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Productivity and FDI of Taiwan Firms: A review from a nonparametric approach

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Abstract

This paper examines whether firms' productivity and the attributes of foreign direct investment (FDI) destinations affect both the choice of these destination as well as the accumulated number. The results of our examination, using firm-level data of Taiwan, present new evidence: (i) the productivity of firms conducting FDI in high-wage countries is higher than that in low-wage countries, but is not higher than the productivity of non-FDI firms; and (ii) the higher the productivity, the larger the number of FDI destinations regardless of the market attributes. These results provide the policy implication that government support for raising the productivity and lowering the cost of internationalization will accelerate the internationalization of Taiwan firms and eventually enhance economic growth in Taiwan.

Keywords: Taiwan firms, Productivity, Exports, FDI, Pecking order, Nonparametric approach
JEL Classification: F1, F23, L6

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1. Introduction

Many theoretical and empirical studies reported that firms would be heterogeneous in their production technologies and that the choices of firms among domestic supply, export, and foreign direct investment (FDI) are sorted by the order of their productivity level[1]. They have posited the order of firms' internationalization thus: firms with low productivity will supply their products only in their domestic markets; firms with higher productivity are able to export; and firms with the highest productivity can engage in FDI, given identical market attributes between the home and host countries. These were supported by empirical evidence from US, EU, and Japanese firms.

It is also noted that the productivity cutoffs for firms' internationalization in terms of export and FDI vary according to the different marginal costs of production. Just as marginal costs differ among countries because of their market attributes, the modes of firm's internationalization will be different among countries. In actuality, market-specific attributes—such as wages, transport costs, and trade costs—are not identical among countries, in particular between developed and developing countries. In fact, we have observed that firms' internationalization is not as clearly divided as some of the theoretical studies imply. The theoretical conjecture by Helpman, Melitz, and Yeaple (2004; hereafter, HYM) may not be applied across the board to firms' choices of internationalization modes in low wage countries. Wakasugi et. al. (2008) provided statistical evidence from Japanese firms that their choice of export or FDI in developed countries is clearly sorted but is rather vague in developing countries. Yeaple (2008) confirms theoretically that the higher the productivity of firms, the greater the number of FDI destinations, regardless of whether the destination is developed or developing countries, and provided the empirical evidence to support it by using US firm-level data. Although many studies provide the findings that the theoretical conjecture of the HMY model is consistent with the actual internationalization of firms within developed countries, we note that there exist few studies of firm's

[1] See Melitz (2003), Helpmanet al. (2004) for theoretical studies, and refer to Bernard and Jensen (1999), Bernard et al. (2007), Mayer and Ottaviano (2007), Tomiura (2007), Wakasugi and Tanaka (2010, 2012), and Wakasugi et al. (2008) for empirical examinations.

internationalization in developing countries.

It is noteworthy that Taiwan firms have developed a large number of FDIs since the early 1980s and have engaged in FDI in two different types of destinations: countries with a high wage rate and countries with a low wage. FDI of Taiwan firms provides useful information for an empirical examination of firms' choice of FDI in different destinations while not many such empirical examinations of developing countries have been done. Most previous studies of FDI firms have concentrated on investments in countries with wages similar to those in the home countries, which constitutes a horizontal type of FDI.[2]

Taiwan has experienced rapid development in its firms' internationalization, which has been the driving force of the high rate of their economic growth. Aw, Chung, and Roberts (2000) confirmed that the productivity of exporting Taiwan firms was higher than that of firms supplying products only to the domestic market. Since the mid-1980s, the FDI of Taiwan firms has become highly active. Aw and Lee (2008) studied the modes of export and FDI according to two different destinations: the United States and China. Focusing on the Taiwanese electronics industry, they examined that the modes of internationalization, whether domestic, export, or FDI, were affected by marginal costs.

Taiwan firms have a unique experience of internationalization. The firms export to and engage in FDI in both developed countries with a high wage and developing countries with a low wage. An examination of Taiwan firms provides useful evidence to identify whether a difference in marginal costs affects firms' choice of internationalization mode.

The purpose of this paper, using Taiwan firm-level data, is to examine how firms' productivity influences their choice of FDI in different destinations—low-wage or high-wage countries—and how robustly the productivity influences the number of FDI destinations. Our empirical examinations have evidence for two clear results: (i) the productivity of firms engaged in FDI in high-wage countries is higher than the productivity of firms with FDI in low-wage countries, and the latter does not vary from the productivity of non-FDI firms; and (ii) the productivity of firms with a larger number of FDI

[2] Japanese firms also invested in two different types of FDI destinations: developed and developing countries.

destinations tends to be higher than the productivity of firms with a smaller number of FDI destinations. These results extend the analyses of HMY model.

The structure of this paper is as follows: the next section presents the analytical framework for the empirical examination and the hypotheses to be tested in the following sections. The third section presents the data and empirical examination of FDI of Taiwan firms in multiple countries. The fourth section describes the pecking order of FDI destinations by firm's productivity, and the final section discusses remaining issues for further examination.

2. Analytical Framework

2.1 Consumption

The theoretical foundation of our model follows the HMY model. Consumer preference is expressed by a CES-type utility function as follows:

$$u = \left[\int_{\omega\in\Omega} x(\omega)^{\alpha} d\omega\right]^{1/\alpha}, \quad 0 < \alpha < 1, \tag{2-1}$$

where $x(\omega)$ is the demand for the differentiated product ω, and Ω presents the set of the consumable differentiated goods. α is the parameter that defines the elasticity of substitution between the differentiated goods, $\varepsilon = 1/(1-\alpha) > 1$.

To maximize the utility of the consumption, which is the demand of the differentiated good ω, the demand of the good $x(\omega)$ is determined as follows:

$$x(\omega) = p(\omega)^{-\varepsilon} Y_j / P_j^{1-\varepsilon}, \tag{2-2}$$

where $p(\omega)$ is the price of the differentiated good ω, Y_j the total expenditure of the consumer in country *j*, and P_j the price index of country *j*, which are defined respectively, as follows:

(2-3) $$Y_j = \int_{\omega \in \Omega} p(\omega) x(\omega) d\omega$$

(2-4) $$P_j = \left[\int_{\omega \in \Omega} p(\omega)^{1-\varepsilon} d\omega \right]^{/(1-\varepsilon)}$$

2.2 Production

We assume that the input factor for production is one, which is labor. Let us assume that the input for unit product is a. Then, the reverse of the labor input for unit production, $1/a$, is the productivity. Following the HMY model, we also assume that a level of productivity is given the firm stochastically when it spends a certain amount of fixed cost, f_e, for entering into the market. Assuming the wage rate in country *i* is given by w_i, the marginal cost for production is expressed by $c_i = w_i a$. Then, the price to satisfy the condition for profit maximization is given as follows:

(2-5) $$p = \frac{c_i}{\alpha} = \frac{w_i a}{\alpha}$$

Assume that the fixed cost for operating domestic production is f_i^D. The total cost of the firm supplying the volume of good $x(\omega)$ in country *i* is expressed by $f_i^D + w_i a \cdot x$. From the above, the profit of the firm is expressed as follows:

(2-6) $$\begin{aligned} \pi_i^D(a) &= p(1/a) \cdot x - \left(w_i a \cdot x + f_i^D \right) \\ &= (1-\alpha) \left(\frac{w_i a}{\alpha P_i} \right)^{1-\varepsilon} Y_i - f_i^D \\ &= (1-\alpha)(\alpha P_i)^{\varepsilon-1} Y_i \left(\frac{1}{w_i} \right)^{e-1} \left(\frac{1}{a} \right)^{\varepsilon-1} - f_i^D \end{aligned} .$$

By denoting $\theta = (1/a)^{\varepsilon-1}$ and $B_i = (1-\alpha)(\alpha P_i)^{\varepsilon-1} Y_i$, the firm's profit is rewritten as a linear function of the productivity index θ, as follows:

$$\pi_i^D(\theta) = \left(\frac{1}{w_i}\right)^{\varepsilon-1} B_i\theta - f_i^D \tag{2-7}$$

Equation (2-7) shows that the higher the productivity of a firm, the larger its profit.

We assume that the fixed cost for export to country *j*, f_j^X, is higher than that for supplying the domestic market, f_i^D, and that the fixed cost for FDI in country *j*, f_j^I, is the highest among the three cases and also assume that export requires additional cost, such as transport costs and tariffs. We denote the export cost, including transport cost, as τ_j ($\tau_j > 1$) of the iceberg type. As the marginal cost for export to country *j* rises to $c_j^X = \tau_j w_i a$, the profit of the firm exporting to country j is expressed as follows:

$$\pi_j^X(\theta) = \left(\frac{1}{w_i\tau_j}\right)^{\varepsilon-1} B_j\theta - f_j^X \tag{2-8}$$

The profit of the firm with FDI in country *j* is expressed as follows:

$$\pi_j^I(\theta) = \left(\frac{1}{w_j}\right)^{\varepsilon-1} B_j\theta - f_j^I \tag{2-9}$$

2.3 Productivity Cutoff for Internationalization

The productivity cutoff of firms to supply for the domestic market, export, or engage in FDI is given by the respective zero profit condition of equations (2-7), (2-8), and (2-9). The productivity cutoff for each mode is expressed by as follows:

$$\text{(2-10)} \qquad \theta = \begin{cases} \theta^D = \dfrac{f_i^D}{B_i}(w_i)^{\varepsilon-1}, & \text{for supply to the domestic market in country i} \\ \theta^X = \dfrac{f_j^X}{B_j}(w_i\tau_j)^{\varepsilon-1}, & \text{for export to country j} \\ \theta^I = \dfrac{f_j^I}{B_j}(w_j)^{\varepsilon-1}, & \text{for FDI in country j} \end{cases}$$

The productivity $\widetilde{\theta}$ to equalize the profit between export and FDI, $\pi_j^X = \pi_j^I$, is expressed as follows:

$$\text{(2-11)} \qquad \widetilde{\theta} = (f_j^I - f_j^X)/B_j\left((\frac{1}{w_j})^{\varepsilon-1} - (\frac{1}{w_i\tau_j})^{\varepsilon-1}\right)$$

where $w_j \le w_i\tau_j$ since we can assume that the wage in FDI destination j at most is equal to the wage and transport cost, that is the marginal cost for exporting from country i.

In comparing between the productivity cutoffs for export and FDI in equations (2-10) and (2-11), we expect two cases of the order of productivity cutoff for export and FDI as follows:

$$\text{(2-12)} \qquad \theta^X < \theta^I < \overline{\theta} = \widetilde{\theta}, \quad \text{if } f_j^X / f_j^I < \left(w_j / w_i\tau_j\right)^{\varepsilon-1},$$

$$\text{(2-12')} \qquad \widetilde{\theta} = \underline{\theta} < \theta^I < \theta^X, \quad \text{if } \left(w_j / w_i\tau_j\right)^{\varepsilon-1} < f^X / f^I$$

We depict two cases of FDI in Figure 1. The case 1 of inequality ((2-12); $\theta_1^X < \theta_1^I < \widetilde{\theta} = \overline{\theta}$) shows the standard case as presented by Helpman et al. (2004), in which the wage rate in the FDI host country is similar to that in the home country. As the solid line in Figure 1 shows, the choice of export or FDI is uniquely sorted out according to

productivity rank. The firm whose productivity is between θ_1^X and $\overline{\theta}$ will export, while the firm whose productivity is higher than $\overline{\theta}$ will engage in FDI. This case is likely if the wage rate in FDI destination is similar to the wage and transport cost for export of country i and also if the relative fixed cost for FDI to export is high. This condition leads to the case that the productivity cutoff for FDI is higher than that for export. We can classify this type of FDI as horizontal type of FDI in developed countries reported by Markusen (1984).

On the other hand, the order of productivity cutoffs for export and FDI may be reversed as presented by (2-12'). The case 2 of inequality ((2-12'); $\widetilde{\theta} = \underline{\theta} < \theta_2^I < \theta_2^X$) is depicted as the dotted line of an FDI firm's profit in Figure 1. This scenario shows only when firms engage in FDI without exporting. This case is likely if the wage rate in FDI destination is lower than the wage in exporting country and also if the relative fixed cost for FDI to export is low. In this case, the productivity cutoff for FDI becomes lower than the productivity cutoff for export. Then firms even with low productivity will produce the goods in the overseas market instead of exporting. This type of FDI is included in vertical type of FDI reported by Helpman (1984).

Figure 1

Firms actually internationalize in multiple markets that differ according to market size, wage rate, transport cost, and fixed cost. When firms internationalize in multiple countries, we cannot expect a simple pattern of internationalization that completely corresponds to the firms' productivity. Focusing on the wage rates, the choice of export or FDI is predicted to vary between high-wage and low-wage countries. The choice of export or FDI depends on market attributes, which determine the productivity cutoff for internationalization. In high-wage countries, such as OECD countries, the standard case tends to be the norm: firms with the highest productivity engage in FDI, and exporters follow. In low wage countries, however, firms even with low productivity may engage in FDI only, instead of export. When we decompose the firms into two groups: FDI firms and non-FDI firms, the difference in wage among FDI destinations leads to the hypothesis on

the distribution of firms' productivity as follows:

Hypothesis 1

The productivity distribution of firms engaging in FDI in high wage countries lies at higher productivity zone than the productivity distribution of non-FDI firms, and the productivity distribution of firms engaging in FDI in low wage countries lies at the same productivity zone as or lower productivity zone than that of non-FDI firms.

2.4 Pecking Order of FDI Destinations

Firms internationalize in multiple countries in mixed modes of export and FDI since the productivity cutoffs for export and FDI vary according to the different country-specific attributes. A firm with a certain level of productivity may export to one country (country A) while it conducts FDI in another country (country B) if the productivity cutoff required for FDI in country B is lower than country A. The firm with more export destinations is not necessarily more productive than the firm with fewer export destinations since a firm with higher productivity tends to switch its internationalization mode from export to FDI.

Suppose the productivity cutoff for FDI destination is common to all FDI candidates. Firm is likely to engage in FDI in the easiest destination, and will move to expand the next FDI destination with obtaining FDI in the easiest destination if the firm's productivity is higher than the productivity cutoff for FDI in the next destination. If we order the FDI destinations along with the order of productivity cutoff, we can predict that the order of firm's productivity coincides with the rank of number of FDI destinations of each firm. Then we can describe it as follows:

$$\theta^i{}_1 < \theta^i{}_2 < \ldots < \theta^i{}_k < \cdots < \theta^i{}_m \Leftrightarrow N^i{}_1(\theta^i_1) < N^i{}_2(\theta^i_2) < \cdots < N^i{}_k(\theta^i_k) < \cdots < N^i{}_m(\theta^i_m) \ ,$$
$$k = 1, 2, \cdots, m$$

where $\theta^i{}_k$ is the productivity cutoff for FDI in destination *k* from country *i*, and $N^i{}_k$ is the aggregated number of FDI destinations of the firm with productivity $\theta^i{}_k$

The productivity of firms engaging in larger number of destinations is higher than that of firms engaging in smaller number of destinations. This leads to the hypothesis to be empirically tested as follows:

Hypothesis 2

The productivity distribution of firms engaging in FDI in larger number of destinations lies at higher productivity zone than the productivity distribution of firms engaging in FDI in smaller number of destinations.

3. FDI in Multiple Markets

3.1 Productivity and Data

In this section, we empirically test whether hypothesis 1 is satisfied, based on micro-data from Taiwan firms. First, we measure the productivity of firms. For calculating the productivity, we construct the firm-level business data set including production, intermediate-inputs, capital stock, labor input. They are collected from 1267 Taiwan firms listed in the Taiwan stock exchange market in 2005.[3]

Based on the method by Caves et al. (1982), total factor productivity (TFP) is measured by the following equation:

$$\ln TFP_i = (\ln VA_i - \overline{\ln VA}) - \widetilde{S}_i(\ln L_i - \overline{\ln L}) - (1-\widetilde{S}_i)(\ln K_i - \overline{\ln K}), \quad (3\text{-}1)$$

where $\ln VA_i$, $\ln L_i$, and $\ln K_i$ are the value-added, the number of employees, and capital stock of firm i, in logarithm value, respectively, $\overline{\ln VA}$, $\overline{\ln L}$, and $\overline{\ln K}$ are the average value-added, the number of employees, and capital stock of firms belonging to 2-digit industry classification, in logarithm. The share of labor, $\widetilde{S}_i$, is defined by $\widetilde{S}_i = (s_i + \bar{s}_i)/2$, where the share of labor s_i is defined by the ratio of the employee's total payroll to the

[3] For collecting the firm-level data in Taiwan, we referred to the research project of International Economics, the Japan Center for Economic Research.

value-added, and $\bar{s}_i$ is given by the average labor share for the industry of firm i. $(1-\widetilde{S}_i)$ is the share of capital.

As for data of FDI firms, the Market Observation Post System (MOPS) provides the firm-level information of FDI destinations of Taiwan firms although it does not provide the destinations of export at all. We collected the firm-level FDI data from the Market Observation Post System (MOPS), Taiwan Stock Exchange, and matched them with the productivity. We used data of the year 2005 because of the limited availability of both business and FDI data. From the 1267 firms of the business data, only 453 are matched with FDI firms from the MOPS data. We regard the rest, 814 firms, as non-FDI firms.[4] As for FDI destinations, we excluded so-called "tax haven" countries and regions from FDI destinations.[5] 172 FDII firms engaged in FDI only in "tax haven" countries and regions. In this paper, eventually we selected 276 FDI firms in non-tax-haven countries and regions as samples for empirical testing.

Figure 2 shows the number of FDI firms of Taiwan in order by the number in each host country and region. The United States hosted the largest number of Taiwan firms, at 161, except for the People's Republic of China.[6] The second was Hong Kong, followed by Singapore and Japan. Here we counted the number of firms as one even if a firm owned multiple numbers of subsidiaries in one country.

Figure 2

3.2 Productivity Premium of FDI Firms

It is theoretically known that the choice of export or FDI depends on the market attributes since they determine the productivity cutoff for internationalization. Therefore, firm's

[4] More precisely, not only non-FDI firms and but also non-identifiable firms are included in the 814 firms.
[5] British Virgin Islands, Cayman, Samoa, Panama, Bahamas, Brunei, Cook Island, Mariana Island, Niue, Belize, Marshall Islands, Netherlands Antilles, Costa Rica, Bermuda, Macao, St. Vincent, Liberia, Luxembourg, and Mauritius are excluded from the destinations of FDI.
[6] PRC is excluded from the FDI destinations since the productivity cutoff for FDI in China is regarded as extremely low compared to that of other countries and regions.

choice of FDI varies between high-wage and low-wage countries. The subject of our empirical examination is to test whether a firm's productivity affects its choice of FDI, taking into account the difference in wages among countries.

For testing *Hypothesis 1*, we first classify the FDI firms in East Asian and Pacific Rim countries into two groups, according to the wage level of destinations: the low-wage countries ("FDI firms-low wage") are Thailand, Vietnam, Indonesia, Malaysia, Philippines, and Cambodia; and the high-wage countries ("FDI firms-high wage") are Korea, Singapore, Japan, Australia, and New Zealand.[7] Here we exclude the firms engaging in FDI in the US and European countries because of the far distance from Taiwan to these countries in comparison with Asia and Oceanic countries, and also exclude the firms having FDI in both high-wage and low-wage countries to avoid contamination of the two groups.

Table 1 shows the average premium in total factor productivity (TFP) of FDI firms-low wage and FDI firms-high wage, in comparison with non-FDI firms. The figures show that the average productivity premium of FDI firms-low wage are higher by 0.079 in logarithm than those of non-FDI firms, and those of FDI firms-high wage are higher by 0.463 in logarithm than those of non-FDI firms. The TFP premium of FDI firms-high wage is larger than the TFP premium of FDI firms-low wage. This is consistent with the theoretical prediction in the previous section.

Here, we statistically test the null hypotheses that the TFP premium is zero. The results of a statistical test demonstrate that the null hypothesis is not rejected for the TFP premium of FDI firms-low wage, while it is rejected for the case of FDI firms-high wage with a high statistical significance.

Table 1

3.3 Different Wage and the Choice of FDI: Nonparametric Approach

[7] We excluded firms engaging in FDI in the US and European countries because of far distance from Taiwan, in comparison with Asian countries. "Low wage" and "high wage" are defined by the relative level of GDP per capita between Taiwan and other countries. "Low-wage countries" are those whose GDP per capita is lower than Taiwan's, and "high-wage countries" are those whose GDP per capita is higher than Taiwan's.

Figure 3 depicts the probability density functions (PDFs) of three groups of firms. It shows that the PDF for FDI firms-high wage looks different from the PDFs for FDI firms-low wage and non-FDI firms. The PDF for FDI firms-high wage lies at the right to the PDFs for FDI firms-low wage and non-FDI firms.

Figure 3

In order to statistically test whether the functions of the three groups are differently distributed, we conduct a Kolmogorov-Smirnov test (K-S test). We assume that $G_1(\theta)$ and $G_2(\theta)$ denote the cumulative distribution functions (CDFs) of productivity θ for two comparison groups and that the stochastic dominance of $G_1(\theta)$ relative to $G_2(\theta)$ is defined by $G_1(\theta) - G_2(\theta) < 0$ for all values of productivity θ, following Delgado et al (2002). First, we test the hypothesis that $G_1(\theta)$ and $G_2(\theta)$ are different. The null and alternative hypotheses are expressed as follows:

(4-1)
$$\begin{aligned} &H_0 : G_1(\theta) - G_2(\theta) = 0 \quad \text{for all } \theta \\ &H_1 : G_1(\theta) - G_2(\theta) \neq 0 \quad \text{for some } \theta \end{aligned}$$

The K-S test statistics for the two-sided test is given by the following:

(4-2)
$$KS_2 = \sqrt{\frac{mn}{N}} \max_{1 \le i < N} \left| G_{1,m}(\theta_i) - G_{2,n}(\theta_i) \right|$$

where m and n are the sample sizes of the distributions $G_1(\theta)$ and $G_2(\theta)$, respectively, and $N = m + n$

Secondly, we test whether one group is stochastically dominant on the other. The null and alternative hypotheses are expressed as follows:

(4-3)
$$H_0 : G_1(\theta) - G_2(\theta) \le 0 \quad \text{for all } \theta$$
$$H_1 : G_1(\theta) - G_2(\theta) > 0 \quad \text{for some } \theta$$

The K-S test statistics for the one-sided test is given by the following:

(4-4)
$$KS_1 = \sqrt{\frac{mn}{N}} \max_{1 \le i < N} \left\{ G_{1,m}(\theta_i) - G_{2,n}(\theta_i) \right\}$$

If the null hypothesis for the two-sided test is rejected and the null hypothesis for the one-sided test is not rejected, we judge that $G_1(\theta)$ is stochastically dominant on $G_2(\theta)$. Graphically, this means that $G_1(\theta)$ lies entirely at the right position to $G_2(\theta)$. We test two hypotheses on the data of Taiwan firms for the year 2005.

The results of the K-S test displayed in the first column of Table 2 show that the null hypothesis for two-sided test—that the PDFs of FDI firms-high wage and non-FDI firms are identical—is rejected at a high statistical significance, although the null hypothesis for the two-sided test —that the PDFs between FDI firms-low wage and non-FDI firms are identical—is not rejected. There is no clear distinction in terms of productivity between FDI firms-low wage and non-FDI firms. The second column of Table 2 shows that the null hypothesis for one-sided test is not rejected. These results are consistent with the theoretical prediction that a high productivity is required for FDI in high-wage countries, although it is not necessarily required for FDI in low-wage countries.

Note that the PDF for FDI firms-low wage looks having two peaks in Figure 3. This suggests that low-wage countries may be further classified to very low-wage countries and middle low-wage countries or that the low-wage countries may be classified by other market attributes than wage.

Table 2

4. Pecking Order of FDI Destinations

As discussed in the previous section, the number of firm's FDI destinations is ordered by the productivity of the firm. Firms with low productivity engage in FDI only in countries that may be entered easily, while firms with high productivity engage in FDI even in countries difficult to enter. This section statistically tests to *Hypothesis 2* in section 2 that the productivity of firms with more FDI destinations is higher than the productivity of firms with fewer FDI destinations.

Table 3 shows the average productivity of firms corresponding to the number of FDI destinations. The first column classifies the number of FDI destinations. The second column presents the number of firms corresponding to the number of FDI destinations, showing that 126 firms engage in FDI in only one country, 73 firms have FDI in two countries, 33 firms have FDI in three countries, and so on. In the third column, the average productivity premium of firms is shown, corresponding to the classification. The results show that firms with a larger number of destinations tend to demonstrate a higher average productivity.

Table 3

The significant difference in productivity between non-FDI firms and firms with FDI in at least one destination suggests that the productivity cutoff for initial FDI is higher than the incremental rise of firm's productivity for additional FDI destinations. It must, however, be noted that the average productivity of firms with FDI in three countries is not higher than that for firms with FDI in two countries. This suggests that the productivity cutoff for FDI may not be only a factor to determine firm's choice of FDI destinations. A country may be easy to enter for one firm but difficult for another firm even if the two require the equal level of productivity for FDI.

In Figure 4 we depict the PDFs of firm's productivity for three groups: non-FDI firms, firms with FDI in one country, and firms with FDI in more than four countries, respectively. The PDFs look shifting to the right according to the increase in FDI destinations.

Figure 4

Figure 5 presents the cumulative distribution functions of the three groups: non-FDI firms, FDI firms with one country, and FDI firms with more than four countries. We also observe that the functions shift to the right according to the increase in FDI destinations.

Figure 5

In order to examine statistically the pecking order of number of FDI destinations according to the productivity, we conduct the K-S test to examine the null hypothesis that the PDFs are identical. According to the same statistical method as described in section 3.3, we examine which PDF is statistically dominant on the others by using the K-S test. The null hypothesis for the one-sided test is that the productivity of firms with a large number of FDI destinations is higher than the productivity of firms with a smaller number of FDI destinations. If the null hypothesis for the two-sided test is rejected and the null hypothesis for the one-sided test is not rejected, we judge that one distribution is stochastically dominant on the other.

Table 4 presents the estimated results. The upper and lower parts of the table show the results of the statistical tests on non-FDI firms as the standard and the group of firms with one FDI destination as the standard, respectively. The P-values for the K-S test in the upper part of the table confirm that the null hypothesis for the two-sided is rejected, and the null hypothesis for the one-sided tests is not rejected, in all cases. This result shows that the productivity of FDI firms is statistically dominant on non-FDI firms.

The P-values for the K-S tests in the lower part of the table do not necessarily show statistically significant results. The P-value is not small for the two-sided t-tests for FDI firms with two destinations or more than three destinations vs. FDI firms with one destination, while the P-value is small for the two-sided t-tests for FDI firms with more

than four destinations vs. FDI firms with one destination, thus rejecting the null hypothesis in terms of statistical significance. This result shows that the K-S tests for only FDI firms with more than four destinations vs. FDI firms with one destination rejects the null hypothesis at the 10 percent significance level, whereas the results of the K-S tests for FDI firms with more than three or less than three destinations vs. FDI firms with one destination do not reject the null hypothesis. On the other hand, the P-value is large for the one-sided t-tests of FDI firms in all cases, thus not rejecting the null hypothesis for the one-sided tests.

Table 4

The results of the statistical tests confirm that the firms with a larger number of FDI destinations tend to be more productive than the firms with a smaller number of FDI destinations, although they do not perfectly confirm a pecking order of FDI destinations according to firm's productivity. For example, the productivity of firms with two FDI destinations is not clearly dominant on the productivity of firms with one FDI destination since the P-value of the K-S two-sided test is not statistically significant. Even though the market specific attributes are common to the firms, the firm-specific attributes except for productivity may be different. This causes a deviation of the pecking order of FDI destinations. As a reason for the inconsistency between the theoretical conjecture and the empirical results, we can assume different firm-specific costs: the fixed and marginal costs for entering the market will be different among firms. This subject remains for further consideration.

5. Concluding Remarks

This paper attempted to examine empirically in what way firm's productivity and market-specific factors jointly affect a firm's choice of FDI in multiple destinations, using Taiwan firm-level data. The paper has contributed two findings. It provides the evidence that market-specific attributes affect the productivity cutoff for a firm's FDI, and then each market sets a different productivity cutoff for FDI. Our empirical results confirm that the

productivity of FDI firms is significantly higher than the productivity of non-FDI firms, We furthermore classify the Taiwan firms with FDI destinations in East Asia and Pacific Rim into two groups—FDI firms in low-wage countries and FDI firms in high-wage countries—and then compare the productivity between two groups. The results of our examination based on nonparametric approach demonstrate that the productivity of firms conducting FDI in high-wage countries is statistically significantly higher than the productivity of firms conducting FDI in low-wage countries and that the latter does not differ from the productivity of non-FDI firms.

Helpman et al. (2004) assumed horizontal FDI in countries of identical wage rate in which the choice of FDI is ordered clearly according to the level of productivity. Their theoretical conjecture is, however, not simply applicable across the board in explaining the choice of firms in terms of FDI destinations with different marginal and fixed costs. Our empirical examination demonstrates the evidence that the choices of FDI firms cannot be clearly ordered according to productivity. Our empirical results extended the previous studies including Helpman et al. (2004) and Yeaple (2008).

The second finding has to do with how robustly the productivity determines the pecking order of FDI destinations. Our empirical results confirm the hypothesis that the productivity of firms with a larger number of FDI destinations tends to be higher than the productivity of firms with a smaller number of FDI destinations. This is evidenced by nonparametric approach of comparing the productivity between FDI firms with one FDI destination and those with more than four FDI destinations.

The results in this paper are fairly robust, but a deviation exists in some cases. This problem may be due to a shortcoming in the data. The firm-level data used in this research are all publicly disclosed, but the number of samples is not sufficiently large because of the necessity of dropping some of the data in matching firms' business data with FDI data. Improvements in firm-level data sources would enable us to conduct a more accurate examination. We must also note that the pecking order of FDI destinations cannot be completely established under certain conditions—for example, if the number of FDI destinations is very close, like between one and two. The implication is that the pecking

order will be distorted if other factors, such as firm-specific attributes, vary even under identical market-specific factors. Further research is needed in order to reveal what firm-specific factors distort the pecking order of FDI destinations. We also note that this paper assumed two-country model. Our theoretical and empirical study does not include the case of FDI for exporting the goods to Taiwan or the third country. Further theoretical framework is needed for the research of FDI as the export platform

Finally, we briefly mention the policy implications in this paper. The results of our empirical studies, which are consistent with the theoretical predictions of HMY model and many empirical studies, confirm that the higher the productivity of firms and the lower the costs for internationalization, the greater their internationalization. The implication is that policies supporting higher productivity and lowering the costs for FDI would accelerate the internationalization of Taiwan firms and would eventually enforce the Taiwanese economic growth which has heretofore depended largely on the world economy.

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Figure 1 Productivity Cutoff for Export and FDI

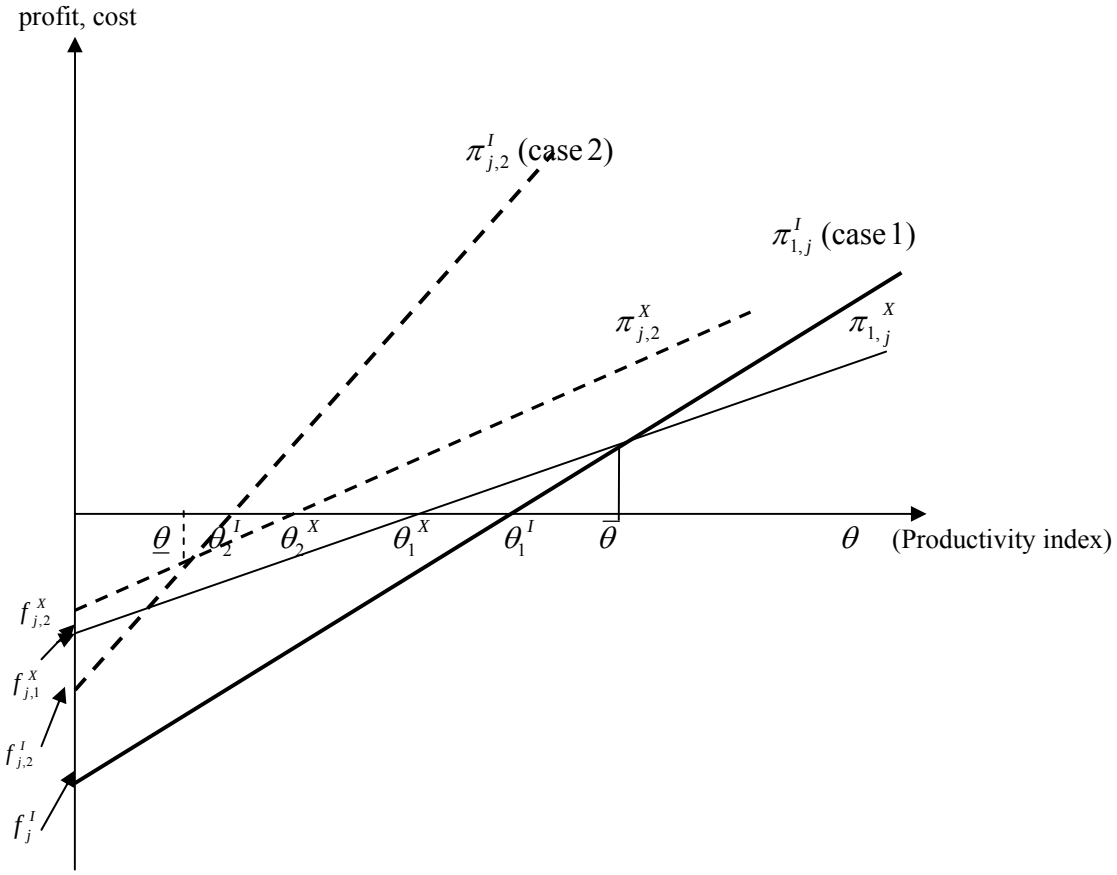

Figure 2. FDI of Taiwan Firms (by Destination, except China, 2005)

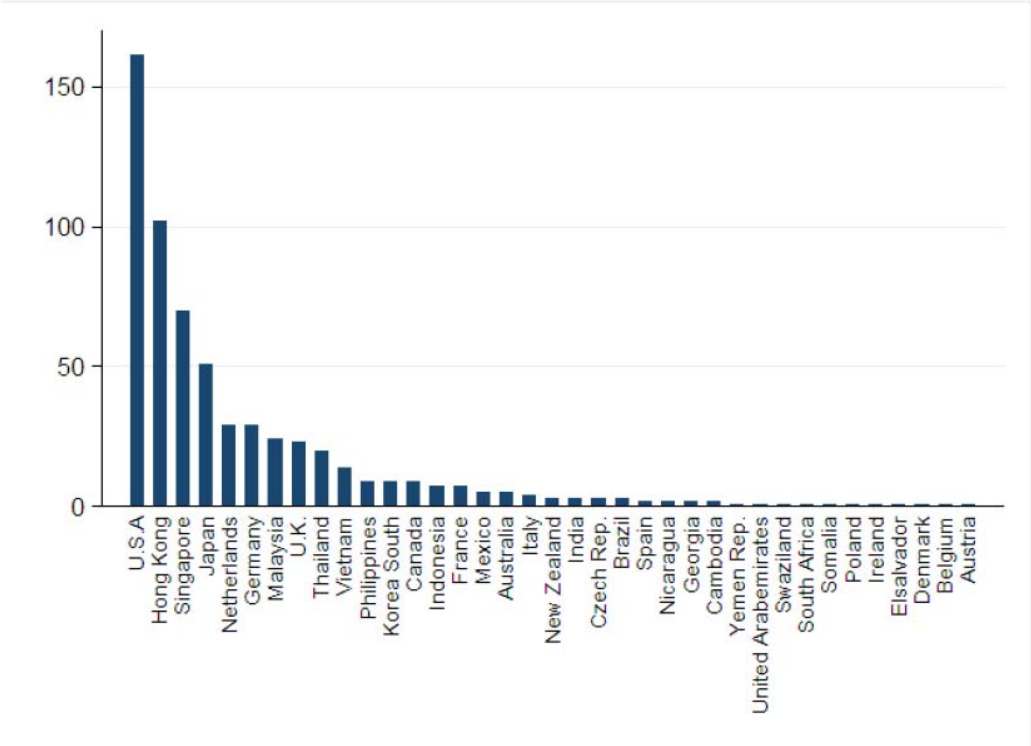

Figure 3. Probability Density Functions of FDI Firms

(Two Destinations: High and Low Wage Countries)

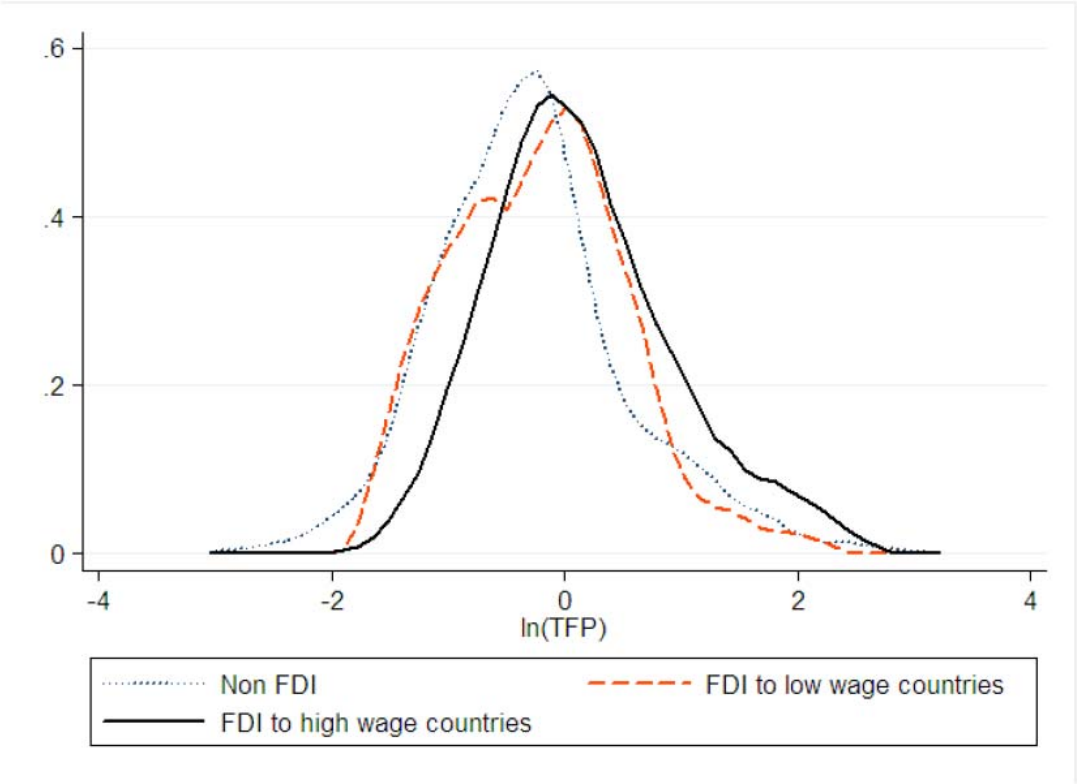

Figure 4. Probability Density Functions of FDI Firms
(by Number of Destinations)

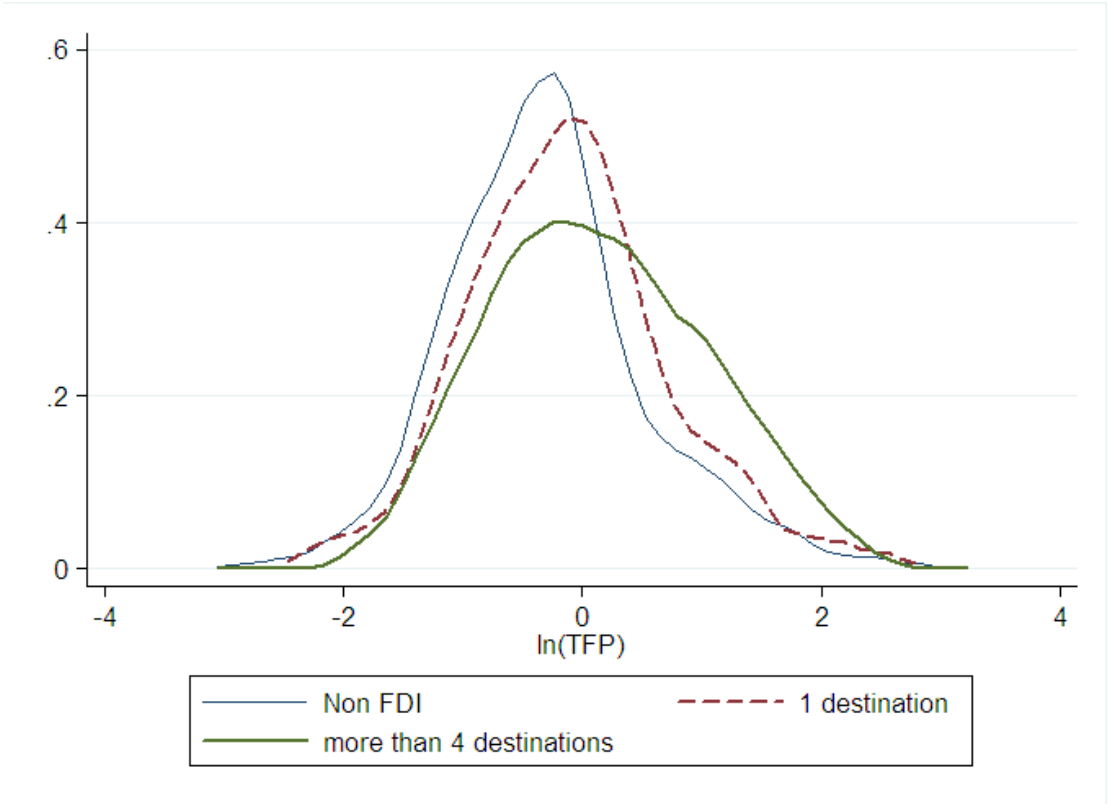

Figure 5. Cumulative Distribution Functions of FID Firms

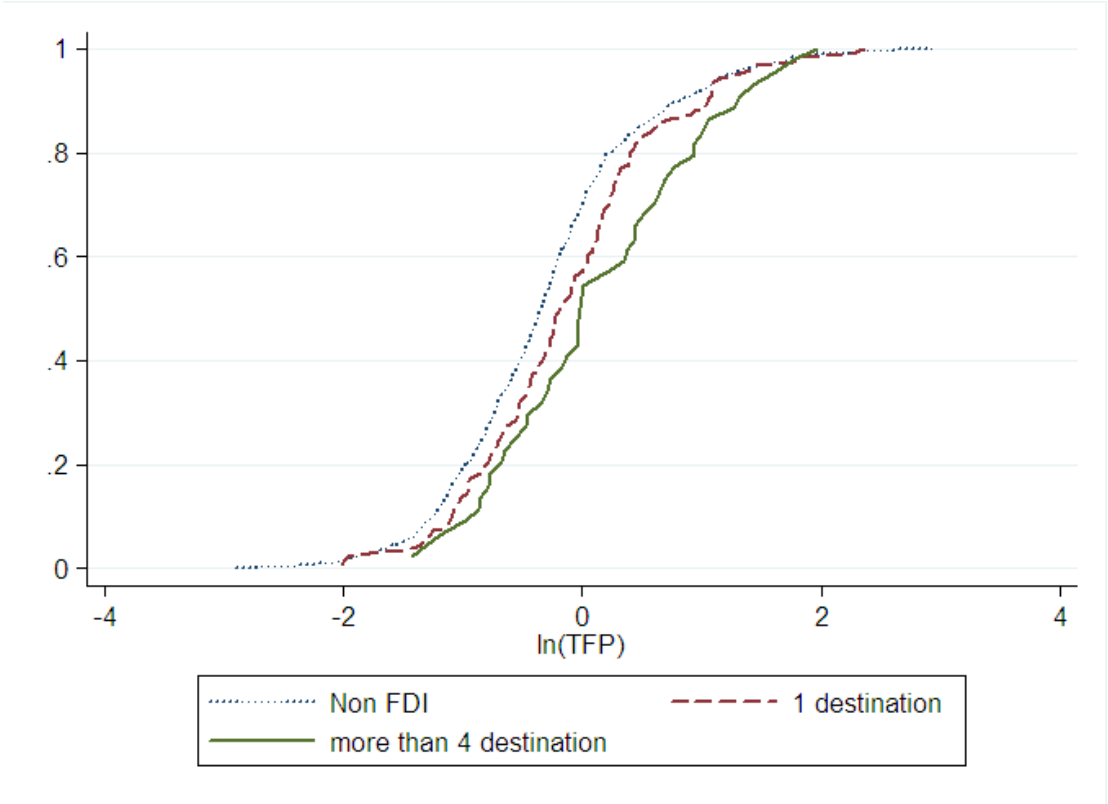

Table 1. Productivity Premium of FDI Firms

Groups	Number of firms	Premia of Productivity to non-FDI Firms (logarithym)	P value for t-test (one-sided)
NON-FDI Firms	774	*****	
FDI firms-low wage	43	0.079	0.271
FDI firms-high wage	97	0.463	0.000

Table 2. K-S test for FDI in Different Markets

	Tow-sided H_0: equality	One-sided H_0: FDI<Non FDI
FDI low wage vs Non FDI	0.1370 [0.345]	-0.1370 [0.209]
FDI high wage vs Non FDI	0.2640 [0.000]	-0.0077 [0.990]

Note: Asymptotic P-values are shown in brackets.

Table 3. Productivity Premium (by Number of Destinations)

Number of FDI destinations	Number of firms	Premia of Productivity to non-FDI Firms (logarithym)
0	774	
1	126	0.1862
2	73	0.2696
3	33	0.1588
more than 3	77	0.3198
more than 4	44	0.4405

Table 4. K-S test for Pecking Order

	Kolmogorov-Smirnov Test	
Number of FDI countries	Tow-sided H_0: equality	One-sided H_0: FDI < Non FDI
Non-FDI firms vs		
1 FDI destination	0.1461 [0.014]	-0.0096 [0.980]
2 FDI destinations	0.2030 [0.005]	-0.0090 [0.989]
more than 3 destinations	0.2177 [0.002]	-0.0103 [0.985]
more than 4 destinations	0.2721 [0.002]	-0.0103 [0.991]
FDI firms with one destination vs		
2 FDI destinations	0.0906 [0.570]	-0.0248 [0.919]
more than 3 destinations	0.1182 [0.449]	-0.0185 [0.968]
more than 4 destinations	0.2035 [0.096]	-0.0157 [0.984]

Note: Asymptotic P-values are shown in brackets.