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Abstract

This paper investigates the productivity differentials between foreign and local plants in the Thai automobile industry, using the plant-level data underlying the 1997 industrial census (1996 data) and the 1999 industrial survey (1998 data) collected by the National Statistical Office of Thailand. According to the traditional theory of multinational corporations (MNCs), foreign-affiliated plants are expected to have higher productivity than local plants because MNCs have several ownership-specific advantages, including superior production technology and managerial resources. The results suggest that the labor productivity of foreign-affiliated plants is higher than that of local plants, as expected. However, most of the difference in higher labor productivity can be explained by higher capital intensity in foreign plants, not ownership-specific advantages. Comparisons of total factor productivity (TFP) levels in foreign and local plants again reveal no evidence that foreign plants have relatively high TFP that can be related to their ownership-specific advantages. Moreover, foreign plants in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries tend to have lower capital productivity than local plants in these industries, though foreign plants in the motor vehicle assembly industry have the relatively high labor productivity, capital productivity, and TFP. The paper thus concludes that the small size of the Thai automobile market prevents both the foreign and the local plants from exploiting scale economies.

Key words: Productivity, Automobile Industry, Thailand, Multinational Corporations.

JEL classification numbers: D24, F23, L11, L62

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1. Introduction

The 1990s were characterized by the rapid liberalization of trade and investment all over the world under the GATT (General Agreement on Tariffs and Trade) and the WTO (World Trade Organization). Furthermore, the revolutionary advances in information technology accelerated the speed of globalization of firms, the growth of international alliances, and of cross-border mergers or acquisitions. The activities of multinational corporations (MNCs) have received more and more attention in the era of globalization. Unfortunately, however, academic studies or evaluations of activities of MNCs have not been able to keep up with the speed of globalization of firms in the real world. In particular, micro-level studies on the economic performance of MNCs or on the economic impacts of MNCs on host countries are severely limited because of the lack of data and problems with the quality of data especially in developing countries. In the traditional theory of MNCs, foreign direct investment (FDI) by MNCs is regarded as the movement of managerial resources (in other words, the intangible assets related to technological knowledge in production and marketing or managerial know-how). A large body of literature on MNCs suggests that a firm becomes internationally active in order to exploit the firm-specific advantages embodied in the managerial resources (e.g., Dunning 1988, Caves 1996, Markusen 1991). Therefore, especially in developing countries, we expect MNCs to possess larger amounts of intangible assets than local firms and to differ from local ones in terms of productivity or efficiency. Moreover, host countries always expect the technology transfer or technology spillover effects from MNCs to local firms.

Recognizing the expected roles of MNCs, many researchers have investigated technology transfer from MNCs to local firms and provided comprehensive analyses based on interviews and questionnaires. However, hardly any quantitative studies have been conducted mainly due to the limited availability of suitable data. However, in the past few years, firm-level or establishment-level data have become partly available in some countries including the ASEAN countries. Although some researchers have examined quantitatively whether significant differences in performance can be observed between foreign MNCs and local firms, some of them conclude that foreign MNCs are not significantly more productive. For example, Okamoto (1999) analyzed the impact of Japanese FDI on the productivity of the U.S. auto parts industry using establishment-level data, and found that Japanese–affiliated firms were less productive than their U.S. counterparts in 1992. For the manufacturing MNCs operating in the East Asian countries, Okamoto and Sjoholm (2000), Ramstetter (1999), Takii and Ramtetter (2000), Ramstetter (2001, 2002), and others compare the performance between foreign MNCs and local firms. They generally found that foreign MNCs had a relatively high average labor productivity. Okamoto and Sjoholm (2000), examining productivity performance and its dynamics in the Indonesian automobile industry between 1990 to 1995, concluded that the overall industry performance was poor despite large government support, and that although foreign establishments tended to show a better performance than local ones, the spillover effect of foreign MNCs did not seem to have been strong.[1] Ramstetter (2001), analyzing labor productivity of manufacturing plants in all industries in Thailand in 1996 and 1998, found that labor productivity differentials across plants mostly derived from differences in factor intensities, such as the capital-labor ratio and the ratio of the number of non-production workers to the number of production workers. He concluded that after controlling for factor intensities, there was no evidence suggesting that foreign plants enjoy systematically higher labor productivity than local firms. Moreover, Ramstetter (2002) compares translog production functions and productivity measures in local plants and plants of foreign MNCs in Thai manufacturing for 1996 and 1998. Being consistent with his previous study, the results suggest that differences in technology between local plants and foreign MNCs are statistically insignificant.

Therefore, in light of the findings of these previous studies, the so-called “Ownership advantage” in the theory of MNCs is not supported and MNCs do not always exploit the firm-specific advantages in terms of productivity. However, such previous works have not investigated why foreign MNCs could not perform well in some host countries, and what characteristics of the MNCs or host countries prevented the MNCs from exploiting their ownership advantages in the host countries.

In this paper, using establishment-level data for the Thai automobile industry in 1996 and 1998, the following two questions are examined: 1) Are foreign plants more productive than local plants? 2) What characteristics determine the productivity of plants? In order to answer these questions, we first investigate performance differentials between local and foreign-owed plants in Thailand. We calculate various measures of the productivity of an establishment, and test if there is a significant difference in productivity between local and foreign plants. Moreover, we explore which factors determine plant productivity, and whether or not the difference in ownership is an important determinant of productivity. Scale effects, vintage effects and learning effects, trade effects, and ownership or managerial ability are discussed and tested. We mainly use two measures of plant productivity, labor productivity (value added per hour for production workers)

[1] Using panel data on Venezuelan plants, Aitken and Harrison (1999) found that plant productivity is positively correlated with foreign participation. However, in their test for spillover effects from foreign-owned plants to local plants, they found that foreign investment negatively affects the productivity of domestically owned plants.

and relative total factor productivity (TFP). As argued in much of the literature, a focus on TFP only is often misleading, because it is impossible to distinguish the productivity of unmeasured factors and measurement errors.[2]

The remainder of the paper is organized as follows. Section 2 provides an overview of the ASEAN and Thai automobile industry and presents some characteristics of local and foreign firms. In Section 3, using plant-level data, we compare various productivity measures between local and foreign establishments, and examine whether the differences are statistically significant or not. Section 4 discusses the theoretical principles of the determinants of productivity levels and reports the results of the regression analyses on the Thai automobile industry. Section 5 concludes the paper by considering the implications of the findings.

2. Overview of the ASEAN and Thai Automobile Industry

Many a developing country government has targeted the automobile sector as a major focus in their industrialization drive. A number of characteristics explain why this industry has been considered to be more conducive to development efforts than other sectors. These particular industry characteristics include the following. It is: 1) A large-scale industry requiring a huge amount of capital, 2) A synthetic industry which has wide-ranging related industries such as the auto parts industry, automobile sales/maintenance industry, materials industry, and cargo/passenger transport industry. Since nearly twenty thousand parts are required to make one car, significant technology transfer effects on related industries are expected. 3) A key industry the output of which makes up a significant proportion of GDP (Gross Domestic Product) due to its large scale, when the conditions of market size, infrastructure, and technology levels are satisfied.[3]

The ASEAN countries are no exception in this attempt to foster an automobile industry within the country, and in response to these efforts, major foreign automakers started operations in these countries in the 1960s and 1970s. Moreover, since the late 1980s, many Japanese auto

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[2] Total factor productivity is defined as the ratio of the quantity of total output to the quantity of total input. Although measurable inputs such as labor and tangible assets can be included in the input index used in the calculation of TFP, it is difficult to measure intangible assets such as technology, management know-how, labor and entrepreneurial skills, and so on. Therefore, estimated TFP is interpreted as an unexplained productivity which includes both the productivity of unmeasured factors and errors in productivity measurement. For the theoretical concept and measurement of TFP, see Jorgenson (1966), Jorgenson and Griliches (1967), Nakajima (2001), etc.

[3] See Waseda Daigaku Shogakubu [Faculty of Commerce, Waseda University, Japan] and Zaidan-Hojin Keizai Koho Center, eds. (1995).

parts suppliers have striven to set up reliable production and marketing networks in the region. As shown in Panel A of Table 1, most of the automobiles sold in the ASEAN countries are made by Japanese automakers except in Malaysia.[4] In the auto parts industry, approximately a third of parts manufacturers are foreign affiliates or subsidiaries (Panel B of Table 1).

Thailand currently has the biggest automobile market and agglomeration of auto firms among the ASEAN-4 countries (Panels A and B in Table 1). The reason for this is probably that the Thai government has pursued relatively laissez-faire policies towards foreign-affiliated automobile firms. Although all the ASEAN-4 countries introduced policies aimed at promoting the automobile industry under the import substitution strategy during 1960s and 70s, the government stance towards foreign multinationals has varied across the countries. The Thai, Malay, and Philippine governments licensed some foreign automakers in automotive assembly, while the Indonesian government intended to foster locally-owned automobile manufactures from the beginning. In Malaysia, in 1983, the Mahathir administration changed the country's policy towards the automobile industry and established its own national car project, the Proton, which is a joint venture with Mitsubishi. In such political circumstances, every ASEAN government has protected the domestic automobile industry with high import tariffs and non-tariff barriers, particularly in Indonesia and Malaysia where the national car project has been promoted (Panel C of Table 1).

In Thailand, the government first began to provide incentives for investment by enacting the 1960 Industrial Promotion Act, under the import substitution strategy. Being attracted by the investment promotion policy, the first automobile assembly plant in Thailand, Anglo-Thai Motor Company, started operating in 1961. After that, at least nine assembly plants were set up during 1961 to 1969. For example, Toyota Motor Thailand Co., Ltd. and Siam Motors & Nissan Co., Ltd. were established in 1962. In the 1970s and early 1980s, due to the strengthening of local content requirements, many Japanese automobile parts suppliers established production companies or concluded license agreements with local manufacturers, while some of the European and U.S. automakers discontinued the local assembly because of the intensified competition. Throughout the process of the automobile industry promotion, the Thai government has been protecting the domestic automobile industry by imposing high tariffs on completely built-up automobiles (CBU), and has been luring foreign automakers by giving them various incentives for investing in the country. The intention was to achieve import substitution by promoting joint ventures between foreign automakers and local firms. In addition, in an attempt to promote the localization of parts

[4] In Malaysia, a national car manufacturer, Proton, has more than 60 percent market share. It should be noted, however, that Proton was established in 1983 as a joint venture with Mitsubishi Motors Corporation of Japan.

and components, the government set local content requirements for automakers. This policy encouraged Japanese automakers to bring in their parts suppliers to Thailand. In the early 1990s, the government reversed its policy and reduced tariff rates and vehicle tax rates. Due to these liberalization policies and to rapid economic growth, the Thai automobile market and FDI inflows into the automobile industry in Thailand grew rapidly in the first half of the 1990s. However, annual automobile production and sales in Thailand at most reach about 600,000 units,[5] which are far lower than in Japan. In Japan, approximately 10 million vehicles are produced annually and 6 - 7 million a year are sold domestically. The fact that domestic markets are too small to support efficient-sized plants has been pointed out by many researchers as a major obstacle to the development of a domestic auto parts industry.[6] To take advantage of economies of scale, the AICO (ASEAN Industrial Cooperation), which succeeded the BBC (Brand to Brand Complementation) scheme, was designed to encourage cooperative industrial production in the ASEAN countries. The AICO became effective in November 1996.[7]

In Thailand, thirteen major foreign automakers possess assembly plants with a total annual production capacity of 976,000 units in 1999.[8] The geographical distribution of the plants owned by those automakers is shown in Figure 1. Most of these plants are located in Bangkok, the Vicinity of Bangkok area, and the Eastern Region. Major local and foreign-owned auto parts plants are also concentrated in these regions.[9] Table 2 summarizes the performance of major automobile and auto parts manufacturers in Thailand for recent years. According to Table 2,

[5] Automobile production and sales in Thailand hit a peak in 1996. After the economic crisis in 1997, however, sales dropped to 363,156 units from 589,126 units in 1996. In 1998, automobile sales continued to tumble, declining to 144,065 units, which was a drop of 76 percent from 1996 sales (Poapongsakorn and Wangdee 2000b).

[6] For the case of Thailand, these issues have been discussed, for example, in Yahata and Mizuno (1988), Maruhashi (1995), Buranathanung (1996), and Terdudomtham (1997).

[7] The AICO scheme permits participants to gain early access to preferential tariff rates thereby creating profitable opportunities while normal tariff rates remain high. However, the member governments of ASEAN have tended to require a degree of reciprocity in terms of balanced trade flows under the agreement (Farrell and Findlay 2001).

[8] The thirteen automakers are as follows: Isuzu (49 percent owned by General Motors), Ford, Mazda (33.4 percent owned by Ford Motor), Volvo (100 percent owned by Ford Motor), DaimlerChrysler (Mercedes-Benz), Mitsubishi (34 percent owned by DaimlerChrysler), Toyota, Hino (33.8 percent owned by Toyota Motor), Nissan (36.8 percent owned by Renault), Nissan Diesel (22.5 percent owned by Renault and 22.5 percent owned by Nissan), Peugeot and Citroen, Honda, and BMW. Out of the total production capacity of 976,000 units in Thailand, the capacity of the Toyota Group (Toyota and Hino) is 260,000 units, thus accounting for about 27 percent in total capacity. Each of the other four major groups, the GM-Isuzu group, the Ford-Mazda-Volvo group, the DaimlerChrysler-Mitsubishi group, and the Renault-Nissan group, has about a 15 percent share in total production capacity. Moreover, the production capacity in Thailand accounts for about 40 percent of total capacity in the ASEAN-4 countries. Even in Thailand, however, the capacity utilization ratio remained around 34 percent in 1999 (FOURIN 2000).

[9] For the regional distribution of the establishments in the Thai automobile industry, see Appendix

foreign-affiliated firms hold nearly an 80 percent share in total revenue. Particularly, Japanese-affiliated firms dominate over others. However, as for the average profit rates, foreign-affiliated firms tended to be less profitable than local firms before the 1997 East Asian Crisis, have shown a more favorable recovery after the crisis.

3. Differences in the Economic Performance of Local and Foreign Plants

In the remainder of this paper, using the plant-level data underlying National Statistical Office (1999), we investigate the difference in various productivity measures between local and foreign plants for the Thai automobile industry. Although plant-level data are available for 1996 and 1998, we mainly use the 1996 data in our analysis. Because most automobile plants in Thailand were still suffering from the slump in 1998 due to the 1997 East Asian crisis, the data for 1998 are not appropriate for the productivity analysis.

Table 3 summarizes the plant-level data used in our analysis.[10] In Thailand, about 20 percent of all plants in the manufacturing sector as a whole are owned by foreigners. Moreover, nearly half of all workers in manufacturing are employed in foreign plants, and more than half of gross output or value added comes from foreign plants in manufacturing as a whole. In the motor vehicle industry, more than half of all workers are employed in foreign plants, and approximately 90 percent of gross output or value added comes from foreign plants.

Given the significance of foreign-owned plants in the Thai automobile industry, let us now explore differences in the productivity of local and foreign plants, using the plant-level data for 1996 underlying National Statistical Office (1999). Figure 2 shows the distribution of labor productivity measured by value added per hour for production workers for the three detailed industries: motor vehicle assembly, motor vehicle bodies and trailers, and motor vehicle parts and accessories. We calculated the number of establishments at each level of productivity for the two groups, foreign plants and local plants. Figure 2 presents the share of the number of establishments at each level in the total number of establishments.[11] It is found that, in the motor vehicle assembly and the motor vehicle bodies and trailers industries, the majority of foreign

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Figure 1.

[10] Figures in Table 3 are compiled using only reliable samples as explained in Ramstetter (2001). Ramstetter (2001) found that the original plant-level data collected by the National Statistical Office of Thailand contain several duplicate or near-duplicate records. He checked the duplicates and eliminated the duplicate records from the data set for his analysis. Therefore, the figures in Table 3 are not equal to those in the National Statistical Office's publication (National Statistical Office 1999).

[11] For the methodologies of calculating productivity measures, see Appendix.

plants enjoy a higher level of productivity, while local ones stay at lower levels of productivity (Panels (a) and (b)). In the motor vehicle parts and accessories industry, however, although foreign plants dominate the higher levels of productivity, they also hold a significantly large share at the lower levels of productivity. There is no clear tendency of foreign plants having a higher labor productivity than local ones (Panel (c)). Looking at the labor productivity distribution in the motor vehicle industry as a whole, foreign plants seem to be distributed almost equally at each level (Panel (d)).

As for capital productivity measured by value added per baht of fixed assets in Figure 3, we see similar tendencies as in Figure 2. In the motor vehicle assembly industry, foreign plants tend to display higher capital productivity, while in the motor vehicle parts and accessories industry, foreign plants tend to have lower capital productivity than local plants (Panels (a) and (c)). In the motor vehicle bodies and trailers industry, many foreign plants are classified in the lower levels of capital productivity (Panel (b)). In the motor vehicle industry as a whole, foreign plants are equally distributed at each level of capital productivity, but it seems that more foreign plants are classified at lower levels (Panel (d)).

In addition, we calculate the relative TFP level of each plant and show its distribution in Figure 4. This also indicates that foreign plants seem to exhibit higher relative TFP in the motor vehicle assembly industry while in the other two industries, there is no clear tendency (Panels (a), (b), and (c)). Looking at the distribution in the whole motor vehicle industry, there is again no clear tendency (Panel (d)).

As mentioned in Section 1, Ramstetter (2001) found that a large part of the higher labor productivity of foreign-owned plants was explained by the higher capital intensity. As we examine this issue in more detail in a later section, let us here look at the capital-labor ratio differentials across plants (Figure 5). In all three industries as well as in the motor vehicle industry as a whole, foreign plants seem to have a higher capital-labor ratio than local plants. According to the results of Figures 2 to 5, it might be expected that foreign plants are more capital intensive and therefore have higher labor productivity in the motor vehicle assembly industry.[12] The capital productivity is also higher for foreign plants in this industry. In the motor vehicle parts and accessories industry, however, this story does not seem to apply. The majority of foreign plants in the industry have a higher capital-labor ratio, but labor productivity is not clearly higher than that of local plants. Capital productivity seems to be clearly lower for foreign plants.

[12] The higher capital-labor ratio means that a worker is equipped with more capital. A worker using more capital will be able to produce more than a worker with less capital. If we assume the neo-classical production function as explained in the literature on economic growth, it is easily shown that a higher capital-labor ratio leads to more output per labor.

In the remainder of this section, we test the hypothesis suggested by MNC theory that firm-specific managerial advantages enable foreign-owned plants to do better than local ones in terms of productivity or efficiency. We compare foreign plants with local plants in terms of productivity (output per hour for production workers, value added per hour for production workers, output per employee, value added per employee, output per one baht of fixed assets, value added per one baht of fixed assets, and the level of relative TFP) and inventory ratios (total inventory ratio, final goods inventory ratio, work-in-process inventory ratio, and raw materials inventory ratio). To enhance the comparison, we add seven more economic indicators: share of non-production workers, capital-labor ratio, price-cost margin, production worker wages, non-production worker wages, total worker wages, and capital utilization. Table 4 shows the results.[13]

Table 4-a compares the various productivity measures and other economic indicators between local and foreign plants in 1996 for each of the three detailed industries. In all three industries, the average employment size per foreign plant is larger than that for local ones, and the difference is statistically significant in the motor vehicle assembly and the motor vehicle bodies and trailers industries. Although the average employment size per foreign plant is approximately 15 times larger than that for local ones in the motor vehicle assembly industry, this may be because many small tuk-tuk repair shops are classified in this industry.[14] As for the years in operation, foreign plants are significantly older than local ones in the motor vehicle assembly industry, while they are newer than local ones in the other two industries, statistically significantly so in the motor vehicle parts and accessories industry. The amount of registered capital is much larger for foreign plants and the difference is statistically significant in all three industries. For each of the four labor productivity measures, foreign plants are significantly more productive than local ones in all three industries. However, as for capital productivity and the relative TFP level, the comparison between local and foreign plants shows different results among the industries. In the motor vehicle assembly industry, capital productivity and the relative TFP level are significantly higher for foreign plants. On the other hand, capital productivity is higher in local

[13] It would also be interesting to examine the differentials among foreign plants by nationality. However, in the automobile industry, the majority of foreign plants are Japanese. In the motor vehicle assembly industry, 14 out of 15 foreign plants are Japanese. In the motor vehicle bodies and trailers industry, 7 out of 8 foreign plants are Japanese. In the motor vehicle parts and accessories industry, 37 out of 53 foreign plants are Japanese, 1 from Korea, 4 from Taiwan, 2 from the United States, 2 from Europe and 1 from China. The nationality of the rest is unknown. Given such dominance of Japanese plants, we do not distinguish foreign plants by nationality in the analyses in this paper.

[14] A tuk-tuk is an auto three-wheeler, which is very popular in Thailand and other Asian developing countries.

plants than in foreign plants in the other two industries and the difference is statistically significant in most cases. As for relative TFP, it tends to be higher for foreign plants in these two industries, but the difference is not statistically significant.

As for the other indicators, the capital-labor ratio, wages, and capital utilization of foreign plants are significantly higher than those of local ones. Although foreign plants in the motor vehicle assembly industry tend to have lower inventory ratios, the gap between foreign and local plants is only weakly significant. Moreover, in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries, the inventory ratios of foreign plants tend to be higher than those of local plants, though the difference between foreign and local plants is not statistically significant. These findings imply that foreign plants in the motor vehicle assembly industry are relatively successful in their inventory management, while the foreign plants in the other two industries still suffer from holding large amounts of inventory. This is probably because foreign (particularly Japanese) parts suppliers in Thailand rely on imported materials to a considerable extent, or because of the lack of lower-tiered parts suppliers in Thailand.[15] The differences in the price-cost margin between foreign and local plants are not statistically significant in all the industries. As for the share of non-production workers in total workers, foreign plants have a significantly larger share in the motor vehicle parts and accessories industry, while the difference between foreign and local plants are not significant in the other two industries. This might be explained by the fact that foreign plants in the motor vehicle parts and accessories industry are relatively newer than local ones. In addition, the fact that foreign plants pay higher wages for both production and non-production workers than local ones might suggest that foreign plants face the difficulty of recruiting workers. Another possibility is that foreign plants (particularly Japanese-owned plants) employ some foreign workers, usually dispatched from parent firms, and pay higher wages for them. It has often been pointed out in previous studies that Japanese MNCs tend to send more Japanese engineers and managers to their foreign affiliates than U.S. or European MNCs. If those foreign skilled workers promote technology transfer to local workers, foreign plants with more foreign workers should be more productive. However, although this is a very important issue in the view of technology transfer, unfortunately data on foreign dispatched workers are not available and we could not further analyze this issue.[16]

[15] In Japan, the parts procurement system has a configuration like a pyramid. There are many tertiary (or third-tiered) suppliers which deliver the low-tech parts to the secondary (or second-tiered) or primary (or first-tiered) suppliers. Owing to this procurement system, it is often pointed out that the Japanese auto parts suppliers do not have a lot of inventories within their plants. In Thailand, however, the agglomeration of secondary and tertiary suppliers is poor. See Ministry of Industry (1995).

[16] Urata and Kawai (2000) analyzed the determinants of intra-firm technology transfer from Japanese manufacturing MNCs to their foreign affiliates. They found that on-the-job training provided by

Table 4-b compares the difference in economic performance between foreign and local plants in the whole motor vehicle industry for both 1996 and 1998.[17] For both years, we find that foreign plants display higher values in terms of employment size per plant, registered capital, labor productivity, relative TFP level, share of non-production workers, capital-labor ratio, and wages. However, foreign plants tend to suffer from significantly lower capital productivity for both years, although the decline in average capital productivity from 1996 to 1998 is larger in local plants. As for inventory ratios, foreign plants tended to exhibit higher inventory ratios in 1996 and the gap between foreign and local plants was statistically significant for the total inventory and final goods inventory ratios. However, in 1998, the inventory ratios tended to be higher for local plants, though the difference was not statistically significant. These figures of inventory ratios imply that the demand shock caused by the 1997 East Asian crisis was relatively more moderate for foreign plants, or that foreign plants were relatively more successful in inventory adjustment by exporting to other countries. Another indication hinting at foreign plants' relatively faster recovery from the crisis is that the price-cost margin was significantly higher in foreign plants in 1998. Although the average price-cost margin of local plants declined from 1996 to 1998, that of foreign plants increased. However, we should be cautious on the comparison between 1996 and 1998, because the sample plants in each data set are not the same.

From the results in Tables 4-a and 4-b, we found that the labor productivity of foreign plants is significantly better than that of local ones. However, we should take account of the fact that foreign plants tend to be larger in terms of employment size per plant and capital intensity.

Conducting the same analysis for large plants only produces similar results.[18] The results for large plants are shown in Table 4-c. Even with the limited sample, the difference between foreign and local plants show the similar tendency in most of the economic indicators as the results of the full sample. Foreign firms show significantly higher labor productivity, capital-labor ratios, and wages. However, capital productivity is lower in foreign plants, and there is almost no difference in the relative TFP level between local and foreign plants.

4. Determinants of Productivity Levels in the Thai Automobile Industry

Japanese employees tended to promote intra-firm technology transfer.

[17] Although each plant in the motor vehicle industry is classified in the three detailed industries for the original 1996 data, for the 1998 original data, it is classified in only two detailed industries, motor vehicle assembly and motor vehicle parts and accessories. Moreover, as the plant code number is different for the two data sets and the number cannot be matched, we could not conduct a panel-data analysis.

[18] Following Ramstetter (2001), we define a large plant as a plant of which output exceeds 25 million

As we have seen in the previous section, foreign plants exhibit significantly higher labor productivity than their local counterparts. However, as Ramstetter (2001) pointed out, the higher labor productivity of foreign plants may be mostly explained by the higher capital-labor ratio, not by the advantages in the managerial resources of MNCs. In order to further investigate this issue, we conduct an analysis of the determinants of labor productivity using the same framework that Ramstetter (2001) employed. Moreover, we also analyze the determinants of the relative TFP level.

4.1 Analytical Principles

We use two measures of productivity, labor productivity calculated as value added per hour for production workers and the relative TFP level of the plant.[19] We estimate these productivity measures directly as a function of plant characteristics as follows:

(a) $\ln(VA/EP) = \alpha_0 + \alpha_1 \ln(K/EP) + \alpha_2 \ln(EN/EP) + \alpha_3 Dold + \alpha_4 Dboi + \alpha_5 Z$

(b) $\ln(RLTFP) = \beta_0 + \beta_1' Dsize + \beta_2' Dage + \beta_3 Dboi + \beta_4 Z$

where

VA : value added of plant *i* ;

RLTFP : relative TFP level of plant *i* ;

EP : hours worked by production workers of plant *i* ;

EN : hours worked by non-production workers of plant *i* ;

K : average book value of fixed assets of plant *i* ;

Dold : a dummy variable that takes 1 if plant *i* started its operations in 1986 or earlier, otherwise 0;

Dboi : a dummy variable that takes 1 if plant *i* is BOI(Board of Investment)-promoted, otherwise 0;

Dsize : a vector of dummy variables representing the size of plant *i* ;

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baht.

[19] The measure of labor productivity ignores substitution of labor input for other inputs and differences in technical efficiency and input composition at different scales of production. Therefore, labor productivity is a more restrictive measure with respect to these points. On the other hand, the measure of the relative TFP level, which is based on the Tornqvist-Theil-translog index, accommodates differential substitution across inputs and allows for scale and regulatory biases, without restrictive assumptions about the shape of the technological relationships. However, we should note that the construction of the relative TFP measure would often contain measurement errors due to the difficulties in calculating the real value of inputs, especially in the case of capital inputs. Particularly in developing countries, constructing comprehensive capital stock data is very difficult because of the lack of deflators. For the exact translog index numbers, see Caves, Christensen, and Diewert (1982).

Dage : a vector of dummy variables representing the age of plant *i* ;

(therefore, β_1' and β_2' are the transposes of the parameter vectors.)

Z : other characteristics of plant *i*, such as ownership, openness to international trade, industry dummies and region dummies.

Further details on the definitions and sources of the variables are provided in the Appendix.

Following Baily, Hulten, and Campbell (1992), we mainly consider five factors which should determine the plant productivity level: 1) factor intensity, 2) differences in managerial resources and other plant fixed effects, 3) returns to scale, 4) learning by doing, and 5) vintage capital.

1) Factor Intensity

As derived from the Cobb-Douglas production function, the coefficients of factor intensities in model (a) will be positive.

2) Differences in Managerial Resources and Other Plant Fixed Effects

The distribution of productivity at a point in time may be a reflection of plant heterogeneity. The heterogeneity is considered to be related to managerial abilities, ownership, BOI status, openness to international trade, products of the plant, or geographical characteristics of the region where the plant is located. According to traditional theory, MNCs possess advantages in managerial resources that make them more productive or efficient than local firms. As BOI-promoted plants tend to have more advanced technologies or management know-how, one might expect them to be more productive. As for openness to international trade, it may be expected that exporting plants face to the international competition and should have higher productivity than non-exporters. If plants use more imported materials which embody high technology or are of higher quality, they might be more productive than those plants that do not import materials. However, on the other hand, plants using imported materials might be less efficient as they incur extra costs such as import tariffs and transportation costs.

3) Returns to Scale

The empirical literature suggests that there may be some increasing returns to scale at the plant level. If scale is an important determinant of productivity, this will give rise to persistence in the productivity distribution.

4) Learning by Doing

Following the idea first proposed by Arrow (1962) that knowledge and productivity gains come from investment and production, we expect experience to have positive effects on productivity. Therefore, we employ a dummy variables for the age of a plant and expect that older plants exhibit higher productivity.

5) The Vintage Capital Model

It is assumed that when a plant is built it embodies a particular technological vintage. Therefore, a measure of the vintage of plant *i* at time *t*, v_{it}, is included in the production function as follows:

$$Q_{it} = F(K_{it}, L_{it}, v_{it})$$

If the vintage model does provide a correct explanation of plant-level productivity, we expect older plants to have lower productivity. Therefore, in contrast to the learning by doing effect, we expect the relative productivity levels of plants to decline over time. However, as there are many old plants that may have been re-equipped, it is possible that plant age is unimportant if technological change is being correctly captured in the capital price deflators. Given the fact that there are no reliable capital deflators in many developing countries, we need to test the assumption.

4.2 Empirical Results

The model specification of (a), which is exactly the same as the one employed by Ramstetter (2001), is derived from the Cobb-Douglas production function under restrictive assumptions: 1) there are constant returns to scale, and 2) differences in ownership or other plant-specific characteristics only affect labor productivity.[20] The estimation results of various specifications of model (a) are presented in Table 5. Panel A shows the results of models without industry dummies, and equations (1) – (4) are exactly the same equations that Ramstetter (2001) estimated in his Appendix Table C12. In equation (5), we add four more dummy variables that control for the degree of export and import orientation of each plant. In the full-sample equations ((1), (2), and (5)), differentials in labor productivity are accompanied by significant differentials in the capital-labor ratio (*ln(K/EP)*) and the ratio of the number of non-production workers to the number of production workers (*ln(EN/EP)*). In the equations for large plants ((3) and (4)), the difference in labor productivity is significantly explained by the higher capital intensity (*ln(K/EP)*). The results do not suggest a strong tendency for foreign plants to show higher labor productivity than local plants (*Df, Df100, Dfmaj, Dfmin*). Plants with BOI promotion (*Dboi*)

[20] Ramstetter (2001) also estimates a model based on the Cobb-Douglas production function with variable returns to scale. Furthermore, Ramstetter (2002) compares the productivity differentials between local and foreign plants, estimating translog production functions. His analyses using the less restrictive production functions produce similar results which suggest that differences in production technology are not statistically significant between foreign and local plants.

achieve significantly higher productivity. As for the openness to international trade (*Dx*, *Dm*), the coefficients do not show a significant correlation with labor productivity except for *Dx* in equation (2). When the degree of trade dependency is controlled for (equation (5)), we find that plants exporting less than 50 percent of their production tend to display higher productivity (*Dxmin*). Moreover, coefficients on the old-plant dummy variable (*Dold*) are not significant, suggesting that there are neither learning nor vintage capital effects or that the two effects offset each other.

Panel B of Table 5 shows the estimation results of model (a) when the industry and the region are controlled for by dummy variables. These results confirm that differentials in the capital-labor ratio (*ln(K/EP)*) and the ratio of non-production workers to production workers (*ln(EN/EP)*) are significantly positively correlated with the differentials in labor productivity. As for the foreign ownership dummy (*Df*), the coefficient is slightly significant only in equation (6) though we obtain positive coefficients in all cases. Therefore, again we could not find strong evidence that foreign plants are more productive because of their advantages in managerial resources. In addition, since the two industry dummies (*Dassy* and *Dbody*) have significantly positive coefficients, it can be concluded that plants in the motor vehicle parts and accessories industry display lower labor productivity than those in the other two industries. We also find that plants in the ZONE 1 region are significantly more productive and that plants in most regions outside Bangkok are significantly less productive. Therefore, these results imply that industrial infrastructure and agglomeration are important factors in determining plant productivity. In equation (9), the dummy variable for large plants (*Dlarge*) has a significantly positive coefficient, suggesting the existence of scale economies.

The estimation results of model (b) are shown in Table 6. The estimates of model (b), as well as the results of model (a), indicate no strong evidence suggesting that foreign plants have a significantly higher relative TFP (*Df, Df100, Dfmaj, Dfmin*). In equations (1) to (4), coefficients on all the size dummy variables are positive and strongly significant. However, the age dummy variables do not have any significant coefficients. Moreover, other plant-specific characteristics, BOI-promotion (*Dboi*) and trade orientation (*Dx*, *Dm*, *Dxmaj*, *Dxmin*, *Dmmaj*, and *Dmmin*), do not have any significant impact on relative TFP levels. In equations (3) and (4), the cross-terms indicate that foreign plants in the motor vehicle assembly industry display a significantly higher productivity than local ones (*Df*Dassy*), while foreign plants in the other two industries do not differ from local plants in terms of TFP (*Df*Dbody, Df*Dparts*).

In order to investigate whether the importance of scale economies differs among the industries or between foreign and local plants, we introduce a variety of cross-terms in equations (5) to (8) in Table 6. The results of equations (5) and (6) indicate that scale economies (*LOUT*) have significantly positive effects on TFP levels but scale economies for foreign plants (*Df*LOUT*) are not significantly larger than those for local plants. However, when we control the industries (equations (7) and (8)), we find that the effects of scale economies are significantly larger in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries (*LOUT*Dbody*, *LOUT*Dparts*). Nevertheless, no differences in the effects of scale economies can be observed when comparing foreign and local plants (*Df*LOUT*Dassy*, *Df*LOUT*Dbody*, *Df*LOUT*Dparts*).

5. Concluding Remarks

In this paper, two questions were examined. One asked whether or not foreign plants are more productive than local plants. The other was what characteristics determine the productivity of plants.

Comparing the simple mean of various productivity measures of foreign plants with that of local plants, we found that foreign plants have significantly higher labor productivity, capital-labor ratios, and higher wages. The capital productivity is significantly higher for foreign plants than for local ones in the motor vehicle assembly industry. However, it is significantly lower for foreign plants than local ones in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries. Moreover, the differentials in inventory ratios and price-cost margins between foreign and local plants are not statistically significant in most cases. The relative TFP level is significantly higher only for foreign plants in the motor vehicle assembly industry. Therefore, the various productivity measures suggest that although foreign plants in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries have a higher capital-labor ratio than local plants, the high capital intensity probably has not yet contributed to productivity improvements.

The results of the regression analyses provided no evidence that foreign plants possess higher labor productivity after controlling for factor intensities. As for the determinants of relative TFP levels, we found strongly significant effects of scale economies, particularly in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries. Again, there was no evidence that foreign plants had relatively higher TFP because of their advantages in managerial resources. Only in the motor vehicle assembly industry were the relative TFP levels of foreign plants found to be significantly higher than those of local plants.

Two problems explicitly raised by the analysis in this paper are the following: First, foreign plants in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries display low productivity despite of their high capital intensity. Many foreign plants in these industries were relatively newly established compared with the foreign plants in the motor vehicle assembly industry. Due to the lack of experience in operation, workers in foreign plants may have been not skilled enough yet to utilize state-of-the-art equipment. Also in the studies on Japanese auto parts suppliers operating in the United States, Cusumano and Takeishi (1991) suggest that the shortage of maintenance workers made it difficult for Japanese-owned firms to effectively utilize the newly purchased equipment.

The second problem raised is that economies of scale are an important determinant of plant productivity, particularly in the motor vehicle bodies and trailers and the motor vehicle parts and accessories industries. Although many foreign plants in these two industries are equipped with a lot of machinery and equipment, their production scale may be far below the minimum efficient scale. This may cause the low TFP for plants in these industries. These results also imply that participating in the AICO scheme in order to achieve economies of scale would raise the productivity of Thai automobile plants.

In line with the major findings in Ramstetter (2001), the results of this paper suggest that productivity differentials between foreign and local plants are not pervasive in the Thai automobile industry. The results also suggest that the low level of productivity and the high capital-labor ratio of foreign plants could be partly explained by the low productivity of capital and by the small scale of production. Ramstetter (2001) provides two interpretations of his results: 1) foreign plants are not that productive in Thai manufacturing, and 2) local plants have been successful in reaching productivity levels that do not differ pervasively from those in generally efficient foreign MNCs. In order to answer which interpretation applies to the Thai automobile industry, we need further investigations regarding the following issues: productivity differentials between MNCs' parent plants and affiliated plants, determinants of the differentials between them, and technology spillover effects from MNC-affiliated plants to local plants.

Appendix

1. The Data

The data used in this paper are plant-level data for 1996 and 1998, compilations of the 1997 Industrial Census and the 1999 Industrial Survey collected by the National Statistical Office, Office of the Prime Minister, Thailand. The original data sets contain several duplicate or near-duplicate records. On the methodology of eliminating these duplicate records, see Ramstetter (2001). Moreover, a large number of small plants (10-19 employees) are included in the original data, but we dropped them from our analysis for the following reasons: (1) we do not think it is very meaningful to compare very small local establishments with foreign MNCs, (2) there are very few foreign establishments that are this small, and (3) it is very difficult to check the duplicate information for smaller establishments. Moreover, we only included in our analysis the data for plants which have positive observations for the number of non-production workers, the number of production workers, intermediate inputs, and value added. Attached Appendix Figure 1 shows the regional distribution of plants in the Thai automobile industry.

2. Calculation of Relative Total Factor Productivity (RLTFP)

Our measure of relative TFP level for each plant is the one suggested by Caves, Christensen, and Diewert (1982): relative TFP is calculated by relating the deviation of plant output from the industry mean to the deviations of the factor inputs from the industry mean. The specification is:

$$\begin{aligned}\ln TFP_i = \ln VA_i - \overline{\ln VA} &- (1/2)*\left[\alpha_{LPi} + (1/n)\sum \alpha_{LPi}\right]*\left(\ln LP_i - \overline{\ln LP}\right)\\ &- (1/2)*\left[\alpha_{LNi} + (1/n)\sum \alpha_{LNi}\right]*\left(\ln LN_i - \overline{\ln LN}\right)\\ &- (1/2)*\left[\alpha_{Ki} + (1/n)\sum \alpha_{Ki}\right]*\left(\ln K_i - \overline{\ln K}\right)\end{aligned}$$

where

$\overline{\ln VA} = (1/n)\sum \ln VA_i$, $\overline{\ln LP} = (1/n)\sum \ln LP_i$, $\overline{\ln LN} = (1/n)\sum \ln LN_i$, and

$\overline{\ln K} = (1/n)\sum \ln K_i$.

VA_i is gross output of plant *i*, and LP_i, LN_i, and K_i are production labor inputs, non-production labor inputs, and capital inputs of plant *i*. $\alpha_{Li}, \alpha_{Ki}, \alpha_{Mi}$ are the factor cost shares of production labor, non-production labor, and capital inputs of plant *i*. For labor inputs, LP_i and LN_i, we used total hours worked by production workers and total hours worked by non-production workers, respectively. As a proxy variable for real stocks, we used the book value of fixed assets. In the calculation of capital costs, we estimated the rental rate of capital (q_k) as follows:

$$p_k = q_k \left[r + \delta_K - dq_k / q_k \right]$$

where q_k is the price of the investment goods, r is the rate of return on all capital, and δ_k is the rate of depreciation of the investment good. Finally, dq_k/q_k is the rate of capital gain on that good (Jorgenson and Griliches 1967). Then the implicit cost of capital is obtained by multiplying the book value of fixed assets with the rental rate per baht of capital. We used the producer price index for capital equipment for the price of the investment goods, the prime lending rates (commercial banks, minimum loan rates) for the rate of return on capital. Both data were taken from Bank of Thailand, *Quarterly Bulletin*. We set the depreciation rate at 10 percent.

3. Definitions and Descriptions of Variables

3.1 Measures for Economic Performance

Average Inventory : 1/2*(Inventory Jan 1 + Inventory Dec 1)

Capital-Labor Ratio : 1/2*(Fixed assets at Jan 1 + Fixed assets at Dec 31)/ Number of total employees

Price-Cost Margin : (Value added – Wage income of all employees – Social security payments of all employees)/ Output

Outsourcing Ratio : Cost of materials and components / Total cost

Capital Utilization : (Hours per day * Days per year) / (24*366)

3.2 Variables used in Regression Analyses

Ownership dummies:

Df : 1 if the foreign ownership share is 1% or greater, 0 otherwise;

Df100 : 1 if the foreign ownership share is 100%, 0 otherwise;

Dfmaj : 1 if the foreign ownership share is 50-99%, 0 otherwise;

Dfmin : 1 if the foreign ownership share is 1-49%, 0 otherwise.

Trade orientation dummies:

Dx : 1 if the plant exports, 0 otherwise;

Dm : 1 if the plant imports, 0 otherwise;

Dxmaj : 1 if the plant exports 50% or more of its production, 0 otherwise;

Dxmin : 1 if the plant exports less than 50% of its production, 0 otherwise;

Dmmaj : 1 if the plant imports 50% or more of its material inputs, 0 otherwise;

Dmmin : 1 if the plant imports less than 50% of its material inputs, 0 otherwise.

Large plant dummy (*Dlarge*): 1 if the output is 25 million baht or more, 0 otherwise.

Industry dummies:

Dassy : 1 if the plant is classified in the motor vehicle assembly industry, 0 otherwise;

Dbody : 1 if the plant is classified in the motor vehicle bodies and trailers industry, 0 otherwise;

Dparts : 1 if the plant is classified in the motor vehicle parts and accessories industry, 0 otherwise.

Region dummies:

Dzone1 : 1 if the plant is located in the BOI-ZONE1 region (Bangkok and Vicinity of Bangkok), 0 otherwise;

Dzone2 : 1 if the plant is located in the BOI-ZONE2 region (some prefectures in the Sub-Central, Eastern, and Western regions), 0 otherwise;

Dvbkk, *Dcent*, *Deast*, *Dneast*, *Dnorth*, *Dwest*, and *Dsouth* : These dummy variables represent Vicinity of Bangkok, Sub-Central, Eastern, Northeastern, Northern, Western, and Southern regions, respectively.

Plant size:

Dsize25-50 : 1 if the plant is in the 25–50% quartile in the size distribution of all plants (size measured by output), 0 otherwise;

Dsize50-75 : 1 if the plant is in the 50–75% quartile in the size distribution of all plants (size measured by output), 0 otherwise;

Dsize75-100 : 1 if the plant size is in the last quartile (75-100%) in the size distribution of all plants (size measured by output), 0 otherwise;

LOUT : logarithm of output of the plant.

Plant age dummies:

Dage20- : 1 if years in operation of the plant is 20 years or more, 0 otherwise;

Dage10-20 : 1 if years in operation of the plant is 10 years or more but less than 20 years, 0 otherwise;

Dage5-10 : 1 if years in operation of the plant is 5 years or more but less than 10 years, 0 otherwise.

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Table 1. Automobile Industry in ASEAN Countries

<Panel A> Automobile markets

	Thailand		Indonesia		Malaysia		Philippines		ASEAN-4	
ASEAN market sales: units (import shares in parentheses)										
1995	571,580	(36.9%)	384,449	(27.7%)	285,792	(4.1%)	128,162	n.a.	1,369,983	n.a.
1996	589,126	(31.1%)	337,399	(27.4%)	364,789	(43.1%)	162,095	n.a.	1,453,409	n.a.
1997	363,156	(22.8%)	392,185	(30.6%)	404,837	(41.6%)	144,434	n.a.	1,304,612	n.a.
1998	201,055	n.a.	167,234	n.a.	198,797	(115.7%)	86,751	n.a.	653,837	n.a.
1999	218,330	n.a.	93,814	n.a.	288,547	n.a.	74,415	n.a.	675,106	n.a.
Japanese automobiles sales: units (market shares in parentheses)										
1995	514,704	(90.0%)	365,520	(95.1%)	83,393	(29.2%)	111,808	(87.2%)	1,075,425	(78.5%)
U.S. and European automobiles: units (market shares in parentheses)										
1995	46,322	(8.1%)	17,137	(4.5%)	21,706	(7.6%)	1,127	(0.9%)	86,292	(6.3%)

Source: Takayasu *et al*. (1996) Tables 3, 8, 13, 17; Nikkan Jidosha Shinbun-sha (2000), *Jidosha Sangyo Handbook 2001* [Handbook of Automobile Industry 2001].

<Panel B> Structure of the automobile parts industry (as of January 1998)

	Thailand		Indonesia		Malaysia		Philippines		ASEAN-4	
Total number of parts manufacturers										
1998	750-800		150-200		200-250		150-200		1300－1500	
Japanese affiliates or subsidiaries (shares in parentheses)										
1998	209	(27.0%)	82	(46.9%)	61	(27.1%)	54	(30.9%)	406	(30.0%)
U.S. and European affiliates or subsidiaries (shares in parentheses)										
1998	21	(2.7%)	7	(4.0%)	19	(8.4%)	5	(2.9%)	406	(4.0%)

Source: Poapongsakorn and Wangdee (2000a) Table 2.

<Panel C> Automotive tariffs and non-tariff barriers, 1998

	Thailand		Indonesia		Malaysia		Philippines		ASEAN-4	
Average applied tariff rates										
	Parts	Vehicles	Parts	Vehicles	Parts	Vehicles	Parts	Vehicles	Parts	Vehicles
	42.7	43.3	21.8	86.4	16.3	53.1	11.5	23.3	26.6	47.2
Share of imports subject to non-tariff barriers										
	Parts	Vehicles	Parts	Vehicles	Parts	Vehicles	Parts	Vehicles	Parts	Vehicles
	2.8	64.7	0.0	70.2	9.4	81.5	2.5	40.6	2.8	64.7

Source: Farrel and Findlay (2001) Table 2.8.

Table 2. Summary Data of Major Automobile and Auto Parts Manufacturers in Thailanc

	1994	1995	1996	1997	1998	1999
All firms						
Number of firms	45	46	46	45	42	38
Total revenue (1,000 baht)	225.4	276.5	286.7	207.1	123.4	198.0
Profit/Revenue (mean, %)	5.2	4.1	5.7	-7.4	-11.8	-6.2
Local firms						
Number of firms	17	18	17	15	16	14
Total revenue (1,000 baht)	57.8	68.8	60.7	45.7	28.0	28.9
Profit/Revenue (mean, %)	6.2	6.2	6.5	-5.1	-21.6	-13.6
Foreign firms						
Number of firms	28	28	29	30	26	24
Total revenue (1,000 baht)	167.6	207.6	225.9	161.4	95.4	169.1
Profit/Revenue (mean, %)	4.5	2.7	5.2	-8.5	-5.7	-1.9
Japanese firms						
Number of firms	22	21	23	23	19	18
Total revenue (1,000 baht)	157.5	194.5	212.8	147.7	85.3	157.9
Profit/Revenue (mean, %)	5.7	6.8	6.9	-6.7	-5.6	-0.8
European firms						
Number of firms	3	4	4	4	4	3
Total revenue (1,000 baht)	5.8	6.9	7.7	7.3	3.2	4.0
Profit/Revenue (mean, %)	-4.0	-21.1	-6.5	-15.0	-14.3	-22.0
U.S. firms						
Number of firms	1	1	1	1	1	1
Total revenue (1,000 baht)	2.2	3.0	3.3	3.0	3.3	3.8
Profit/Revenue (mean, %)	4.7	8.2	8.9	5.2	6.5	10.1
Other foreign firms						
Number of firms	2	2	1	2	2	2
Total revenue (1,000 baht)	2.1	3.2	2.2	3.3	3.6	3.4
Profit/Revenue (mean, %)	4.8	5.0	8.6	-23.6	4.2	12.3

Note: The list of firms included in our firm-level data set is presented in Appendix Table 2.1.

Source: Author's compilation of firm-level data from published sources; see Ramstetter anc Matsuoka (2001) for details.

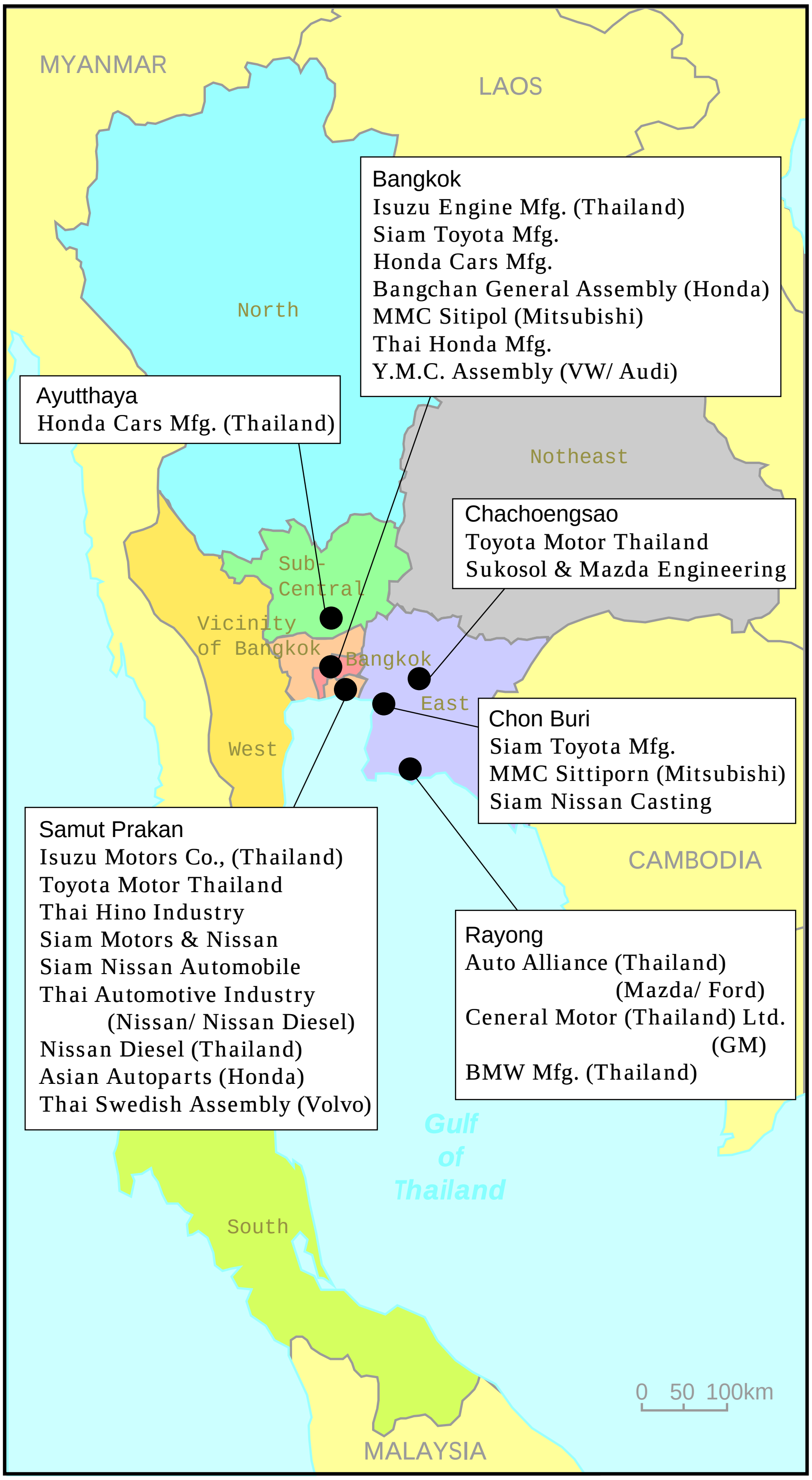


Figure 1. The Geographical Distribution of Major Automobile Assembly Plants in Thailand

Source: FOURIN (2000)

Table 3. Summary of the Plant-Level Data underlying the Thai Industrial Census

	Year 1996							
	Number of plants/firms		Number of workers		Gross output (mil. baht)		Value added (mil. baht)	
	Value	Share	Value	Share	Value	Share	Value	Share
Manufacturing sector total								
Total	**8,952**	**(100.0%)**	**1,669,504**	**(100.0%)**	**2,717,842**	**(100.0%)**	**809,575**	**(100.0%)**
Local	7,214	(80.6%)	948,990	(56.8%)	1,145,301	(42.1%)	378,400	(46.7%)
Foreign	1,738	(19.4%)	720,514	(43.2%)	1,572,541	(57.9%)	431,175	(53.3%)
Motor vehicles								
Total	**406**	**(100.0%)**	**78,253**	**(100.0%)**	**420,434**	**(100.0%)**	**129,401**	**(100.0%)**
Local	330	(81.3%)	32,808	(41.9%)	43,362	(10.3%)	13,744	(10.6%)
Foreign	76	(18.7%)	45,445	(58.1%)	377,072	(89.7%)	115,657	(89.4%)

	Year 1998							
	Number of plants/firms		Number of workers		Gross output (mil. baht)		Value added (mil. baht)	
	Value	Share	Value	Share	Value	Share	Value	Share
Manufacturing sector total								
Total	**3,974**	**(100.0%)**	**853,697**	**(100.0%)**	**1,328,983**	**(100.0%)**	**408,017**	**(100.0%)**
Local	3,026	(76.1%)	461,593	(54.1%)	559,402	(42.1%)	164,787	(40.4%)
Foreign	948	(23.9%)	392,104	(45.9%)	769,581	(57.9%)	243,230	(59.6%)
Motor vehicles								
Total	**134**	**(100.0%)**	**27,164**	**(100.0%)**	**105,952**	**(100.0%)**	**35,044**	**(100.0%)**
Local	81	(60.4%)	8,389	(30.9%)	8,053	(7.6%)	1,901	(5.4%)
Foreign	53	(39.6%)	18,775	(69.1%)	97,899	(92.4%)	33,143	(94.6%)

Sources: Ramstetter (2001) Appendix Tables A1, A2, A3, A6, A7, and author's calculations.

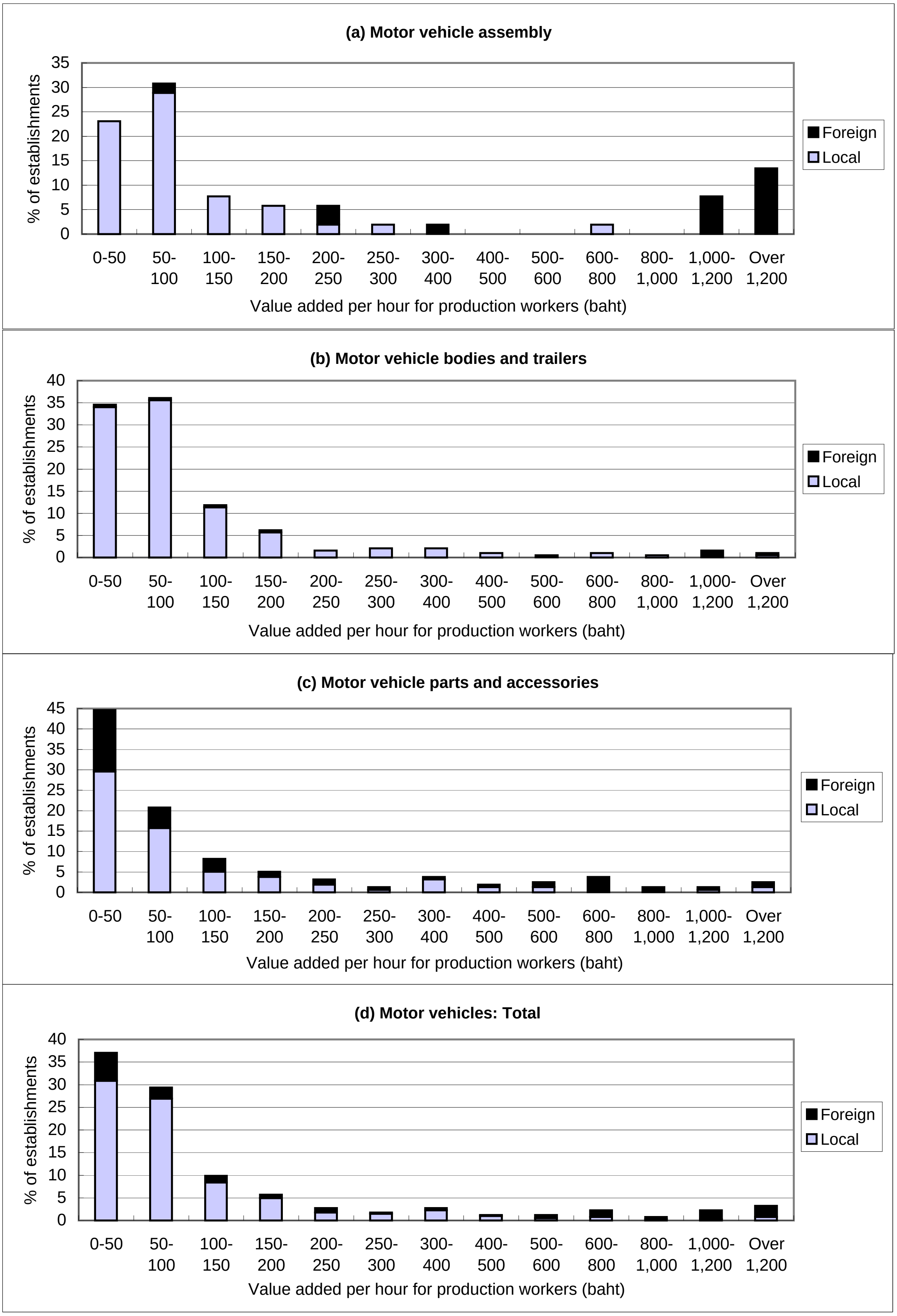


Figure 2. Labor Productivity Distribution in 1996

(Value added per hour for production workers) Local vs. Foreign

Note: Compiled from plant-level data underlying National Statistical Office (1999).

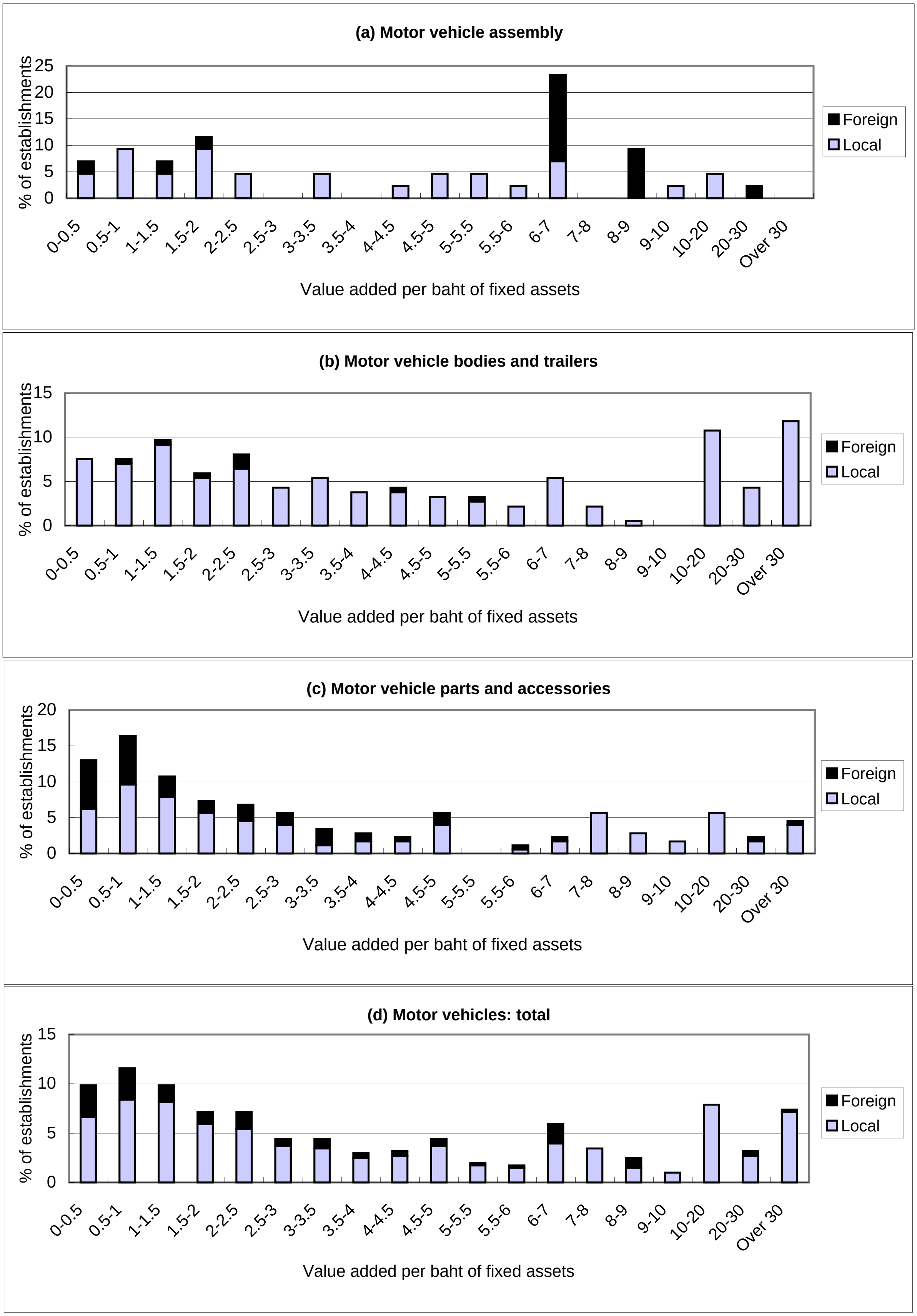


Figure 3. Capital Productivity Distribution in 1996
(Value added per baht of fixed assets) Local vs. Foreign

Note: Compiled from plant-level data underlying National Statistical Office (1999).

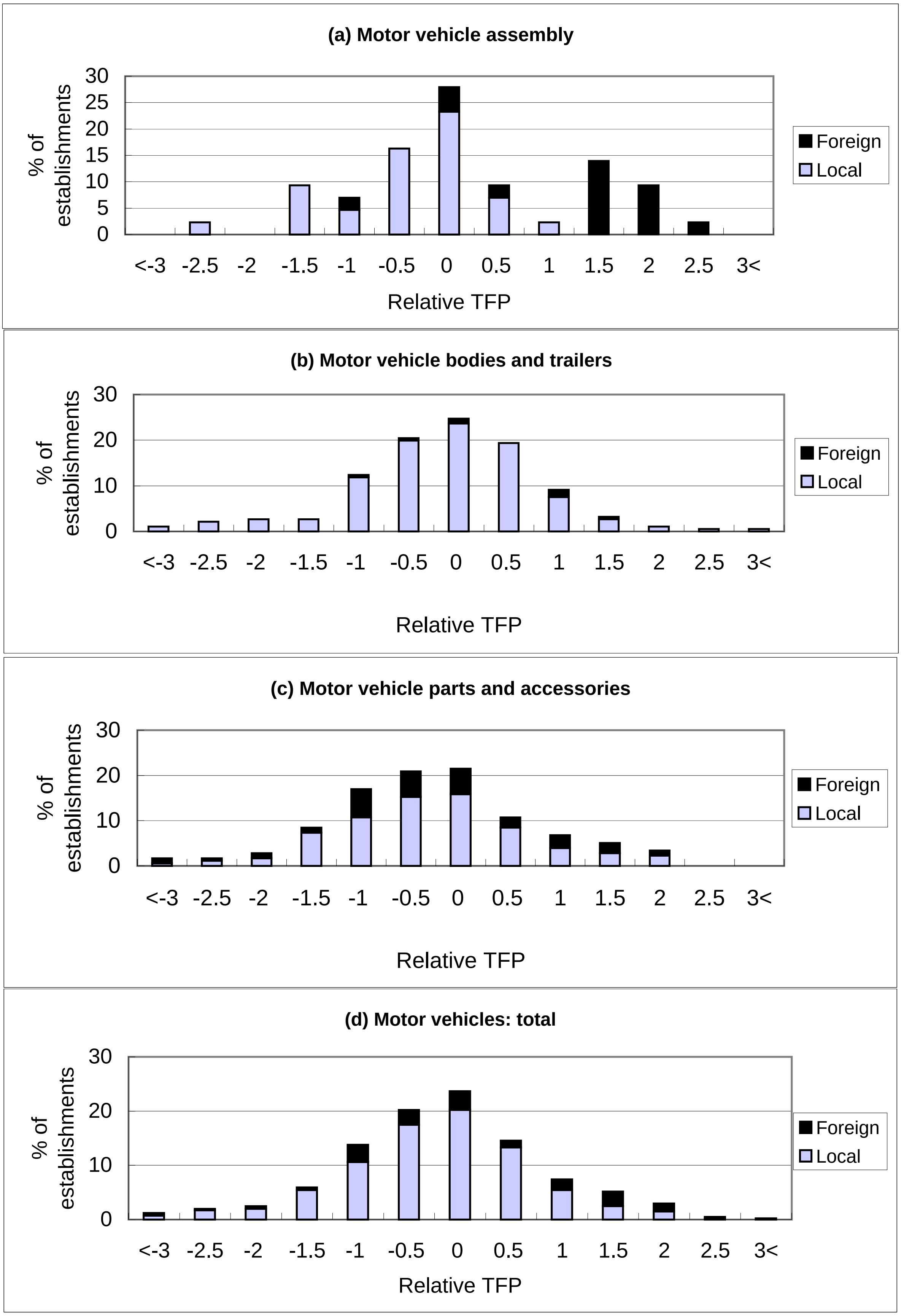


Figure 4. Distribution of Relative Total Factor Productivity in 1996

Note: Compiled from plant-level data underlying National Statistical Office (1999).

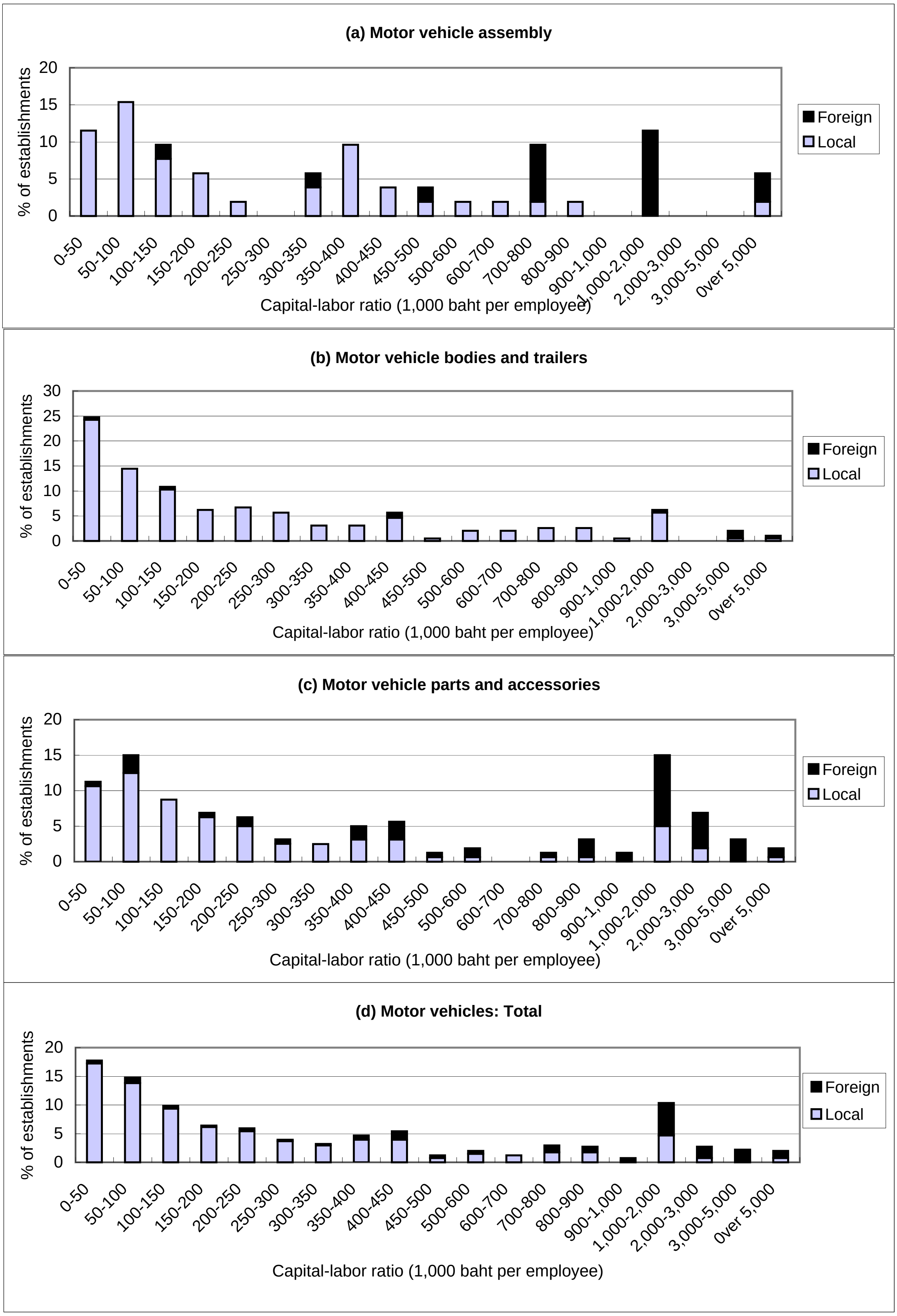


Figure 5. Capital-Labor Ratio Distribution in 1996
Local vs. Foreign

Note: Compiled from plant-level data underlying National Statistical Office (1999).

Table 4-a. Comparison of Economic Performance: by ownership and by industry 1996

	Assembly			Bodies and trailers			Parts and accessories		
	Simple Average		T-test	Simple Average		T-test	Simple Average		T-test
	Local	Foreign		Local	Foreign		Local	Foreign	
Number of Establishments	28	15	-	178	8	-	124	53	-
Total number of employees	3,433	29,629	-	10918	4507	-	18457	11309	-
Employment per establishment	123	1,975	***	61	563	***	149	213	
Years in operation	10	18	*	9.5	8.4		11.2	7.4	***
Registered capital (bil. baht)	50	1,442	**	14.0	248.4	**	21.4	110.9	***
Productivity measures									
Output per hour for production workers (baht)	539	5,490	***	411.3	3303.4	**	355.8	896.1	***
Value added per hour for production workers (baht)	102	1,032	***	128.3	793.1	**	124.7	317.7	***
Output per employee (1,000 baht)	818.7	11,857.6	***	738.9	6,984.7	**	759.0	1,967.0	***
Value added per employee (1,000 baht)	186.9	2,884.1	***	244.1	1,603.8	**	271.4	654.9	***
Output per 1 baht of fixed assets	0.101	0.401	**	0.382	0.096	***	0.261	0.080	**
Value added per 1 baht of fixed assets	0.037	0.070	**	0.159	0.026	***	0.117	0.031	
Relative TFP	-0.403	1.275	***	-0.146	0.377		-0.296	-0.292	
Inventory ratios (%)									
Total inventory (%)	11.7	6.7	*	9.1	9.4		17.2	20.9	
Final goods inventory (%)	0.6	1.1		1.0	0.9		4.3	8.6	
Work-in-process inventory (%)	3.2	0.5		2.2	1.3		2.2	3.2	
Raw materials inventory (%)	7.9	5.1	*	6.0	7.2		10.7	9.1	
Other indicators									
Share of non-production workers (%)	19.3	18.6		16.5	17.8		15.8	20.4	**
Capital-labor ratio (1,000 baht)	605	1,732	*	385	3,078	*	412	1,405	***
Price-cost margin (%)	22.2	26.1		21.9	21.1		17.8	22.3	
Production worker wages (1,000 baht)	63.5	161.8	***	77.6	143.1	**	75.2	103.9	***
Non-production worker wages (1,000 baht)	95.9	158.3	**	102.7	226.2	**	141.9	302.4	***
Total worker wages (1,000 baht)	68.8	160.7	***	81.1	166.1	**	80.7	133.4	***
Capital utilization (%)	27.5	38.6	***	27.6	35.4		31.9	38.5	**

Note: 1) The t-tests are performed based on the assumption of unequal variances.
2) Figures are in market price for each year.
3) * significant at 10% level, ** significant at 5% level, *** significant at 1% level. (two-tailed test)
Source: Compiled from plant-level data underlying National Statistical Office (1999).

Table 4-b. Comparison of Economic Performance: by ownership (motor vehicles total, 1996 and 1998)

	Total (1996)			Total (1998)		
	Simple Average		T-test	Simple Average		T-test
	Local	Foreign		Local	Foreign	
Number of Establishments	330	76	-	81	53	-
Total number of employees	32,808	45,445	-	8,389	18,775	-
Employment per establishment	99.4	598.0	***	103.6	354.2	**
Years in operation	10.2	9.6		12.6	9.8	
Registered capital (bil. baht)	19.6	388.1	***	27.4	290.9	**
Productivity measures						
Output per hour for production workers (baht)	401.3	2,056	***	373.2	1,402.8	***
Value added per hour for production workers (baht)	124.7	508.8	***	124.4	473.2	***
Output per employee (1,000 baht)	753.2	4,447.2	***	528.8	1,906.3	***
Value added per employee (1,000 baht)	249.5	1,194.8	***	196.2	624.8	***
Output per 1 baht of fixed assets	0.313	0.145	***	0.112	0.092	
Value added per 1 baht of fixed assets	0.133	0.038	***	0.048	0.027	*
Relative TFP	-0.224	0.088	**	-0.367	0.115	**
Inventory ratios (%)						
Total inventory (%)	12.4	16.9	*	26.7	24.4	
Final goods inventory (%)	2.2	6.3	**	6.8	7.5	
Work-in-process inventory (%)	2.3	2.5		5.7	3.8	
Raw materials inventory (%)	7.9	8.1		14.2	13.1	
Other indicators						
Share of non-production workers (%)	16.5	19.8	**	26.6	34.2	**
Capital-labor ratio (1,000 baht)	413.6	1,645.6	***	633.0	2,249.0	***
Price-cost margin (%)	20.4	22.9		14.6	24.0	**
Production worker wages (1,000 baht)	75.5	119.5	***	99.6	145.3	***
Non-production worker wages (1,000 baht)	116.9	265.9	***	136.3	322.3	***
Total worker wages (1,000 baht)	79.9	142.3	***	87.9	154.1	***
Capital utilization (%)	29.2	38.2	***	26.9	29.3	

Note: 1) The t-tests are performed based on the assumption of unequal variances.
2) Figures are in market price for each year.
3) * significant at 10% level, ** significant at 5% level, *** significant at 1% level. (two-tailed test)

Source: Compiled from plant-level data underlying National Statistical Office (1999).

Table 4-c. Comparison of Economic Performance: by ownership (motor vehicles total, large plants, 1996 and 1998)

	Total (1996)			Total (1998)		
	Simple Average		T-test	Simple Average		T-test
	Local	Foreign		Local	Foreign	
Number of Establishments	117	70	-	29	50	-
Total number of employees	25,210	45,183	-	6,049	18,671	-
Employment per establishment	215	645	***	208.6	373.4	
Years in operation	12.6	9.8	**	15.8	10.0	
Registered capital (bil. baht)	44.8	420.1	***	58.9	308.6	**
Productivity measures						
Output per hour for production workers (baht)	824.6	2220.0	***	699.9	1,470.5	***
Value added per hour for production workers (baht)	212.7	548.9	***	197.6	494.0	***
Output per employee (1,000 baht)	1,522.7	4,803.9	***	932.0	1992.9	***
Value added per employee (1,000 baht)	426.8	1,289.2	***	314.1	649.7	***
Output per 1 baht of fixed assets	0.372	0.145	**	0.117	0.096	
Value added per 1 baht of fixed assets	0.141	0.036	*	0.050	0.028	
Relative TFP	0.123	0.194		0.120	0.138	
Inventory ratios (%)						
Total inventory (%)	12.5	14.3		23.8	24.0	
Final goods inventory (%)	2.2	3.7	*	4.4	6.9	
Work-in-process inventory (%)	2.7	2.5		3.7	4.0	
Raw materials inventory (%)	7.6	8.1		15.6	13.1	
Other indicators						
Share of non-production workers (%)	16.9	19.6		30.5	34.6	
Capital-labor ratio (1,000 baht)	618.1	1,745.7	***	783.3	2,335.2	***
Price-cost margin (%)	20.1	24.1		23.4	23.5	
Production worker wages (1,000 baht)	90.4	124.9	***	143.7	151.0	
Non-production worker wages (1,000 baht)	164.2	279.1	***	128.3	337.3	***
Total worker wages (1,000 baht)	97.3	148.7	***	115.5	160.0	***
Capital utilization (%)	30.9	38.8	***	27.2	29.5	

Note: 1) The t-tests are performed based on the assumption of unequal variances.
2) Figures are in market price for each year.
3) * significant at 10% level, ** significant at 5% level, *** significant at 1% level. (two-tailed test)

Source: Compiled from plant-level data underlying National Statistical Office (1999).

Table 5. OLS Regressions for Labor Productivity

Dependent Variable: Value added per hour for production workers (ln(VA/EP))

<Panel A> Industry not controlled

			Large	Large	
	(1)	(2)	(3)	(4)	(5)
Factor intensity					
ln(K/EP)	**0.225** ***	**0.226** ***	**0.355** ***	**0.360** ***	**0.224** ***
	(6.10)	(6.07)	(5.22)	(5.15)	(5.86)
ln(EN/EP)	**0.209** ***	**0.208** ***	**0.153**	**0.145**	**0.197** ***
	(3.15)	(3.12)	(1.39)	(1.29)	(2.97)
Age					
Dold	**0.176**	**0.171**	**0.173**	**0.163**	**0.105**
	(1.60)	(1.53)	(1.06)	(0.97)	(0.94)
Foreign plants					
Df	**0.244**		**-0.010**		**0.234**
	(1.25)		(-0.04)		(1.16)
Df100		**0.040**		**-0.402**	
		(0.16)		(-1.30)	
Dfmaj		**0.308**		**0.002**	
		(0.87)		(0.01)	
Dfmin		**0.235**		**0.007**	
		(1.14)		(0.03)	
Dboi	**0.592** ***	**0.585** ***	**0.504** **	**0.480** *	**0.555** **
	(2.78)	(2.74)	(2.08)	(1.93)	(2.56)
Dx	**0.160**	**0.160** *	**-0.049**	**-0.036**	
	(1.00)	(0.99)	(-0.24)	(-0.17)	
Dm	**-0.036**	**-0.035**	**-0.078**	**-0.070**	
	(-0.33)	(-0.31)	(-0.41)	(-0.36)	
Dxmaj					**-0.095**
					(-0.47)
Dxmin					**0.309** *
					(1.73)
Dmmaj					**-0.179**
					(-1.44)
Dmmin					**0.141**
					(0.99)
_cons	**3.905** ***	**3.901** ***	**3.773** ***	**3.740** ***	**3.907** ***
	(20.90)	(20.83)	(9.50)	(9.19)	(20.40)
No. of obs.	406	406	187	187	406
F	24.9 ***	20.31 ***	14.42 ***	11.17 ***	23.24 ***
Adj. R-squared	0.287	0.2873	0.3211	0.3226	0.3036

Table 5. OLS Regressions for Labor Productivity --- *Continued* ---

Dependent Variable: Value added per hour for production workers (ln(VA/EP))

<Panel B> Industry controlled

	(6)	(7)	(8)	(9)
Factor intensity				
ln(K/EP)	**0.229** ***	**0.236** ***	**0.228** ***	**0.204** ***
	(6.16)	(5.52)	(5.23)	(4.94)
ln(EN/EP)	**0.197** ***	**0.190** **	**0.169** **	**0.187** ***
	(3.05)	(2.59)	(2.37)	(2.73)
Age				
Dold	**0.165**	**0.101**	**0.101**	**-0.002**
	(1.51)	(0.80)	(0.80)	(-0.02)
Foreign plants				
Df	**0.321** *	**0.280**	**0.199**	**0.097**
	(1.66)	(1.30)	(0.96)	(0.46)
Dboi	**0.508** **	**0.659** ***	**0.614** **	**0.493** **
	(2.37)	(2.69)	(2.53)	(2.09)
Dx	**0.218**	**0.220**	**0.268**	**-0.018**
	(1.37)	(1.15)	(1.49)	(-0.10)
Dm	**0.023**	**0.008**	**0.048**	**0.024**
	(0.20)	(0.07)	(0.39)	(0.21)
Dlarge				**0.811** ***
				(5.84)
Industry				
Dassy	**0.435** ***	**0.567** ***	**0.833** ***	**0.924** ***
	(2.64)	(3.08)	(3.68)	(4.21)
Dbody	**0.318** ***	**0.347** ***	**0.322** **	**0.437** ***
	(2.62)	(2.46)	(2.34)	(3.35)
Region				
Dzone1		**0.371** **		
		(2.05)		
Dzone2		**0.135**		
		(0.57)		
Dvbkk			**-0.323** *	**-0.400** **
			(-1.82)	(-2.36)
Dcent			**-0.853** ***	**-0.859** ***
			(-3.08)	(-3.24)
Deast			**0.112**	**-0.079**
			(0.48)	(-0.36)
Dneast			**-0.154**	**-0.145**
			(-0.64)	(-0.71)
Dnorth			**-0.742** ***	**-0.641** **
			(-2.68)	(-2.28)
Dwest			**-0.749** ***	**-0.769** ***
			(-3.09)	(-3.71)
Dsouth			**-0.598**	**-0.454**
			(-0.96)	(-0.72)
_cons	**3.633** ***	**3.270** ***	**3.695** ***	**3.566** ***
	(17.12)	(11.27)	(15.91)	(16.02)
No. of obs.	406	337	337	337
F	21.65 ***	18.7 ***	14.58 ***	16.31 ***
Adj. R-squared	0.3057	0.3286	0.3654	0.4242

Note: t-statistics are in parentheses. We have examined the residuals of the regressions for heteroskedasticity, and found little evidence of its importance.

* significant at 10% level, ** significant at 5% level, *** significant at 1% level. (two-tailed test)
Source: Author's calculations.

Table 6. OLS Regressions for Relative TFP Level

Dependent variable: ln(RLTFP)

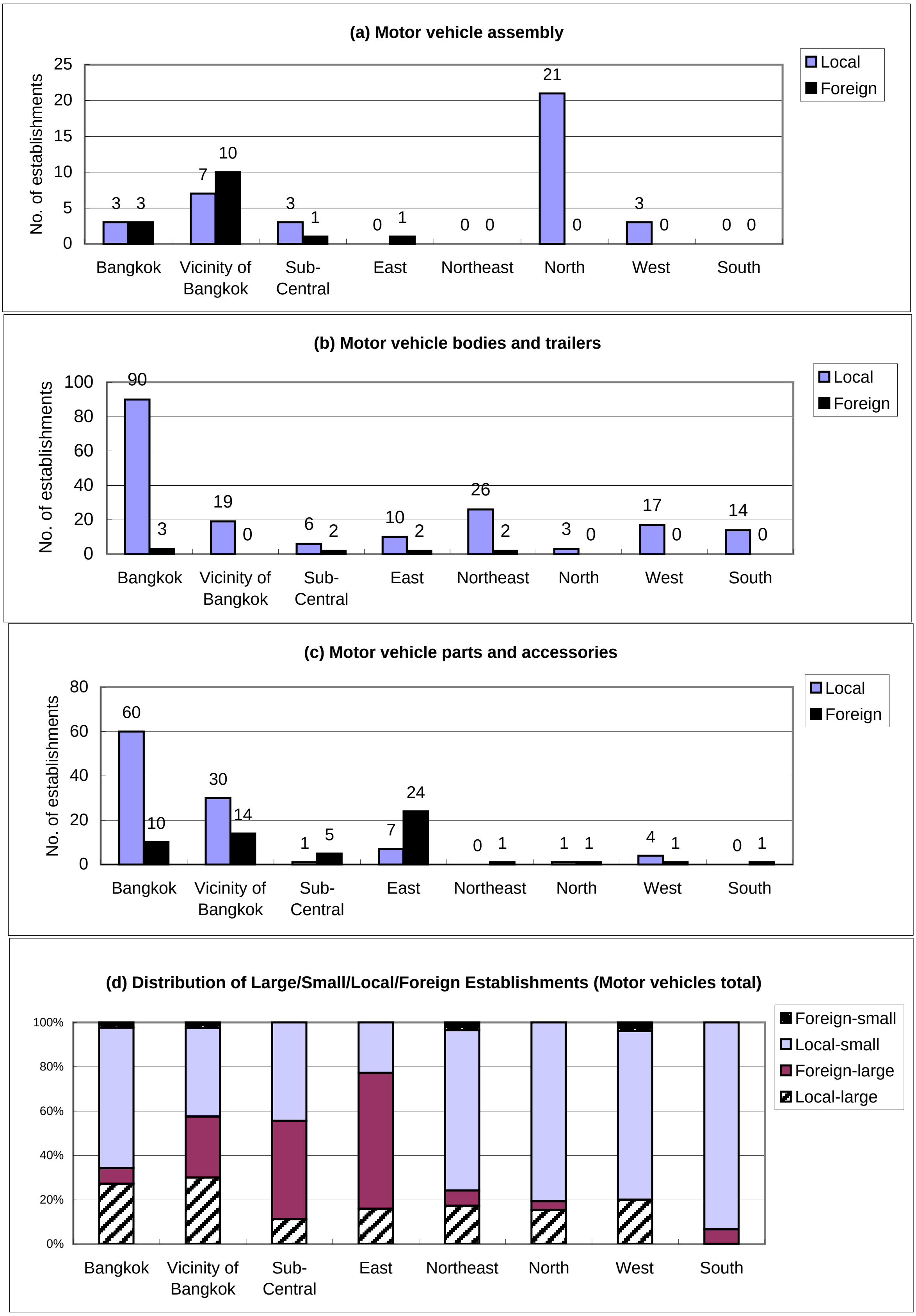
	(1)	(2)	(3)	(4)
Size				
Dsize25-50	**0.454** ***	**0.455** ***	**0.545** ***	**0.547** ***
	(3.53)	(3.52)	(3.87)	(3.87)
Dsize50-75	**0.675** ***	**0.677** ***	**0.834** ***	**0.835** ***
	(4.68)	(4.67)	(5.43)	(5.35)
Dsize75-100	**1.294** ***	**1.296** ***	**1.458** ***	**1.452** ***
	(6.66)	(6.65)	(6.19)	(5.96)
Age				
Dage20-	**0.018**	**0.004**	**-0.067**	**-0.070**
	(0.12)	(0.03)	(-0.42)	(-0.43)
Dage10-20	**-0.176**	**-0.174**	**-0.078**	**-0.080**
	(-1.29)	(-1.27)	(-0.54)	(-0.55)
Dage5-10	**-0.110**	**-0.113**	**-0.079**	**-0.076**
	(-0.81)	(-0.82)	(-0.55)	(-0.54)
Foreign plants				
Df	**-0.136**			
	(-0.80)			
Df100		**-0.870** *		
		(-1.90)		
Dfmaj		**-0.073**		
		(-0.29)		
Dfmin		**-0.108**		
		(-0.58)		
Df*Dassy			**0.885** **	**0.857** **
			(2.14)	(2.04)
Df*Dbody			**-0.243**	**-0.259**
			(-0.74)	(-0.78)
Df*Dparts			**-0.339**	**-0.335**
			(-1.53)	(-1.50)
Dboi	**-0.018**	**-0.047**	**0.049**	**0.048**
	(-0.09)	(-0.23)	(0.20)	(0.20)
Dx	**0.103**	**0.118**	**-0.042**	
	(0.69)	(0.79)	(-0.23)	
Dm	**-0.122**	**-0.118**	**-0.111**	
	(-1.14)	(-1.10)	(-0.97)	
Dxmaj				**-0.073**
				(-0.32)
Dxmin				**-0.013**
				(-0.06)
Dmmaj				**-0.122**
				(-0.97)
Dmmin				**-0.098**
				(-0.63)
Industry				
Dassy	**0.472 *****	**0.483 *****	**0.164**	**0.160**
	(2.92)	(3.06)	(0.67)	(0.66)
Dbody	**0.442 *****	**0.444 *****	**0.280 ****	**0.277 ****
	(3.91)	(3.93)	(2.06)	(2.05)
Region				
Dvbkk			**-0.591** ***	**-0.590** ***
			(-3.34)	(-3.33)
Dcent			**-0.591 *****	**-0.583 *****
			(-2.80)	(-2.72)
Deast			**-0.245**	**-0.242**
			(-1.08)	(-1.06)
Dneast			**-0.338 ***	**-0.338 ***
			(-1.69)	(-1.68)
Dnorth			**-0.216**	**-0.214**
			(-0.77)	(-0.76)
Dwest			**-0.610** ***	**-0.610** ***
			(-2.95)	(-2.95)
Dsouth			**-0.570**	**-0.565**
			(-0.97)	(-0.95)
_cons	**-0.882 *****	**-0.885** ***	**-0.635** ***	**-0.634** ***
	(-6.01)	(-6.05)	(-4.08)	(-4.05)
Number of obs.	406	406	337	337
F	6.99 ***	6.23 ***	5.90 ***	5.48 ***
R-squared	0.187	0.1908	0.2787	0.2789

Table 6. OLS Regressions for Relative TFP Level --- *Continued* ---

Dependent variable: ln(RLTFP)

	(5)	(6)	(7)	(8)
Size				
LOUT	**0.250** ***	**0.278** ***		
	(5.85)	(5.41)		
Df*LOUT	**0.059**	**0.047**		
	(0.87)	(0.63)		
LOUT*Dassy			**0.144**	**0.129**
			(1.37)	(1.39)
LOUT*Dbody			**0.307** ***	**0.355** ***
			(5.55)	(6.06)
LOUT*Dparts			**0.225** ***	**0.267** ***
			(3.98)	(3.67)
Df*LOUT*Dassy			**0.098**	**0.100**
			(1.03)	(1.01)
Df*LOUT*Dbody			**0.032**	**0.017**
			(0.32)	(0.16)
Df*LOUT*Dparts			**0.032**	**0.055**
			(0.56)	(0.45)
Age				
Dold	**-0.018**	**-0.033**	**-0.012**	**-0.025**
	(-0.18)	(-0.28)	(-0.12)	(-0.21)
Foreign plants				
Df	**-1.391**	**0.047**	**-1.421**	**-1.334**
	(-1.08)	(-0.88)	(-0.70)	(-0.61)
Dboi	**-0.099**	**-0.053**	**-0.071**	**-0.029**
	(-0.49)	(-0.22)	(-0.35)	(-0.12)
Dx	**-0.015**	**-0.039**	**-0.017**	**-0.045**
	(-0.10)	(-0.23)	(-0.12)	(-0.26)
Dm	**-0.119**	**-0.100**	**-0.117**	**-0.091**
	(-1.11)	(-0.87)	(-1.09)	(-0.80)
Industry				
Dassy	**0.104**	**0.215**	**1.375**	**2.493**
	(0.61)	(0.80)	(0.72)	(1.32)
Dbody	**0.306 *****	**0.221 ***	**-1.064**	**-1.197**
	(2.68)	(1.70)	(-0.84)	(-0.84)
Region				
Dvbkk		**-0.542** ***		**-0.569** ***
		(-3.11)		(-3.22)
Dcent		**-0.545 ****		**-0.555 ****
		(-2.60)		(-2.52)
Deast		**-0.107**		**-0.141**
		(-0.50)		(-0.62)
Dneast		**-0.290**		**-0.332 ***
		(-1.55)		(-1.85)
Dnorth		**-0.301**		**-0.323**
		(-0.96)		(-1.07)
Dwest		**-0.587** ***		**-0.601** ***
		(-3.01)		(-3.05)
Dsouth		**-0.523**		**-0.531**
		(-0.87)		(-0.89)
_cons	**-4.558 *****	**-4.786 *****	**-4.131 *****	**-4.611** ***
	(-6.42)	(-5.76)	(-4.36)	(-3.87)
Number of obs.	406	337	406	337
F	12.21 ***	7.11 ***	10.01 ***	6.67 ***
R-squared	0.2099	0.2692	0.2182	0.2816

Note: The figures in parentheses are t-statistics based on White's robust standard errors (White 1980).
* significant at 10% level, ** significant at 5% level, *** significant at 1% level. (two-tailed test)
Source: Author's calculations.



Appendix Figure 1. Distribution of Establishments: By Region

Note: 1. "Large plants" refers to plants with output of 25 million baht or more.
2. Compiled from plant-level data underlying National Statistical Office (1999).

Appendix Table 1. The List of Major Automobile and Auto Parts Manufacturers in Thailand

Local firms

1	BANGKOK MOTOR WORKS CO
2	MSC ENGINE CO
3	P.CHAROEN PHAN FEEDMILL CO
4	PATKOL PLC
5	SAM MITR MOTORS MANUFACTURING CO
6	SIAM INTERNATIONAL CO
7	SUMMIT AUTO BODY INDUSTRY CO
8	SUMMIT AUTOSEATS INDUSTRY CO
9	SUMMIT LEAMCHABANG AUTO BODY WORK CO
10	THAI SUMMIT AUTOPARTS INDUSTRY LTD
11	THAI ENGINE MANUFACTURING PLC
12	THAI ENGINEERING PRODUCTS CO
13	THAI KAWASAKI MOTORS CO
14	THAI RUNG UNION CAR PLC
15	THAI YARNYON CO
16	THERMSTAR CO
17	THONBURI AUTOMOTIVE ASSEMBLY PLANT CO
18	YARNA PUND CO

European Firms

1	ABB T&D LTD
2	DANA SPICER (THAILAND) LTD
3	THAI BARODA INDUSTRIES CO
4	THAI -SWEDISH ASSEMBLY CO
5	INCHCAPE TECHNICAL LTD

U.S. firms

1	GOODYEAR (THAILAND) PLC

Other foreign firms

1	SKF (THAILAND) LTD
2	THAI BRANTA MULIA CO

Japanese firms

1	DENSO (THAILAND) CO
2	ASIAN AUTOPARTS CO
3	DAISIN KOGYO CO
4	F C C (THAILAND) CO
5	HONDA CARS MANUFACTURING (THAILAND) CO
6	ISUZU ENGINE MANUFACTURING CO
7	SANDEN THECO CO
8	SIAM COMPRESSOR INDUSTRY CO
9	SIAM GS BATTERY CO
10	SIAM HITACHI CONSTRUCTION MACHINERY CO
11	SIAM MOTORS AND NISSAN CO
12	SIAM NISSAN AUTOMOBILE CO
13	SIAM TENNEX MANUFACTURING CO
14	SIAM TOYOTA MANUFACTURING CO
15	THAI COMPRESSOR MANUFACTURING CO
16	THE SIAM KUBOTA INDUSTRY CO
17	YANMAR S.P. CO
18	ZEXEL SALES (THAILAND) CO
19	SUKOSOL AND MAZDA MOTOR INDUSTRY CO
20	THAI HONDA MANUFACTURING CO
21	TOYOTA MOTOR THAILAND CO
22	ISUZU MOTORS CO
23	MITSUBISHI ELEVATOR ASIA CO
24	SIAM YAMAHA CO
25	SODICK (THAILAND) CO
26	THAI SUZUKI MOTOR CO

Note: The firms in this list are those for which revenue and profit data are available for at least one year from 1994 to 1999.
Source: Compilation of firm-level data from published sources; see Ramstetter and Matsuoka (2001) for details.

Appendix Table 2. Correlation Matrix

	ln(VA/EP)	RLTFP	ln(K/EP)	ln(EN/EP)	Dold	Dsize25-50	Dsize50-75
ln(VA/EP)	1						
RLTFP	0.8237	1					
ln(K/EP)	0.4552	-0.091	1				
ln(EN/EP)	0.2378	0.035	0.209	1			
Dold	0.0608	0.0813	-0.0015	0.0083	1		
Dsize25-50	-0.105	-0.0394	-0.1212	0.0294	-0.0736	1	
Dsize50-75	-0.0539	-0.0015	-0.0535	-0.0268	-0.0326	-0.3333	1
Dsize75-100	0.5447	0.3158	0.4674	0.1082	0.1884	-0.3355	-0.3333
Dage20-	0.1031	0.1051	0.0347	-0.0219	0.6656	-0.0757	-0.0106
Dage10-20	-0.0891	-0.0428	-0.0946	-0.0145	0.3806	0.0291	-0.0087
Dage5-10	-0.0179	-0.0202	0.0097	0.0164	-0.4595	0.055	0.0713
LOUT	0.6434	0.4037	0.5047	0.1139	0.1725	-0.2831	0.0201
Df	0.3628	0.1167	0.4435	0.1101	-0.0732	-0.2634	-0.0132
Df100	0.0365	-0.0372	0.1086	-0.0547	-0.0556	-0.05	0.0169
Dfmaj	0.1814	0.0938	0.1874	0.0174	0.0623	-0.1283	0.0344
Dfmin	0.2947	0.0851	0.3654	0.1294	-0.1088	-0.2102	-0.0408
Dboi	0.3965	0.1576	0.432	0.1329	-0.0436	-0.1959	-0.0666
Dx	0.2632	0.1524	0.2611	0.0176	0.1341	-0.2313	0.0517
Dm	0.1971	0.0559	0.2574	0.1817	0.0536	-0.0659	-0.014
Dxmaj	0.0289	-0.0076	0.0939	-0.0442	-0.0879	-0.1273	0.1488
Dxmin	0.2849	0.1828	0.2346	0.053	0.2206	-0.1755	-0.0493
Dmmaj	-0.004	-0.0844	0.1245	0.065	-0.0599	0.0359	0.0396
Dmmin	0.2275	0.1501	0.1636	0.1391	0.1223	-0.1116	-0.0567
Dlarge	0.4402	0.2797	0.3663	0.0459	0.1323	-0.5353	0.4399
Dassy	0.1679	0.1148	0.1191	0.0512	0.0773	0.0036	-0.1425
Dbody	-0.0755	0.0375	-0.2218	-0.0237	-0.0599	0.1969	-0.0946

	Dsize75-100	Dage20-	Dage10-20	Dage5-10	LOUT	Df	Df100
Dsize75-100	1						
Dage20-	0.1595	1					
Dage10-20	0.0019	-0.2304	1				
Dage5-10	-0.0531	-0.3058	-0.3836	1			
LOUT	0.8304	0.1924	-0.0136	-0.0425	1		
Df	0.4936	0.021	-0.1065	-0.022	0.5632	1	
Df100	0.0826	-0.037	0.0226	-0.0007	0.0879	0.1798	1
Dfmaj	0.2212	0.1305	-0.0911	-0.0348	0.3019	0.4617	-0.0191
Dfmin	0.4086	-0.0477	-0.0714	-0.0034	0.437	0.8162	-0.0338
Dboi	0.4875	0.0483	-0.1268	-0.0668	0.5521	0.6465	0.0442
Dx	0.4479	0.1587	0.0036	-0.0456	0.5346	0.5011	0.154
Dm	0.3334	0.1032	-0.0565	-0.0305	0.3749	0.3227	0.0785
Dxmaj	0.1467	-0.0496	-0.0257	0.1006	0.1414	0.2346	0.1882
Dxmin	0.413	0.221	0.023	-0.1269	0.5178	0.4104	0.0408
Dmmaj	0.0359	0.0301	-0.0784	0.0675	0.0578	0.1577	0.0091
Dmmin	0.3409	0.086	0.0167	-0.104	0.3655	0.2035	0.0797
Dlarge	0.6269	0.1362	-0.0108	-0.0011	0.7608	0.4433	0.0934
Dassy	0.1513	0.1178	-0.0698	-0.0086	0.2542	0.1426	0.0638
Dbody	-0.2933	-0.08	0.0274	0.0129	-0.3068	-0.3399	-0.0793

Appendix Table 2. Correlation Matrix --- *Continued* ---

	Dfmaj	Dfmin	Dboi	Dx	Dm	Dxmaj	Dxmin
Dfmaj	1						
Dfmin	-0.0868	1					
Dboi	0.2985	0.5458	1				
Dx	0.3408	0.3249	0.4595	1			
Dm	0.1549	0.2546	0.3274	0.3708	1		
Dxmaj	0.2814	0.0469	0.2096	0.5221	0.1745	1	
Dxmin	0.1895	0.3433	0.3804	0.7792	0.303	-0.1277	1
Dmmaj	0.1955	0.0573	0.1308	0.1827	0.5758	0.159	0.0956
Dmmin	-0.0255	0.2296	0.2366	0.2324	0.5412	0.0342	0.2451
Dlarge	0.2398	0.3366	0.3859	0.4673	0.2754	0.2615	0.3512
Dassy	0.1511	0.0538	0.1689	0.1075	0.04	-0.1007	0.199
Dbody	-0.1569	-0.2728	-0.2206	-0.3297	-0.2751	-0.2139	-0.2262

	Dmmaj	Dmmin	Dlarge	Dassy	Dbody
Dmmaj	1				
Dmmin	-0.3759	1			
Dlarge	0.0609	0.2495	1		
Dassy	-0.0582	0.1052	0.0192	1	
Dbody	-0.1985	-0.1076	-0.3438	-0.3165	1