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Heterogeneous Impact of Trade Liberalization on Vertical FDI: Evidence from Japanese firm-level data[1]

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Abstract

This paper empirically explores the reason why a recent surge of foreign direct investment (FDI) to developing countries has been mainly driven by less productive firms. To this end, we present a simple model of FDI with vertical division of labor in a heterogeneous firm framework. From a theoretical point of view, in countries with low unskilled worker wages and low trade costs, firms with high productivity invest abroad and engage in international division of labor. Moreover, if trade costs have further reduced, the productivity cut-off level becomes lower and firms within the middle range of productivity will start investing in low wage countries. Our empirical analysis using logit estimation or a multinomial logit model of Japanese firms' FDI choices reveals that a reduction in tariff rates attracts even less productive vertical foreign direct investment (VFDI) firms. This result is consistent with a different definition of VFDI. Because developing countries, particularly East Asian countries, have experienced a relatively rapid decrease in tariff rates, our results indicate that the increase in VFDI through tariff rate reduction has led to the recent relative surge of FDIs in developing countries.

***Keywords*:** Multinational firms; Firm heterogeneity; Productivity

***JEL Classification*:** D24; F23

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1. Introduction

In these two decades, foreign direct investments (FDIs) from developed countries to developing countries have increased significantly compared with FDIs between developed countries. Navaretti and Venables (2004) report that *although FDI goes predominantly to advanced countries, the share of developing countries has been rising*. They show that the share of worldwide FDI received by the developing and transition economies jumped from 24.6% in the period 1988-93, to more than 40% in the period 1992-97. FDI to developing countries are considered as the investment which is intended to exploit low price-production factors of the host country and engages in the vertical division of labor among production stages between home country and host country. Such a division of labor is clearly important for the economic growth of developing countries. In case of Japan, many firms have actively invested in developing countries, particularly in East Asia in 1990s and 2000s. Furthermore, the recent investors are relatively low productive firms (e.g., Obashi et al., 2009; Wakasugi and Tanaka, 2012). What encourages low productivity firms to invest in developing countries?

There have been a number of theoretical papers that have sought to clarify the mechanics of the vertical division of labor among production processes (e.g., Jones and Kierzkowski, 1990). Academically this division of labor has become virtually interchangeable with the terms fragmentation, outsourcing, or vertical specialization. Fragmentation is the splitting of a product process into two or more steps that lead to the same final product. When a fragmented production block is placed beyond national borders, the fragmentation is called “international fragmentation” or “cross-border fragmentation”. International fragmentation is also discussed within the context of vertical foreign direct investment (VFDI). Studies show that theoretically once fragmentation becomes possible due to trade cost reductions, multinational enterprises (MNEs) in a country (often termed a developed country) locate their affiliates in a country (often termed a developing country) which has a comparative advantage in assembly processes. Obviously, since trade liberalization has progressed globally, particularly in developing countries, trade cost reduction due to trade liberalization is a driving force for the rapid increase of FDIs in developing countries.

However, “traditional” theories of the vertical division of labor do not incorporate heterogeneity in terms of firm’s productivity. As for firm heterogeneity in terms of productivity, the papers by Helpman et al. (2004) and Chen and Moore (2010) examine the relationship between productivity and horizontal FDI. Due to the presence of fixed entry cost for FDI, only firms with productivity beyond a cutoff can afford to pay the

entry costs to invest abroad; thus, they become multinationals. Since their framework is based on horizontal FDI, which is motivated to avoid high trade cost when supplying products to the market, the productivity cutoff for FDI become lower (higher) as trade costs has increased (decreased). Therefore, this extended version of HFDI in heterogeneous firm framework cannot demonstrate that trade liberalization plays a crucial role in increasing low productive firms' FDIs in developing countries.

In this paper, we extend the Helpman et al. (2004) model to incorporate vertical division of labor, namely VFDI. Subsequently, we theoretically summarize the situations regarding the relationship between trade cost reduction and firms' decision to conduct FDI. Next we empirically examine those predictions for Japanese FDIs in five Asian countries—China, Thailand, Malaysia, the Philippines and Indonesia—by employing firm-level data. We estimate the discrete choice model regarding firms' FDI decision. In the classification of VFDI, we adopt various criteria such as export or import intensity of each affiliate and qualitative question items on the motivation for investing abroad. Their reduction induces firms in the middle range of productivity distribution to follow VFDI. Because developing countries, particularly East Asian countries, have experienced a relatively rapid decrease in tariff rates, our findings imply that the increase in VFDI through tariff rate reduction has resulted in the recent relative surge of FDIs in developing countries.

This paper builds upon earlier theoretical and empirical works that examine the decision of heterogeneous firms to participate in international markets by extending the Helpman et al. (2004) model: Grossman et al. (2006), Aw and Lee (2008), Yeaple (2009), Chen and Moore (2010), Hur and Hyun (2011), and Hayakawa and Matsuura (2011). Grossman et al. (2006) theoretically investigate the complex types of FDI incorporating vertical division of labor in the framework of heterogeneous firm. Aw and Lee (2008) consider Taiwanese HFDI as the investment of middle income country firms in terms of wage levels and have four options: domestic production, investment in a lower wage country (China), investment in a higher wage country (the US), and investment in both higher and lower wage countries. Then, they examine the ranking of firms' productivity according to the option chosen and find it as follows: domestic production, FDI in China, FDI in the US, and FDI in both China and the US. Yeaple (2009) and Chen and Moore (2010) examine the relationship of productivity cutoff with several host country characteristics in HFDI in the US and France, respectively. For example, they show that the cutoff for investing is lower in countries with larger markets. Recently, Hur and Hyun (2011) examine the role of firm heterogeneity in choosing FDI type by using Korean firm-level data. They distinguish FDI types,

including HFDI, VFDI, and combined FDI, and demonstrate a pecking order of firm productivity across FDI types[2]. The paper by Hayakawa and Matsuura (2011) is closely related to this paper. They conduct the detailed analysis on MNEs which get engaged in vertical division of labor more than two countries in heterogonous firm framework and using spatial econometric analysis, demonstrate that there is an interrelation among foreign affiliates that belong to same MNEs. Using a simplified version of model of Hayakawa and Matsuura (2011), this paper examines productivity cutoff for VFDI, shedding light on changes in tariff rates and their effect on VFDI, as in Chen and Moore (2010).

The remainder of this paper is organized as follows. The next section illustrates a model to motivate our empirical analysis. Empirical analyses and their results are reported in Sections 3 and 4, respectively. Section 5 concludes.

2. Theoretical Framework

This section examines the decision to conduct VFDI in order to clarify which type of country attracts those firms that engages in international division of labor. To do that, it is essential to extend the model of FDI in heterogeneous firm framework to two-production stage setting. This section describes the kinds of country that can attract investment from the home country, while allowing for heterogeneity among firms in terms of productivity. It should be noted that the aim of this section is not to provide a general equilibrium model of VFDI, but simply to obtain insights into the driving forces working behind VFDI in a partial equilibrium model.

2.1. Settings

Suppose that there are three countries: country 1 (home country), country 2 (foreign country), and a country in the outside economy. In this supposition we consider finished products that are horizontally differentiated. Each of a continuum of firms manufactures a different brand with zero measure. For simplicity, the finished products are consumed only in the outside economy,[3] and are transported from any of the two

[2] While the model of Hur and Hyun (2011) focus only on the differences in factor prices for unskilled worker between home country and host country, our paper considers trade costs differences as well as factor price differences.

[3] You may assume that country 2 is East Asian country and the outside economy is U.S. or European countries. Indeed, in the 1990s, around 80% of finished machinery goods produced in East Asia were exported to other regions, particularly to U.S. and European countries (Kimura et al., 2007).

countries without charge.[4] A representative consumer in the outside economy country has a constant elasticity of substitution utility function over varieties. As usual in the literature, utility maximization yields

$$x(k) = A\, p(k)^{-\varepsilon},$$

where $x(k)$ is the demand for the variety k and $p(k)$ is its price. ε is the elasticity of substitution between varieties, and is assumed to be greater than unity. The brand name k is omitted from this point onwards for brevity. $A \equiv P^{1-\varepsilon}Y$, where P is the price index and Y is total income in the outside country. A is a measure of the demand level and is taken as exogenous by producers.

The market structure of the finished products sector is monopolistic competition. For simplicity, firms and their headquarters are assumed to locate only in country 1 (home country). Firms are heterogeneous in terms of their cost efficiency a. The finished products are produced in two stages of production. The production function in each stage is kept as simple as possible to bring out the nature of the dependence among production stages. Our Leontief-type production structure is as follows. A first stage product (intermediate goods) is produced by inputting a units of skilled labor; a second stage product (finished goods) is produced with input of one unit of the first stage product and a units of unskilled labor.[5] Factor prices for skilled labor, and unskilled labor are represented by r, and w, respectively.

For simplicity, we assume that $w_1 \geq w_2$ and $r_2 \geq r_1$, respectively, indicating that country 1 (the home country) has higher wages for unskilled labor. The assumption of factor prices order indicates simply that country 2 have location advantages in producing the second-stage products. There are iceberg trade costs t ($\geq$1) for the shipment of intermediate goods from home country to foreign country. Although firms do not need to pay any fixed costs if they produce all stage products only in country 1, they must incur plant set-up costs f if they locate plants abroad.

Let c_D band c_V be total cost in the production pattern for domestic production and vertical FDI, respectively. Then c_D, and c_V are given by:

$$c_D = (r_1 a + w_1 a)x,$$
$$c_V = (tr_1 a + w_2 a)x + f.$$

[4] The assumption of no trade costs may be thought too unrealistic. However, as long as we assume that countries 1 and have identical trade costs with the outside economy, the assumption of positive trade costs do not change qualitatively our results, which are later provided. Indeed, the trade costs with U.S. or European countries are not so different among East Asian countries, which are supposed as samples of country 2 in our empirical analysis.

[5] Our results are qualitatively unchanged even if assuming the different input coefficients of production factors among products.

The profit-maximizing strategy yields $p = \varepsilon\, c_x/(\varepsilon - 1)$, where $c_x = d\, c/d\, x$, so that profits are given by:

$$\pi_D = (r_1 + w_1)^{1-\varepsilon}\,\Theta$$
$$\pi_V = (tr_1 + w_2)^{1-\varepsilon}\,\Theta - f,$$

where $\Theta \equiv A\ \varepsilon^{-\varepsilon}\,(\varepsilon - 1)^{\varepsilon-1} a^{1-\varepsilon}$. We call Θ the productivity measure. Since $\varepsilon > 1$, the smaller the cost efficiency a is, the larger the measure Θ is.

2.2. Domestic production and VFDI

We consider the problem of selecting production patterns, i.e., domestic type and VFDI type. If the location advantages in producing the second-stage products in country 2 is trivial compared with country 1, π_D is always higher than π_V due to the existence of trade costs between host and home countries. To shed light on the production pattern of interest in this study, i.e., the international production-stage division of labor, we restrict ourselves only to the cases where the location advantages in countries 2 are relevant. Specifically, we assume $(1 - t)\ r_1 > w_1 - w_2$. Then, drawn as a function of the productivity measure Θ, the slope of π_V is steeper than π_D. As a result, since VFDI firms must incur fixed set-up costs f for the plant in country 2, a profit line in each production type can be drawn as in figure 1. Figure 1 shows productivity cutoff dividing firms between domestic and VFDI categories. This figure shows that more productive firms choose VFDI whereas less productive firms concentrate on production activity at home.

In this setting, a reduction in trade costs increases revenues for VFDI firms, inducing that the slope of π_V becomes steeper and thus that productivity cutoff level get lowered. The reduction of unskilled workers' wages in country 2 has the same kind of effects on the productivity cutoff. As a result, the reduction of trade costs or unskilled workers' wages in country 2 encourages firms that do not invest in the initial year to start setting up overseas affiliates for international vertical division of labor. Obviously, such firms have the lower productivity than firms who already have overseas affiliates but the higher productivity than firms who leave both production stages in country 1. In this sense, we may say that trade liberalization in potential host countries encourages firms with a medium range of productivity to conduct VFDI in those countries.

=== Figures 1 ===

3. Empirical Framework and Data

This section first takes an overview of Japanese FDI. Then, after explaining our empirical specification, we present our variables to be examined and their data sources.

3.1. Overview of Japanese FDI

This section explains our empirical strategies. Before discussing the empirical specification, we present some preliminary findings on Japanese manufacturing FDI by using the micro database of *Kaigai Jigyou Katsudou Kihon (Doukou) Chousa* (*Survey on Overseas Business Activities*, hereafter SOBA) prepared by the Research and Statistics Department, Ministry of Economy, Trade and Industry (hereafter, METI). SOBA aims to obtain basic information on the activities of foreign affiliates of Japanese firms. The survey covers all Japanese firms that have affiliates abroad. SOBA includes items such as the year of establishment of the affiliate, and a breakdown in sales and purchases, employment, costs, and research and development.

Table 1 reports the number of newly established Japanese overseas affiliates by year and region. In our sample, the total number of new investment was highest in 2000 and then gradually decreased toward 2003. As for regional distribution, the numbers of firms investing in North America and Europe were 2,104 and 1,894, respectively, and new investment toward Asia[6] was 7,160 among total 12,377 investments from 1995 to 2003.

=== Table 1 ===

Table 2 shows the ratio of export-intensive overseas affiliates by region and industry. We define as an export-intensive affiliate, an affiliate whose share of exports in total sales is greater than the industry average of all sampled affiliates. Export intensity in MNEs' affiliates is sometimes used as a proxy for the extent of VFDI[7] because, although HFDI is an investment to avoid broadly defined trade costs by setting up plants within a targeted market/country rather than by exporting from the home country,

[6] In this table, Asia includes not only East Asian countries but also South Asian countries. Whereas North America consists of the US and Canada, Europe includes not only Western European countries but also Eastern European countries.

[7] For example, Fukao et al. (2003) compares the share of sales destination in total sales for Japanese and US MNE affiliates among regions and finds that for both Japanese and US MNEs, although the share of local sales by MNE affiliates in Europe and Latin America exceed 50% or 60%, that for affiliates in East Asia was less than 50%. Because VFDI is considered as investments that take advantage of the differences in factor prices and export the output to foreign countries, they conclude that FDI in East Asia is more likely to be "vertical" in nature.

VFDI is intended to exploit low price-production factors of the host country. In other words, most of the goods produced by HFDI affiliates are intended for sales in the host country; however, sales of products from VFDI affiliates are not aimed at the host country. Thus, the larger export share suggests that overseas affiliates are more likely to be involved in vertical production networks.

== Table 2 ==

The findings from Table 2 are as follows. Clearly, affiliates in Asia are more likely to fall into the category of export-intensive affiliates than those in developed countries. For example, in electric machinery manufacturing sector, while the ratios of export-intensive affiliates for North America and Europe are 24% and 18%, respectively, that for Asia is 47%. Export-intensive affiliate ratio in Asia exceeds 50% for Textile, Information and Communication devises and Precision Instrument. It suggests that MNEs in these industries are investing in Asia to exploit low price-production factors of the host country and engages in the vertical division of labor among production stages between home country and host country.

Asian countries have experienced gradual trade liberalization through the 1990s and 2000s. Panels (a) and (b) in Figure 2 present the changes in tariff rates against products from Japan (the simple-average in manufacturing sectors) by region or certain Asian countries. Our tariff rates data source is the World Integrated Trade Solution (WITS), particularly TRAINS raw data. Panel (a) shows that tariff rates in regions other than Asia remained almost unchanged during the sample period, but those in Asia gradually decreased. In other words, Asia has achieved greater trade liberalization in terms of tariff rate reductions than other regions. Panel (b) reports the trend in tariff rates in five Asian countries: China, Thailand, Malaysia, the Philippines, and Indonesia. These countries experienced a significant tariff reduction in the late 1990s and the early 2000s.

=== Figure 2 (a) & (b) ===

3.2. Empirical Specification

This paper focuses on the first investment for firms in Asia countries. Specifically, it includes China plus the ASEAN 4 countries (i.e. Thailand, Malaysia, the Philippines, and Indonesia). First, this investment accounts for 67.9% of new overseas affiliates by Japanese firms from 1995 to 2003. Namely, FDI in Asia covers a majority of Japanese

FDI. Second, as found in Table 2, more than half of Japanese affiliates in Asia are export-intensive affiliates. Thus, most of FDI in Asia are regarded as VFDI. Third, as shown in Figure 2, Asia has achieved significant trade liberalization. This change is expected to yield the fruitful change in firms' decision on investing abroad. As a result, Japanese FDI in Asia will serve as a good example to examine the impacts of trade liberalization in VFDI as we discussed in Figure 1 in section 2.

In the model, firms' status of FDI is sorted according to their productivity: low productivity firms become engaged only in domestic production, whereas high productivity firms invest abroad. To confirm this sorting pattern, we first estimate the following discrete choice model:

$$\Delta FDI_{ijs} = \begin{cases} 1 & \text{if } \beta \Delta \tau_{js} + \mathbf{Z}_{ijs,1994}\boldsymbol{\gamma} > 0 \\ 0 & \text{otherwise} \end{cases},$$

where ΔFDI_{ijs} is a dummy variable that takes the value of 1 if firm i in industry s starts investing in country j from 1995 to 2003 and $\Delta\tau_{js}$ represents changes in tariff rates for inputs from home country. Z is a vector of other control variables including firms' total factor productivity, industry dummy variables, and host country dummy variables. These variables are defined in 1994 in order to avoid the simultaneity issues between FDI decision and firm characteristics. As mentioned above, since most of FDI in Asia seem to be VFDI, the reduction of tariff rates increases Japanese FDI in Asia.

Our theoretical model suggests that a further reduction in trade costs reduces the productivity cutoff that divides firms into domestic and VFDI categories, meaning the increase of new VFDI inflow by firms in the middle range of productivity distribution, but not by firms in its low or high range, as depicted in Figure 3. While firms with a high range of productivity have been already invested abroad, for firms with a low range of productivity, their productivity levels might be far below the productivity cut-off level even after trade liberalization. Thus, firms in high or low range of productivity distribution are less likely to start VFDI after tariff reduction.

=== Figure 3 ===

To examine this prediction closely, we follow the specification proposed by Bustos (2011), which uses Argentina plant-level data and investigates the effect of tariff reduction in a destination country in the early 1990s on changes in productivity cutoff for exporting. The equation to be estimated is as follows:

$$\Delta FDI_{ijs} = \begin{cases} 1 & \text{if } \sum_r \beta_r \Delta\tau_{js} Q_{ir} + \mathbf{Z}_{ijs,1994}\boldsymbol{\gamma} > 0 \\ 0 & \text{otherwise} \end{cases}$$

where r indexes each of the four quartiles of productivity distribution and Q_r is a dummy variable taking unity if firm i belongs to quartile r.[8] The reason for the use of quartile dummy variables rather than a continuous variable of productivity is that trade liberalization affects only firms in the middle range (the second or third quartile) of productivity distribution, not all firms.[9] In addition, as highlighted in Chen and Moore (2010) and demonstrated in our theoretical model, productivity cutoff for HFDI/VFDI depends on host country characteristics such as wages. To control for the relationship of productivity cutoff with such host country characteristics, we add host country-firm productivity interaction terms.

Last, in order to confirm more closely our model's validity, we estimate the above model for HFDI and VFDI separately. Specifically, we estimate the following multinomial logit model:

$$\text{Prob}\left(I_{ijs} = k \mid \Delta\tau_{js}, Q_{ir}, \mathbf{Z}_{ijs,1994}\right) = \frac{\exp\left(\sum_k \sum_r \beta_{kr} \Delta\tau_{js} Q_{ir} + \mathbf{Z}_{ijs,1994}\boldsymbol{\gamma}_k\right)}{\sum_{l=0}^{2} \exp\left(\sum_l \sum_r \beta_{lr} \Delta\tau_{js} Q_{ir} + \mathbf{Z}_{kijs,1994}\boldsymbol{\gamma}_l\right)}, \; k = 0, 1, 2.$$

β_{kr} and $\boldsymbol{\gamma}_k$ are coefficients to be estimated using the maximum likelihood estimation (MLE) technique. Indicator variable I takes the value of zero for no investment, one for HFDI, and two for VFDI. We expect that tariff reduction encourages firms with the middle range of productivity to conduct VFDI. In contrast, as demonstrated theoretically and empirically in Chen and Moore (2010), HFDI by the lower productivity firms is expected to increase through the rise of trade costs. Therefore, we will expect contrasting results on the impacts of trade costs between HFDI and VFDI.

We adopt three kinds of the classification of HFDI and VFDI. The first is to classify export-intensive affiliates into VFDI affiliates and the other affiliates into HFDI affiliates. The second is based on a questionnaire item on investment motivation. Some supplier firms (automobile parts companies) invest abroad following their assemblers' investment (Toyota) to maintain the relationship with those assemblers. Because such suppliers' motivation for investing is to reduce transaction costs with their assemblers,

[8] Implicitly, we assume productivity distribution within our sample firms does not change from 1994 to 2003. We confirmed Peason's correlation index for TFP between 1994 and 2003 is 0.43 and that for Spearman's rank correlation index is 0.49, both of which are statistically significant from zero. Furthermore, even if we restrict our sample to those investments from 1995 to 1999, major findings are qualitatively unchanged.

[9] Four quartiles of productivity distribution are defined for domestic and new investing firms as well as incumbent MNEs. However, we exclude incumbent MNEs from sample firms for estimation.

regarding those affiliates as HFDI type affiliates may be more appropriate. By utilizing a qualitative questionnaire item on the motivation to invest abroad, we classify affiliates with the motivation to maintain the supplier–assembler relationship as HFDI type affiliates and others as VFDI type affiliates. The third classification is based on another questionnaire item, which asks Japanese overseas affiliates whether they get engaged in full-scale local production. Those affiliates engaging in that type of production are regarded as HFDI affiliates. Affiliates that engage in international division of labor are classified as VFDI affiliates.[10]

3.3. Variables and Data

Our firm-level variables are as follows. The productivity measure used in this paper is total factor productivity (TFP), specifically the TFP index proposed in Caves et al. (1982, 1983) and Good et al. (1983). It is calculated as follows:

$$TFP_{it} = \left(\ln Y_{it} - \overline{\ln Y_t}\right) - \sum_f \frac{1}{2}\left(s_{ift} + \overline{s_{ft}}\right)\left(\ln X_{ift} + \overline{\ln X_{ft}}\right)$$

$$+ \sum_s \left(\overline{\ln Y_s} - \overline{\ln Y_{s-t}}\right) - \sum_s \sum_f \left(\overline{s_{fs}} - \overline{s_{fs-t}}\right)\left(\overline{\ln X_{fs}} - \overline{\ln X_{fs-t}}\right),$$

where Y_{it}, s_{ift}, and X_{ift} denote the shipments of firm i in year t, the cost share of input f for firm i in year t, and input of factor f for firm i in year t, respectively. The inputs are labor, capital, and intermediates. The industry average variables are denoted using an upper bar. As for other control variables for firm characteristics, we introduce the capital-labor ratio (KL-ratio), R&D intensity, and share of unskilled workers in total workers.[11] These firm-level variables are constructed using the *Basic Survey of Japanese Business Structure and Activities* (BSJBSA). This survey covers all Japanese manufacturing firms with more than 50 employees and capitalization of more than 30 million yen and captures the overall picture of Japanese corporate firms: the diversification and globalization of corporate activities and corporate strategies on R&D and other topics.

The other variables and their data sources are as follows. The data source of tariff rates is the same as before; TRAINS raw data. We construct input tariff rates by industry as a weighted average of tariff rates against investing country at the Harmonized System (HS) 1988 six-digit level. As for the weight, we use an intermediate input share calculated with the basic table from the 2000 Japanese Input–

[10] In these classifications, 40% to 60% of investments in our samples are classified into VFDI. For more details, see Table A1.

[11] Unskilled workers are defined as those who work at production site.

Output Table (Ministry of Internal affairs and Communications). The three-digit SOBA industry classification is used. We also include some country-level variables. We control for the number of Japanese foreign affiliates in 1994 in each country as a proxy for an agglomeration of Japanese MNEs. Industry dummy variables are constructed at two-digit SOBA industry level.

Last, we take a brief overview of sample firms. Table 3 presents the number of investing firms and the comparison of productivity distribution for three groups of firms: non-MNEs, new MNEs, and incumbent MNEs by country. In this table, while non-MNEs are firms without investment in both 1994 and 2003, new MNEs are those that set up the first affiliate between 1994 and 2003 in each country. Firms with a foreign affiliate in 1994 are referred to as incumbent MNEs. It shows the share of firms categorized into each quartile for the 1994 productivity distribution. For example, in case of China, the share for incumbent MNEs in the fourth quartile is highest among three groups of firms. For new MNEs, 35.3% of firms fall into the third quartile of productivity distribution, which is higher than those in the upper and lower categories. In contrast, non-MNEs are uniformly distributed, although the share of the lowest quartile firms is slightly higher than the share of the other three-quartile firms. A similar tendency is found in other Asian countries except for new MNEs in Indonesia. The productivity distribution presented in Table 3 seems consistent with our empirical hypothesis in Figure 6. Namely most incumbent MNEs fall into the highest productivity categories, new MNEs in the middle range of productivity distribution, and non-MNEs in the lower productivity categories. Our empirical analysis examines whether this relationship is more substantial in industries with significant reductions in tariff rates.

=== Table 3 ===

4. Empirical Results

The estimation results for the logit model are found in Table 4.[12] The results in column (1) do not contain interaction terms with the quartile dummies, the results from

[12] As Ai and Norton (2003) suggest, paying additional attention when we interpret the parameter of an interaction term in a nonlinear model is necessary. Actually, some programs help calculate the marginal effect for an interaction term in a logit or probit model. However, programs such as *inteff* in Stata allow an evaluation of only one interaction term in a logit or probit model and do not incorporate multiple interaction terms or a multinomial logit model. Instead, we calculate marginal effects at different change levels in tariff rates and confirm that the effect of tariff changes is most significant for firms in the middle range of the productivity distribution. In Figure A1 and A2, the marginal effects corresponding to column (3) in Table 5 and column (1) in Table 6 are presented.

column (2) to column (3) include interaction terms with a productivity quartile dummy and tariff changes. The coefficient for tariff changes in column (1) is negative but insignificant. In contrast, TFP has a significant positive effect on FDI decision. This result of MNEs' high productivity is consistent with that from a large number of previous studies, such as Kimura and Kiyota (2006). That is, MNEs are productive firms compared with domestic firms. In columns (2) and (3), we include the interaction terms between productivity quartile dummy and changes in tariff rates. For column (3), we add the interaction term between country dummy and TFP to control for changes in the TFP cutoff level depending on country-specific factors. In both cases, the third quartile dummy variables always have significantly negative coefficients in both models with or without country dummy-TFP interaction. As mentioned, because the quartile dummy variables are constructed including incumbent MNEs, we expect the effect of trade liberalization to be higher for firms in the middle range of the productivity distribution. This result is consistent with our hypothesis.

For other control variables, agglomeration of Japanese MNEs has a significantly positive coefficient, suggesting that firms investing abroad prefer countries that have a large agglomeration of Japanese MNEs. The positive and significant coefficient for the capital-labor ratio may imply that firms with capital-embodied technology are more likely to invest abroad. Moreover, the share of unskilled workers always has a significantly negative coefficient. Because the intensity of the non-manufacturing worker is sometimes regarded as the skilled worker ratio, this result indicates that skilled worker-intensive firms tend to invest abroad.

=== Table 4 ===

Table 5 presents the estimation results for a multinomial logit model for three different FDI choices: no investment, HFDI, and VFDI. In column (1), VFDI affiliates are defined as those affiliates with higher export intensity than their industry average. Interaction terms between the productivity of the third and fourth quartile dummy and tariff changes for VFDI are negative and highly significant. Such terms for HFDI are negative in the third quartile but not significant. Different definitions of VFDI and HFDI are used in columns (2) and (3). In column (2), firms investing abroad so as to maintain a supplier–assembler relationship are regarded as HFDI firms while other investing firms are regarded as VFDI firms. The interaction terms between changes in tariff and the third and fourth quartile dummy are significantly negative for VFDI but not for HFDI. This result is consistent with our theoretical prediction. Column (3)

defines those affiliates that engage in division of labor as VFDI. The interaction terms between changes in tariff and third quartile dummy are significantly negative for both HFDI and VFDI. However, this term's magnitude is larger for VFDI affiliates. Moreover, for VFDI, the interaction term with the fourth quartile dummy is significantly negative. Therefore, the effects of tariff reduction on VFDI are always significant for the third quartile of productivity distribution. These results are consistent with our hypothesis[13].

=== Table 5 ===

The estimation results are reported in Table 6. As destination countries, we select four European countries: UK, France, Germany, and Italy. Samples in Table 6 are selected in the same manner as for Table 4.[14] The interaction terms between the third or fourth quartile dummy and changes in tariff have significantly negative coefficients particularly for VFDI in Table 5, but mostly not in Table 6. In particular, VFDIs classified based on affiliates' characteristics do not show the negative results in those terms, except for column (2), though some of the interaction terms in HFDI have negative coefficients.

=== Table 6 ===

5. Concluding Remarks

This paper empirically explores the reason why a recent surge of FDI to developing countries has been mainly driven by less productive firms. To this end, we present a simple model of FDI with vertical division of labor in heterogeneous firm framework. We first extended the Helpman et al. (2004) model to allow firms to choose an option, VFDI, and derive several predictions regarding the relationship between trade cost reduction and firms' decision to invest abroad. Next, we empirically examined these propositions in relation to Japanese FDIs in China, Thailand, Malaysia, and

[13] As a robustness check, we replace the TFP index with the TFP estimates calculated using the Levinsohn and Petrin (LP) methodology (Levinsohn and Petrin, 2003). Although the interaction term for tariff changes and the fourth quartile dummy becomes negative and significant instead of the third quartile dummy in some cases, major findings do not change. Estimation results of TFP estimates using the LP method are provided on request.

[14] The number of samples and basic statistics for TFP corresponding to Table 7 are presented in Table A2.

Indonesia by estimating the discrete choice model. As a result, our estimation revealed that the reduction in tariff rates in host countries is affected differently depending on productivity level and type of FDI. This reduction attracts the middle range of productive firms but does not attract the most productive or the least productive firms. Because developing countries, particularly East Asian countries, experienced a relatively rapid decrease in tariff rates, we conclude that the increase in VFDI through a reduction in the tariff rates led to the recent relative surge of FDIs in developing countries. Furthermore, our results are also suggestive for policy maker in Japan. The further trade liberalization, e.g. Trans-Pacific Partnership or Regional Comprehensive Economic Partnership, encourages Japanese firms, including even less productive Japanese firms, to conduct VFDI to Asia and thus presents the benefits from international division of labor to those firms.

References

Ai, C.R. and E.C. Norton, 2003. Interaction terms in logit and probit models, *Economics Letters*, 80(1), pp.123-129.

Aw, B.Y. and Y. Lee, 2008, Firm heterogeneity and location choice of Taiwanese multinationals. *Journal of International Economics*, **75**, pp. 167-179.

Bustos, P., 2011, Trade Liberalization, Exports and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms, *American Economic Review*, 101, pp.304-340.

Caves, D., L. Christensen and W. Diewert, 1982, Multilateral comparisons of output, input, and productivity using superlative index numbers. *Economic Journal*, **92**, pp. 73-96.

Caves, D., L. Christensen and M. Tretheway, 1983, Productivity performance of U.S. trunk and local service airline in the era of deregulation. *Economic Inquire*, **21**, pp. 312-324.

Chen, M. and M. Moore, 2010, Location decision of heterogeneous multinational firms. *Journal of International Economics*, **80**(2), pp. 188-199.

Fukao, K., H. Ishido and K. Ito, 2003, Vertical intra-industry trade and foreign direct investment in East Asia. *Journal of the Japanese and International Economics*, **17**, pp.468-506.

Jones R.W., Kierzkowski H., 1990. The role of services in production and international trade: A theoretical framework, In: Jones, R.W. Krueger, A.O. (Eds.). *The Political Economy of International Trade: Essays in Honor of R.E. Baldwin*, Basil Blackwell, Oxford, 31-48.

Good, D., I. Nadiri and R. Sickles, 1983, Efficiency and productivity growth comparisons of European and U.S air carriers: A first look at the data. *Journal of Productivity Analysis*, **4**, pp. 115-125.

Grossman, G., E. Helpman and A. Szeidl, 2006, Optimal integration strategies for the multinational firm, *Journal of International Economics*, **70**, pp. 216-238.

Hayakawa, K., T. Matsuura, 2011, Complex Vertical FDI and heterogeneity: Evidence from East Asia, *Journal of the Japanese and International Economies*, **25**(3), pp.273-289.

Helpman, E., M. Melitz and S. Yeaple, 2004, Export versus FDI with heterogeneous firms, *American Economic Review*, **94**(1), pp. 300-316.

Hur, J. and H-J, Hyun, 2011, Who Goes Where and How? Firm Heterogeneity in the

Choice of FDI Type and Location, *Sogan University Research Institute for Market Economy Working Paper*, 1105.

Kimura, F. and K. Kiyota, 2006, Exports, FDI, and productivity: dynamic evidence from Japanese firms, *Review of World Economics*, **142**(4), pp. 695-719.

Kimura, F., Takahashi, Y., Hayakawa, K., 2007. Fragmentation and parts and components trade: Comparison between East Asia and Europe. *North American Journal of Economics and Finance*, **18**(1), 23-40.

Levinsohn, J. and A. Petrin, 2003, Estimating production functions using inputs to control for unobservables, *Review of Economic Studies*, **70**, pp. 317-341.

Navaretti, B. and A.J. Venables, 2004, *Multinational Firms in the World Economy*, Princeton University Press.

Obashi, A., K. Hayakawa, T. Matsuura and K. Motohashi, 2009, A two-dimensional analysis of the impact of outward FDI on performance at home: Evidence from Japanese manufacturing firms, Discussion papers 09053, Research Institute of Economy, Trade and Industry.

Yeaple, S., 2009, Firm heterogeneity and the structure of U.S. multinational activity. *Journal of International Economics*, **78**(2), pp. 206-215.

Wakasugi, R. and A. Tanaka, 2012, Productivity Heterogeneity and Internationalization: Evidence from Japanese Firms, *Millennial Asia*, **3**(1), pp.45-70.

Table 1: The Number of Newly Established Japanese Oversea Affiliates by Region

	North America	Europe	Asia	Others	Total
1995	370	365	686	151	1,572
1996	251	311	514	122	1,198
1997	194	224	577	118	1,113
1998	166	153	679	104	1,102
1999	176	151	1,017	152	1,496
2000	282	210	1,414	161	2,067
2001	253	186	1,022	144	1,605
2002	254	149	826	154	1,383
2003	158	145	425	113	841
Total	2,104	1,894	7,160	1,219	12,377

Source: Authors' calculation based on the linked database of Basic Survey of Japanese Business Activities and Survey of Overseas Business Activities.

Table 2: Share of Export-intensive Affiliates: 2003

	North America	Europe	Asia
Textile	8%	61%	7%
Chemical	30%	41%	25%
General Machinery	19%	49%	20%
Electric Machinery	18%	47%	22%
Information and Communication devices	24%	55%	18%
Transport Equipment	23%	39%	29%
Precision Instrument	19%	56%	11%
Other manufacturing	21%	39%	36%

Source: Authors' calculation based on the Survey of Overseas Business Activities.

Table 3: Number of Investing firms and Comparison of TFP distribution by country and FDI Status from 1995 to 2003

		Productivity Distribution				
China	# of firms	1st quartile	2nd quartile	3rd quartile	4th quartile	Total
Non-MNEs	2,382	27%	26%	23%	24%	100%
New MNES	275	19%	17%	35%	29%	100%
Incumbent MNEs	271	12%	21%	31%	35%	100%
Indonesia						
Non-MNEs	2,647	26%	26%	24%	24%	100%
New MNES	92	7%	16%	36%	41%	100%
Incumbent MNEs	128	10%	15%	36%	39%	100%
Malaysia						
Non-MNEs	2,645	26%	26%	24%	24%	100%
New MNES	37	14%	16%	41%	30%	100%
Incumbent MNEs	185	12%	14%	34%	39%	100%
The Philippines						
Non-MNEs	2,727	26%	26%	25%	24%	100%
New MNES	60	13%	15%	37%	35%	100%
Incumbent MNEs	71	6%	13%	28%	54%	100%
Thailand						
Non-MNEs	2,530	27%	26%	24%	24%	100%
New MNES	117	10%	21%	38%	31%	100%
Incumbent MNEs	229	13%	17%	32%	38%	100%

Notes: Non-MNEs are firms with no foreign investment between 1994 and 2003. New MNEs are firms with no investment in 1994 but set an affiliate in a concerned country between 1995 and 2003. Incumbent MNEs are firms with an affiliate in a concerned country in 1994.

Source: Authors' calculation based on the linked database of Basic Survey of Japanese Business Activities and Survey of Overseas Business Activities.

Table 4: Estimation Results for Logit Model. FDI in Five Asian Countries (Marginal Effect)

	(1)	(2)	(3)
$\Delta\tau$	-0.00036		
	(0.00028)		
TFP	0.06059**	0.01362	0.02047
	(0.02641)	(0.01365)	(0.03119)
Q1*$\Delta\tau$		0.00058	0.00082***
		(0.00036)	(0.00031)
Q2*$\Delta\tau$		0.00009	0.00016
		(0.00033)	(0.00032)
Q3*$\Delta\tau$		-0.00077***	-0.00076***
		(0.00028)	(0.00026)
Q4*$\Delta\tau$		-0.00047	-0.00058**
		(0.00031)	(0.00029)
KL ratio	0.01515***	0.01552***	0.01518***
	(0.00252)	(0.00240)	(0.00244)
R&D intensity	0.02075	0.01962	0.01839
	(0.06174)	(0.05914)	(0.05810)
Share of unskilled worker	-0.01557***	-0.01510***	-0.01477***
	(0.00462)	(0.00463)	(0.00460)
Agglomeration	0.00039**	0.00040**	0.00039**
	(0.00018)	(0.00018)	(0.00016)
Country dummy	Yes	Yes	Yes
Country dummy x TFP	No	No	Yes
Industry dummy	Yes	Yes	Yes
Observations	13,512	13,512	13,512
logll	-2093	-2076	-2071
pseudo-R-squared	0.127	0.134	0.136

Notes: Standard errors are clustered at the two-digit industry level. Figures in parenthesis are standard errors. ***, **, and * represent statistical significance at 10%, 5%, and 1% levels, respectively.

Table 5: Estimation Results for Multinomial Logit Model. Choice of FDI Type to Five Asian Countries (Marginal Effect)

	(1)		(2)		(3)	
	Local sales intensive FDI	Export intensitve FDI	Supplier FDI	Other FDI	FDI with full-scale local	FDI with division of
	(HFDI)	(VFDI)	(HFDI)	(VFDI)	(HFDI)	(VFDI)
Q1*Δτ	0.00058**	0.00010	0.00030**	0.00023	0.00048**	0.00031
	(0.00024)	(0.00026)	(0.00012)	(0.00032)	(0.00022)	(0.00019)
Q2*Δτ	0.00014	-0.00007	0.00009	-0.00008	0.00012	0.00003
	(0.00029)	(0.00031)	(0.00017)	(0.00034)	(0.00020)	(0.00016)
Q3*Δτ	-0.00031	-0.00048**	-0.00011	-0.00063**	-0.00029*	-0.00041**
	(0.00020)	(0.00023)	(0.00009)	(0.00028)	(0.00017)	(0.00016)
Q4*Δτ	-0.00018	-0.00040	-0.00005	-0.00052**	-0.00028	-0.00024**
	(0.00026)	(0.00025)	(0.00014)	(0.00027)	(0.00020)	(0.00012)
TFP	0.02463	0.00402	0.01096	0.00778	0.00868	0.01205
	(0.02962)	(0.00871)	(0.01377)	(0.01134)	(0.01605)	(0.02303)
KL ratio	0.00772***	0.00682***	0.00291***	0.01009***	0.00664***	0.00790***
	(0.00185)	(0.00072)	(0.00068)	(0.00160)	(0.00122)	(0.00139)
R&D intensity	0.02483	-0.01025	0.00617	0.00716	0.01331	0.00363
	(0.03341)	(0.02300)	(0.02082)	(0.02330)	(0.01841)	(0.04356)
Share of unskilled worker	-0.00572	-0.00813**	-0.00011	-0.01396***	-0.01354***	-0.00099
	(0.00381)	(0.00320)	(0.00138)	(0.00266)	(0.00196)	(0.00344)
Agglomeration	0.00024*	0.00015**	0.00007*	0.00022**	0.00014	0.00022***
	(0.00012)	(0.00006)	(0.00004)	(0.00010)	(0.00012)	(0.00005)
Country dummy	Yes		Yes		Yes	
Country dummy x TFP	Yes		Yes		Yes	
Industry dummy	Yes		Yes		Yes	
Observations	13,512		13,512		13,512	
logll	-2432		-2404		-2455	
pseudo-R-squared	0.127		0.136		0.123	

Notes: Standard errors are clustered at the two-digit industry level. Figures in parenthesis are standard errors. ***, **, and * represent statistical significance at 10%, 5%, and 1% levels, respectively.

Table 6: Estimation Results for Multinomial Logit Model. Choice of Type of FDI to four European Countries (Marginal Effect)

	(1)		(2)		(3)	
	Local sales intensive FDI (HFDI)	Export intensitve (VFDI)	Supplier FDI (HFDI)	Other FDI (VFDI)	FDI with full-scale local (HFDI)	FDI with division of labor (VFDI)
Q1*Δτ	-0.00006	-0.00032	0.00009*	-0.00147	-0.00175**	0.00043
	(0.00094)	(0.00059)	(0.00006)	(0.00136)	(0.00085)	(0.00029)
Q2*Δτ	-0.00076	0.00054	0.00004	-0.00022	-0.00164*	0.00075**
	(0.00055)	(0.00085)	(0.00002)	(0.00182)	(0.00084)	(0.00033)
Q3*Δτ	-0.00174***	-0.00013	0.00000	-0.00193*	-0.00193***	-0.00009
	(0.00055)	(0.00039)	(0.00003)	(0.00103)	(0.00065)	(0.00025)
Q4*Δτ	-0.00086*	-0.00009	0.00007***	-0.00143	-0.00159**	0.00030
	(0.00048)	(0.00056)	(0.00003)	(0.00129)	(0.00065)	(0.00034)
TFP	-0.00268	0.00860**	-0.00015	0.01984	0.01575***	-0.00209
	(0.00493)	(0.00338)	(0.00031)	(0.01237)	(0.00479)	(0.00278)
KL ratio	0.00148**	0.00177*	0.00002	0.00485***	0.00171	0.00133***
	(0.00067)	(0.00092)	(0.00005)	(0.00155)	(0.00114)	(0.00020)
R&D intensity	0.04562**	0.01436	0.00044	0.06048**	0.00986	0.02758***
	(0.02068)	(0.01043)	(0.00086)	(0.02438)	(0.01751)	(0.00956)
Share of unskilled worker	0.00506**	-0.00188	0.00029*	-0.00187	-0.00223	0.00321*
	(0.00255)	(0.00117)	(0.00016)	(0.00426)	(0.00285)	(0.00178)
Agglomeration	0.00011	0.00006*	0.00000	0.00013	0.00017***	0.00001
	(0.00008)	(0.00003)	(0.00001)	(0.00011)	(0.00007)	(0.00005)
Country dummy	Yes		Yes		Yes	
Country dummy x TFP	Yes		Yes		Yes	
Industry dummy	Yes		Yes		Yes	
Observations	5,507		5,507		5,507	
logll	-489.7		-470.2		-474.5	
pseudo-R-squared	0.151		0.170		0.166	

Notes: Standard errors are clustered at the two-digit industry level. Figures in parenthesis are standard errors. ***, **, and * represent statistical significance at the 10%, 5%, and 1% level, respectively.

Figure 1: Medium Trade Cost and Low Wages for Unskilled Labors

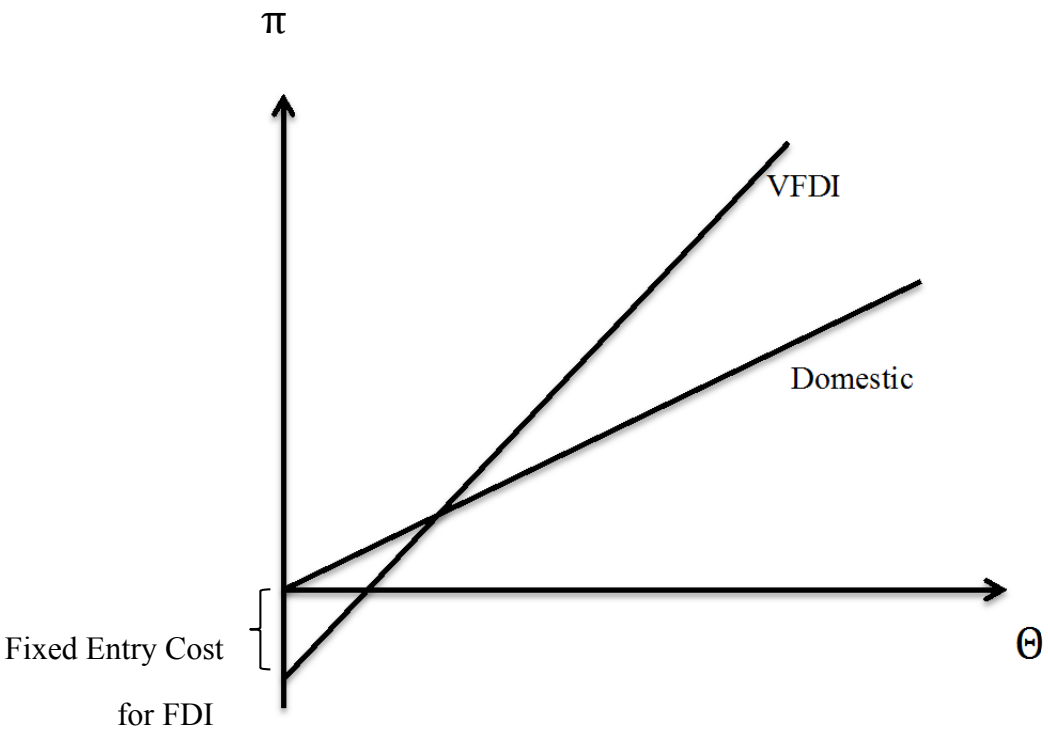
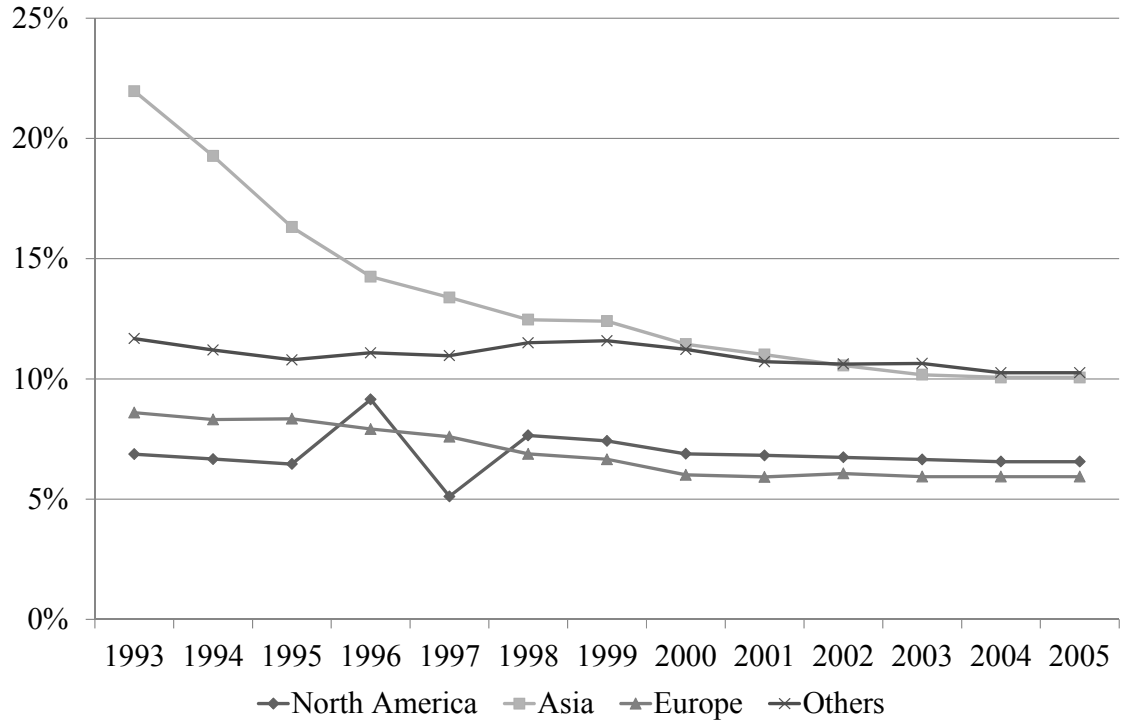
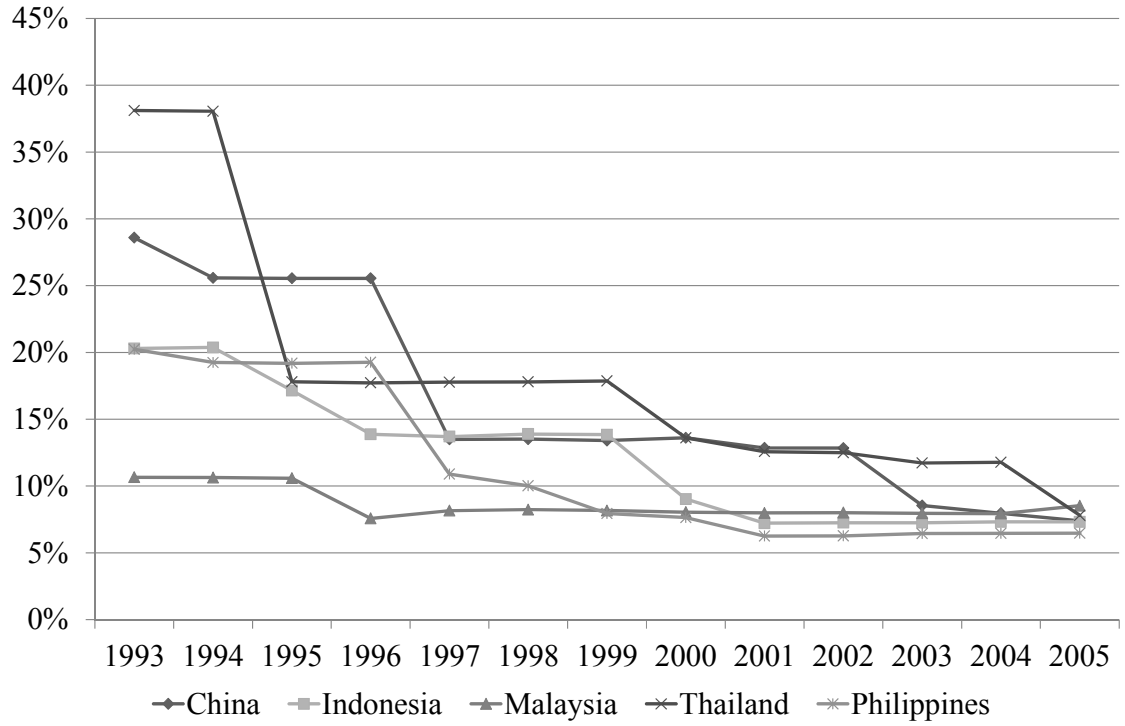


Figure 2: Changes in Tariff Rates by Region and Country

Panel (a)



Panel (b)



Source: The World Integrated Trade Solutions.

Figure 3: Effects of Tariff Reduction on Productivity Cutoff

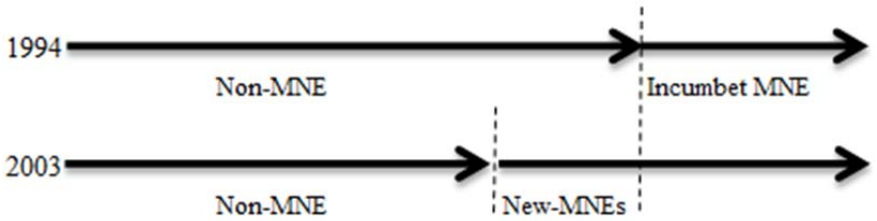


Table A1: The number of firms by destination country and types of FDI

	Non-MNEs	Local sales intensive FDI (HFDI)	Export intensitve FDI (VFDI)
Indonesia	2,647	54	38
Malaysia	2,645	25	12
The Philippines	2,727	25	35
Thailand	2,530	80	37
China	2,382	165	110

	Non-MNEs	FDI with full-scale local production	FDI with division of labor (VFDI)
Indonesia	2,647	35	57
Malaysia	2,645	24	13
The Philippines	2,727	26	34
Thailand	2,530	51	66
China	2,382	136	139

	Non-MNEs	HFDI	VFDI
	Non-MNEs	Local input intensive FDI	Imported input intensive FDI
Indonesia	2,647	52	40
Malaysia	2,645	20	17
The Philippines	2,727	25	35
Thailand	2,530	76	41
China	2,382	163	112

Table A2: Number of Investing firms and Comparison of TFP distribution by country and FDI Status from 1995 to 2003 in Europe

			Productivity Distribution				
UK			1st quartile	2nd quartile	3rd quartile	4th quartile	Total
	Non-MNEs	1,292	26%	26%	24%	24%	100%
	New MNES	36	19%	11%	31%	39%	100%
	Incumbent MNEs	118	17%	20%	31%	31%	100%
France							
	Non-MNEs	1,379	25%	26%	24%	25%	100%
	New MNES	14	21%	7%	43%	29%	100%
	Incumbent MNEs	53	19%	15%	38%	28%	100%
Germany							
	Non-MNEs	1,324	26%	26%	25%	23%	100%
	New MNES	10	10%	10%	10%	70%	100%
	Incumbent MNEs	113	18%	14%	27%	41%	100%
Italy							
	Non-MNEs	1,410	25%	25%	25%	25%	100%
	New MNES	8	25%	25%	38%	13%	100%
	Incumbent MNEs	27	19%	19%	30%	33%	100%

Note: For definitions of non-MNEs, new MNEs, and incumbent MNEs, see Table 3.

Source: Authors' calculation based on the linked database of Basic Survey of Japanese Business Activities and Survey of Overseas Business Activities.

Figure A1: Marginal Effects for the Interaction Terms at Different Level of Changes in Tariff Rates for the Logit Model (Corresponding to Model (3) in Table 5)

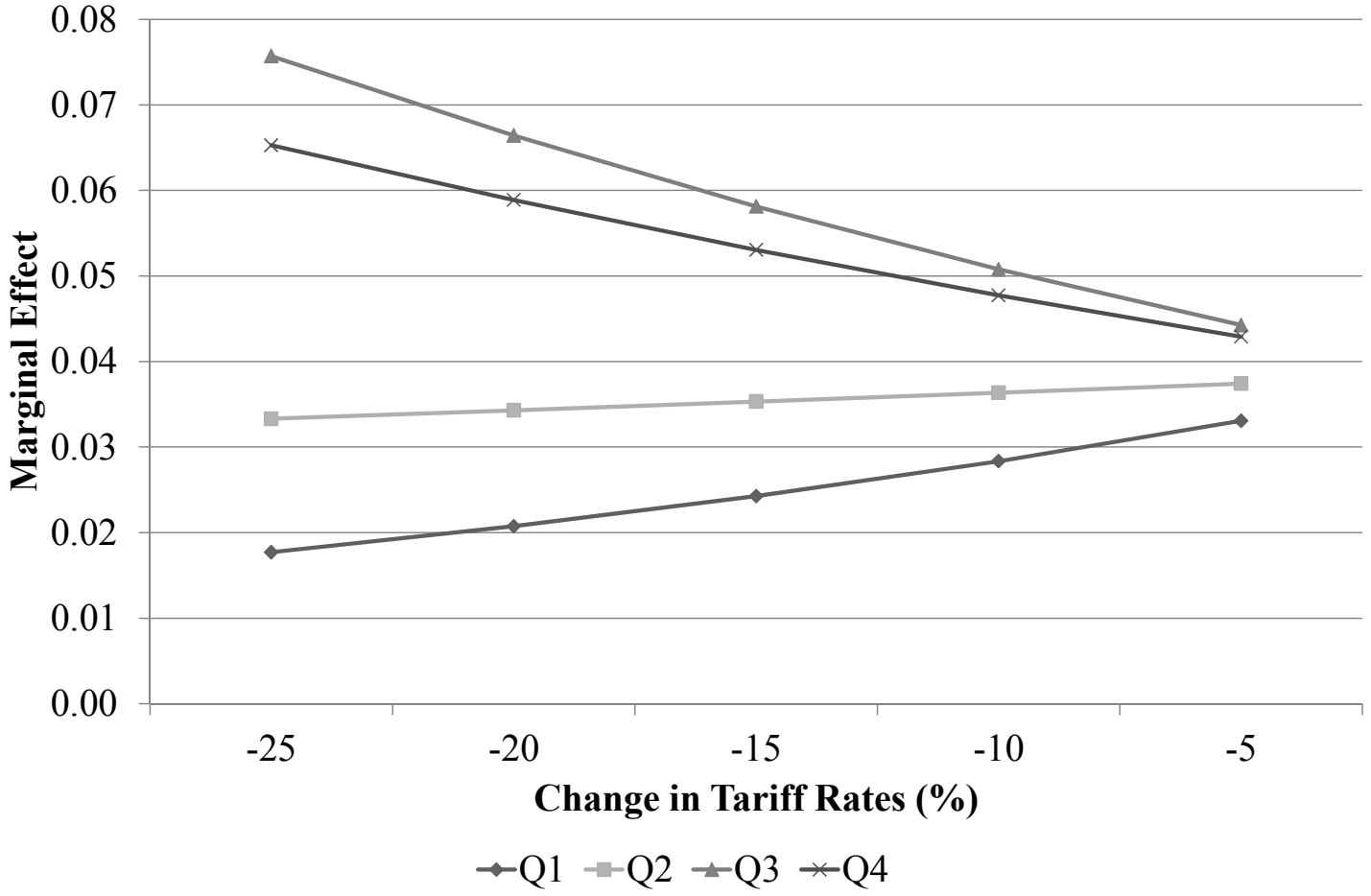
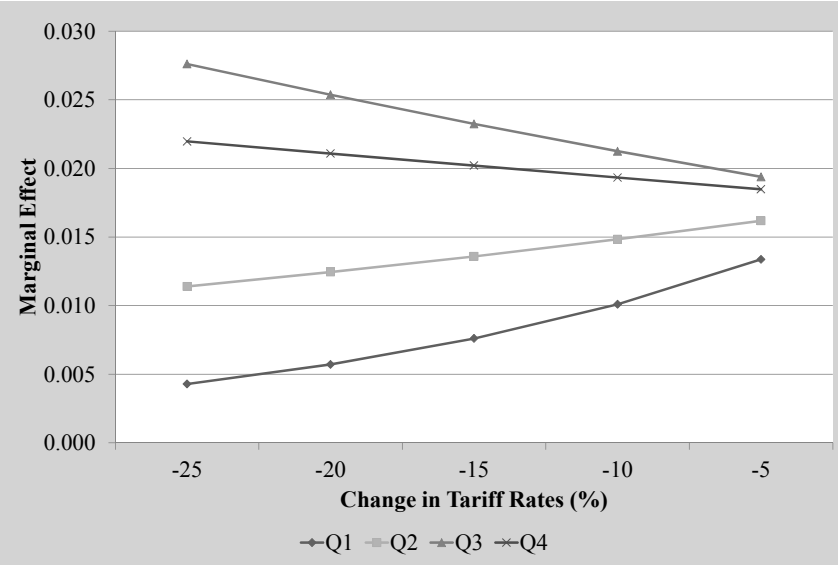


Figure A2: Marginal Effects for the Interaction Terms at Different Change Levels in Tariff Rates in the Multinomial Logit Model (Corresponding to Model (1) in Table 6)

Panel (a) HFDI



Panel (b) VFDI