
TELCOMP	Telecommunications and computers	
PARTS	Electronics parts	
OTHERIND	Other electronic devices	
EXPER	Operating experience: Number of months of production since start of operations until March 1993	1
REGUSUB	Subsidiary-specific local content requirements. Dummy variable. Takes value 1 if subsidiary reports that it faced such requirements.	1
LOCSALES	Local sales ratio: Sales in host country / total sales	1
SUPPLIERS	Size of local supply industry of electronics parts and components: Natural logarithm of host country's production of electronic parts	3
JRATIO	Presence of Japanese owned suppliers in the local supply industry: Nat. log of total sales by Japanese subsidiaries manufacturing electronic parts / Nat. log. of total production of host country electronic parts industry	1, 3
INFRA	Quality of infrastructure: indicated on a 0-10 range	4
REGULATION	Strictness of local content requirements and restrictions on components and materials import. Indicated on a 0-10	4

range, where 0=no regulation, 10 strict regulation

- (1) MITI, 1994, *Basic Survey on Foreign Direct Investment No 5 (Dai 5-kai Kaigai Tousei Tokei Souran)*;
- (2) Touyou Keizai Shinpousha, 1990, *Japanese Corporate Groups (Nihon no Kigyuu Guruu)*;
- (3) Elsevier Science Publishers, 1995, *Yearbook of World Electronics Data*;
- (4) Business International Corporation, 1989, *Country Assessment Service*;
- (5) Japan Ministry of Finance, 1993, *Financial Reports of Listed Firms (Yuuka Shouken Houkokusho)*.

Endnotes

¹ Although this conceivably may have been due to a relative lack of ‘absorptive capacity’ of local firms.

² Okamoto (1997) failed to find productivity increasing effects of supplier relationships with Japanese assemblers located in the US throughout the 1980s but did obtain weakly significant coefficients in the early 1990s.

³ The findings may also be taken to indicate that US-owned firms have been able to increase productivity by actively introducing organisational practices such as ‘just in time’ delivery systems pioneered by Japanese automobile producers. It is conceivable that introduction of these practices was facilitated by the ‘demonstration’ effect of plants set up by Japanese assemblers and suppliers, which is a particular form of spillovers. Similarly, Oliver and Wilkinson (1992) found that a majority of UK firms in their sample had successfully introduced ‘Japanese’ manufacturing management practices such as just-in-time delivery, quality circles, and flexible manufacturing techniques by the early 1990s. The UK firms were able to emulate these practices after Japanese plants set up in the UK in the mid 1980s had demonstrated that they could be successful in the UK environment.

⁴ Capannelli (1997b, 172-173) estimates that a mere 6.4 percent of local procurement was from Malaysian-owned firms in 1995.

⁵ The MITI data do allow for a distinction between procurements from suppliers owned by the same parent firm as the subsidiaries (‘intra-group procurement’ in the MITI terminology), which is a narrower definition than intra-keiretsu procurement. However, there is no distinction between procurements from third country, Japanese or locally-owned suppliers, and the question on intra-group procurement has a low response rate.

⁶ Only 12 percent of components were supplied from Scotland and another 30 percent from the rest of the United Kingdom (Turok 1993, 406).

⁷ Matsushita Electric and Seiko Epson are reported to have recently transferred part of their die making activities to South East Asia in order to reduce cost and reduce the period from design to delivery of new models. Matsushita Electric makes dies for television parts and cabinets in Singapore and Malaysia, and Seiko Epson is producing dies for computer printers

in Hong Kong. See “Manufacturing Technology Leaving its Stamp on Asia”, *Nikkei Weekly*, 23 June, 1997.

⁸ In case a subsidiary also imported finished goods, we deducted the value of such imports from both the total sales value and the total import value.

⁹ In addition, our results appeared robust with respect to the choice of the dependent variable (including or excluding value added): we obtained very similar results with local procurement as the dependent variable. If the local procurement share of measured local content were systematically biased we would have expected differences in these results.

¹⁰ We tested a model including both EXPER for greenfield and EXPER for acquired firms. As expected the latter had a small and insignificant coefficient, while the coefficient of the former was only marginally different from the EXPER coefficient for all subsidiaries.

¹¹ REGULATION neither reaches significance if the cross-effect with LOCSALES is excluded.

¹² Including KEIRINT itself in Equation 10 does not change these results.

¹³ This gave us the following rates: Hong Kong: 0.138, Korea: 0.348, Singapore: 0.192, Taiwan: 0.207, Indonesia: 0.286, Malaysia: 0.112, Thailand: 0.369, Philippines: 0.217, China: 0.065.

¹⁴ It may be possible to study such local linkages in future, since MITI is planning to introduce such a distinction in the 1999 survey.

¹⁵ For example, Hitachi Consumer Products in Thailand reportedly plans to raise the local content of its washing machine manufacturing operations from 43% (in early 1998) to 85% within a year. See ‘Local Procurement up in Southeast Asia’, *Nikkei Weekly*, 27 July 1998.