The Role of Trade Costs in FDI Strategy in Heterogeneous Firms: Evidence from Japanese Firm-level Data

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Abstract

This paper attempts to clarify the reasons for the rapid growth of FDI in developing countries, particularly East Asian countries, compared with that of FDI to developed countries. To do this, we will examine the mechanics of HFDI and VFDI, in order to shed light on the role of trade costs. Our empirical analysis by estimation of a multinomial logit model of Japanese firms' FDI choices reveals that the reduction of trade costs between host and home countries attracts even less productive VFDI firms. In contrast, it does not attract HFDI firms. Since developing countries, particularly East Asian countries, have experienced a relatively rapid decrease in trade costs with Japan, our results indicate that the increase of VFDI through trade cost reduction has led to the recent relative surge of FDIs in developing countries.

INTRODUCTION

Recently, foreign direct investments (FDIs) from developed countries to developing countries have experienced a remarkable increase, compared with FDIs between developed countries. Navaretti and Venables (2004) report the fact 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". Also, in Japan, as confirmed in the next section, there have of late, been few investors in developed countries. Almost all investment goes to developing countries, particularly East Asian countries. Why have FDIs in developing countries grown so rapidly compared with those to developed countries?

In the FDI literature, many types of FDI classification have been proposed. One of the most common is horizontal FDI (HFDI). HFDI is a market-seeking investment and thus is likely to be directed towards developed countries. In order to avoid high trade costs when supplying products to the market, the HFDI firms locate their affiliates in the market country and directly supply their products from that country. In other words, it is generally acknowledged as a proximity-concentration hypothesis that firms invest in countries with large markets and substantial trade costs with their home country (Brainard, 1997). Indeed, Chen and Moore (2010) found that French firms are likely to invest in countries located geographically far from France. Therefore, a rise in trade costs will be expected to result in an increase of HFDI. However, it is obvious that trade liberalization has occurred in the world. Furthermore, incorporating firm heterogeneity in terms of productivity into the HFDI model, Helpman et al. (2004) shows the presence of a sorting effect according to firms' productivity: only firms with productivity beyond a cutoff can afford to pay the entry costs involved in investing abroad, and thus are able to become multinationals. This indicates that even if trade costs do not decrease, the rise of firms' productivity leads to an increase of HFDI. As a result, except for the global productivity rise, the mechanics of HFDI do not clearly explain the recent increase of FDIs to developing countries, relative to those to developed countries.

One candidate for models attempting to clarify the reasons for the relative increase of FDIs to developing countries is the vertical FDI (VFDI) model.[1] VFDI is an investment the aim of which is to relocate a part of the production process to cheap-labor countries and to engage, insofar as their production processes are concerned, in a vertical division of labor between host and home countries. Therefore, VFDI is likely to be directed towards developing countries rather than developed countries. Furthermore, the production cost reduction by the division of labor needs to outweigh the additional cost burden incurred in linking remotely-located production blocks. The main costs are obviously trade costs between host and home countries. Thus, it is apparent that VFDI is likely to be conducted in countries with a large gap in wages and a low level of trade costs between home and host countries. Therefore, it is expected that trade cost reduction should lead to an increase of VFDI. In other words, the mechanics of VFDI seem to be consistently able to explain the recent increase of FDIs in developing countries.

This paper attempts to clarify the reasons for this relatively rapid growth of FDIs to developing countries by examining the mechanics of HFDI and VFDI, thus shedding light on the role of trade costs. We first extend the Helpman et al. (2004) model so as to allow firms to choose another option, VFDI. In other words, we explicitly integrate the

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[1] In addition, more specific types of FDI are also proposed. In particular, to explore the mechanics of setting up multiple affiliates, FDI theories have been reconstructed in the framework of a three-country, not the traditional two-country, setting (Yeaple 2003; Grossman, Helpman, and Szeidl 2006; Baltagi, Egger, and Pfaffermayr 2007; Ekholm, Forslid, and Markusen 2007).

HFDI and VFDI models into a single framework. Subsequently, we derive some propositions regarding the relationship between trade cost reduction and firms' FDI choice. More specifically, we examine how changes in host country characteristics affect the productivity cutoffs separating firms' FDI choice. Next, we empirically examine those propositions for Japanese FDIs around the world by employing firm-level data. We estimate the multinomial logit model regarding firms' choice among three options: domestic production, HFDI, and VFDI. In the classification of HFDI and VFDI, we adopt the criterion that the HFDI affiliates are those in which the ratio of exports to total sales is above the world average by sector, and the VFDI is the inverse. As a result, our estimation reveals that the reduction of trade costs between host and home countries has different impacts between HFDI and VFDI. Their reduction attracts comparatively less productive VFDI firms in contrast to HFDI firms. Since developing countries, particularly East Asian countries, have experienced a relatively rapid decrease of trade costs with Japan, as confirmed in the next section, our findings imply that the increase of VFDI through trade cost reduction has resulted in the recent relative surge of FDIs to developing countries.

Our paper complements the recent empirical studies that examine the decision of heterogeneous firms to participate in international markets by extending the Helpman et al. (2004) model: Aw and Lee (2008), Yeaple (2009), and Chen and Moore (2010). Aw and Lee (2008) extend the model further still, suggesting that firms have four options: domestic production, VFDI, HFDI, and both VFDI and HFDI. Then, for Taiwanese firms, they examine the ranking of firms' productivity according to their chosen option and found it to be as follows: domestic production, VFDI to China, HFDI to the U.S., and both VFDI to China and HFDI to the U.S. Yeaple (2009) focuses on HFDI in U.S.

multinational enterprises (MNEs) and demonstrates that the sorting effect in the Helpman et al. (2004) model extends to the scale and scope of MNEs: more productive firms have affiliates in a larger set of countries, and their affiliates are larger than those of less productive firms. Chen and Moore (2010) derive further a number of testable predictions from the Helpman et al. (2004) model. In particular, they focus on HFDI in France and show empirically that productivity differences among MNEs lead to differential effects of host-country attributes and consequently distinct choices of foreign production locations. Conversely, as in Chen and Moore (2010), , our paper allows heterogeneous effects of host-country characteristics across firms and heterogeneous effects of firms' productivity across countries. But, in contrast to Chen and Moore (2010), we incorporate VFDI into firms' options, as in Aw and Lee (2008), though we exclude the option of both HFDI and VFDI.

The rest of this paper is organized as follows: The next section takes an overview of the distribution of Japanese FDIs. Section 3 lays out a model to motivate our empirical analysis. Empirical analyses and their results are reported in Section 4. Lastly, we conclude the paper in Section 5.

2. TRANSITION OF JAPANESE FDI

In this section, we will look briefly at the transition of Japanese FDI and the environment surrounding it. Table 1 reports the number of overseas affiliates by entry year, in both the machinery and automobile industries, in which most Japanese FDIs are concentrated. The data source is the *Survey of Overseas Business Activities*, an affiliate-level survey conducted by the Ministry of Economy, Trade and Industry

(METI).[2] From this table, we can see that during the 1980s, Japanese MNEs invested intensively in both developed and Asian countries . In later years however, they tended to invest mostly in Asia. Particularly in the mid-1990s, most Japanese MNEs concentrated their overseas affiliates in Asia. In summary, Japanese firms have, since the 1990s, changed the main location of their overseas affiliates from developed countries to Asian ones.

=== Table 1 ===

How have wages and trade costs, which should be important factors in deciding firms' investment, changed? Table 2 reports the average ratio of GDP per capita abroad to that of Japan, for which the data source is the World Development Indicator. From this table, we can see that the ratio is much lower in Asia than in North America and Europe. In other words, Asian countries have comparatively low GDP per capita. The ratio for European countries falls between the figures for North America and Asian countries. It can be seen that there have not been any significant changes in these ratios over the time frame..

=== Table 2 ===

[2] The aim of this survey is to obtain basic information on the activities of foreign affiliates of Japanese firms. The survey covers all Japanese foreign affiliates. The survey consists of two parts. One is the Basic Survey, which is more detailed and is carried out every 3 years. The other is the Trend Survey, which is less comprehensive and carried out between the Basic Surveys. A foreign affiliate of a Japanese firm is defined as an overseas subsidiary in which a Japanese firm holds 10 percent or more of the invested capital. The survey provides, for example, the establishment year of a foreign affiliate, a breakdown of its sales and purchases, its employment, cost of labor, research and development expenditures, etc.

On the other hand, Figure 1 shows the changes in the average trade costs with Japan. This measure takes into account tariffs, geographical distance, participation in the World Trade Organization (WTO), regional trade agreements, identical continental benefits, linguistic commonality, and colonial relationships. A more detailed method of estimating these measures is explained in Appendix 1. The figures show that trade costs with Japan are much lower and have experienced a more rapid decrease in Asia than in developed countries. While the former result is obviously due to the geographical proximity of Asia, the latter is based on the tariff reduction in each country and a number of countries' participation in the WTO (i.e. China and Taiwan).

=== Figure 1 ===

3. THEORETICAL FRAMEWORK

This section examines the problem of selecting an FDI pattern, i.e. HFDI or VFDI. It should be noted that the aim of this section is not to provide a general equilibrium model of multi-production-stages and multi-country operations, but simply to obtain insights into the driving forces behind firms' choices of FDI patterns in a partial equilibrium model.

3.1. Profit functions in each strategy

Suppose that there are two countries: country 1 (home country) and country 2 (foreign country). In this supposition we consider finished products that are horizontally differentiated. Each of a continuum of firms manufactures a different brand with zero measure. The finished products are consumed in both countries. A representative consumer in country i has the following preference, specified as a constant elasticity of substitution function over varieties:

$$u_i = \left(\sum_{j \in R} \int x_{ji}(k)^{\frac{\sigma-1}{\sigma}} dk \right)^{\frac{\sigma}{\sigma-1}},$$

where R and x_{ji} are respectively the set of countries (i.e. countries 1 and 2) and the demand of country i for the product varieties produced in country j. σ 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.

Utility maximization yields:

$$x_{ji} = t^{-(\sigma-1)} p_j^{-\sigma} A_i,$$

where p_j is the price of the variety produced in country j. $A_i \equiv P_i^{\sigma\text{-}1} Y_i$, where P_i is the price index in country i and Y_i is total income in country i. Although the demand level A is endogenous to the industry, it is treated as exogenous by producers because every producer is of negligible size relative to the size of the industry. There are ice-berg trade costs $t\,(\geq 1)$ for the shipment of products between countries 1 and 2.

The market structure of the finished goods sector can be regarded as monopolistic competition. Each firm knows its cost efficiency θ only after its entry into the market. Finished products are produced in two stages of production. The production function in each stage is kept as simple as possible in order to highlight the nature of interdependence of production stages. Our Leontief-type production structure is as follows: A first-stage product is produced inputting θ units of skilled-labor; a second-stage product is produced inputting one unit of the first-stage product and θ units of unskilled-labour. Factor prices for skilled-labor and unskilled-labor are represented by r

and w. Once again, there are ice-berg trade costs t for the shipment of each-stage product between countries 1 and 2. Although firms with headquarters in country 1 do not need to pay any fixed costs if they produce both two-stage products in only country 1, they must incur plant set-up costs f if they locate plants in country 2.

We should consider the production pattern of firms with headquarters in country 1. It is assumed for the sake of simplicity that the headquarters cannot be relocated. Due to data limitation, which will be discussed later, we restrict the considerations to firms with at least one production stage in country 1. This restriction rules out the pattern of complete specialization in headquartered services at home. Our interest in the production pattern is devoted to three specific patterns: domestic production (D), VFDI (V), and HFDI (H). Domestic production indicates that firms locate both stages in the home country and supply their finished products from home to both countries. In VFDI, firms locate the first stage of production at home and the second stage abroad. Since the finished products are completed abroad, firms supply their finished products from the foreign plant to both countries. Lastly, HFDI firms locate both production stages in both countries and supply their finished products domestically.

Among these three patterns, firms choose the pattern which yields the highest total profit. Let $c^{M}{}_{k}$ be a variable cost in producing products for the country k market in the production pattern M, then respective variable costs are given by:

$$c^{D}{}_{1} = (r_1\theta + w_1\theta)\, x_{11}, \qquad c^{D}{}_{2} = (r_1\theta + w_1\theta)\, x_{12},$$

$$c^{V}{}_{1} = (t\, r_1\theta + w_2\theta)\, x_{21}, \qquad c^{V}{}_{2} = (t\, r_1\theta + w_2\theta)\, x_{22},$$

$$c^{H}{}_{1} = (r_1\theta + w_1\theta)\, x_{11}, \qquad c^{H}{}_{2} = (r_2\theta + w_2\theta)\, x_{22}.$$

Thus, we can express respective total profit as:

$$\pi^{D} = \{p_1 x_{11} - (r_1\theta + w_1\theta)\, x_{11}\} + \{p_1 x_{12} - (r_1\theta + w_1\theta)\, x_{12}\},$$

$$\pi^V = \{p_2x_{21} - (t\, r_1\theta + w_2\theta)\, x_{21}\} + \{p_2x_{22} - (t\, r_1\theta + w_2\theta)\, x_{22}\} - f,$$

$$\pi^H = \{p_1x_{11} - (r_1\theta + w_1\theta)\, x_{11}\} + \{p_2x_{22} - (r_2\theta + w_2\theta)\, x_{22}\} - f.$$

In each equation, the first term and the second term are operating profits obtained from home markets and foreign markets, respectively. The profit-maximizing strategy yields $p = C^M{}_k / \alpha$, where $C^M{}_k = d\ c^M{}_k / d\ x$ and $\alpha \equiv (1\text{-}\sigma)/\sigma$, so that profit functions are represented by:

$$\pi_1{}^D = (r_1 + w_1)^{1\text{-}\sigma} (A_1 + A_2 t^{1\text{-}\sigma})\ \Theta$$

$$\pi_1{}^V = (tr_1 + w_2)^{1\text{-}\sigma} (A_1 t^{1\text{-}\sigma} + A_2)\ \Theta - f,$$

$$\pi_1{}^H = \{(r_1 + w_1)^{1\text{-}\sigma} A_1 + (r_2 + w_2)^{1\text{-}\sigma} A_2\}\ \Theta - f.$$

where $\Theta \equiv (1\text{-}\alpha)\ \alpha^{\alpha\text{-}1} \theta^{1\text{-}\sigma}$. We call Θ the productivity measure. Since $\sigma > 1$, the smaller the cost efficiency θ is, the larger the measure Θ is.

3.2. FDI choice

This subsection examines which production pattern the firms in country 1 choose according to their productivity levels. Let S_i^M to be a slope of the profit function of country i's firm in production type M then the three slopes are represented by:

$$S_1{}^D = (r_1 + w_1)^{1\text{-}\sigma} (A_1 + A_2 t^{1\text{-}\sigma}),$$

$$S_1{}^V = (tr_1 + w_2)^{1\text{-}\sigma} (A_1 t^{1\text{-}\sigma} + A_2),$$

$$S_1{}^H = (r_1 + w_1)^{1\text{-}\sigma} A_1 + (r_2 + w_2)^{1\text{-}\sigma} A_2.$$

For simplicity, it is assumed that $w_1 \geq w_2$ and $r_2 \geq r_1$, which indicate that country 1 (the home country) has higher wages for unskilled labor while country 2 (the potential host country) has higher wages for skilled labor.

Assumption 1: $w_1 = a\, w_2$ *and* $r_2 = b\, r_1$, *where* $a \geq 1$ *and* $b \geq 1$.

Furthermore, we assume that the home country has as large or larger demand than any potential host country.

Assumption 2: $A_1 \geq A_2$.

Our assumption of identical plant set-up costs between VFDI and HFDI assures that firms choosing VFDI and those choosing HFDI do not coexist. In other words, in our model setting, firms tend to choose between VFDI and Domestic or between HFDI and Domestic production patterns. In this subsection, we present only theoretical results. For more details, see Appendix 2.

We can confirm the well-documented conditions for the dominance of each FDI. First, we consider how the differences in wages affect the choice of production type. Given trade costs between countries, the greater the differences in wages for unskilled-labor (i.e. the lower the wages for unskilled-labor abroad), the steeper slope is likely to be in vertical FDI (S_1^V) compared with domestic production (S_1^D) (Corollary 2). In contrast, the smaller the differences in wages for skilled-labor (i.e. the lower the wages for skilled-labor abroad), the steeper slope is likely to be in horizontal FDI (S_1^Hcompared with domestic production (S_1^D) (Corollary 8). Both horizontal and vertical FDI firms have an identical and negative interception point because they must incur fixed set-up costs f for the plant in country 2. As a result, a profit line in each production type can be drawn as in figures 2 and 3. Figure 2 shows the productivity-cutoff which divides firms between into domestic and vertical FDI categories, in the case of large differences in wages. It indicates that more productive firms choose vertical FDI while less productive firms concentrate on domestic production. On the other hand, in the case of small differences in wages for skilled-labor, productive firms opt for horizontal FDI while those which are less productive select domestic production (Figure 3).

=== Figures 2&3 ===

Secondly, we take the differences in wages for both types of labor as a given. Then, the lower the trade costs between countries, the greater the likelihood of the slope in vertical FDI (S_1^V) being steeper than that of domestic production (S_1^D) (Corollary 3). In contrast, the larger the trade costs, the greater the likelihood there is of the slope in horizontal FDI (S_1^H) going beyond that of domestic production (S_1^D) (Corollary 9). Thus, we can again draw two figures, 3 and 4, according to the magnitude of trade costs. In the case of low trade costs, more productive firms choose vertical FDI while less productive firms focus on domestic production (Figure 4). On the other hand, in the case of high trade costs, more productive firms choose horizontal FDI while less productive ones focus on domestic production (Figure 5). The above-described patterns in both wage gaps and trade costs for each FDI type have already been well-documented.

=== Figures 4&5 ===

Next, we consider how the above cutoffs change according to host country characteristics. As shown above, VFDI is likely to be chosen in the case of low trade costs and large gaps in wages (i.e. lower wages for unskilled-labour abroad). Then, a further reduction in trade costs (Corollary 4), fixed costs (Corollary 5), or wages (Corollary 7) or a market-size expansion (Corollary 6) in foreign countries reduces the cutoff which divides firms into domestic and VFDI categories. In other words, these changes in potential host countries succeed in attracting even less productive firms in a form of VFDI. On the other hand, HFDI is likely to be chosen in cases where gaps in wages are small and trade costs are high. (i.e. lower wages for skilled-labor abroad). Then, except for trade-cost reduction, similar kinds of changes in host country characteristics also lead to the attraction of a form of HFDI by less productive firms (Corollaries 10 and 11). In short, the reduction in fixed entry costs or wages or a market-size expansion in foreign countries further attracts less productive firms, to a form of VFDI in the case of low trade costs and large gaps in wages and in a form of HFDI in the case of high trade costs and small gaps in wages. However, while trade cost reduction attracts less productive firms to a form of VFDI, it requires HFDI firms to be more productive. As a result, some HFDI firms with relatively low productivity exit. We will empirically examine this contrast in trade cost reduction in the following section.

4. EMPIRICAL ANALYSIS

In this section, we first explain our empirical method of examining firms' FDI choices. Next, some empirical issues are discussed, and finally, the estimation results are reported.

4.1. Empirical method

We estimate the multinomial logit model for firms' decisions on investing. The use of such a discrete choice model is appropriate because our model has multiple choices (i.e. Domestic, HFDI, and VFDI), and firms in the model choose the one with the highest profit margins. Let Y_{if} be a random variable that indicates the choice made by firm f in country i: 0 = Domestic, 1 = Horizontal FDI, 2 = Vertical FDI. A firm f in country i has characteristics $\boldsymbol{x}_{if}$, which do not vary across choices and are specific to the individual. This is the second reason for the use of the multinomial logit model. The overseas location of firms can be drawn from the *Survey of Overseas Business Activities*. If we assume that all disturbances are independent and identically distributed in the form of type I extreme value distribution, the probability that it chooses option j can be shown as:

$$Prob\left(Y_{if} = j \mid x_{if}\right) = \frac{e^{x_{if}\beta_j}}{\sum_{k=0}^{2} e^{x_{if}\beta_k}}, \qquad j = 0, 1, 2, \boldsymbol{\beta}_0 = \mathbf{0}.$$

$\boldsymbol{\beta}_j$ is a vector of coefficients to be estimated using the maximum likelihood estimation technique. Time script t is dropped for the sake of brevity, although it should be noted that our sample years are 1995-2006.

Our explanatory variables based on the theoretical framework in the previous section are as follows: we introduce firms' total factor productivity (TFP) as the measurement of their productivity. The firm-level data for its calculation are drawn from METI's *Results of the Basic Survey of Japanese Business Structure and Activities*.[3]

[3] This survey was first conducted in 1991, then again in 1994, and annually thereafter. The survey covers all firms, both manufacturing and non-manufacturing, with more than 50 employees and capitalized at more than 30 million yen.

From this data we estimate the TFP index following Caves et al. (1982, 1983) and Good et al. (1983). The TFP index is calculated as follows:

$$TFP_{it} = \left(\ln Q_{it} - \overline{\ln Q_t}\right) - \sum_{f=1}^{F} \frac{1}{2}\left(s_{ift} + \overline{s_{ft}}\right)\left(\ln X_{ift} + \overline{\ln X_{ft}}\right)$$
$$+ \sum_{s=1}^{t}\left(\overline{\ln Q_s} - \overline{\ln Q_{s-t}}\right) - \sum_{s=1}^{t}\sum_{f=1}^{F} \frac{1}{2}\left(\overline{s_{fs}} + \overline{s_{fs-1}}\right)\left(\overline{\ln X_{fs}} - \overline{\ln X_{fs-1}}\right) \quad ,$$

where Q_{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. Variables with an upper bar denote the industry average for that variable. We define a hypothetical (representative) firm for each year and industry. Its input and output are calculated as the geometric means of the input and output of all establishments in the industry. The first two terms on the right-hand side of the equation denote the cross-sectional TFP index based on the Theil-Tornqvist specification for each firm and year relative to the hypothetical establishment. Since the cross-sectional TFP indexes for *t* and *t*-1 are not comparable, we adjust the cross-sectional TFP index with the TFP growth rate of the hypothetical firm, which is represented by the third and fourth terms in the equation.

We interact several country-specific variables to firms' TFP in order to examine the heterogeneous effects of host country characteristics across firms. The first one is related to labor costs. In the previous section, we categorized labor into skilled and unskilled. However, since this is somewhat difficult to achieve through empirical analysis, we simply introduce and compare the ratio of GDP per capita in the host country to that of Japan. The lower ratio is linked to firms' probability of choosing both HFDI and VFDI. Second, the role of the market size in possible host countries is examined by introducing the market potential measure which is proposed by Harris

(1954), i.e., sum of distance-weighted GDP. The data on bilateral distance and GDP are from the CEPII website and the World Development Indicator. Third, we introduce countries' credibility index to control, to some extent, the elements associated with plant set-up costs. . The index is drawn from "Institutional Investor" and is the aggregate of bankers' evaluation of risk of default. The higher the index, the smaller the risk of default in the country. Fourth, as a proxy for trade costs, we use the following two measures: geographical distance from Japan and the estimate of trade costs with Japan (the same as were used in section 2). Finally, we introduce sector and year dummy variables.

4.2. Empirical issues

Before reporting estimation results, there are three points that should be borne in mind: First, as in section 2, we focus on the machinery and automobile industries. These industries consist of the following six sectors: household electrical appliances, electronic data processing machines, communications equipment, electronic parts and devices, miscellaneous electrical machinery equipment, and motor vehicles, parts and accessories. Additionally, this focus may enable us to control various kinds of industry heterogeneity in our empirical estimates.

The second is how to differentiate between overseas affiliates opting for HFDI and those choosing VFDI. In fact, there are a number of ways to do this. Among them, this paper sheds light on the main sales destinations in affiliates. Since the aim of HFDI is to supply products within the market country, the main sales destination is the host country in the case of HFDI affiliates. On the other hand, it is not necessarily the host country in the case of VFDI. Thus, we define an HFDI affiliate as an affiliate whose share of exports in total sales is greater than the sectoral average in all sampled affiliates, which is not the case with VFDI affiliates. As a result, the share of VFDI affiliates is reported in Table 3. In line with our expectations in the introductory section, affiliates in Asia are more likely to fall into the category of VFDI than those in developed countries. However, it might also be worth noting that nearly half of the affiliates are of the HFDI type even in Asia and that affiliates in the automobile sector are less likely to be of the VFDI type compared with those in the machinery industry.

=== Table 3 ===

The third issue is consistency between the theoretical and empirical frameworks. In the theoretical framework, given one candidate for the host country (it should be remembered that our model is a two-country setting), firms choose their operation type from among three models. On the other hand, firms are faced with many candidates for investment and may additionally have to decide whether or not to invest in *each* country. We did not extend the theoretical model to such a many-country setting in order to avoid various kinds of interaction among overseas affiliates. For example, the first VFDI affiliate in a country may stop supplying to the home country after setting up the second VFDI affiliate in another country closer to the home country. As a result, in order to ensure as much consistency between the empirical model and our theoretical framework as possible, we restrict investing firms to "first investors": firms who have never had overseas affiliates in the focus sector at time t-1. Such firms would not take interaction among affiliates into consideration. Furthermore, sample firms are restricted only to those who became involved in exporting activities at time t-1.

4.3. Empirical results

In this subsection, we report our estimation results. Basic statistics for the estimation sample are provided in Table 4, and the estimation results can be found in Table 5. Column (I) reports the case of introducing geographical distance as a proxy for trade costs, and column (II) introduces our estimates of trade costs.

=== Tables 4&5 ===

The estimation results are as follows: The coefficients for TFP are positive although insignificant in both types of FDI. These insignificant results might be due to the inclusion of many interaction terms with country-specific variables, i.e. multi-colinearity in the equation. Indeed, Chen and Moore (2010) also obtain an insignificant result in the equations due to the interaction terms. The negatively significant results in GDP per capita ratio in both types of FDI are consistent with our expectations, indicating that even less productive firms can invest in countries where lower wages are the norm. Such firms' entry becomes a form of VFDI in the case of host countries with low-waged unskilled labor and a form of HFDI in the case of host countries with low-waged, skilled labor. The Country Credibility Index has significant positive coefficients, which are also in line with our expectations. Productive firms are more likely than less productive firms to invest in countries with higher default risks, which will be related to fixed-entry costs. The market potential variable is inaccurate and produces insignificant results. This might be due to the high correlation between Market Potential and the GDP per capita ratio.

The coefficients for trade cost-related variables, i.e. Distance and Trade Cost, are insignificant in the case of HFDI and significantly negative in the case of VFDI. The results in VFDI are consistent with our theoretical prediction: even less productive firms can choose vertical FDI in countries with lower trade costs with Japan. Thus, we can say that continuing trade liberalization further increases Japanese vertical FDI. On the other hand, the results with regard to HFDI may be unexpected. One possible reason is that, as mentioned in Chen and Moore (2010), our trade cost measurement is also partly related to fixed-entry costs. For example, long distance leads to increased monitoring costs for firms. Since the low fixed costs encourage firms to conduct HFDI, the trade costs exhibit opposing forces in the case of HFDI. As a result, our insignificant results in trade costs may indicate that such forces are balanced. However, we can, at the very least, say that HFDI does not have a significantly negative association with trade costs with Japan.

5. CONCLUDING REMARKS

This paper has attempted to clarify the reasons for the relatively rapid growth of FDIs in developing countries by examining the mechanics of HFDI and VFDI in order to shed light on the role of trade costs. We first extend the Helpman et al. (2004) model so as to allow firms to choose another option, i.e. VFDI, and derive some propositions regarding the relationship between trade cost reduction and firms' FDI choices. Next, we have empirically examined these propositions in relation to Japanese FDIs around the world by estimating the multinomial logit model of firms' choices among three options: domestic production, HFDI, and VFDI. As a result, our estimation reveals that the reduction of trade costs between host and home countries is impacted differently depending on which form of investment firms choose: HFDI or VFDI. Their reduction attracts less productive VFDI firms but does not attract HFDI firms. Since developing countries, particularly East Asian countries, have experienced a relatively rapid decrease in trade costs with Japan, we conclude that the increase of VFDI through the trade cost reduction has led to the recent relative surge of FDIs in developing countries.

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APPENDIX 1. ESTIMATION OF BILATERAL TRADE COSTS

This appendix provides explanations of how we estimate the bilateral trade costs. Our theoretical background lies in Anderson and van Wincoop (2003). Under the usual assumptions (e.g., CES utility function), they derive the following gravity equation (equation 9 on page 175):

$$x_{ij} = \frac{y_i y_j}{y^W}\left(\frac{\tau_{ij}}{\Pi_i P_j}\right)^{1-\sigma}, \tag{A.1}$$

where

$$\Pi_i \equiv \left(\sum_j \left(\tau_{ij}/P_j\right)^{1-\sigma}\theta_j\right)^{1/(1-\sigma)},\ \ P_j \equiv \left(\sum_i \left(\tau_{ij}/\Pi_i\right)^{1-\sigma}\theta_i\right)^{1/(1-\sigma)}, \text{and}\ \ \theta_j \equiv y_j / y^W .$$

x_{ij}, y_i, τ_{ij}, and y^W are the nominal value exports from countries i to j, total income of country i, iceberg trade costs from countries i to j, and world nominal income, respectively. σ denotes the elasticity of substitution among varieties. Taking logs in equation (A.1), we obtain:

$$\ln x_{ij}^t = \ln y_t^W + \ln y_i^t + \ln y_j^t + (1-\sigma)\tau_{ij}^t + (\sigma-1)\ln\Pi_i^t + (\sigma-1)\ln P_j^t . \tag{A.2}$$

In this equation, we add time script t.

In this paper, we specify the trade cost function as:

$$\begin{aligned}\tau_{ij}^t = &\left(1+tariff_j^t\right)\cdot Dist_{ij}^{\alpha_1}\cdot\exp\left(\alpha_2 WTO_{ij}^t\right)\cdot\exp\left(\alpha_3 RTA_{ij}^t\right)\cdot\exp\left(\alpha_4 Continent_{ij}\right)\\ &\cdot\exp\left(\alpha_5 Language_{ij}\right)\cdot\exp\left(\alpha_6 Colony_{ij}\right)\end{aligned} . \tag{A.3}$$

Dist is geographical distance between trading partners. *RTA* is a binary variable taking unity if trading partners conclude on regional trade agreements (RTAs) and zero otherwise. *tariff* is the weighted average of most favored nation (MFN) rates (100**tariff*%). *Language* is a linguistic dummy variable that takes one if the same language is spoken by at least 9% of the population in both countries. Colony is a binary variable which takes one if an importer (an exporter) was ever a colonizer of an exporter (importer) and zero otherwise. WTO is a binary variable which takes one if both exporter and importer are members of the World Trade Organization (WTO) and zero otherwise.

Introducing this trade cost function into equation (A.2) and taking logs, we obtain:

$$
\begin{aligned}
\ln x_{ij}^{t} = {} & \ln y_{t}^{W} + \ln y_{i}^{t} + \ln y_{j}^{t} + (1-\sigma)\ln\left(1+tariff_{j}^{t}\right) + (1-\sigma)\alpha_{1}\ln Dist_{ij} \\
& + (1-\sigma)\alpha_{2}WTO_{ij}^{t} + (1-\sigma)\alpha_{3}RTA_{ij}^{t} + (1-\sigma)\alpha_{4}Continent_{ij} + (\sigma-1)\ln\Pi_{i}^{t} + (\sigma-1)\ln P_{j}^{t}.
\end{aligned}
$$

This can be rewritten as:

$$
\begin{aligned}
\ln x_{ij}^{t} = {} & \beta_{0} + \beta_{1}\ln y_{i}^{t} + \beta_{2}\ln y_{j}^{t} + \gamma_{0}\ln\left(1+tariff_{j}^{t}\right) + \gamma_{1}\ln Dist_{ij} + \gamma_{2}WTO_{ij}^{t} \\
& + \gamma_{3}RTA_{ij}^{t} + \gamma_{4}Continent_{ij} + \gamma_{5}Language_{ij} + \gamma_{6}Colony_{ij} + \beta_{3}\ln\Pi_{j}^{t} + \beta_{4}\ln P_{j}^{t}.
\end{aligned} \tag{A.4}
$$

Because γ_0=1-σ, α_i=γ_i/γ_0 for i ={1,2,3,4,5,6}. Thus, obtaining the consistent estimators of γ_i for i ={0,1,2,3,4,5,6}, we can calculate bilateral trade costs τ_{ij}, based on equation (A.3).

We estimate (A.4) after introducing an error term. Our estimation procedures are as follows: First, we obtain the consistent estimators of γ_i for i ={1,2,3,4,5,6} by estimating:

$$
\begin{aligned}
\ln x_{ij}^{t} = {} & \gamma_{1}\ln Dist_{ij} + \gamma_{2}WTO_{ij}^{t} + \gamma_{3}RTA_{ij}^{t} + \gamma_{4}Continent_{ij} \\
& + \gamma_{5}Language_{ij} + \gamma_{6}Colony_{ij} + u_{j}^{t} + u_{i}^{t} + \varepsilon_{ij}^{t}
\end{aligned} \tag{A.5}
$$

As is well-documented in the gravity literature, data on Π and P are difficult to obtain. Thus, in order to avoid suffering from an omitted variables bias, we control their effects on trade by introducing importer-year and exporter-year dummy variables. Then, we need to drop total incomes and tariffs because they are not pair-specific variables. This model is called "Model I" in this paper.

The second step is to estimate γ_0. This is done by estimating the following:

$$\ln x_{ij}^t = \beta_1 \ln y_i^t + \beta_2 \ln y_j^t + \gamma_0 \ln\left(1 + tariff_j^t\right) + \gamma_2 WTO_{ij}^t + \gamma_3 RTA_{ij}^t + u_{ij} + u^t + \varepsilon_{ij}^t . \qquad \text{(A.6)}$$

Although this estimation controls all time-invariant pair effects in addition to time effects, it fails to precisely control the effects of Π and *P*. Since the variable *tariff* is time-variant importer-specific, it is impossible to obtain its coefficient under the estimation controlling the effects of Π and *P* unless we adopt other methods, e.g. non-linear estimation in Anderson and van Wincoop (2003). But we believe that the bias resulting from omitting Π and *P* becomes less serious if we introduce both pair-fixed effects and time-fixed effects. This model is called "Model II".

Our data cover 82 countries worldwide. Data on international trade values (code 7 in SITC rev.2) have been obtained from the UN Comtrade. RTA and WTO dummies are constructed by using lists of RTAs and of WTO member countries provided on the WTO website. Our RTA dummy is based on RTAs not only under the GATT Article XXIV but also under the Enabling Clause for developing countries. *tariff* is obtained from the UNCTAD Handbook of Statistics Online (code 7 in SITC rev.2). The source of geographical distance and other dummy variables is the CEPII website.

The OLS results of the estimation for Models I and II are reported in Table A1. We find that coefficients for all variables are estimated to be significant and have expected signs. In particular, the coefficient for (1+*tariff*) is -6.037, implying that the elasticity of substitution is 7.037. Head and Ries (2001) and Hanson (2005) obtained estimates of σ ranged between 7 and 11 and between 5 and 8, respectively, and Anderson and van Wincoop (2004) conclude that it is likely to be in the range of 5 to 10. Thus, we can say that our estimate is a reasonable value. By using these estimates of γ_i into equation (A.3), we are able to calculate the bilateral trade costs.

=== Table A1. ===

Last, we point out the advantage of our method of estimating trade costs over other methods. Our primary purpose is to obtain *country-pair-specific* (asymmetric) trade costs. In this sense, we cannot adopt the method/specification employed in McCallum (1995), Feenstra (2002), and Anderson and van Wincoop (2003) because their method requires us to employ data on transactions among sub-national level regions such as provinces. Since our sample is targeted throughout the world, it is not possible to obtain such data. Also, Head and Mayer (2000) proposes the "log odds ratio" method, which requires national-level transaction data but provides only *importer-specific* trade costs. Furthermore, it might be expected that we take the residuals of regression as trade costs. That is, the following equation is first estimated:

$$\ln x_{ij}^t = \beta_0 + \beta_1 \ln y_i^t + \beta_2 \ln y_j^t + \varepsilon_{ij}^t,$$

then the difference between actual bilateral trade values and fitted bilateral trade values is calculated. Such a difference is certainly country-pair-specific, but it includes the effects of Π and P in addition to various other elements. However, if we introduce importer-year and exporter-year dummy variables in order to control them, the residuals turn out not to include importer-specific border barriers, which are unlikely to be negligible. On the other hand, our method also has a shortcoming: Our estimator can cover trade cost components that are included in the trade cost function, i.e. (A.3). For example, the effects of customs efficiency are not taken into account. Thus, we can say that our method prefers capturing some of the most important components of trade costs to including trade cost unrelated elements or even omitting some important components.

APPENDIX 2. SLOPE OF PROFIT FUNCTION

In this appendix, we examine differences in slopes of profit function among production types.

A2.1. DOMESTIC VS. VFDI

The condition that the slope in VFDI is greater than the slope in domestic production is as follows:

$$S_1^V > S_1^D \Leftrightarrow r_1 < \frac{(Ba-1)w_2}{t-B}, \quad B \equiv \left(\frac{A_1 + A_2 t^{1-\sigma}}{A_1 t^{1-\sigma} + A_2} \right)^{\frac{1}{1-\sigma}}.$$

Assumption 2 gives us the following corollary.

Corollary 1: $0 < B \leq 1$.

Proof. It is obvious that $B > 0$. $(A_1+A_2t^{1-\sigma})$ - $(A_1t^{1-\sigma}+A_2) = (A_1-A_2)(1-t^{1-\sigma})$. Since $1 \geq t^{1-\sigma}$, $A_1+A_2t^{1-\sigma} > A_1t^{1-\sigma}+A_2$ with Assumption 2. Then, since $\sigma > 1$, $B \leq 1$. ■

We define function $g(a,t)$:

$$g(a,t) = \frac{(Ba-1)w_2}{t-B}.$$

Then, we can easily show (remember that $t \geq 1$):

$$\frac{\partial g(a,t)}{\partial a} = \frac{Bw_2}{t-B} > 0, \quad g(1,t) = \frac{(B-1)w_1}{t-B} < 0.$$

Also,

$$r_1 = \frac{(Ba^*-1)w_2}{t-B} \Leftrightarrow a^* = \frac{(t-B)r_1 + w_2}{Bw_2} > \frac{1}{B}.$$

By employing these relationships and results, we can draw Figure A1 and obtain the following result:

Corollary 2: *If $a \geq a^*$, then $S_1^V \geq S_1^D$. Otherwise, $S_1^V < S_1^D$.*

=== Figure A1 ===

On the other hand, the condition can be also rewritten as:

$$S_1^V > S_1^D \Leftrightarrow 1 + \left(\frac{r_1}{w_2} \right) t < \left(a + \frac{r_1}{w_2} \right) B .$$

Due to assumption 2, we have:

$$\frac{\partial B}{\partial t} = -t^{-\sigma} \left(A_1 + A_2 t^{1-\sigma} \right)^{\frac{\sigma}{1-\sigma}} \left(A_1 t^{1-\sigma} + A_2 \right)^{\frac{2-\sigma}{1-\sigma}} \left(A_1 + A_2 \right) \left(A_1 - A_2 \right) < 0 .$$

Using the sign of this derivative, we can draw the above condition as in Figure A2 and find t so that RHS = LHS, which is denoted by t^*. As a result, we obtain the following result:

Corollary 3: *If $t \leq t^*$, then $S_1^V \geq S_1^D$. Otherwise, $S_1^V < S_1^D$.*

=== Figure A2 ===

Last, let Θ_k^{VD} be the productivity in which Domestic and VFDI have equal profits for firms in country *k*. Its derivatives with respect to various parameters are examined. The derivative with respect to trade cost is as follows:

$$\frac{\partial \Theta_1^{VD}}{\partial t} = \frac{f(1-\sigma)}{\left(S_1^V - S_1^D\right)^2} \left\{ t^{-\sigma} \left[(tr_1 + w_2)^{1-\sigma} A_1 - (r_1 + w_1)^{1-\sigma} A_2 \right] + r_1 (tr_1 + w_2)^{-\sigma} \left(A_1 t^{1-\sigma} + A_2 \right) \right\}.$$

With the Assumption 2,

$$(tr_1 + w_2)^{1-\sigma} A_1 - (r_1 + w_1)^{1-\sigma} A_2 \geq \left[(tr_1 + w_2)^{1-\sigma} - (r_1 + w_1)^{1-\sigma} \right] A_2.$$

As a result, the sufficient condition for the positive derivative can be written as:

Corollary 4: $(t-1)r_1 < (a-1)w_2 \Rightarrow \dfrac{\partial\left(\Theta_1^V - \Theta_1^D\right)}{\partial t} > 0.$

Its derivative with respect to fixed entry cost is given by:

$$\frac{\partial \Theta_1^{VD}}{\partial f} = \frac{1}{S_1^V - S_1^D}.$$

Due to the corollaries 2 and 3, we obtain:

Corollary 5: *If* $a \geq a^*$ *or* $t \leq t^*$, *then* $\partial\Theta_1^{VD}/\partial f > 0$.

With respect to the size of foreign market,

$$\frac{\partial \Theta_1^{VD}}{\partial A_2} = \frac{f}{\left(S_1^V - S_1^D\right)^2} \left[(tr_1 + taw_2)^{1-\sigma} - (tr_1 + w_2)^{1-\sigma} \right].$$

The following corollary is obtained:

Corollary 6: *If* $ta \leq 1$, *then* $\partial\Theta_1^{VD}/\partial A_2 \geq 0$. *Otherwise,* $\partial\Theta_1^{VD}/\partial A_2 < 0$.

The derivatives with respect to the other parameters are summarized as:

Corollary 7: $\frac{\partial \Theta_1^{VD}}{\partial a} = \frac{f(1-\sigma) w_2 (r_1 + a w_2)^{-\sigma} \left(A_1 + A_2 t^{1-\sigma}\right)}{\left(S_1^V - S_1^D\right)^2} < 0, \qquad \frac{\partial \Theta_1^{VD}}{\partial b} = 0.$

A2.2. DOMESTIC VS. HFDI

The condition that the slope in HFDI is greater than the slope in domestic production can be simplified as follows:

$$(tr_1 - r_2) + (tw_1 - w_2) > 0.$$

This condition can be expressed as follows:

Corollary 8: $b < \left(\frac{w_2 t}{r_1}\right) a + \left(t - \frac{w_2}{r_1}\right) \Leftrightarrow S_1^H > S_1^D$.

Corollary 9: $t > \frac{r_2 + w_2}{r_1 + w_1} \Leftrightarrow S_1^H > S_1^D$

Figure A3 shows corollary 8, meaning that, given the trade costs, the smaller the gap in wages for skilled labor, the more likely the slope in HFDI is to be greater than the slope in Domestic. Corollary 9 indicates that, given wages for skilled and unskilled labor, larger trade costs also lead to a similar relationship of .

=== Figure A3 ===

Let Θ_k^{HD} be the productivity in which Domestic and HFDI yield equal profits for firms in country *k*. Its derivatives with respect to fixed entry cost and the size of foreign market are given by:

$$\frac{\partial \Theta_1^{HD}}{\partial f} = \frac{1}{S_1^H - S_1^D}, \qquad \frac{\partial \Theta_1^{HD}}{\partial A_2} = \frac{f}{\left(S_1^V - S_1^D\right)^2}\left[t^{1-\sigma}\left(r_1 + w_1\right)^{1-\sigma} - \left(r_2 + w_2\right)^{1-\sigma}\right]$$

Since the latter becomes negative if $t > (r_2+w_2)/(r_1+w_1)$, with corollaries 8 and 9, these two derivatives can be summarized as follows.

Corollary 10: $S_1^H > S_1^D \Leftrightarrow \dfrac{\partial \Theta_1^{HD}}{\partial f} > 0 \Leftrightarrow \dfrac{\partial \Theta_1^{HD}}{\partial A_2} < 0.$

The derivatives with respect to the other parameters are summarized as:

Corollary 11: $\dfrac{\partial \Theta_1^{HD}}{\partial t} = \dfrac{-f(\sigma-1)(r_1+w_1)^{1-\sigma} A_2 t^{-\sigma}}{\left(S_1^V - S_1^D\right)^2} < 0,$

$$\frac{\partial \Theta_1^{HD}}{\partial a} = \frac{f(1-\sigma)w_2 A_2 t^{1-\sigma}\left(r_1 + aw_2\right)^{-\sigma}}{\left(S_1^H - S_1^D\right)^2} < 0, \qquad \frac{\partial \Theta_1^{HD}}{\partial b} = \frac{f(\sigma-1)r_1 A_2\left(br_1 + w_2\right)^{-\sigma}}{\left(S_1^H - S_1^D\right)^2} > 0.$$

A2.3. VFDI VS. HFDI

Our assumption of identical plant set-up costs between VFDI and HFDI assures that firms choosing VFDI and those choosing HFDI do not coexist. In other words, in our model setting, firms select their production patterns from a choice of either VFDI or Domestic or between HFDI and Domestic. If we assume the different plant set-up costs between these two FDIs, however, we can show that by integrating Figures A1 and A3 there are situations in which firms choosing VFDI, HFDI, and Domestic production patterns can coexist. From Figure A4, we can see that there are combinations of a and b in which $S_1^H > S_1^D$ and $S_1^V > S_1^D$. For example, if $S_1^H > S_1^V$ in these combinations, by assuming that plant set-up costs are cheaper in VFDI than HFDI, firms with high levels of productivity choose HFDI, those with medium levels choose VFDI, and those with low levels choose Domestic. To avoid these ambiguous results, we assume identical plant set-up costs between VFDI and HFDI.

=== Figure A4 ===

Table 1: Overseas affiliates' entry year

	Developed Countries			Asia	Others	Total
		NAmerica	Europe			
1985	38	19	19	20	4	62
1986	78	60	18	58	8	144
1987	83	56	27	126	13	222
1988	113	78	35	96	9	218
1989	115	70	45	127	11	253
1990	105	52	53	110	10	225
1991	58	25	33	83	13	154
1992	49	23	26	99	10	158
1993	34	16	18	109	9	152
1994	52	36	16	211	11	274
1995	89	51	38	326	17	432
1996	80	54	26	191	15	286
1997	68	42	26	153	15	236
1998	58	28	30	89	15	162
1999	47	22	25	67	4	118
2000	66	48	18	82	12	160
2001	47	23	24	118	6	171
2002	31	17	14	86	5	122
2003	14	10	4	41	1	56
2004	2	1	1	20	0	22

Source: The Survey of Overseas Business Activities

Table 2: The average ratio of GDP per capita in host countries to GDP per capita in Japan

	NAmerica	Europe	Asia
1995	0.64	0.50	0.14
1996	0.73	0.56	0.16
1997	0.83	0.56	0.17
1998	0.92	0.62	0.14
1999	0.83	0.54	0.13
2000	0.79	0.45	0.13
2001	0.88	0.50	0.14
2002	0.91	0.55	0.15
2003	0.89	0.60	0.14
2004	0.85	0.61	0.14
2005	0.89	0.62	0.15

Source: World Development Indicator

Table 3: The share of VFDI-type affiliates

	NAmerica	Europe	Asia
1995			
Household electric appliances	0.083	0.333	0.607
Electronic data processing machines	0.282	0.176	0.586
Communication equipment	0.255	0.196	0.573
Electronic parts and devices	0.300	0.185	0.477
Miscellaneous electrical machinery equipment	0.268	0.206	0.504
Motor vehicles, parts and accessories	0.203	0.276	0.318
2000			
Household electric appliances	0.100	0.125	0.521
Electronic data processing machines	0.270	0.129	0.596
Communication equipment	0.192	0.260	0.550
Electronic parts and devices	0.317	0.205	0.581
Miscellaneous electrical machinery equipment	0.197	0.152	0.528
Motor vehicles, parts and accessories	0.206	0.210	0.383
2004			
Household electric appliances	0.143	0.067	0.542
Electronic data processing machines	0.345	0.348	0.568
Communication equipment	0.196	0.167	0.583
Electronic parts and devices	0.261	0.111	0.528
Miscellaneous electrical machinery equipment	0.265	0.182	0.495
Motor vehicles, parts and accessories	0.213	0.270	0.382

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

Table 4: Basic statistics

	Mean	S.D.	p25	p75
FDI type	0.00	0.03	0.00	0.00
TFP	1.08	0.20	0.95	1.22
* GDP per capita ratio	-1.70	1.53	-2.59	-0.39
* Distance	9.63	1.93	8.39	10.87
* Credibility	66.40	27.09	45.32	85.80
* Market Potential	30.26	5.77	26.56	34.01
* Trade Cost	16.59	4.47	13.90	19.30

Table 5: Results of multinomial logit

	(I)		(II)	
	HFDI	VFDI	HFDI	VFDI
TFP	8.239	12.414	6.102	8.173
	[1.14]	[1.11]	[0.92]	[0.78]
* GDP per capita ratio	-0.834	-0.602	-0.885	-0.695
	[-4.59]***	[-3.03]***	[-5.28]***	[-3.81]***
* Distance	-0.236	-0.706		
	[-0.94]	[-2.49]**		
* Credibility	0.089	0.022	0.089	0.022
	[5.50]***	[1.71]*	[5.48]***	[1.72]*
* Market Potential	-0.466	-0.327	-0.447	-0.305
	[-1.91]*	[-0.89]	[-1.83]*	[-0.83]
* Trade Cost			-0.038	-0.174
			[-0.67]	[-2.88]***
Year Dummy	YES	YES	YES	YES
Sector Dummy	YES	YES	YES	YES
Observations	154,596		154,596	
Log likelihood	-747		-746	

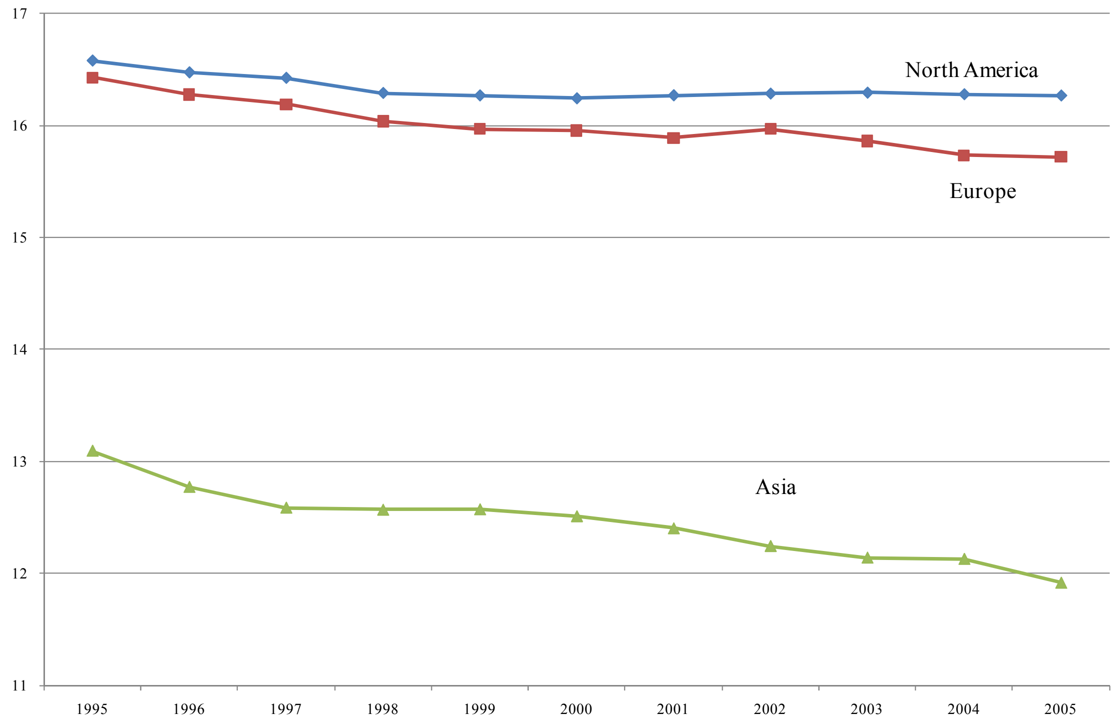
Notes: z-ratios are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table A1: OLS results

	Model I			Model II		
	Coef.		Robust SE	Coef.		Robust SE
Ex GDP	1.502	***	0.067			
Im GDP	1.816	***	0.069			
Dist				-1.864	***	0.028
1 + tariff	-6.037	***	0.430			
WTO	0.158	**	0.076	0.471	***	0.139
RTA	0.879	***	0.120	0.244	***	0.039
Continent				0.114	**	0.048
Language				1.308	***	0.045
Colony				0.968	***	0.097
Obs	79,704			79,704		
Adj R2	0.7854			0.7838		

Note: ***, ** and * shows 1%, 5% and 10% significance, respectively.

Figure 1: Changes in the average trade costs with Japan: by region



Source: Authors' estimation.

Note: For the method of estimation, see Appendix 1.

Figure 2: Medium trade cost and large wage differentials

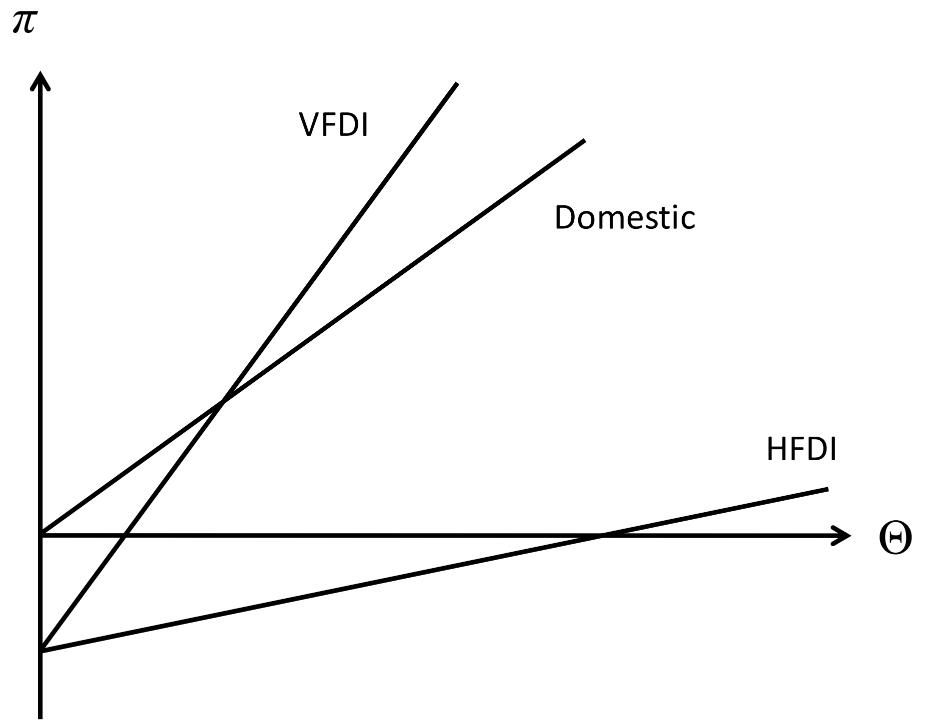


Figure 3: Medium trade cost and small wage differentials

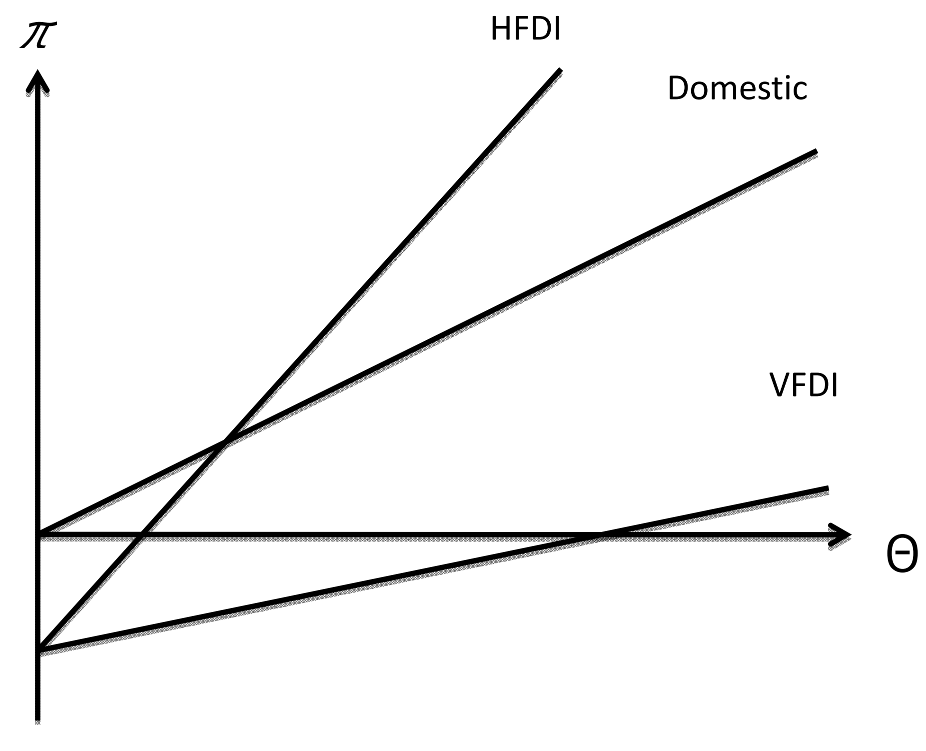


Figure 4: Medium wage differentials and low trade cost

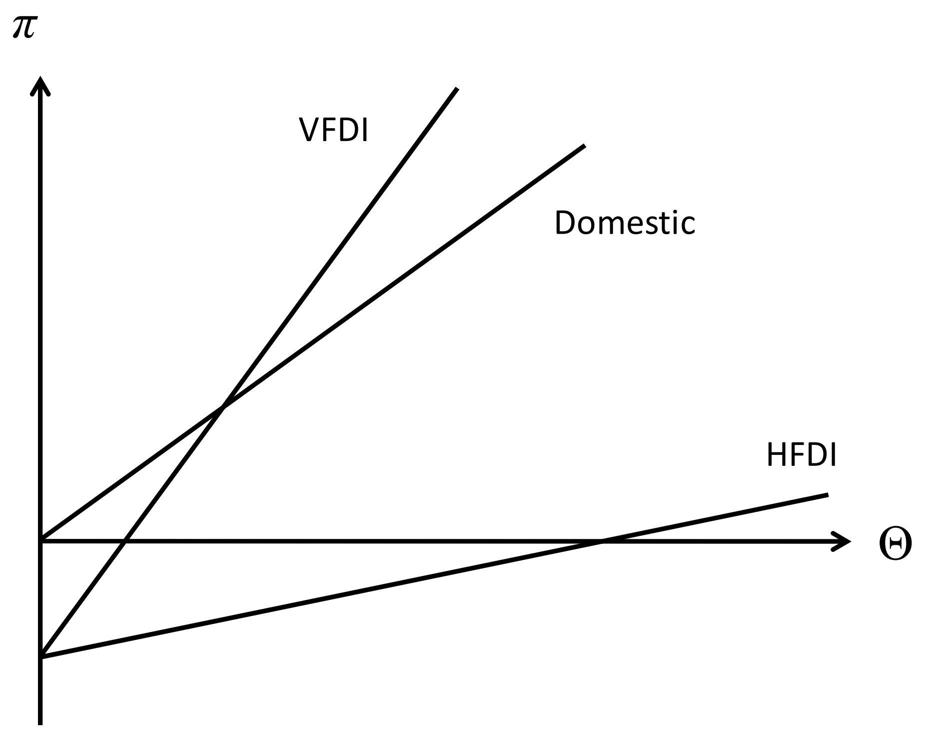


Figure 5: Medium wage differentials and high trade cost

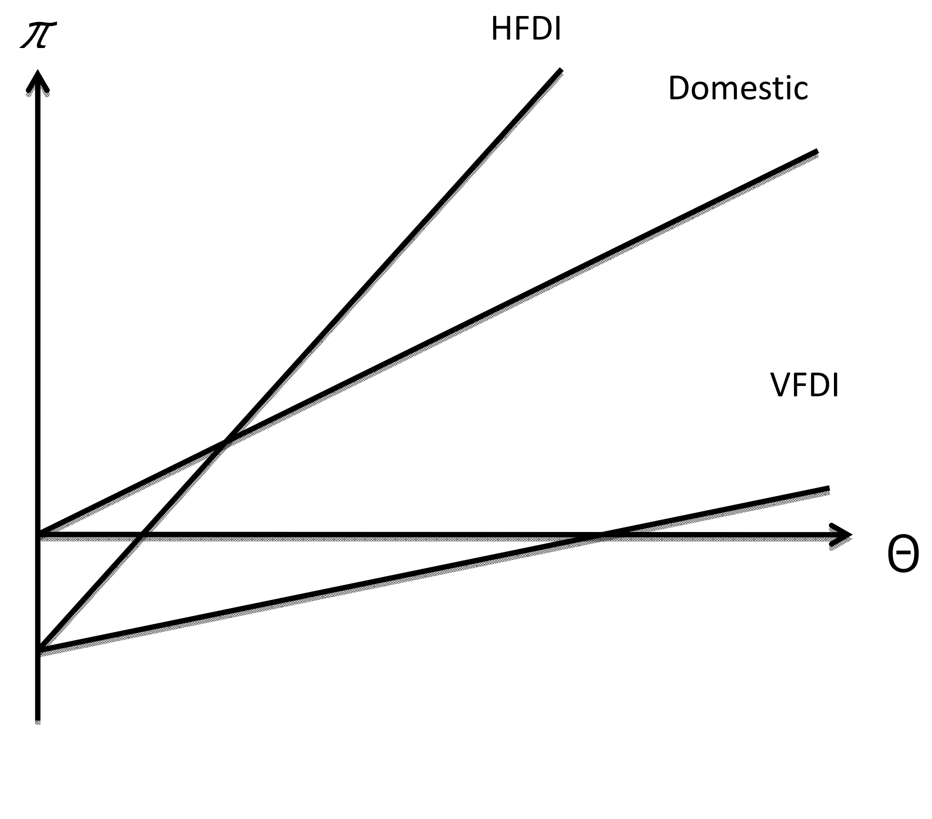


Figure A1: The relationship between S_1^V and S_1^D: the role of *a*

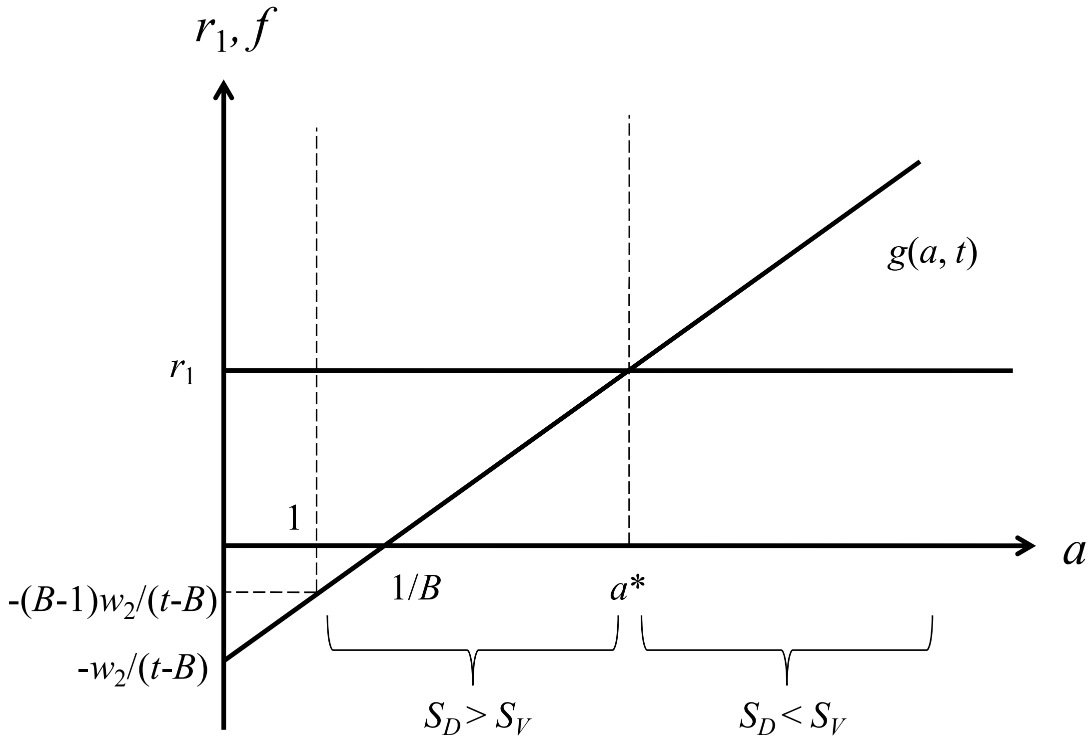


Figure A2: The relationship between S_1^V and S_1^D: the role of *t*

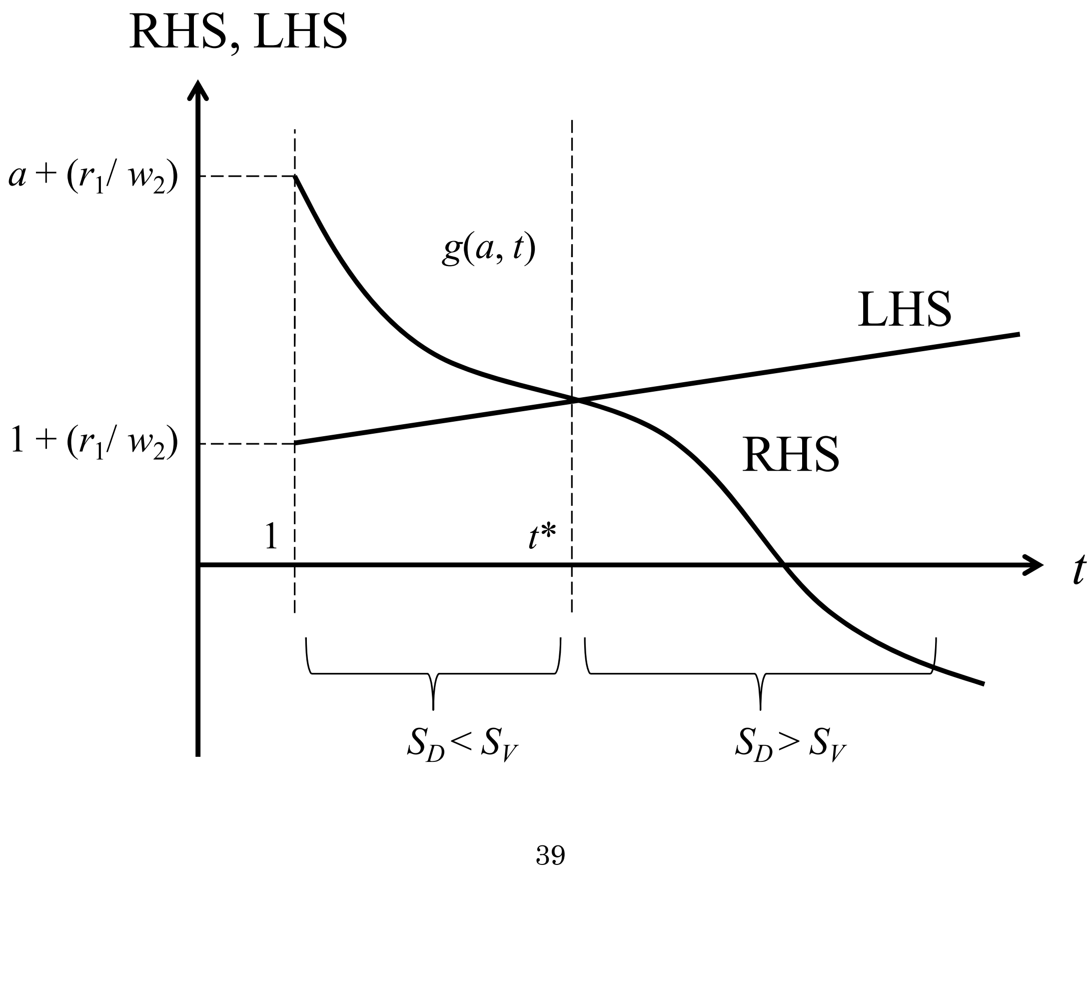


Figure A3: The relationship between S_1^H and S_1^D: the role of a and b

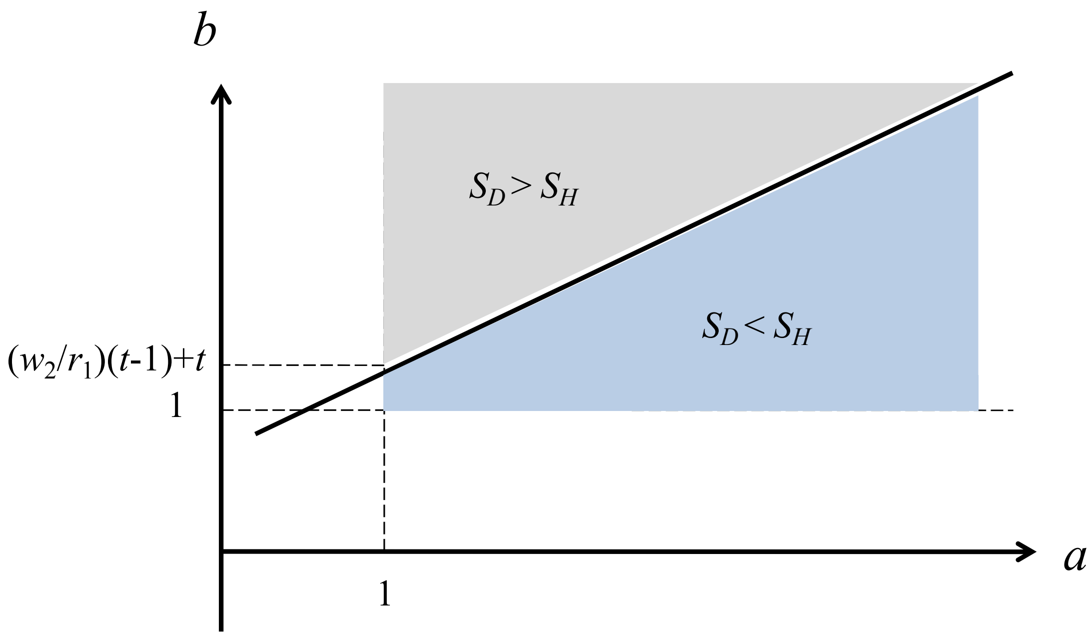


Figure A4: The relationship between S_1^V, S_1^H, and S_1^D: the role of a and b