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Countries**

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# Heterogeneous Firms Serving Developing Countries\*

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## Abstract

Many previous studies based on a simple model of heterogeneous firms have identified characteristics of multinational firms engaging in export or foreign direct investment (FDI). While they focused mainly on firms that serve developed countries, this study analyzes both firms serving developing countries as well as those serving developed countries. The purpose was to identify the determining factors of firms' decision to either export or provide FDI. The results of our analyses indicated that the determining factors differ according to characteristics of the destination country; they differ between the two cases. In accordance with previous studies, firms that served developed countries were found to base their decision on the productivity level. On the other hand, firms that served developing countries were found to base their decision primarily on the capital-labor ratio, and secondarily on the productivity level. Thus, among the firms serving developing countries, capital-intensive firms chose to export while labor-intensive firms chose to provide FDI, regardless of the productivity level, and only firms with a mid-value capital-labor ratio based their decision on the productivity level. These findings, which were supported by empirical evidence derived from Japanese manufacturing firm-level data, indicated that productivity level is not as significant a factor for firms serving developing countries as it is for firms serving developed countries.

**JEL classification:** F12; F21; F23

**Key words:** Firm heterogeneity; Developing countries; Export; FDI

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# 1 Introduction

Developing countries experiencing strong economic growth are making their presence felt more than ever in the global economy. Moreover, multinational firms are increasingly focusing on developing countries, especially after the recent financial crisis. In contrast to most research into recent international trade, which focused mainly on firms that serve developed countries, this study focuses on firms serving developing countries. Multinational firms primarily serve foreign countries by either the export of goods or the provision of foreign direct investment (FDI).<sup>1</sup> This study focuses on identifying and comparing the most significant factors that influence their decision to either export or provide FDI in the following two cases: firms serving developed countries and those serving developing countries.

Research of heterogeneous firms, particularly Melitz (2003) and Helpman, Melitz, and Yeaple (2004: hereafter HMY) have contributed considerably to the recent international trade literature.<sup>2</sup> Assuming that firms are heterogeneous in their productivity levels, Melitz (2003) argued that only high-productivity firms should serve the home country and foreign export markets while all other firms should serve the home country only. Adding the proximity-concentration trade-off demonstrated by Brainard (1997) to Melitz's model, HMY concluded that high-productivity firms should serve foreign countries via export and very high-productivity firms should serve them via FDI: this implied that the productivity of FDI firms is higher than that of export firms.

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<sup>1</sup>We assume that each firm is a domestic firm, an exporting firm (hereafter referred to as an export firm), or a firm providing FDI (hereafter referred to as an FDI firm). Domestic firms serve the home country only, while export and FDI firms serve both the home and foreign countries. To serve foreign countries, export firms produce domestically, while FDI firms produce in the destination countries.

<sup>2</sup>See Helpman (2006) for an excellent survey of the research on heterogeneous firms.

Empirical studies have examined these theoretical analyses using firm-level data. Based on the analysis of U.S. firm-level data, Bernard et al. (2007a) concluded that high-productivity firms should serve foreign countries via export. Extending this analysis using European firm-level data, Mayer and Ottaviano (2007) argued that high-productivity firms should serve foreign countries via export while very high-productivity firms should serve them via FDI. Using Japanese firm-level data, Wakasugi et al. (2008) obtained results similar to those of Mayer and Ottaviano (2007). However, Wakasugi et al. (2008) also found that the productivity differences between FDI firms and export firms are substantially smaller in Japan than those in Europe because some productive firms serve foreign countries via export while other less-productive firms do so via FDI in Japan, which phenomenon a simple model of heterogeneous firms cannot explain. This may be because many developing countries surrounding Japan have many Japanese firms serving their markets.<sup>3</sup>

To explain this phenomenon, we must primarily identify undetected factors and add them to the model in order to improve its accuracy. These undetected factors can be identified by considering a destination country's characteristics, which previous studies based on a simple model of heterogeneous firms did not adequately assess. Yeaple (2009) demonstrated that the characteristics of destination countries determine a productivity cutoff. Aw and Lee (2008) and Wakasugi and Tanaka (2009) empirically examined Taiwanese and Japanese firm-level data respectively, assuming the existence of two types of destination countries (developed and developing countries). They observed that the productivity level does not explain whether firms

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<sup>3</sup>A simple model of heterogeneous firms only considers symmetric countries and the case of firms in developed countries serving developed countries. Thus it cannot consider firms serving developing countries.

serving developing countries chose to export or provide FDI there while it does explain that aspect for firms serving developed countries, the reason for which has not been stated.

Head and Ries (2003) extended HMY's model to consider international factor price differences assuming that destination countries have a labor cost advantage.<sup>4</sup> They observed that not only high-productivity firms but also some low-productivity firms chose to provide FDI, and explained that the latter may do so to take advantage of low labor costs in the destination countries. This explanation implied that firms serving developing countries, which generally have a labor cost advantage, by providing FDI are not necessarily productive. In addition, previous studies have still not addressed the issue that some productive firms choose to export instead of providing FDI.

In this paper, we incorporate two factors of production (labor and capital) into a model of heterogeneous firms, assuming that firms are heterogeneous in their productivity levels and capital-labor ratios.<sup>5</sup> We also assume that developed countries including the home country have a capital advantage, while developing countries have a labor advantage. This assumption is different from that of Head and Ries (2003) as developing (developed) countries do not always have advantage (disadvantage) in production. The values for global real wages and capital rental rates, as reported by Marshall (2010) and standardized according to Japanese values, are shown in Figure 1 providing further evidence that this assumption is realistic.

[Figure 1 around here]

Analysis based on these realistic assumptions may yield new findings.

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<sup>4</sup>Head and Ries (2003) considered labor as the only factor of production, and thus assumed that destination countries always have an advantage in production.

<sup>5</sup>Bernard et al. (2007b) presented a model that incorporates heterogeneous firms and comparative advantage, but does not consider FDI firms.

Multinational firms choose to either export or providing FDI to minimize their production costs. In the case of firms serving developing countries, labor-intensive firms have an incentive to produce in developing countries while capital-intensive firms have an incentive to produce in the home country, and thus each of them takes advantage of low production cost. In short, labor-intensive firms choose to provide FDI, while capital-intensive firms choose to export regardless of the productivity level. In this case, the capital-labor ratio explains firms' choice between exporting and providing FDI, and the productivity level matters only to firms with a mid-level capital-labor ratio. Thus our model explains the phenomenon that some productive firms choose to export to developing countries, while less-productive firms choose to provide FDI, which previous studies have not explained. In the case of firms serving developed countries, the productivity level explains firms' choice between exporting and providing FDI, where the capital-labor ratio is not significant. This is because the home and developed destination countries offer the same capital and labor advantages and variations in production costs do not depend on the capital-labor ratio but rather on the productivity level. Then, our model demonstrates that the productivity of firms that provide FDI is higher than that of firms that export, which accords with the results obtained by HMY in their analysis of firms serving developed countries.

In contrast, our model can adequately explain the choices of both types of firms. In particular, our model demonstrates that the determining factors in firms' choice between exporting and providing FDI differ between the two cases. Subsequently, it explains why some productive firms choose to export while other less-productive firms choose to provide FDI when they serve developing countries. The remainder of this paper is organized as fol-

lows: Section 2 introduces the theoretical framework of this study; Section 3 empirically tests the framework using Japanese manufacturing firm-level data. Finally, Section 4 conclude the paper.

## 2 The Model

### 2.1 Demand

The basic framework of this study is based on the HMY model. The preferences of a representative consumer are given by the constant elasticity of substitution (CES) utility function over a continuum of goods indexed by  $\omega$ :

$$U = \left[ \int_{\omega \in \Omega} q(\omega)^\rho d\omega \right]^{1/\rho}, \quad (1)$$

where the measure of the set  $\Omega$  represents the mass of available goods, and  $q(\omega)$  is the demand for goods  $\omega$ . These goods are substitutes, implying  $0 < \rho < 1$  and that an elasticity of substitution of  $\sigma = 1/(1 - \rho) > 1$  exists between any two goods. The demand for goods  $\omega$  in country  $j$  can be written as

$$q_j(\omega) = \frac{p_j(\omega)^{-\sigma} E_j}{\int_{\omega \in \Omega} p_j(\omega)^{1-\sigma} d\omega} = p_j(\omega)^{-\sigma} A_j, \quad (2)$$

where  $E_j$  is the total expenditure of country  $j$ , and  $A_j$  is the demand level, which is exogenous from the firms perspective.

### 2.2 Production

Each firm chooses to produce a different variety of  $\omega$  using two factors of production, labor and capital.<sup>6</sup> We assume that firms draw the productiv-

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<sup>6</sup>This assumption led our results to differ from those of previous studies that focused mainly on firms serving developed countries. By making this assumption, we could also

ity level and capital-labor ratio from some distributions before they begin production, and that they are heterogeneous in their productivity level and capital-labor ratio. Based on these assumptions, the marginal costs of firm  $i$  in the home country  $d$  can be written as

$$c_{id} = \frac{w_d l_i + r_d k_i}{\theta_i}, \quad (3)$$

where  $w_d$  and  $r_d$  are the wages and the capital rental rates in the home country  $d$ ;  $l_i$  and  $k_i$  are the unit requirements of labor and capital for firm  $i$  to produce; and  $\theta_i$  is the productivity of firm  $i$ . Hereafter we normalize  $l_i = 1$  since doing so is sufficient for determining the capital-labor ratio of each firm, which is now represented as  $k_i$ .<sup>7</sup> Briefly, the marginal costs vary as a function of the capital-labor ratio and the productivity of firms, and the wages and capital rental rates of the country where firms produce.

Let us consider the case of firms serving foreign countries by either exporting or providing FDI to them. If a firm chooses to export, it additionally bears a melting-iceberg transport cost of  $\tau > 1$ . Thus, the marginal costs of firms that export to country  $f$  can be written as

$$c_{iXf} = \frac{w_d l_i + r_d k_i}{\theta_i} \tau. \quad (4)$$

On the other hand, if a firm chooses to provide FDI, it does not bear

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analyze firms serving developing countries.

<sup>7</sup>We assumed the existence of the Leontief production function, which implies that factors of production should be used in fixed proportions as there is no substitutability between factors for two reasons; first, assuming this type of production function allowed us to avoid the problems that would have arisen if we could not obtain data on the capital-labor ratio of foreign affiliates when we tested our model empirically. Second, we assumed that firms could not elastically modify their production technologies to adapt to factor prices, especially when firms produce in foreign countries. Although firms might be heterogeneous in the elasticity that modifies their technologies, for simplicity we did not consider this factor.

the transport cost because it produces and sells its goods in each foreign destination country. Thus, the marginal costs of firms that provide FDI to country  $f$  can be written as

$$c_{iIf} = \frac{w_f l_i + r_f k_i}{\theta_i}, \quad (5)$$

where  $w_f$  and  $r_f$  are the wages and the capital rental rates in the foreign destination country  $f$ . Under these assumptions, the price of the goods supplied by firm  $i$  is

$$p_{im} = \frac{c_{im}}{\alpha}, \quad (6)$$

where  $\alpha$  is the markup and  $c_{im}$  is either  $c_{id}$ ,  $c_{iXf}$ , or  $c_{iIf}$ .

Now let us consider the firms' profit. Firms should first enter the home country and bear the fixed cost  $f_d$ . When they do so, their operating profit from serving the home country is

$$\pi_{id} = B_d(w_d + r_d k_i)^{1-\sigma} \Theta_i - f, \quad (7)$$

where  $\Theta_i = \theta_i^{\sigma-1}$  and  $B_d$  denotes the home country's demand level from the firms perspective. In addition to this form of profit, both firms that export and those that provide FDI earn profit from their foreign operation. Whereas firms that export bear the additional fixed cost  $f_{Xf}$  as the cost of forming a distribution and service network in a foreign country  $f$ , firms that provide FDI bear the additional fixed cost  $f_{If}$  as the costs of forming a distribution and service network as well as establishing a subsidiary in a foreign country  $f$ . Assuming that  $f_d < f_{Xf} \tau^{\sigma-1} < f_{If}$ , the additional operating profits earned from exporting and providing FDI are respectively

$$\pi_{iXf} = B_f[\tau(w_d + r_d k_i)]^{1-\sigma} \Theta_i - f_{Xf}, \quad (8)$$

$$\pi_{iIf} = B_f(w_f + r_f k_i)^{1-\sigma} \Theta_i - f_{If}. \quad (9)$$

As discussed by HMY, there is a trade-off between exporting and providing FDI. In particular, exporting (providing FDI) benefits multinational firms by decreasing fixed (marginal) costs, but disadvantages them by increasing marginal (fixed) costs. HMY concluded that because firms base their decisions on the best means available for maximizing profit and on their productivity levels, this variable explains firms' choice between exporting and providing FDI. However, this study found that the variable of the capital-labor ratio  $k_i$  is also significant in firms' choice, which led to the new findings described in the following sections.

### 2.3 Zero-Cutoff Profit Conditions

The cutoff productivity level of domestic firms, export firms, and FDI firms is respectively

$$\hat{\Theta}_d = \frac{f_d}{B_d(w_d + r_d k_i)^{1-\sigma}}, \quad (10)$$

$$\hat{\Theta}_{Xf} = \frac{f_{Xf}}{B_f[\tau(w_d + r_d k_i)]^{1-\sigma}}, \quad (11)$$

$$\hat{\Theta}_{If} = \frac{f_{If}}{B_f(w_f + r_f k_i)^{1-\sigma}}. \quad (12)$$

For simplicity, let us assume  $B_d = B_f$ . As both export and FDI firms should enter the home country before serving foreign countries, the following conditions exist:

$$\begin{cases} f_d < \tau^{\sigma-1} f_{Xf}, \\ f_d < \left(\frac{w_f + r_f k_i}{w_d + r_d k_i}\right)^{\sigma-1} f_{If}, \end{cases}$$

From these conditions, it is clear that a firm can serve foreign countries by either exporting or providing FDI. However, it remains unclear whether

the firm should choose to serve by exporting or providing FDI because the magnitude relation between  $\hat{\Theta}_{Xf}$  and  $\hat{\Theta}_{If}$  remains unknown. This magnitude relation depends on the factor price differences between the home and foreign destination countries, as well as the capital-labor ratio of firms. Therefore, we should consider two cases; first when firms serve developing countries, and second when firms serve developed countries. In the first case, we assume that there is a factor price difference between the home and foreign destination countries; thus, the magnitude relation depends on the capital-labor ratio of firms and is heterogeneous. In contrast, in the second case, we assume that there is no factor price difference between the home and foreign destination countries; thus, the magnitude relation does not depend on the capital-labor ratio of firms and the result should be the same as that obtained by HMY.

## 2.4 Destination Country Characteristics

We have so far incorporated two factors of production into the model of heterogeneous firms. Let us advance this model by adding the variables of the destination country's characteristics. We assume that the home country is a developed country and that each foreign destination country is either a developed or developing country. Assuming that these countries differ only in their factor prices for simplicity, developed countries have a capital advantage and developing countries have a labor advantage, as shown in Figure 1.<sup>8</sup> These assumptions can be written as

$$\begin{cases} \frac{w_S}{w_d} < 1 < \frac{r_S}{r_d}, \\ \frac{w_N}{w_d} = 1 = \frac{r_N}{r_d}, \end{cases}$$

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<sup>8</sup>There might be another possibility; the destination country has both a capital and labor advantage. In such a case, we would not necessarily have to consider the two factors of production, and the theoretical result would be the same as that obtained by Head and Ries (2003). This case, however, does not generally arise as demonstrated by Figure 1.

$$\begin{cases} f_{XS} = f_{XN} = f_X, \\ f_{IS} = f_{IN} = f_I, \\ B_d = B_S = B_N = B, \end{cases} \quad (13)$$

where the subscript  $S$  denotes developing countries and the subscript  $N$  denotes developed countries. As described above, we simply represent the fixed costs of export firms and FDI firms as  $f_X$  and  $f_I$ , regardless of the destination countries. Similarly, we can simply represent the demand level of each destination country as  $B$ .

We now once again focus on the magnitude relation between  $\hat{\Theta}_{Xf}$  and  $\hat{\Theta}_{If}$  by separately considering the two cases, as discussed in detail below.

#### 2.4.1 Firms Serving Developing Countries

We first consider the case of firms serving developing countries. As we cannot generally determine the magnitude relation between  $\hat{\Theta}_{XS}$  and  $\hat{\Theta}_{IS}$  here, let us consider the case of  $\hat{\Theta}_{IS} < \hat{\Theta}_{XS}$ . In this case, the following condition exists:

$$k_i \left( r_d - \frac{f_I^{1/\sigma-1}}{\tau f_X^{1/\sigma-1}} r_S \right) > - \left( w_d - \frac{f_I^{1/\sigma-1}}{\tau f_X^{1/\sigma-1}} w_S \right). \quad (14)$$

Assuming that a factor price difference exists between the home and developing countries, this equation can be rewritten as

$$0 < k_i < k^*, \quad (15)$$

where  $k^* \equiv - \left( w_d - \frac{f_I^{1/\sigma-1}}{\tau f_X^{1/\sigma-1}} w_S \right) / \left( r_d - \frac{f_I^{1/\sigma-1}}{\tau f_X^{1/\sigma-1}} r_S \right)$  is the capital-labor ratio cutoff pertaining to a firm's choice between exporting and providing FDI. This value clearly relates that  $0 < k_i < k^*$  if and only if  $\hat{\Theta}_{IS} < \hat{\Theta}_{XS}$ , in which case the profit function  $\pi_{iIS}$  is higher than  $\pi_{iXS}$  at any possible productivity

level, as shown in Figure 2. Therefore, this value implies that labor-intensive firms, that is, firms for which  $k_i < k^*$  should provide FDI rather than export, regardless of their productivity levels, to developing countries.

[Figure 2 around here]

Subsequently, let us consider the case of  $\hat{\Theta}_{XS} < \hat{\Theta}_{IS}$ . In this case, it is important to determine whether  $\pi_{iXS}$  and  $\pi_{iIS}$  intersect, given  $\pi_{iIS}$  is steeper than  $\pi_{iXS}$ , at the productivity level  $\dot{\Theta}_{IS}$ . Here, our model can get the same result as the HMY model: low-productivity firms should export and high-productivity firms should provide FDI, as shown in Figure 3. This occurs under the following condition:

$$k^* < k_i < k^{**}, \quad (16)$$

where  $k^{**} \equiv -(\tau w_d - w_s)/(\tau r_d - r_s)$  and is also the capital-labor ratio cutoff. In this case, low-productivity firms, that is, firms for which  $\hat{\Theta}_{XS} < \Theta_i < \dot{\Theta}_{IS}$ , where  $\dot{\Theta}_{IS}$  is the productivity cutoff, choose to export, whereas high-productivity firms, that is, firms for which  $\dot{\Theta}_{IS} < \Theta_i$  choose to provide FDI. Briefly, firms characterized by a mid-value capital-labor ratio, that is, firms for which  $k^* < k_i < k^{**}$ , face the same situation as those in the HMY model.

[Figure 3 around here]

On the other hand, as long as  $\pi_{iXS}$  and  $\pi_{iIS}$  run parallel to one another or the former is steeper than the latter, they do not intersect. This occurs under the following condition:

$$k^{**} < k_i. \quad (17)$$

Here, the profit function  $\pi_{iXS}$  is higher than  $\pi_{iIS}$  at any productivity level, as shown in Figure 4. The relationship between these variables implies that firms with a high capital-labor ratio, that is, firms for which  $k^{**} < k_i$  should export rather than provide FDI, regardless of their productivity levels.

[Figure 4 around here]

Here, we briefly conclude the discussion (see Figure 5 and 6). In the case of firms serving developing countries, firms choose to either provide FDI or export to these countries. As the primary factor in their decision is their capital-labor ratio, labor-intensive firms choose to provide FDI, while capital-intensive firms choose to export. Firms with a mid-level capital-labor ratio, however, cannot base their decision on their capital-labor ratio, and thus, instead base it on their productivity levels.

[Figure 5 around here]

[Figure 6 around here]

**Proposition 1** *In the case of firms serving developing countries:*

- (1) *Labor-intensive firms choose to provide FDI, regardless of their productivity levels.*
- (2) *Firms with a mid-level capital-labor ratio choose to either provide FDI or export based on their productivity levels, whereas high-productivity firms choose to provide FDI and low-productivity firms choose to export.*
- (3) *Capital-intensive firms choose to export, regardless of their productivity levels.*

These propositions are significant in explaining why some productive firms choose to export to developing countries, while other less-productive firms provide FDI there; however, previous studies does not explain the actions of all the firms in this case.

### 2.4.2 Firms Serving Developed Countries

We now consider the case of firms serving developed countries. Similar to the previous subsection, let us consider the magnitude relation between  $\hat{\Theta}_{XN}$  and  $\hat{\Theta}_{IN}$ , as well as the existence of  $\dot{\Theta}_{IN}$ . Without a difference in factor prices between the home and destination countries, which we now assume are developed countries,  $k^* = -w_d/r_d < 0$ . Because  $k_i$  should be positive,  $\hat{\Theta}_{XN} < \hat{\Theta}_{IN}$  always consists, and there are no low-productivity firms that provide FDI to developed countries. On the other hand, because  $\pi_{iIN}$  is steeper than  $\pi_{iXN}$ ,  $\dot{\Theta}_{IN}$  always exists, and there are no high-productivity firms that export to developed countries. All the firms serving developed countries cannot base their decision on their capital-labor ratio, and thus, instead base it on their productivity levels: low-productivity firms, that is, firms for which  $\hat{\Theta}_{XS} < \Theta_i < \dot{\Theta}_{IS}$  choose to export, whereas high-productivity firms, that is, firms for which  $\dot{\Theta}_I < \Theta_i$  choose to provide FDI.

**Proposition 2** *All the firms serving developed countries base their decision of either providing FDI or exporting on their productivity levels, regardless of their capital-labor ratio.*

This proposition accords with the HMY model. As described above, as the factor price difference between the home and destination countries increases (decreases), the HMY model becomes less (more) significant. Our model clearly demonstrates that the determining factors in firms' choice between exporting and providing FDI differ according to the destination country's characteristics.

### 3 Empirical Analysis

#### 3.1 Empirical model

We begin this section by demonstrating a significant problem with the simple model that has been previously applied. While it can clearly explain firms' choice between exporting and providing FDI in the case of firms serving developed countries, it fails to explain firms' choice in the case of firms serving developing countries. In accordance with many previous studies regarding firms' choice between exporting and providing FDI, we commence by specifying the following equations:

$$D_{iIS} = \alpha_S + \beta_S \ln(\theta_i) + \gamma_S \ln(K/L_i) + \delta_S(\text{characters}_i) + \epsilon_{Si}, \quad (18)$$

$$D_{iIN} = \alpha_N + \beta_N \ln(\theta_i) + \gamma_N \ln(K/L_i) + \delta_N(\text{characters}_i) + \epsilon_{Ni}, \quad (19)$$

where each dependent variable is a dummy variable as follows:

$$D_{ij} = \begin{cases} 1 & \text{if firm } i \text{ invests in country } j, \\ 0 & \text{if firm } i \text{ exports to country } j, \end{cases} \quad (20)$$

where  $j \in S, N$ . As previously described, this study is based on the assumption that firms serve foreign countries by either exporting or providing FDI to them. While we acknowledge the existence of domestic firms solely serving the home country, we do not consider them here because our interest lies mainly in multinational firms' choice in serving foreign countries. Conversely, for equations (18) and (19), the independent variable  $\theta_i$  is the productivity level, the independent variable  $K/L_i$  is the capital-labor ratio, and the control variable  $\text{characters}_i$  contains the sales and industry-dummy variable of

firm  $i$ . Our interest here lies in  $\beta_S$  and  $\beta_N$ . According to the simple model,  $\beta_S$  should be nonnegative. However, we cannot categorically describe it as significantly positive or zero, because according to **Proposition 1**, it should be zero for capital or labor-intensive firms but positive for firms with a mid-level capital-labor ratio. According to previous studies, including those of Aw and Lee (2008) and Wakasugi and Tanaka (2009),  $\beta_S$  could be zero. On the other hand, according to **Proposition 2**,  $\beta_N$  should be significantly positive. Thus, the simple model explains the decisions of firms that serve developed countries but not of those that serve developing countries. These estimations are conducted by both probit and logit methods.

We now test our new model by grouping firms into four quartiles based on the value of  $K/L_i$ . Let  $p = 1, \dots, 4$  subscripts denote the quartiles and  $I_{ip}$  be the dummy variable of whether firm  $i$  is in quartile  $p$ . We estimate the equation as follows:

$$D_{iIS} = a_S + \sum_{p=1}^4 b_{Sp}[\ln(\theta_i)I_{ip}] + d_S(\text{characters}_i)e_{Si}, \quad (21)$$

$$D_{iIN} = a_N + \sum_{p=1}^4 b_{Np}[\ln(\theta_i)I_{ip}] + d_N(\text{characters}_i)e_{Ni}, \quad (22)$$

where  $[\ln(\theta_i)I_{ip}]$  are the four primary regressors and  $b_{j1}, \dots, b_{j4}$  are the corresponding coefficients. Equation (21) addresses the problems faced by firms serving developing countries that the simple model (18) does not. According to **Proposition 1**,  $b_{Sp}$  in middle  $p$  should be positive and the others should be zero. Equation (22) is relevant to firms that serve developed countries. According to **Proposition 2**, all  $b_{Np}$  should be positive. These estimations are also conducted by both probit and logit methods.

As demonstrated, the simple model clearly explains the decisions of firms that serve developed countries but not of those firms that serve developing

countries. However, our new model explains the decisions of both types of firms.

### 3.2 Data Collection

For empirical analysis, we collected data regarding listed Japanese manufacturing firms from the period 1990-2000. From the *Nikkei NEEDS* database, we collected data on the variables of employment (as labor input), tangible fixed assets (as capital input), value added, investments, total sales, and industrial classifications. From the *Toyokeizai Japan Overseas Investment*, we collected data on firms' investment activities abroad. Although we also desired to collect data regarding firms' export activities, it is difficult to obtain such data in Japan. However, lack of access to these data posed no serious problems. The data in our analysis were limited to those regarding large firms, which would be expected to export or invest abroad. We can therefore regard exporting firms as those that do not invest abroad.

Regarding the selection of countries, we considered the United States and China adequate for our analysis. We regarded the United States, the top destination of Japanese exports and FDI, as a developed country, and China, the second top destination of Japanese exports and FDI, as a developing country. Regarding the productivity of firms, we analyzed firm-level financial data to calculate two types of productivity using two types of analyses, the ordinary least squares method (OLS) and a method developed by Olley and Pakes (1996). Whereas the former could pose selection and simultaneity problems, the latter resolves these problems.<sup>9</sup>

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<sup>9</sup>We calculated the productivity level assuming the existence of the Cobb-Douglas production function, but assumed the existence of the Leontief production function in the previous section. However, this apparent contradiction did not affect our results because there was little change in the relative factors prices in Japan between 1990 and 2000. As the relative prices remained unchanged, using this approach was not problematic.

Although construction of a panel data set may be desirable, doing so poses three problems. The first problem concerns simultaneity. Although we are interested in whether productivity explains firms' choice of either providing FDI or exporting, there could also be the opposite effect.<sup>10</sup> The second problem concerns fixed effects. Using panel data, firms' individual effects might perfectly explain whether firms choose to provide FDI or export, as firms do not generally change their decision on a short-term basis. If so, we cannot estimate any coefficients. The third problem concerns accidental shocks. Although firms sometimes drastically decrease their activity because of accidental shocks resulting from some economic fluctuation, they would not simultaneously change their mode of serving foreign countries. The regressions would not be efficient with such accidental shocks. To address these problems, we calculated the average of each independent variable over time (1990-1999) and used the dependent variable of only one year (2000).

### 3.3 Empirical Results

Table 1 shows the estimated results in the case of firms serving China. The values in the first, third, fifth, and seventh columns correspond to the estimates obtained from equation (18). The results clearly reveal that firms base their decision to export or provide FDI not on their productivity levels but rather on their capital-labor ratio; thus, this partially supports **Proposition 1**. The values in the second, fourth, sixth, and eighth columns, which were obtained from equation (21), confirm this conclusion. As expected, productivity explains the decision of firms with a high-middle capital-labor ratio; however, it is insignificant in the decision of other types of firms. Firms with a low or low-middle capital-labor ratio could choose to provide FDI, regardless

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<sup>10</sup>As demonstrated by Kimura and Kiyota (2006).

of their productivity level, and low-productivity firms could also choose to invest abroad. Conversely, firms with a high capital-labor ratio could choose to export, regardless of their productivity levels, and high-productivity firms could also choose to export.

[Table 1 around here]

Table 2 similarly shows the estimated results in the case of firms serving United States. The values in the first, third, fifth, and seventh columns correspond to the estimates obtained from equation (19). These results clearly reveal that firms base their decision on their productivity levels, regardless of their capital-labor ratio; thus, this supports **Proposition 2**. The values in the second, fourth, sixth, and eighth columns, which were obtained from equation (22), confirm this conclusion. Although the productivity level is expected to be a significant factor in the decision making of all firms, it is insignificant for firms with a low capital-labor ratio. This is demonstrated by the values in the fourth and eighth columns. This finding may be attributed to the fact that factor prices in the United States and Japan are not perfectly equal, as is often assumed. Unlike firms serving China, almost all the firms serving the United States base their decision on their productivity levels.

[Table 2 around here]

## 4 Conclusion

Many previous studies based on a model of heterogeneous firms have presented significant findings, especially considering the case of firms serving developed countries. However, they have failed to clearly explain the case of firms serving developing countries. To consider both cases, we incorporated

the factors of production and country characteristics into a model of heterogeneous firms. Our resulting model demonstrated that the determining factors in a firm's choice between exporting and providing FDI differ according to the destination country's characteristics. When a firm serves developed countries, it bases its decision on its productivity level; high-productivity firms tend to invest abroad, while low-productivity firms export. On the other hand, when a firm serves developing countries, it bases its decision primarily on the capital-labor ratio and secondarily on its productivity level. Our analysis of the latter case revealed that labor-intensive firms choose to provide FDI, while capital-intensive firms choose to export, regardless of their productivity levels, and that productivity is a significant factor only for firms with a mid-value capital-labor ratio. These findings, which we confirmed via empirical testing using Japanese manufacturing firm-level data, also explain why some less productive firms choose to invest in developing countries, while other productive firms choose to export to these countries.

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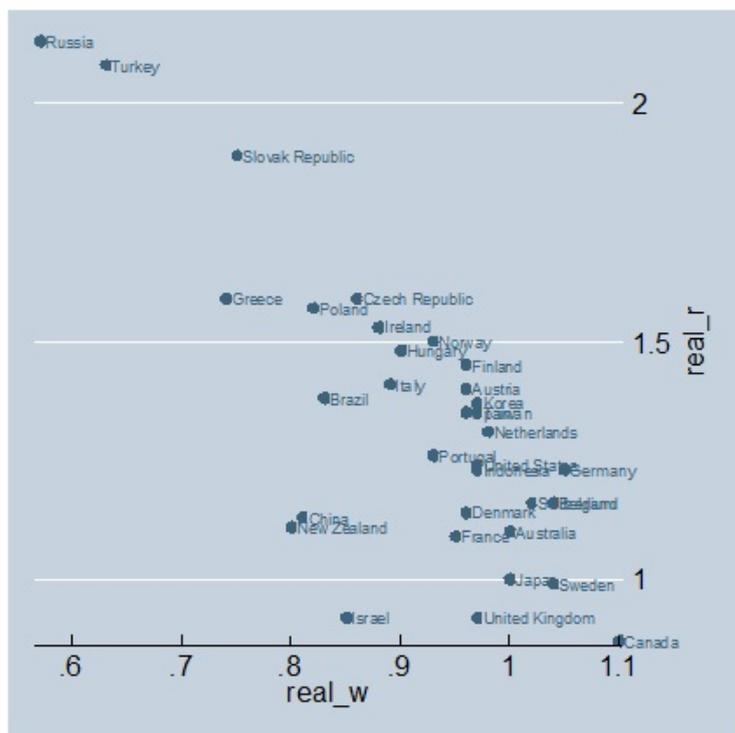


Figure 1: Global real wages and capital rental rates

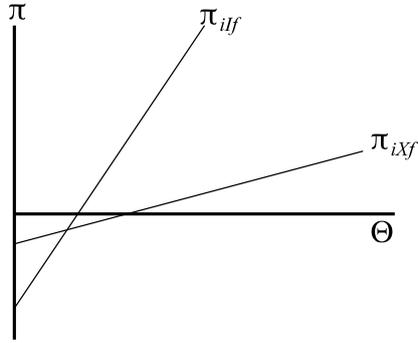


Figure 2: The relationship between  $\pi_{ixf}$  and  $\pi_{if}$  in the case of  $0 < k_i < k^*$

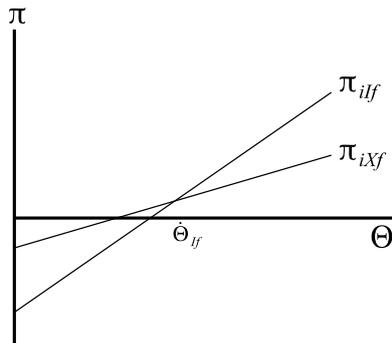


Figure 3: The relationship between  $\pi_{ixf}$  and  $\pi_{if}$  in the case of  $k^* < k_i < k^{**}$

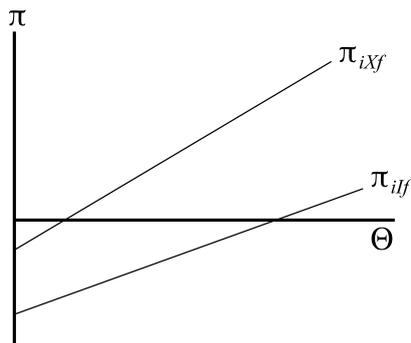


Figure 4: The relationship between  $\pi_{ixf}$  and  $\pi_{if}$  in the case of  $k^{**} < k_i$

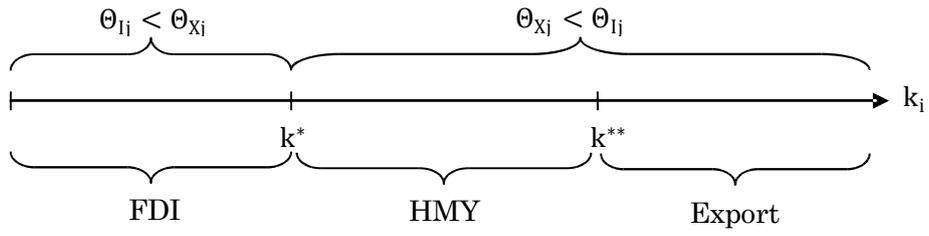


Figure 5: How firms choose their mode of serving foreign countries

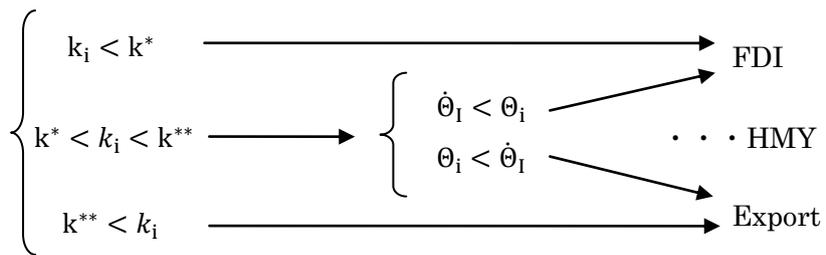


Figure 6: How firms choose their mode of serving foreign countries

China								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TFP_ols	-0.038				-0.019			
	[-0.28]				[-0.23]			
low K/L		0.138				0.083		
		[0.60]				[0.58]		
low-middleK/L		0.024				0.014		
		[0.09]				[0.09]		
high-middleK/L		0.906				0.550		
		[3.14]***				[3.16]***		
highK/L		0.428				0.266		
		[1.42]				[1.44]		
TFP_op			-0.039				-0.019	
			[-0.28]				[-0.24]	
low K/L				0.105				0.062
				[0.46]				[0.44]
low-middleK/L				-0.004				-0.003
				[-0.02]				[-0.02]
high-middleK/L				0.905				0.549
				[3.14]***				[3.16]***
highK/L				0.402				0.250
				[1.32]				[1.34]
log K/L	-0.322		-0.327		-0.195		-0.197	
	[-3.16]***		[-3.20]***		[-3.15]***		[-3.19]***	
Constant	-5.060		-5.011		-3.023		-2.998	
	[-10.16]***		[-10.15]***		[-10.30]***		[-10.32]***	
Firm Char.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1690	1690	1690	1690	1690	1690	1690	1690
r2	0.10	0.06	0.10	0.06	0.10	0.06	0.10	0.06

Table 1: The estimated results in the case of firms serving China: Standard Errors are in parentheses. \*\*\*, \*\*, and \* show statistical significance of the coefficients at the 99, 95, and 90 percent levels, respectively.

US								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TFP_ols	0.339				0.198			
	[2.29]**				[2.28]**			
low K/L		0.434				0.259		
		[1.72]*				[1.72]*		
low-middleK/L		0.707				0.417		
		[2.48]**				[2.44]**		
high-middleK/L		1.021				0.596		
		[3.27]***				[3.29]***		
highK/L		0.924				0.542		
		[2.79]***				[2.81]***		
TFP_op			0.336				0.197	
			[2.27]**				[2.26]**	
low K/L				0.347				0.208
				[1.39]				[1.40]
low-middleK/L				0.671				0.395
				[2.37]**				[2.32]**
high-middleK/L				1.004				0.587
				[3.22]***				[3.23]***
highK/L				0.912				0.537
				[2.75]***				[2.76]***
log K/L	0.031		0.071		0.003		0.026	
	[0.28]		[0.64]		[0.05]		[0.40]	
Constant	-6.840		-7.274		-4.005		-4.260	
	[-12.42]***		[-13.08]***		[-12.77]***		[-13.53]***	
Firm Char.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1690	1690	1690	1690	1690	1690	1690	1690
r2	0.18	0.11	0.18	0.11	0.18	0.15	0.18	0.15

Table 2: The estimated results in the case of firms serving United States: Standard Errors are in parentheses. \*\*\*, \*\*, and \* show statistical significance of the coefficients at the 99, 95, and 90 percent levels, respectively.

This paper had been written before the author joined Bank of Japan. Views expressed in this paper are those of the author and do not reflect those of the Bank of Japan.