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Abstract

This paper examines whether technology levels were higher in foreign-owned plants than in locally-owned plants and whether technology levels in foreign-owned plants were related with foreign ownership shares in Indonesian manufacturing in 1995. The results first indicate that foreign-owned plants have higher technology levels than locally-owned plants. Second, after accounting for age of each plant, results also indicate that wholly-foreign plants tended to have higher technology levels than other foreign-owned plants and that relatively new foreign-owned plants tend to have relatively low technology levels. However, the relationship between foreign ownership shares and technology levels differs among industries, and in some industries majority-foreign plants have relatively high technology levels.

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1 Introduction

The international activities of multinational corporations (MNCs) can be important especially in developing countries. First, the entry of MNC affiliates can contribute to the economic growth of host countries by increasing capital accumulation. Second, the entry of MNC affiliates disturbs the existing equilibrium in the market and forces local firms to take actions to protect their market shares and profits (Blomström and Kokko, 1997, p. 7). Third, the activities of MNC affiliates can stimulate the demand for labor, other factors of production, and intermediate goods, as well as exports. Finally, MNCs are generally thought to possess firm-specific proprietary assets and the transfer of such assets to their affiliates can be an important means through which advanced technology is diffused internationally. This paper focuses on this last point by examining whether MNC affiliates were more productive than local plants in Indonesian manufacturing in 1995.

The international diffusion of technology through MNCs is important, especially in some of the richer developing countries. One reason for this is because most of the world's modern technology is developed and controlled by MNCs based in advanced countries (Blomström and Kokko, 1997) and most developing countries have a relatively weak technological base and must import advanced technology from abroad. Another reason is that markets for knowledge-based intangible capital often do not exist or are imperfectly competitive because this kind of capital can often be appropriated by third parties and because potential buyers and sellers often do not have symmetric access to information about the technology for sale (e.g., Markesen, 1995). For these same reasons MNCs tend to internalize the utilization of proprietary technology by investing abroad, instead of selling their knowledge-based intangible capital to third parties. In this context, foreign affiliates may also impart externalities on technology development in local firms in host countries. These externalities exist whenever the MNC parent transfers relatively sophisticated technology or skills to its affiliates (compared to the technology controlled by local firms) and the affiliates use this technology efficiently in host countries.

Thus, the primary purpose of this paper is to examine whether foreign-owned plants in Indonesian manufacturing were more productive than locally-owned plants in 1995, or in other words, if the technology levels in foreign-owned plants were higher than in locally-owned plants. Second, the paper examines whether the technology levels of foreign-owned plants were related to their foreign ownership shares. It is important to examine this hypothesis because it is often thought that foreign affiliates with relatively low foreign ownership shares have troubles accessing sophisticated technology controlled by MNC parents. This can occur because parents may fear losing control of their proprietary technology if they share it with affiliates they cannot control closely. This hypothesis is also important in that it is related to policy problems in Indonesia which has regulated foreign direct investment regarding foreign ownership share (see Pangestu, 1996, ch. 6). To examine these hypotheses, the next section reviews the relationships among the level of technology transferred, ownership structure, and productivity. Section 3 explains the methodology used to evaluate the productivity differentials and reviews some previous analyses. Section 4 explains the data used and section 5 describes empirical results. Finally, section 6 summarizes the results and offers some concluding remarks.

2 Technology Transferred, Ownership Share, and Productivity

According to the theoretical literature, MNCs possess proprietary assets including intangible assets related to production, management, and marketing, especially international marketing, that non-MNCs often cannot access in arms-length markets (Dunning, 1993; Caves, 1996; Blomström et al., 2000). The possession and transfer of such assets enable their foreign affiliates to compete with local firms in overseas markets even when local firms have better knowledge of those markets. MNCs decide to invest abroad when they perceive the benefits of internalizing the utilization of these assets in their affiliates located in foreign countries to be larger than the benefits of selling these assets to third parties in those countries, or larger than the benefits of not entering the foreign markets at all. This suggests that MNC affiliates or foreign-owned plants may have higher technology levels than locally-owned plants. However, this is not always the case. For example, MNCs often have less information than local plants about local markets, labor-relations, business practices, and other factors affecting plant profitability. Of course, MNCs invest abroad when they think they can offset these disadvantages by utilizing their proprietary assets, but these expectations may not be realized. Thus, even in theory, the question of whether foreign-owned plants are more productive or not is an empirical one. [1]

The second point to be considered in this paper is what determines the extent MNCs transfer the proprietary assets to their affiliates. Blomström et al. (1999) reviewed the literature on the benefits and costs associated with the decision to transfer technology and argued that the relevant cost is a pos-

[1] It is important to test even the most basic theoretical assertions empirically because even widely accepted economic theory has been shown to be inconsistent with the data in some cases.

itive function of the commercial value of the technology involved, as well as the capabilities of local firms. Transferring and utilizing more sophisticated proprietary technology puts the MNC at a risk of having those proprietary assets appropriated by local competitors. Moreover the degree of technological sophistication tends to be positively related to the potential cost of appropriation and the cost of preventing appropriation. In other words, the cost of appropriation and the cost of preventing appropriation tend to be greater when the technology involved is relatively sophisticated. Therefore, the risk of appropriation can affect technology transfer by MNCs.

A critical relationship in this respect is between the extent of technology transfer and the mode of investment, in particular the choice of foreign ownership share. As described above, MNCs that decide to invest abroad generally have less experience and information on local markets, among other important business-related factors. Thus, to some extent, MNCs may prefer to enter the markets in joint ventures with local partners in order to reduce operational and managerial risks. However, when forming joint ventures, MNCs may run the risk of having their proprietary assets appropriated by joint-venture partners. Thus, parents may decide to transfer less sophisticated technology to the foreign affiliates when joint-venture partners are involved, even if this means the affiliates are less profitable than they might otherwise be. MNCs can reduce the risk of appropriation by local competitors if they enter foreign markets with wholly- or majority-foreign affiliates because they can exert relatively strong managerial influence on these affiliates.

The above arguments yield two hypotheses that will be tested in the case of Indonesian manufacturing below. First, the hypothesis that technology levels in foreign-owned plants are higher than in locally-owned plants will be examined. Second, the paper will also attempt to test the hypothesis that technology levels in wholly- or majority-foreign plants tends to be higher than in other foreign-owned plants.

3 Review of Previous Studies and Measuring Productivity

There are several studies that examined productivity differentials between foreign-owned and locally-owned plants or firms (for example, see Caves, 1996, p. 227). Some of these studies come from the literature on spillover effects (see Kokko, 1992, chapter 1 for reference). Using Mexican industry-level data for 1970, for example, Blomström (1988) tested an hypothesis that production functions for foreign and domestic firms were the same, and concluded that foreign affiliates seem to be more productive than Mexican firms. Haddad and Harrison (1993) and Aitken and Harrison (1999) examined firm-level panel data for Morocco from 1985 through 1989 and for Venezuela from 1972 through 1989 with the exception of 1980, respectively. Both also concluded that foreign-owned firms are more productive. On the other hand, for Thailand, Malaysia, and other Asian countries there are many studies that failed to find statistically significant productivity differentials in many samples (for example, see Khanthachai et al., 1987; Menon, 1998; Oguchi, 2002; Ramstetter, 1994, 1999a, 2001; Tambunlertchai and Ramstetter, 1991; Takii and Ramstetter, 2000).

Regarding Indonesian manufacturing, Blomström and Sjöholm (1999) analyzed spillover effects using data for 1991, and their results suggest that foreign ownership share is an important determinant of labor productivity, but that the degree of foreign ownership in a plant does not affect labor productivity level. Similarly, Sjöholm's (1999b) results for 1980 and 1991 imply that foreign-owned plants have higher labor productivity in most 3-digit ISIC industries, with footwear and apparel being the major exception. Rudimentary results from Takii and Ramstetter (2000) for 14 years from 1985 through 1998, suggest that majority-foreign plants generally had higher average labor productivity levels than minority-foreign, heavily-foreign, and locally-owned plants, but there are several years in which this was not the case and several years in which heavily-foreign plants in particular had lower labor productivity than locally-owned plants. [2]

In this paper, some of the results in Blomström and Sjöholm (1999) are reexamined, though there are some differences between the two analyses. First, Blomström and Sjöholm (1999) estimated the following model:

$$\ln \frac{V_i}{L_i} = \boldsymbol{\alpha D}_i + \beta \ln \frac{K_i}{L_i} + \boldsymbol{\gamma Z}_i, \tag{1}$$

where V, L, and K refer to value added, the number of labor, and capital stock for the i th plant, respectively. $\boldsymbol{D}$ is a vector of constant term and dummy variables related to foreign ownership share of the plant and $\boldsymbol{Z}$ is a vector of some other variables affecting productivity, including the industry dummy variables. $\boldsymbol{\alpha}$, β, and $\boldsymbol{\gamma}$ are the vectors of parameters. This model can be considered a Cobb-Douglas type with constant returns to scale. In this paper, the following model of translogarithmic form is estimated for generality (for more detail, see below):

$$\begin{aligned} \ln V_i &= \boldsymbol{\alpha D}_i + \beta_1 \ln L_i + \beta_2 \ln K_i \\ &\quad + \beta_3 (\ln L_i)^2 + \beta_4 (\ln K_i)^2 + \beta_5 (\ln L_i)(\ln K_i) + \boldsymbol{\gamma Z}_i. \end{aligned} \tag{2}$$

Here $\boldsymbol{\alpha D}_i$ refers to the level of technology or efficiency for the i th plant.

[2] In this paper, majority-foreign affiliates were defined as affiliates with foreign ownership shares of 50-89 percent, heavily-foreign affiliates were defined as affiliates with foreign ownership shares of 90 percent or more, and minority-foreign affiliates were defined as affiliates with foreign ownership shares of 10-49 percent.

It should be noted that this term includes not only the level of technology but also inefficiency derived from a lack of knowledge, such as information on advanced technology and sophisticated managerial skill, especially in a locally-owned plant, and also information on local markets, especially in a foreign-owned plant. Therefore, the difference between locally- and foreign-owned plants, which will be estimated, is the average productivity differential resulting from such inefficiency as well as differences in the level of technology. It should be noted that this difference is defined rather narrowly as the shift parameter (the intercept) of the production function, and it is important to emphasize that this is only one of several possible differences related to the production process.[3]

Second, the dummy variables related to the age of plants are included as explanatory variables in order to account for the disadvantages (inefficiency) of relatively new (foreign-owned) plants in this paper. As described in the previous section, foreign-owned plants have less information on the local environment than locally-owned plants. Although this disadvantage would diminish over time, it might be prominent for newly established foreign-owned plants. When that is the case, even if foreign-owned plants are utilizing more sophisticated technology than locally-owned plants, statistically significant differences in productivity between foreign- and locally-owned plants may not be observed. This is more likely when a relatively large number of newly established plants exist. In the next section, some descriptive statistics regarding this aspect are explained.

Third, this paper partly takes into account the characteristics of the mi-

[3] In order to examine the differences in production functions between locally- and foreign-owned plants, distinct production functions should be estimated for each, as done in Blomström (1988). However, in the case, we can test whether the production functions are same or not, but it is difficult to test which is more productive.

cro data. In general, micro data appear to contain outliers and measurement errors. In order to avoid misleading results, some records that seem to contain outliers or measurement errors were eliminated from the sample on which the analysis was based. In addition, in order to avoid sample selection problems, regression analysis was done both before and after elimination. The next section explains the characteristics of the data and the simple method to detect outliers and measurement errors.

The basic model to be estimated in this paper is expressed as follows:

$$\begin{aligned}\ln V_i = {} & \alpha_0 + \alpha_1 D_i^f + \beta_1 \ln L_i + \beta_2 \ln K_i + \beta_3 (\ln L_i)^2 + \beta_4 (\ln K_i)^2 \\ & + \beta_5 (\ln L_i)(\ln K_i) + \gamma_1 D_i^{fd} + \gamma_2 S_{ij} + \boldsymbol{\gamma}_3 \boldsymbol{D}_i^{ind},\end{aligned} \tag{3}$$

where D^f is a dummy variable which has value one if foreign ownership share for the plant is positive, and has value zero otherwise. If foreign-owned plants, which are defined as plants with positive foreign ownership share, [4] have higher productivity than locally-owned plants on average, the coefficient α_1 on the variable is expected to be positive. D^{fd} is a dummy variable which has value one if the plant's foreign ownership share in 1995 was positive but the share in 1990 was zero, and has value 0 otherwise. This variable is included in the model in order to account for the possibility that such foreign-owned plants have advantages that only locally-owned plants have and to distinguish such plants from other foreign-owned plants. S_{ij} refers to the relative size of the i th plant in the j th industry. This variable was calculated as the ratio of output of a particular plant to the average output of all plants in the industry. Therefore, the variable has a value of more than one if the plant produces more than the average output in the industry. $\boldsymbol{D}^{ind}$ is a vector of 3-digit industry dummy variables. L and K in Eq. (3) are the number of labor and capital

[4] Of all foreign-owned plants defined in this paper, there are only 2 plants with under 10 percent foreign-ownership shares.

stock divided by the average of all plants, respectively.[5]

Next, Eq. (3) is extended by including two variables in order to compare these results with the results in Blomström and Sjöholm (1999). The two variables are D^{maj} and D^{who}. The former is a dummy variable that has value one if the foreign ownership share of the plant is more than 50 percent, and has value zero otherwise. The later is a dummy variable that has value one if the foreign ownership share is 100 percent, and has value zero otherwise. Therefore, if majority-foreign plants (more than 50 percent foreign ownership) have higher productivity levels than minority-foreign plants (50 percent or less) on average, the coefficient on the D^{maj} is expected to be positive. Additionally, if wholly-foreign plants (100 percent foreign ownership) are more productive than other majority-foreign plants on average, the coefficient on D^{who} is expected to be positive. Thus, the model to be estimated is as follows:

$$\begin{aligned}\ln V_i = \alpha_0 &+ \alpha_1 D_i^f + \alpha_2 D_i^{maj} + \alpha_3 D_i^{who} \\ &+ \beta_1 \ln L_i + \beta_2 \ln K_i + \beta_3 (\ln L_i)^2 + \beta_4 (\ln K_i)^2 \\ &+ \beta_5 (\ln L_i)(\ln K_i) + \gamma_1 D_i^{fd} + \gamma_2 S_{ij} + \boldsymbol{\gamma}_3 \boldsymbol{D}_i^{ind}.\end{aligned} \tag{4}$$

As described above, Eq. (4) does not account for the possibility that some of the disadvantages might diminish over time. In order to account for this possibility, additional variables are included in the model. In order to distinguish relatively new foreign-owned plants from other foreign-owned plants, dummy variables D^{fn} and D^{fnn} were defined to be equal to 1 if the foreign-owned plants started commercial production after 1991 and 1994, respectively, and 0 otherwise. However, there are inconsistent entries in the datasets. For example, the raw data examined here indicate that a plant started production in 1991 but the record for the plant exists in the dataset for 1990. To elimi-

[5] Thus, the Eq. (3) can be considered as an approximation of arbitrary production function at averages for the number of workers and the capital stock.

nate such inconsistency, the condition that there exists no record for the plant in 1988-1990 or 1988-1993 is added to the two conditions explained above.[6] If foreign plants that started production after 1991 are less productive than other foreign-owned plants on average, then the coefficient on D^{fn} is expected to be negative. Additionally, if foreign-owned plants that started production after 1994 are less productive than other foreign-owned plants that started production after 1991 on average, the coefficient on D^{fnn} is expected to be negative. Similarly, relatively new locally-owned plants may be less productive than other locally-owned plants. Therefore, similar variables, D^{dn} and D^{dnn} are defined for locally-owned plants. The estimated model is as follows:

$$\begin{aligned}\ln V_i = \alpha_0 &+ \alpha_1 D_i^f + \alpha_2 D_i^{maj} + \alpha_3 D_i^{who} \\ &+ \alpha_4 D_i^{fn} + \alpha_5 D_i^{fnn} + \alpha_6 D_i^{dn} + \alpha_7 D_i^{dnn} \\ &+ \beta_1 \ln L_i + \beta_2 \ln K_i + \beta_3 (\ln L_i)^2 + \beta_4 (\ln K_i)^2 \\ &+ \beta_5 (\ln L_i)(\ln K_i) + \gamma_1 D_i^{fd} + \gamma_2 S_{ij} + \boldsymbol{\gamma}_3 \boldsymbol{D}_i^{ind}.\end{aligned} \tag{5}$$

Furthermore, several variables possibly affecting plant productivity are included in the above models. The regression results in Sjöholm (1999a) indicate that there exists a positive relationship between plant labor productivity on the one hand, and export and import propensities on the other. Although the relationship is somewhat ambiguous, exporting plants facing international competition may have more incentive to improve their productivity, and exporting and importing plants may be able to obtain information on more sophisticated technology through trading partners (backward and forward linkages). If this is true and foreign-owned plants tend to export or import more than locally-owned plants, and foreign-owned plants are expected to be more productive on average.[7] Although it is difficult to know whether higher

[6] Data for 1988 was the earliest available at the time when this analysis was done.
[7] Note that there is some statistical evidence that foreign-owned plants tend to

trade propensities themselves resulted from technology related an ownership advantages, if empirical results show that foreign-owned plants are more productive even after accounting for the effects of trade on productivity, it would be strong evidence of that foreign ownership does lead to higher productivity. There export and import propensities, E and M, were calculated as the ratio of a plant's export-output ratio or a plant's import-total material cost ratio to the industrial average. Similarly, the non-production worker ratio, N, which is defined as the ratio of a plant's non-production worker ratio to the industrial average, and added to the models to account for the influences of variation in skilled-worker intensity.

4 The Data and Foreign Affiliates in Indonesia

The data analyzed here is the original raw dataset for *Large and Medium Manufacturing Statistics 1995*, which was compiled by Indonesia's Central Bureau of Statistics. The dataset covers most plants that were operating in 1995 with 20 or more workers in Indonesian manufacturing. Several papers examining Indonesian manufacturing have used similar datasets for analyses of related issues(for example, Blomström and Sjöholm, 1999; Hill, 1999a,b; Ramstetter, 1999b; Sjöholm, 1999a,b; Takii and Ramstetter, 2000). The dataset for 1995 (which is the main focus of this paper) contains information on 25,510 plants, of which 1,200 were classified as foreign-owned plants (i.e., plants with positive foreign ownership shares. See Table 1 for the number of plants by industry. [8]). The dataset also contains various information about each plant, for example, location, ownership structure, starting year of commercial produc-

export more than locally-owned plants (see Ramstetter, 1999b).

[8] Six plants belonging to petroleum-related industries, ISIC = 353 or 354 were dropped from the sample.

tion, value added, and fixed assets. In addition to this dataset, another dataset, called the *backcast dataset* is available. While the original raw dataset consists of cross sections for each year, the backcast dataset 1996 consists of time series from 1975 through 1996 and appears to contain more comprehensive and reliable information on the few variables included. However, the backcast dataset excludes information on a number of variables used in this study such as foreign ownership share and fixed capital. Therefore, when data for a plant were reported in both the raw data and the backcast dataset (e.g., employment, value added, output), data from the backcast dataset were used. In this process, there is the possibility of inconsistency between the number of workers and the sum of production workers and non-production workers because the backcast dataset reports only the number of workers. Therefore, the non-production worker ratio, N was calculated from the original raw dataset.

As mentioned above, one of the important characteristics of a micro dataset is that it contains a relatively large number of inappropriate data entries and outliers. In order to weaken the influence of these on the results, they were eliminated as follows: a) calculate value added per worker for each plant; b) sort plants by value added per worker for each industry; c) eliminate plants in the top 1/64 and in the bottom 1/64 of the sorted sample for each industry; d) repeat steps a) to c) using fixed assets per worker instead of the value added per worker; e) repeat steps a) to c) using value added per unit of capital instead of value added per worker; f) repeat steps a) to c) using $T \equiv V/L^{0.25} \times K^{0.75}$, where T can be thought of as an index of total factor productivity assuming constant returns to scale and a labor share of 0.25.[9] The

[9] The labor share value is an arbitrary approximation based on regression results. However, there were no large differences in the set of plants remaining in the sample if other values close to 0.25 were tried.

remaining sample was used to estimate the models explained in the previous section (see Table 1), and the entire sample was used for comparison.

Several descriptive statistics are summarized in Table 1. Columns [5-7] present data for ownership structure and starting year of commercial production. Of the 827 foreign-owned plants, 597 plants were classified as majority-foreign and 149 were classified as wholly-foreign. This indicates that majority-foreign plants dominated foreign plants in Indonesian manufacturing in 1995. About half of the majority-foreign plants and two-thirds of the wholly-foreign plants started commercial production after 1991. Furthermore, 81 majority-foreign plants and 49 wholly-foreign plants started commercial production after 1994. These facts reflect that Indonesia had promoted inward foreign direct investment by deregulating restrictions during this period (see Pangestu, 1996, ch. 6), and imply that majority- and wholly-foreign plants were relatively new. There were a large number of foreign-owned plants in electric machinery (383), apparel (322), textiles (321) and fabricated metals (381). There were also a relatively large number of foreign-owned plants compared to the total number of plants in footwear (324) and electric machinery (383).

Columns [8-9] show the average labor productivities of locally- and foreign-owned plants, respectively. These figures were calculated based on the data in columns [3-4] of the table. The average labor productivity of foreign-owned plants in total is about four times higher than that of locally-owned plants. Higher labor productivity of foreign-owned plants is seen in all industries. There are relatively large differentials in beverage (313), cement products (363) and iron and steel (371). Columns [10-11] show the average export-output ratios of locally- and foreign-owned plants, respectively. The figures were calculated by averaging the ratios of each plant, which were directly answered in the questionnaire. The data for some plants were missing, so the samples do not coincide with columns [4-5] of the table. These figures show that foreign-owned plants tended to export more than locally-owned plants in all industries. Notably, a large proportion of goods produced by foreign-owned plants in wood products (331), apparel (322), furniture (332) and footwear (324) were exported. Columns [12-13] show the average import-material cost ratios of locally- and foreign-owned plants, respectively. These figures were calculated by averaging the ratio of imported material cost to total material cost for each plant. Some plants didn't report imported material cost, so the data for these plants were missing. Similarly, foreign-owned plants tended to import more than locally-owned plants in all industries and the differentials in import propensity are often greater than the differentials in export propensity. Finally, columns [14-15] show the average non-production worker ratios of locally- and foreign-owned plants, respectively. The differential for all manufacturing is relatively small compare to the differentials in export-output ratio and import-material cost ratio. Foreign-owned-plants didn't always employ more non-production workers than locally-owned plants in each industry, on average.

5 Regression Results

The regression results are shown in Tables 2-5. Column [1] in Table 2 shows the regression results of Eq. (3) using the sample after eliminating inappropriate entries based on the method explained in the previous section. The significantly positive estimated coefficient on D^f indicates that foreign-owned plants were more productive than locally-owned plants on average. However, both D^{maj} and D^{who} are positive but not significant in column [2], which shows the regression results of Eq. (4). The results imply that the productivity of foreign-owned plants were not dependent on the ownership structure. The implication was also supported by the regression results in Blomström and Sjöholm (1999). However, the regression model does not account for the disadvantages that relatively new foreign-owned plants face. Column [3] in the table shows the regression results of Eq. (5), which accounts for age of plants, and column [4] shows the regression results after omitting insignificant variables (at the 10 percent level) of the first 8 variables in the model. D^{fn} is significantly negative and D^{fnn} is negative but significant at the 10 percent level. These results imply that foreign-owned plants that started their commercial production after 1991 (or 1994) tended to be less productive than other foreign-owned plants. Furthermore, the results in column [4] show that D^{who} is significantly positive. This implies that wholly-foreign plants were more productive than other foreign-owned plants after accounting for starting year of commercial production.

Table 3 shows the regression results using all data for which capital stock was available (some of the data were missing because some plants didn't report their capital stock). The results in columns [1-4] of Table 3 correspond to the results in columns [1-4] of Table 2. The adjusted R^2s in columns [1-4] are smaller than corresponding results in Table 2. This implies that the variation of productivity is greater in the sample including all plants than in the sample after eliminating inappropriate entries. All of the results suggest that foreign-owned plants were more productive than locally-owned plants. The main difference in the results of Table 2 and Table 3 is that the latter suggests that not only wholly-foreign plants but also majority-foreign plants were more productive than other foreign-owned plants. These differences might reflect the fact that some of the majority-foreign plants were eliminated from the sample in the process explained in the previous section because their productivity levels were extremely high. In this respect, data for the eliminated plants should be checked closely, but both results suggest that productivity in foreign-owned plants tended to be dependent on foreign ownership share.

Columns [1] and [2] in Table 4 show the regression results of Eqs. (4) and (5), which include E, M, and N as independent variables. The coefficients on the three variables are significantly positive. The results imply that productivity of plants is positively related to export propensity, import propensity, and non-production worker ratio. As shown in the previous section, the variables for foreign-owned plants have higher values. These elements may contribute to the higher productivity of foreign-owned plants on average, though causality is ambiguous in these cases. However, the results in column [2] show that even after accounting for the effects, the coefficient on D^f is significantly positive. This suggests that foreign-owned plants were more productive than local plants, and that wholly-foreign plants were more productive than other foreign-owned plants. However the coefficient on D^{who} is not significant at the 5 percent level (but is at the 10 percent level).

The regression results presented so far are for data that include relatively small plants as well as relatively large plants. Columns [3] and [4] show the regression results using data for only relatively large plants. Plants whose outputs were greater than the industrial average were selected. The estimated models for columns [3-4] correspond to the models for columns [1-2] in the table, respectively. The estimated coefficients on E and M were not significant. These results imply that the effects of exporting and importing activity on productivity (or backward and forward linkage effects) are not significant if the sample is limited to relatively large plants. The significantly negative coefficients on D^{dnn} in column [4] indicate that relatively new and large locally-owned plants were less productive than other locally-owned plants. The significantly positive coefficients on D^{f} and D^{who} indicate that foreign-owned plants, especially wholly-foreign plants were more productive than locally owned plants in samples of relatively large plants.

The results by industry shown in Table 5 are mixed. The industries analyzed here were chosen mainly based on the sample size of foreign-owned plants. The columns with odd numbers show the regression results of Eq. (5) and the columns with even numbers show the results of the model incorporating E, M, and N. Of 6 industries analyzed, results for 4 industries suggest that foreign-owned plants were more productive than locally-owned plants on average. On the other hand, results for footwear (324), electric machinery (383), and transport equipment (384) indicate that D^{f}s are not significant, but D^{maj} for electric machinery and transport equipment is positive and significant while D^{who} for footwear (324) is significantly negative. The results for industrial chemicals (351) also suggest that wholly-foreign plants were less productive than other foreign plants. These results imply that productivity differentials depend on industrial characteristics, such as the number of foreign-owned plants, market shares of foreign-owned plants, and the degree of competition in the industry. In these industries there were a relatively large number of foreign-owned plants and the degree of competition seems greater than in other industries.

6 Concluding Remarks

The purpose of this paper was to examine whether foreign-affiliates of multinational corporations are utilizing more sophisticated technology or skills than locally-owned plants. To examine the hypothesis, several statistical tests were conducted estimating the differences in the level of productivity between foreign-owned plants and locally-owned plants in Indonesian manufacturing in 1995. Most of the results suggest that foreign-owned plants were more productive than locally-owned plants and support the hypothesis. Furthermore, results suggest that foreign-owned plants with 100 percent foreign ownership were more productive than other foreign-owned plants when we accounted for starting year of commercial production. This finding is different from the results in Blomström and Sjöholm (1999), which concluded that the productivity of foreign-owned plants is not dependent on ownership structure. It also differs from more rudimentary analysis in Takii and Ramstetter (2000), suggesting that differences in functional form, variables included, and productivity measures can affect the results of this analysis. The regression results for some industries, however, imply that the hypothesis is not true, and therefore further examination is warranted.

It should be noted that there is another interpretation of the results related to the definition of relatively new foreign-owned plants, which were distinguished from other foreign-owned plants in this paper. New plants were defined as plants reporting that they started commercial production after 1991 or 1994 and that didn't exist in the datasets for earlier years. The analysis in this paper was based on cross sectional data, so plant age does not only represent the volume of experience in the local markets as of 1995 but also represents other characteristics of the foreign-owned plants.

For example, the nationalities of foreign-owned plants that started production after 1991 or 1994 might be different from that of the existing plants. If a relatively large number of plants with different nationalities from existing foreign-owned plants started production after 1991 or 1994 (for example, new plants from adjacent developing countries and existing plants from Japan and other developed countries), and if their characteristics were different from that of the existing foreign-owned plants, then similar results with the results in this paper could be observed. Therefore, further research focusing on nationalities of foreign-owned plants is needed.

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Table 1
Descriptive Statistics for 1995

Item	No. of plants		Number of plants after the elimination of outliers				
		Foreign		Foreign-owned plants			
					Majority (Wholly)-foreign plants		
						Starting after 1991	Starting after 1994
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Total	21526	1194	16682	827	597(149)	295(101)	81(49)
311	2470	79	1905	48	32(11)	11(3)	5(2)
312	1802	43	1420	23	13(5)	6(3)	0(0)
313	249	18	206	12	7(2)	2(1)	0(0)
314	815	7	608	2	1(1)	0(0)	0(0)
321	2242	100	1746	63	51(13)	23(5)	2(2)
322	2110	102	1476	69	54(12)	29(8)	6(3)
323	217	7	166	2	1(0)	1(0)	0(0)
324	389	48	304	45	33(2)	15(1)	4(1)
331	1754	50	1469	39	18(2)	7(1)	2(1)
332	1159	30	925	19	18(7)	12(6)	6(5)
341	311	21	231	15	10(2)	6(2)	3(2)
342	594	9	450	7	2(0)	0(0)	0(0)
351	403	63	301	50	37(3)	14(1)	2(0)
352	605	80	477	57	41(5)	4(0)	3(0)
355	441	38	356	26	22(10)	1(1)	0(0)
356	938	56	694	34	24(11)	17(10)	5(4)
361	95	10	83	6	3(1)	2(1)	1(0)
362	71	7	54	6	1(0)	1(0)	0(0)
363	629	20	538	10	4(1)	2(0)	1(0)
364	957	1	751	0	0(0)	0(0)	0(0)
369	275	2	208	2	1(0)	0(0)	0(0)
371	103	18	75	14	10(1)	5(1)	1(0)
372	66	10	56	7	6(1)	5(1)	2(0)
381	958	84	743	59	42(5)	21(4)	4(3)
382	322	41	261	25	17(2)	11(2)	0(0)
383	459	132	348	94	75(38)	57(38)	25(23)
384	577	50	438	38	27(6)	11(4)	3(2)
385	73	11	59	10	9(5)	7(5)	1(1)
390	442	57	334	45	38(3)	25(3)	5(0)

Table 1 (continued)
Descriptive Statistics for 1995

Item	Average labor productivity (Rp. mil.)		Average export propensity (%)		Average import propensity (%)		Average Non-production worker ratio (%)	
Plant	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign
Industry	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Total	2.2	8.6	10.0	41.6	6.5	45.1	13.7	20.6
311	2.0	4.4	8.1	33.8	1.2	9.6	15.8	27.6
312	1.4	5.5	3.7	26.8	1.8	18.2	15.1	28.8
313	2.5	13.6	3.5	8.6	1.8	18.8	22.0	44.9
314	0.7	0.8	2.7	25.3	0.6	27.3	5.0	20.4
321	2.1	5.5	5.3	35.6	8.8	38.5	9.2	12.8
322	1.9	3.2	14.4	72.3	4.6	60.3	7.3	7.5
323	2.4	4.2	14.8	66.3	9.9	66.1	11.7	7.3
324	2.3	3.2	19.6	68.2	10.8	66.8	10.0	6.8
331	2.5	5.2	26.2	73.7	0.5	3.3	15.0	13.7
332	1.6	3.3	32.5	68.9	0.7	9.0	10.3	14.5
341	4.4	7.5	5.5	17.0	8.8	27.8	20.1	20.2
342	3.0	5.9	1.8	45.0	6.0	38.4	22.8	21.0
351	6.5	23.8	10.9	20.8	17.3	60.8	28.5	42.5
352	3.8	14.0	4.5	7.8	28.2	57.6	26.5	43.2
355	2.3	5.6	23.2	59.1	6.6	8.9	24.1	23.9
356	1.6	4.6	4.0	40.0	19.3	54.9	15.6	21.8
361	2.6	5.8	7.4	40.6	25.4	44.3	15.4	12.7
362	4.0	10.3	11.6	24.4	18.0	38.9	18.6	16.5
363	1.9	8.4	0.6	11.9	1.2	9.7	14.5	23.3
364	0.7	–	0.8	–	0.6	–	3.2	–
369	2.7	5.3	5.1	20.5	8.0	34.2	18.3	30.4
371	7.3	32.0	3.0	28.2	19.4	32.8	23.8	21.9
372	16.9	48.5	9.3	44.1	18.3	70.4	21.3	20.1
381	2.3	7.6	3.6	33.3	10.8	49.1	14.2	23.4
382	4.6	12.3	1.1	20.2	15.4	64.2	16.0	29.4
383	4.9	9.0	8.8	53.2	26.3	74.2	19.7	14.0
384	3.0	9.9	3.0	24.7	10.2	60.1	17.7	15.5
385	2.9	5.2	9.3	45.5	21.0	69.6	13.6	11.7
390	1.7	3.6	19.7	62.5	11.8	42.9	9.9	12.3

Table 2
Estimation Regression (Sample: after the elimination of outliers)

Model	Eq. (3)	Eq. (4)	Eq. (5)	Eq. (5')
Variable	[1]	[2]	[3]	[4]
D^f	0.34 (10.79)	0.30 (5.32)	0.46 (7.37)	0.49 (10.98)
D^{maj}	—	0.05 (0.70)	0.05 (0.73)	···
D^{who}	—	0.03 (0.41)	0.15 (1.88)	0.16 (2.15)
D^{fn}	—	—	−0.30 (4.84)	−0.31 (5.09)
D^{fnn}	—	—	−0.17 (1.76)	−0.17 (1.80)
D^{dn}	—	—	−0.01 (0.65)	···
D^{dnn}	—	—	0.00 (0.01)	···
D^{fd}	−0.08 (0.7)	−0.07 (0.63)	−0.24 (2.21)	−0.25 (2.27)
$\boldsymbol{D}^{ind}$	included	included	included	included
constant	7.11 (219.87)	7.11 (219.85)	7.12 (218.24)	7.11 (221.42)
$\ln L$	0.62 (27.62)	0.62 (27.63)	0.61 (27.88)	0.61 (27.85)
$\ln K$	0.42 (31.61)	0.42 (31.63)	0.42 (31.86)	0.42 (32.02)
$(\ln L)^2$	−0.01 (1.40)	−0.01 (1.42)	−0.01 (1.46)	−0.01 (1.44)
$(\ln K)^2$	0.03 (10.43)	0.03 (10.42)	0.03 (10.58)	0.03 (10.6)
$(\ln L)(\ln K)$	−0.06 (7.50)	−0.06 (7.48)	−0.06 (7.62)	−0.06 (7.62)
S	0.05 (3.25)	0.05 (3.25)	0.05 (3.25)	0.05 (3.25)
# of obs.	16682	16682	16682	16682
Adjusted R^2	0.85	0.85	0.85	0.85

Note) t-statistics within parentheses are based on White's adjustment for heteroskedasticity (Mackinnon and White, 1985).
"—" means that the variable was not included. "···" means that the variable was omitted bacause it was not significant in the original model. The original model for Column [4] is Eq. (5), and "Eq. (5')" means Eq. (5) that does not iclude some insignificant dummy variables.

Table 3
Estimation Regression (Sample: before the elimination of outliers)

Model	Eq. (3)	Eq. (4)	Eq. (5)	Eq. (5')
Variable	[1]	[2]	[3]	[4]
D^f	0.44 (10.03)	0.36 (4.62)	0.61 (6.98)	0.61 (7.01)
D^{maj}	—	0.15 (1.77)	0.16 (1.90)	0.17 (2.06)
D^{who}	—	−0.15 (1.46)	0.04 (0.43)	$\cdots$
D^{fn}	—	—	−0.47 (5.49)	−0.49 (5.79)
D^{fnn}	—	—	−0.34 (2.48)	−0.32 (2.42)
D^{dn}	—	—	−0.02 (1.12)	$\cdots$
D^{dnn}	—	—	0.00 (0.06)	$\cdots$
D^{fd}	−0.09 (0.76)	−0.07 (0.62)	−0.36 (3.04)	−0.36 (3.01)
$\boldsymbol{D}^{ind}$	included	included	included	included
constant	7.06 (168.68)	7.06 (168.86)	7.06 (169.37)	7.06 (171.51)
$\ln L$	0.73 (34.02)	0.73 (34.09)	0.72 (34.24)	0.72 (34.32)
$\ln K$	0.33 (21.08)	0.33 (21.08)	0.33 (21.39)	0.33 (21.42)
$(\ln L)^2$	−0.02 (1.79)	−0.02 (1.80)	−0.02 (1.80)	−0.02 (1.80)
$(\ln K)^2$	0.02 (6.72)	0.02 (6.71)	0.02 (6.88)	0.02 (6.86)
$(\ln L)(\ln K)$	−0.05 (5.46)	−0.05 (5.48)	−0.06 (5.65)	−0.05 (5.64)
S	0.04 (3.42)	0.04 (3.42)	0.04 (3.45)	0.04 (3.45)
# of obs.	18307	18307	18307	18307
Adjusted R^2	0.79	0.79	0.79	0.79

Note) t-statistics within parentheses are based on White's adjustment for heteroskedasticity (Mackinnon and White, 1985).
"—" means that the variable was not included. "$\cdots$" means that the variable was omitted bacause it was not significant in the original model. The original model for Column [4] is Eq. (5), and "Eq. (5')" means Eq. (5) that does not iclude some insignificant dummy variables.

Table 4
Estimation Regression with additional three variables (Sample: after the elimination of outliers)

Sample	All plants		Large plants	
Model	Eq. (4')	Eq. (5')	Eq. (4')	Eq. (5')
Variable	[1]	[2]	[3]	[4]
D^f	0.32 (9.99)	0.47 (10.49)	0.19 (4.86)	0.26 (5.41)
D^{maj}	$\cdots$	$\cdots$	$\cdots$	$\cdots$
D^{who}	$\cdots$	0.13 (1.74)	$\cdots$	0.18 (2.02)
D^{fn}	—	−0.35 (5.78)	—	−0.21 (3.10)
D^{fnn}	—	$\cdots$	—	$\cdots$
D^{dn}	—	$\cdots$	—	$\cdots$
D^{dnn}	—	$\cdots$	—	−0.13 (1.84)
E	0.33 (2.64)	0.39 (3.07)	$\cdots$	$\cdots$
M	0.52 (3.60)	0.53 (3.68)	$\cdots$	$\cdots$
N	0.08 (12.64)	0.08 (12.53)	0.03 (2.98)	0.03 (2.91)
D^{fd}	$\cdots$	−0.22 (2.01)	$\cdots$	−0.20 (1.75)
$\boldsymbol{D}^{ind}$	included	included	included	included
constant	6.97 (213.54)	6.97 (215.01)	7.74 (136.93)	7.75 (137.64)
$\ln L$	0.63 (28.66)	0.63 (28.88)	0.47 (16.58)	0.46 (15.91)
$\ln K$	0.40 (30.06)	0.40 (30.43)	0.20 (8.47)	0.20 (8.63)
$(\ln L)^2$	−0.01 (1.53)	−0.01 (1.59)	0.00 (0.22)	0.00 (0.13)
$(\ln K)^2$	0.02 (8.99)	0.02 (9.11)	0.01 (1.06)	0.01 (1.14)
$(\ln L)(\ln K)$	−0.06 (6.38)	−0.06 (6.45)	−0.01 (0.49)	−0.01 (0.52)
S	0.05 (3.18)	0.05 (3.18)	0.04 (2.62)	0.04 (2.61)
# of obs.	16129	16129	2304	2304
Adjusted R^2	0.86	0.86	0.78	0.78

Note) t-statistics within parentheses are based on White's adjustment for heteroskedasticity (Mackinnon and White, 1985).
"—" means that the variable was not included. "$\cdots$" means that the variable was omitted bacause it was not significant in the original model. "Eq. (4')" or "Eq. (5')"means Eq. (4) or Eq. (5) that does not iclude some insignificant dummy variables.

Table 5
Regression Results by Industry

Estimation results of Eq. (5') with E, M, and N

Industry	321		322		324		331	
EMN	no	yes	no	yes	no	yes	no	yes
Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
D^f	0.34 (3.57)	0.27 (2.80)	0.30 (2.75)	0.26 (2.27)	···	···	0.27 (2.16)	0.27 (2.20)
D^{maj}	···	···	···	···	···	···	···	···
D^{who}	···	···	···	···	−0.36 (2.19)	−0.41 (2.85)	0.60 (2.52)	···
D^{fn}	···	···	−0.30 (2.24)	−0.27 (1.91)	···	···	···	−0.12 (2.96)
D^{fnn}	−0.47 (3.70)	−0.41 (3.39)	···	···	···	···	···	···
D^{dn}	···	···	···	···	···	···	···	···
D^{dnn}	···	···	0.16 (2.65)	0.12 (1.77)	···	···	−0.11 (1.97)	···
E	—	1.14 (2.69)	—	2.82 (3.72)	—	4.32 (1.72)	—	5.68 (4.16)
M	—	···	—	···	—	4.54 (2.32)	—	···
N	—	0.12 (6.53)	—	0.05 (3.48)	—	···	—	0.07 (3.08)
D^{fd}	···	···	···	···	···	···	···	···
constant	6.87 (202.8)	6.69 (148.26)	6.91 (101.58)	6.75 (86)	6.94 (79.95)	6.83 (66.94)	6.99 (182.78)	6.85 (123.25)
$\ln L$	0.65 (16.86)	0.67 (16.4)	0.51 (8.45)	0.49 (7.85)	0.69 (6.80)	0.61 (5.61)	0.73 (17.48)	0.70 (16.86)
$\ln K$	0.44 (17.91)	0.39 (14.62)	0.37 (7.43)	0.35 (6.82)	0.20 (2.21)	0.20 (2.14)	0.27 (9.03)	0.25 (8.42)
$(\ln L)^2$	0.03 (1.26)	0.01 (0.47)	−0.01 (0.41)	0.00 (0.10)	−0.02 (0.61)	−0.03 (0.86)	0.02 (0.73)	0.02 (0.93)
$(\ln K)^2$	0.04 (5.27)	0.03 (3.59)	0.03 (2.79)	0.03 (2.93)	0.00 (0.05)	0.01 (0.24)	0.01 (0.96)	0.01 (0.87)
$(\ln L)(\ln K)$	−0.09 (3.73)	−0.06 (2.47)	−0.10 (3.70)	−0.10 (3.70)	−0.06 (1.12)	−0.07 (1.20)	−0.04 (1.78)	−0.05 (1.84)
S	0.04 (3.07)	0.04 (3.14)	0.10 (6.10)	0.10 (6.27)	0.18 (6.32)	0.18 (6.69)	0.07 (5.18)	0.07 (5.21)
# of obs.	1746	1556	1476	1318	304	294	1469	1395
Adj. R^2	0.89	0.90	0.86	0.87	0.91	0.91	0.85	0.85

Note) t-statistics within parentheses are based on White's adjustment for heteroskedasticity (Mackinnon and White, 1985).
"—" means that the variable was not included. "···" means that the variable was omitted bacause it was not significant. "Eq. (5')"means Eq. (5) that does not iclude some insignificant dummy variables.

Table 5 (continued)
Regression Results by Industry

Estimation results of Eq. (5') with E, M, and N

Industry	351		381		383		384	
EMN	no	yes	no	yes	no	yes	no	yes
Variable	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
D^f	0.72 (3.82)	0.47 (3.12)	0.57 (4.09)	0.50 (3.68)	···	···	···	···
D^{maj}	···	···	···	···	0.38 (2.96)	0.44 (3.20)	0.66 (4.29)	0.58 (3.21)
D^{who}	−0.64 (2.24)	−0.72 (2.24)	···	···	···	···	···	···
D^{fn}	−0.50 (2.19)	···	−0.74 (3.82)	−0.73 (3.75)	···	···	···	···
D^{fnn}	···	···	···	···	−0.29 (1.76)	···	···	···
D^{dn}	···	···	···	···	−0.19 (1.98)	−0.19 (2.12)	···	···
D^{dnn}	···	···	0.17 (1.83)	0.14 (1.61)	···	···	···	···
E	—	···	—	···	—	···	—	1.28 (1.97)
M	—	···	—	3.09 (2.75)	—	···	—	···
N	—	0.29 (3.54)	—	0.12 (3.91)	—	0.27 (3.80)	—	0.11 (2.19)
D^{fd}	···	···	0.72 (3.01)	0.72 (3.22)	···	···	···	···
constant	7.57 (79.26)	7.27 (54.42)	7.30 (117.30)	7.06 (89.49)	7.55 (85.82)	7.24 (60.32)	7.55 (118.97)	7.39 (86.15)
$\ln L$	0.33 (3.62)	0.40 (4.27)	0.58 (10.12)	0.62 (10.97)	0.56 (7.93)	0.66 (8.95)	0.74 (11.9)	0.72 (11.10)
$\ln K$	0.38 (7.20)	0.31 (5.56)	0.34 (8.78)	0.29 (7.45)	0.42 (8.40)	0.34 (6.52)	0.43 (10.73)	0.43 (10.42)
$(\ln L)^2$	−0.20 (2.62)	−0.19 (2.45)	−0.10 (2.72)	−0.10 (2.80)	0.06 (1.34)	0.04 (0.89)	0.00 (0.07)	0.00 (0.04)
$(\ln K)^2$	0.00 (0.20)	0.01 (0.56)	0.02 (1.70)	0.01 (1.10)	0.06 (3.42)	0.04 (2.51)	0.06 (4.40)	0.06 (4.74)
$(\ln L)(\ln K)$	−0.06 (0.98)	−0.09 (1.25)	−0.07 (1.79)	−0.04 (1.22)	−0.19 (4.19)	−0.14 (3.24)	−0.12 (2.61)	−0.13 (2.72)
S	0.18 (5.24)	0.18 (5.12)	0.12 (4.84)	0.11 (4.86)	0.12 (2.49)	0.11 (2.49)	0.03 (2.03)	0.04 (2.42)
# of obs.	301	287	743	733	348	334	438	431
Adj. R^2	0.79	0.80	0.85	0.85	0.82	0.83	0.86	0.86

Note) t-statistics within parentheses are based on White's adjustment for heteroskedasticity (Mackinnon and White, 1985).
"—" means that the variable was not included. "···" means that the variable was omitted bacause it was not significant. "Eq. (5')" means Eq. (5) that does not iclude some insignificant dummy variables.