Complex Vertical FDI and Firm Heterogeneity

Toshiyuki MATSUURA[*§]

The Institute of Economic Research, Hitotsubashi University, Japan

Research Institute of Economy, Trade and Industry, Japan

Kazunobu HAYAKAWA

Inter-Disciplinary Studies Center, Institute of Developing Economies, Japan

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Abstract: In this paper, we statistically test the validity of mechanics of complex VFDI in Japanese machinery FDI to East Asia. Our simple illustration shows that, in complex VFDI, the affiliates' production activity in a country is positively related to that in neighboring countries with large differences in location advantages with the country. Furthermore, we illustrate that firms with high productivity are likely to choose not pure VFDI but complex VFDI strategy. Based on such illustrations, we estimate multiple-spatial lag model for Japanese machinery FDI to East Asia. As a result, our empirical results show that mechanics of the complex VFDI work in Japanese FDI to East Asia and that those work more strongly in the MNEs with higher productivity.

***Keywords*:** Third-country effects; Complex VFDI, Spatial lag model

***JEL Classification*:** F21; F23

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[*] Corresponding author. Toshiyuki Matsuura, address: The Institute of Economic Research, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo 186-8603 Japan. Phone: 81-42-580-8369; Fax: 81-42-580-8333. E-mail: matsuura@ier.hit-u.ac.jp

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1. Introduction

In the recent wave of globalization, vertical division of labor among production stages has developed all over the world. Its well-known example is automobile production in the US-Mexico nexus. Cross-border production sharing between the US and Mexico is accompanied with back-and-forth intra-firm transactions between headquarters in the US and their assembly plants in Maquila, Mexico. The WE (Western Europe)-CEE (Central and Eastern Europe) nexus is another example. Indeed, exports of finished machinery products from CEE to WE have experienced a rapid increase.[1] Now we can observe such division of labor between developed and developing countries all over the world.

There have been a number of theoretical papers that attempt to clarify the mechanics of vertical division of labor among production processes (e.g., Jones and Kierzkowski, 1990). In the academic field, such division of labor is almost interchangeably called 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". The international fragmentation is also discussed within the context of vertical foreign direct investment (VFDI). Such studies show theoretically that once fragmentation becomes possible due to the trade costs reduction, multinational enterprises (MNEs) in a country (often termed a developed country) locate their affiliates in a country (often termed a developing country) which has the comparative advantage in assembly process, and get engaged in production-process wise vertical division of labor by exporting intermediate products to their affiliates. Such a two-country version of the VFDI is recently called "Pure VFDI".

However, such "traditional" theories of vertical division of labor seem not to well explain Japanese machinery FDI to East Asian countries. Each Japanese MNE often locates its affiliates at many East Asian countries with different income levels. Ando and Kimura (2005) presents an actual good example of a Japanese manufacturer in electronic machinery industry, which extends production/distribution networks all over East Asia and the US. The pure VFDI theory assumes a model in which an MNE selects one country with the lowest production costs in activities that it wishes to relocate among all potential destination countries. Thus, it can not describe a picture of multiple-country locations.

Instead, the "Complex VFDI" theory seems to fit better to the mechanics of such

[1] See Ando and Kimura (2007) and Hanson et al. (2005).

Japanese FDI. Recently, third-country effects attract much attention in the FDI theories. The FDI theories are reconstructed in the framework of three-country, not traditional two-country setting (Baltagi et al., 2007; Ekholm et al., 2007; Grossman et al., 2006; Yeaple, 2003). As briefly illustrated in section 3, the complex VFDI is a model in which an MNE sets up its vertical chain of production across multiple countries to exploit the differences in location advantages. Imagine that an MNE in a country (home country) locates its affiliate at the other country (host country) and gets engaged in vertical division of labor between the two countries. If production processes in the host country can be fragmented, and near the host country there is a country (third country) with comparative advantages in producing a part of the processes being performed in the host country, the MNE relocates such a part of the processes from the host country to the third country. As a result, the MNE has two affiliates and gets engaged in three-country vertical division of labor.

In this paper, we statistically test the validity of mechanics of complex VFDI in Japanese machinery FDI to East Asia. We first classify Japanese machinery FDI to East Asia by FDI type according to our simple criteria, finding that most of the Japanese affiliates in the information and communication electronics equipment and the electronic parts and devices in East Asia are complex VFDI. With keeping such a finding in mind, we next investigate the relationship between production activity in each affiliate and that in affiliates in neighboring countries with large differences in location advantages. According to our simple illustration, in complex VFDI, overseas plants are linked with one another through proximity and factor prices' differentials among countries. If this argument is correct, we should find positive link in Japanese FDI to East Asia in the information and communication electronics equipment and the electronic parts and devices. To examine such relationship, we employ spatial econometric technique, particularly spatial lag model.[2]

This paper further extends conceptually the complex VFDI model so as to allow for heterogeneity among firms. The well-known Melitz model tells us that only firms with higher productivity can afford to pay expenses for exporting activity and entry to overseas (Melitz, 2003; Helpman et al., 2007). Obviously, complex VFDI is a fixed cost-consuming strategy, and firms must pay a large amount of expenses to set up affiliates in multiple countries. This argument implies that compared with firms with low productivity, firms with high productivity would be likely to perform complex VFDI. We statistically test this argument by augmenting our spatial lag model.

Our paper is in line with various kinds of empirical studies. First, in the sense that

[2] As for more details of spatial econometrics, see Anselin (1988).

we try to classify FDI according to a certain criteria, our paper is related to Feinberg and Keane (2006). By using Bureau of Economic Analysis data on U.S. MNEs, they find that 12% and 19% of the MNEs are pure horizontal FDI (pure HFDI) and pure VFDI, respectively, and the rest of them adopts more complex integration strategies. Second, it is related to the studies that analyze FDI by spatial econometrics (Coughlin and Segev, 2000; Baltagi et al., 2007; Blonigen et al., 2007). In particular, our paper is closest to Blonigen et al. (2007), which estimates spatial lag model and attempts to empirically differentiate FDI types (pure HFDI, export-platform, pure VFDI, and complex VFDI) of the US outbound FDI. Although our paper basically follows the methodology employed in Blonigen et al. (2007), we introduce weighting matrices of not only bilateral distance but also wage gap based on the prediction by our illustration. This way enables us to more successfully test the validity of mechanics of complex VFDI. Third, our analysis on the relationship between overseas activity and firms' productivity is obviously in line with a large number of firm-level studies, e.g., Bernard and Jensen (1999) and Head and Ries (2003). Our analysis of the relationship between firms' productivity and their choice of VFDI strategy adds new facts to this literature.

The rest of this paper is organized as follows. The next section reports some preliminary evidence on Japanese machinery FDI. In section 3, we illustrate the selection problem of VFDI pattern, i.e., pure VFDI or complex VFDI. Section 4 explains our empirical methodology to examine the mechanics of Japanese FDI to East Asian countries, and section 5 reports our regression results. In section 6, we conclude.

2. Overview of Japanese Machinery FDI

Before discussing the specification of analysis, we will show some preliminary evidence on Japanese machinery FDI. To do that, in this section, we use the micro database of *Kaigai Jigyou Katsudou Kihon (Doukou) Chousa* (*The Survey on Overseas Business Activities*, hereafter the METI survey) prepared by the Research and Statistics Department, Ministry of Economy, Trade and Industry(hereafter, METI).[3] Its more details are provided in section 4. As argued later, we employ data of affiliates' intra-firm

[3] The METI survey is conducted annually by mail, based on self-declaration survey forms (one for parent company and one for each overseas affiliate) given to the parent company. Its main purpose is to obtain basic information on the activities of Japanese affiliates. It covered all Japanese firms that had affiliates abroad (hereinafter referred to as parent firm) as of the end of fiscal year (March 31). Japanese affiliate is defined as the firm that locates in foreign country in which a Japanese firms had more than or equal to 10 percent equity share. Industry is available at 2-digit level. From this annual cross-section survey, we developed a longitudinal (panel) data set at the overseas affiliate level. Each affiliate is traced throughout the period using its company name as a key.

trade to indentify affiliates of complex VFDI. Thus, this section restricts sample period only to years in which such data are available: 1995, 1998, and 2001. The country list is reported in Appendix.

Table 1 presents the average number of overseas manufacturing affiliates by region, parent's size, and parent's industry for Japanese machinery MNEs. The size of parent company is measured by parents' employees. Four points are noteworthy.

== Table 1 ==

First, there is a minor difference in the average number of affiliates among regions. While Japanese MNEs own more than two manufacturing affiliates both in Asia and Europe, the average number of manufacturing affiliates in North America is around one, in almost all machinery industries and parent's sizes. But, such a difference may be because the number of covered countries in our definition of regions is smaller in North America than in Asia and Europe.

Second, in case of Asia and Europe, there are remarkable differences among parent's industries. In Asia, while MNEs in information and communication devices industry have more than three manufacturing affiliates on average, those in transportation equipment and precision instruments industries have less than two manufacturing affiliates. That is, MNEs in information and communication devices industry have relatively large number of manufacturing affiliates. This is the case with Europe. On the other hand, we can not find such a difference in the case of North America.

Third, there seems to be positive correlation between the parent's size and the number of overseas manufacturing affiliates. In case of general machinery industry in Asia in 1995, for example, while the average number of manufacturing affiliates for large firms is 2.52, that for small firms is 1.21. Such relationship can be basically found in other years, other industries, and other regions, particularly Europe. Because there is often positive correlation between firm size and its productivity, this fact suggests efficient firms tend to own multiple overseas affiliates. Investigating this argument in the context of VFDI is one of our major interests in this paper.

Fourth, there is upward trend in the average number of overseas manufacturing affiliates in Asia for large firms, but not for small firms. In general machinery industry in Asia, for example, while small firms have 2.91 and 2.37 affiliates in Asia in 1995 and 2001, respectively, the average number of affiliates increases from 3.87 to 4.17 for large firms during the period. Another outstanding fact is that such an upward trend can be found only in Asia. These facts imply that large Japanese MNEs have extended their vertical chain of production network in Asian countries.

Next, we turn to the type of manufacturing affiliates. Table 2 shows the ratio of vertical type-overseas affiliates to all manufacturing foreign affiliates by region and affiliates' industry. From the theoretical point of view, since the VFDI is considered as the FDI type which takes advantage of international factor price differentials, we define vertical type FDI in statistical sense as subsidiaries with less than the mean value of local sales ratio in the world. Based on the fact of few border barriers in Europe, we define the sales for European countries as "local sales" for affiliates in Europe.[4] In Asia and North America, local sales mean sales in a country in which affiliates locate. The table shows that, compared with affiliates in North America and Europe, Asian affiliates tend to be vertical type. In Asia, about half of the affiliates are vertical type. In case of information and communication devices in 1998, for example, while the ratio of the VFDI for Asian affiliates is 60%, that for North America and Europe is 25% and 20%, respectively. This result suggests that vertical production network by Japanese MNEs have substantially grown in Asia.

== Table 2 ==

Last, we further decompose Japanese machinery VFDI into pure VFDI and complex VFDI. We define the following affiliates as the complex VFDI: affiliates with intra-firm sales to and intra-firm procurements from identical parent's affiliates in the third countries, affiliates with intra-firm sales to identical parent's affiliates in the third countries and with procurements from Japan, and affiliates with sales to Japan and with intra-firm procurements from identical parent's affiliates in the third countries. This definition is based on the assumption that affiliates' transactions with Japan are always intra-firm ones. Table 3 compares the ratio of complex VFDI to all types of VFDI. Compared with North America and Europe, the ratios are again higher in Asia. In particular, near half of all the VFDI-affiliates in electronic machinery and information devices industries is complex type. Furthermore, the ratios in the two industries slightly rise during the sample period, accounting for 40% and 42% respectively in 2001. These results indicate that vertical division of labor by Japanese MNEs in Asia gradually covers a large number of countries. Table 4 shows that the complex VFDI ratios in Asia

[4] Using the same definition of "local sales" in European countries as Asian and North American countries, European ratios reported in tables 2-4 slightly rise though they are still smaller than those in Asian countries. The detailed information is available upon request.

are a little bit higher for affiliates that belong to parents with more than 1,000 employees. In 2001, for example, while 35% of Asian affiliates are complex VFDI type in large MNEs, 31% is classified as complex VFDI in small MNEs. This fact suggests that large MNEs enjoy more benefits of vertical chain of production across multiple countries.

== Tables 3 and 4 ==

3. Illustration of VFDI

This section illustrates the selection problem of VFDI pattern, i.e., pure VFDI or complex VFDI, in order to clarify the mechanics of complex VFDI. To do that, it is essential to extend the mechanics of the pure VFDI theory to at least three-country and three-production stage setting. In three-country and three-production stage setting, this section illustrates what kinds of country can attract investment from the home country, with allowing for heterogeneity among firms, in terms of productivity. Notice that the aim of this section is not to provide a general equilibrium model of VFDI in multi-production stage and multi-country but simply to get insights on driving forces working behind VFDI to multiple countries with various location advantages in partial equilibrium model.

3.1. Settings

Suppose that there are four countries (substantially three countries); country 1, country 2, country 3, and outside economy. We consider finished machinery goods of which products are horizontally differentiated. Each of a continuum of firms manufactures a different brand with zero measure. The finished machinery goods are consumed only in the outside economy and are transported from any countries without any charge. Consumers in the outside economy have the CES utility function in the consumption of brand k, $x(k)$, such that:

$$U = \left(\int_{k \in \Omega} x(k)^{\alpha} \, dk \right)^{\frac{1}{\alpha}}, \quad 0 < \alpha < 1.$$

Ω denotes a set of varieties available in the outside economy. With this utility function, we can derive the demand function of a brand as $x = A\, p^{-\varepsilon}$, where x is its quantity, p is its price,

$$A \equiv E \left(\int_{k \in \Omega} p(k)^{1-\varepsilon} \, dk \right)^{-1},$$

$\varepsilon \equiv 1/(1-\alpha)$, and E is the total expenditure in the outside country. A is a measure of the demand level and is taken as exogenous by producers due to the zero-measure assumption of each brand.

The market structure of finished machinery goods sector is monopolistic competition. Firms and their headquarters are assumed to locate only in country 1 for simplicity (home country). Each firm knows its cost efficiency θ only after its entry. The machinery products are produced with three-stage production. The production function in each stage is kept as simple as possible to bring out the nature of dependence among production stages. Our Leontief-type production structure is as follows. A first stage product is produced inputting θ units of knowledge; a second stage product is produced inputting one unit of the first stage product and θ units of skilled-labor; a third stage product (i.e., finished machinery product) is produced with inputting one unit of the second stage product and θ units of unskilled-labor. Factor prices for knowledge, skilled-labor, and unskilled-labor are represented by h, r, and w, respectively.

We assume that only country 1 has knowledge for simplicity, so that the first stage can be produced only in country 1, i.e., home country. It is also assumed that $w_1 > w_2 > w_3$ and that $r_1 < r_2 < r_3$. There are ice-berg costs t_{ij} (≥ 1) for shipment of each stage-product between countries i and j ($t_{ij} = 1$ if $i = j$). Although firms do not need to pay any fixed costs if they produce all stage products in only country 1, they must incur plant set-up costs f_i if they produce products of a stage in country i. But if firms produce products of both the second and the third stages in country i, they only need to pay f_i, not $2f_i$ for simplicity.

3.2. Pure VFDI vs. Complex VFDI

Although the first stage always locates in country 1, there are still many possible patterns of production in this model. Thus, we restrict our attention only to three patterns, in which our interest lies: (2nd stage country, 3rd stage country) = (1, 1), (2, 2), and (2, 3). Let c_{lm} be total cost in the production pattern (l, m), then c_{11}, c_{22}, and c_{23} are given by:

$$c_{11} = (h_1\theta + r_1\theta + w_1\theta)x,$$
$$c_{22} = (t_{12}h_1\theta + r_2\theta + w_2\theta)x + f_2,$$
$$c_{23} = (t_{12}t_{23}h_1\theta + t_{23}r_2\theta + w_3\theta)x + f_2 + f_3.$$

The profit-maximizing strategy yields $p = c^{ij}_x / \alpha$, where $c^{ij}_x = d\, c_{ij}/d\, x$, so that profits are given by:

$$\pi_{11} = (h_1 + r_1 + w_1)^{1-\varepsilon}\,\Theta,$$
$$\pi_{22} = (t_{12}h_1 + r_2 + w_2)^{1-\varepsilon}\,\Theta - f_2,$$
$$\pi_{23} = (t_{12}t_{23}h_1 + t_{23}r_2 + w_3)^{1-\varepsilon}\,\Theta - f_2 - f_3,$$

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

First consider the selection problem between (1, 1) and (2, 2), i.e., between domestic and pure VFDI. Now suppose large differences in w and r between countries 1 and 2 and low transportation costs between them so that $(1- t_{12})h_1 + (r_1- r_2)+ (w_1- w_2) > 0$. Figure 1 depicts profits as a function of the productivity measure Θ in such a case. As is evident from the figure, firms with high productivity choose the production of the 2nd and 3rd stages in country 2 (Pure VFDI), while firms with low productivity choose domestic production of all stages (Domestic) because, for those firms, variable profit can not cover fixed costs f_2. On the other hand, if gap in factor prices is small and transportation costs are high so that $(1- t_{12})h_1 + (r_1- r_2)+ (w_1- w_2) < 0$, firms with any levels of productivity choose "Domestic". As a result, key drivers of pure VFDI are gap in factor prices and transportation costs between home and host countries. This is an essence of Helpman, et al. (2004).

== Figure 1 ==

Second, we add an alternative of "Complex VFDI", i.e., the pattern (2, 3). In particular, we assume that not only $(1- t_{12})h_1 + (r_1- r_2)+ (w_1- w_2) > 0$ but also $(w_2 - w_3) > (t_{23} -1)\ (t_{12}h_1 + r_2)$. These conditions hold if transportation costs t_{12} and t_{23} are low enough and gap in factor prices among countries is large enough. Under those conditions, we further assume that fixed costs incurred in country 3, f_3 are large so that intersection between π_{22}-line and π_{23}-line lies in the right hand side of intersection between π_{11}-line and π_{22}-line. Figure 2 depicts three profits in such an *artificial* case. As is evident from the figure, firms with high productivity choose to produce the third stage products in country 3 (Complex VFDI), firms with medium productivity choose to produce in country 2 (Pure VFDI), and firms with low productivity choose domestic production of all stages (Domestic). Dropping the assumption on f_3 gives rise to the possibility that pure VFDI-firms do not exist, while dropping the assumption that $(w_2 - w_3) > (t_{23} -1)\ (t_{12}h_1 + r_2)$ yields the case that complex VFDI-firms do not exist.

== Figure 2 ==

In sum, key drivers are gap in factor prices among countries, transportation costs among them, and fixed costs in each country. Suppose that fixed costs in each country are not negligible, and that transportation costs among countries are trivial. At this time, a crucially important condition for the development of multiple-country VFDI is that each country has production stages with its best location advantages among countries. Taking geographical distance as a major source of transportation costs, we can summarize the mechanics of complex VFDI as the following testable hypotheses:

Testable Hypothesis 1: *In complex VFDI, overseas plants are linked with one another through proximity and factor prices' differentials among countries.*

Testable Hypothesis 2: *MNEs with high productivity are more likely to choose complex VFDI strategy than those with low productivity.*

3.3. Other Types of FDI

So far, we have listed the characteristics of complex VFDI. In the rest of this section, we briefly summarize those of the other types of FDI. In particular, we examine the relationship of the other types of FDI to the proximity to third countries and factor prices' differential of third countries, which are shaded light on the complex VFDI above.

Blonigen et al. (2007) provide the relationship of pure HFDI and export-platform FDI to the proximity to third countries. As for pure HFDI, they argue that the pure HFDI model *would not be associated with any spatial relationship between FDI into neighboring markets as the MNE makes independent decisions about the extent to which it will serve that market through exports or affiliate sales*. On the other hand, in export-platform FDI, *a parent country invests in a particular host country with the intention of serving "third" markets with exports of final goods from the affiliate in the host country*. In other words, *the MNE will choose the most preferred destination market*. In short, the pure HFDI is not related to the proximity to third countries, and export-platform FDI is negatively related to it. As a result, investigating the relationship to the proximity to third countries, we can differentiate complex VFDI with pure HFDI and export-platform FDI.

One may worry about the impacts of border costs on pure HFDI, which is also discussed in Blonigen et al. (2007). Suppose ten countries, five of which have relatively large demand and in which there are high border costs. Then, MNEs would invest to each of five countries to access to its demand. If the five countries geographically concentrate on a particular area, it seems that such HFDI has positive relationship to the proximity to third countries, as well as the complex VFDI. However, considering the relationship to factor prices' differentials enables us to successfully differentiate complex VFDI with such HFDI. HFDI does not have any relationship to *third countries*' factor price differentials. Thus, FDI with the positive relationship to both the proximity to third countries and factor prices' differential of third countries is complex VFDI without doubt.

4. Empirical Methodology

In section 2, we confirm that most of the Japanese overseas affiliates in East Asia in the information and communication electronics equipment and the electronic parts and devices are complex VFDI. Indeed, East Asia seems to be potentially the most suitable region for multiple-country VFDI since it consists of countries with different stages of economic development and (broad) transportation costs among East Asian countries have experienced a remarkable decrease (Hayakawa, 2007). Thus, the following sections empirically investigate whether or not the Japanese FDI to East Asia has the above-listed characteristics of the complex VFDI. Particularly in this section, we explain our empirical methodology.

Based on the illustration, in complex VFDI, the affiliates' production activity in a country is positively related to that of affiliates in neighboring countries with large differences in location advantages with the country. Thus, we examine the relationship between the activity of each affiliate and the activity of affiliates locating in the other East Asian countries and belonging to the same parent firm. If the above-listed hypotheses are correct, we should find its positive correlation in Japanese FDI to East Asia. We focus on firms in the information and communication electronics equipment and the electronic parts and devices, in which most of Japanese overseas affiliates in East Asia are complex VFDI.

We employ spatial econometric technique in order to enable us to incorporate the activity of affiliates in the third countries into our empirical framework. While adding separately the activity variables in each third country as explanatory variables loses greatly degree of freedom, spatial lag model can analyze the above-mentioned relationship without losing degree of freedom. Our spatial lag model is as follows. Let Y_{it}^{j} denote the log of sales (or employment) of the affiliate of firm $j \in \{1,\ldots,m\}$ in country $i \in \{1,\ldots,9\}$ in year $t \in \{1994,\ldots,2003\}$. Our sample countries are 9 economies: Republic of Korea, China, Taiwan, Hong Kong, the Philippines, Thailand, Malaysia, Singapore, and Indonesia. Sample period is 1994-2003.

Our spatial lag equation to be first estimated is given by:

$$\mathbf{Y} = \rho_D \mathbf{W}_D\mathbf{Y} + \rho_G \mathbf{W}_G\mathbf{Y} + \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}.$$

Y is an N×1 vector. **X** includes standard variables in the pure VFDI theory: wages, country risk, geographical distance from Japan (home country). **ε** is a vector of disturbances. $\mathbf{W}_D$ and $\mathbf{W}_G$ are weighting matrices and are constructed as follows:

$$\mathbf{W}_{Dj}{}^{t} = \begin{bmatrix} 0 & d_{1,2}^{t} & \cdots & d_{1,9}^{t} \\ d_{2,1}^{t} & 0 & \ddots & \vdots \\ \vdots & \ddots & 0 & d_{8,9}^{t} \\ d_{9,1}^{t} & \cdots & d_{9,8}^{t} & 0 \end{bmatrix}, \mathbf{W}_{Dj} = \begin{bmatrix} W_{Dj}^{1994} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & W_{Dj}^{2003} \end{bmatrix}, \mathbf{W}_{D} = \begin{bmatrix} W_{D1} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & W_{Dm} \end{bmatrix},$$

$$\mathbf{W}_{Gj}{}^{t} = \begin{bmatrix} 0 & g_{1,2}^{t} & \cdots & g_{1,9}^{t} \\ g_{2,1}^{t} & 0 & \ddots & \vdots \\ \vdots & \ddots & 0 & g_{8,9}^{t} \\ g_{9,1}^{t} & \cdots & g_{9,8}^{t} & 0 \end{bmatrix}, \mathbf{W}_{Gj} = \begin{bmatrix} W_{Gj}^{1994} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & W_{Gj}^{2003} \end{bmatrix}, \mathbf{W}_{G} = \begin{bmatrix} W_{G1} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & W_{Gm} \end{bmatrix},$$

where $d^{t}_{i,k}$ and $g^{t}_{i,k}$ are the inverse of distance and the wage gap between countries i and k in year t, respectively. Since distances are time-invariant, $\mathbf{W}_{Dj}{}^{1994} = \mathbf{W}_{Dj}{}^{1995} = \ldots = \mathbf{W}_{Dj}{}^{2003}$. Each weighting matrix is symmetric and row-normalized. Contrary to Blonigen el al. (2007), our equation has two kinds of weighting matrices. We call such an equation "multiple-spatial lag model".

As is well known, ordinary least squares estimates (OLS estimates) are biased as well as inconsistent for the parameters of the spatial model. Our multiple-spatial lag model is also no exception. Rewriting the above equation as:

$$\mathbf{Y} = \mathbf{Z\rho} + \mathbf{X\beta} + \boldsymbol{\varepsilon},$$

where $\mathbf{Z} = [\mathbf{W}_D\mathbf{Y}, \mathbf{W}_G\mathbf{Y}]$ and $\boldsymbol{\rho} = [\rho_D, \rho_G]'$, we can express our OLS estimate γ_{OLS} for $\boldsymbol{\rho}$ as:

$$\gamma_{\mathrm{OLS}} = \boldsymbol{\rho} + [\mathbf{Z'MZ}]^{-1}\ \mathbf{Z'M}\boldsymbol{\varepsilon},$$

where $\mathbf{M} = \mathbf{I} - \mathbf{X}(\mathbf{X'X})^{-1}\mathbf{X}'$. The expected value of the second term is not equal to zero, therefore the OLS estimate is biased. Furthermore, while the probability limit of $\mathrm{N}^{-1}(\mathbf{Z'MZ})$ can be a finite and nonsingular matrix, that of $\mathrm{N}^{-1}(\mathbf{Z'M}\boldsymbol{\varepsilon})$ is not equal to zero, except in the trivial case where $\boldsymbol{\rho} = \mathbf{0}$. Thus, the OLS estimate is not only biased but also inconsistent. To obtain consistent estimators, we perform two-stage least squares (2SLS). Following Kelejian and Prucha (1998) and Dow (2007), we use **X**, $\mathbf{W}_D\mathbf{X}$, and $\mathbf{W}_G\mathbf{X}$ as instruments for $\mathbf{W}_D\mathbf{Y}$ and $\mathbf{W}_G\mathbf{Y}$. Our 2SLS estimate γ_{2SLS} for $\boldsymbol{\rho}$ is given by:

$$\gamma_{\mathrm{2SLS}} = [\mathbf{Z'H}(\mathbf{H'H})^{-1}\mathbf{H'MH}(\mathbf{H'H})^{-1}\mathbf{H'Z}]^{-1}\ [\mathbf{Z'H}(\mathbf{H'H})^{-1}\mathbf{H'MY}]$$

where $\mathbf{H} = [\mathbf{X}, \mathbf{W}_D\mathbf{X}, \mathbf{W}_G\mathbf{X}]$, instrument matrix. The significantly positive sign of ρ_D and ρ_G implies that production activity in each affiliate is positively related to that in affiliates in neighboring countries with large differences in location advantages, as our illustration of the complex VFDI predicts.

Furthermore, we examine if the type of VFDI depends on firms' productivity or not. To this end, the following equation is estimated:

$$\mathbf{Y} = \rho_D\,(\mathbf{I} + \lambda_D\,\mathbf{A})\mathbf{W}_D\mathbf{Y} + \rho_G\,(\mathbf{I} + \lambda_G\,\mathbf{A})\mathbf{W}_G\mathbf{Y} + \mathbf{X\beta} + \boldsymbol{\varepsilon},$$

where **I** is the square matrix with ones on the main diagonal and zeros elsewhere (identity matrix) and:

$$\mathbf{A} = \begin{bmatrix} \begin{bmatrix} a_1^{1994}I & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & a_1^{2003}I \end{bmatrix} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \begin{bmatrix} a_m^{1994}I & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & a_m^{2003}I \end{bmatrix} \end{bmatrix}.$$

a_j^t denotes productivity in firm j in year t. As argued above, if all Japanese firms' FDI to East Asia is complex VFDI, the sign of both ρ_D and ρ_G should be positive. On the other hand, if all Japanese firms' FDI to East Asia is pure VFDI, in which an MNE selects *one* country with the lowest production costs, affiliates' activities would not be associated with any spatial relationship: ρ_D and ρ_G are estimated to be insignificant. In sum, as illustrated in the previous section, if firms with high productivity are likely to perform complex VFDI and firms with low productivity tend to perform pure VFDI, both λ_D and λ_G should be estimated to be significantly positive. And then, both ρ_D and ρ_G may be estimated to be insignificant.

Our data sources are as follows. As in section 2, we use the micro database of the METI survey for affiliates' sales. We employ firms' scale measured by parent's employees as productivity, of which data are drawn from the *Kigyou Katsudou Kihon Chousa Houkokusho* (*The Results of the Basic Survey of Japanese Business Structure and Activities*) by the METI.[5] As for the sources of the other regressors, data on the average wages in each country are estimated by aggregating the affiliate-level wage data in the METI survey. The country risk index is drawn from "Institutional Investor". This index is the aggregate of bankers' evaluation on risk of default, and the larger index indicates that the risk of default in the country is smaller. Data on distance are drawn from CEPII website.[6] The data on GDP and GDP deflator in each country can be obtained from "World Development Indicator" (World Bank). Those in Taiwan are from

[5] This survey was first conducted in 1991, then in 1994, and annually afterwards. The survey covers all firms with more than 50 employees and with more than capital of 30 million yen, for both manufacturing and non-manufacturing firms.

[6] http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

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5. Empirical Results

This section reports regression results examining the above-listed hypotheses. The correlation matrix is shown in Table 5. We first present baseline results of regression for all Japanese FDI to East Asia and then those of some robustness checks.

== Table 5 ==

The regression results for the first hypothesis are provided in Table 6. We perform not only 2SLS estimation but also OLS estimation. There are two points to be noted.

== Table 6 ==

First, the results for standard bilateral variables look good. Coefficients for country risk and wages have expected sign; positive for country risk and negative for wages. These results indicate that Japanese MNEs seek the low wages and low risk countries in East Asia as the pure VFDI theory predicts. In particular, one may say that country risk partly embodies set-up costs of affiliates. If this argument is correct, the significantly positive coefficient for country risk implies that low plant set-up costs are surely ones of major determinants of Japanese VFDI. On the other hand, the sign of coefficients for both GDP and distance from Japan are disappointingly out of our expectation.

Second, coefficients for weighting matrices, in which our interest lies, are significantly estimated with expected sign in the OLS estimation of (1). The positive coefficients of both matrices imply that affiliates in *each* Japanese MNE are linked with one another through proximity and wage differentials. That is, we can say that mechanics of the complex VFDI work in Japanese FDI to East Asia. But, such results become worse in 2SLS. The coefficient for distance-weighting matrix turns out to be insignificant and have unexpected sign. Rather than the indication of the pure VFDI, this result seems to be due to the high correlation between the two matrices, i.e., multi-colinearity issue. Indeed, as in Table 5, such correlation is 0.86. Introducing the two matrices separately, we get significantly positive 2SLS coefficients for both matrices. Consequently, we conclude the validity of the mechanics of complex VFDI in Japanese FDI to East Asian countries

The regression results for the second hypothesis are provided in Table 7. Although the results in the standard bilateral variables are unchanged with those in Table 6, the results of weighting matrices are bad. As shown in Table 5, such disappointing results seem to be because there is high correlation not only between two weighting matrices but also between a respective weighting matrix and its product of scale. To decrease the pairs of variables with high correlation, we drop some weighting matrix-related variables. First, we eliminate distance- and gap-weighting matrices since their coefficients are expected to be zero in this table, as argued in the previous section. The results are in the column (5). Both OLS and 2SLS estimates have expected signs though the coefficient for the interaction term of distance-weighting matrix to scale is insignificant in the 2SLS. Next, as an extreme way, we introduce only one weighting matrix-related variable. Our main interest in this table is the results in the products of scale to two matrices, which are reported in the columns (6) and (7). Both of the coefficients for their products of scale are estimated to be significantly positive, indicating that MNEs with higher productivity (large scale) are more likely to be engaged in the complex VFDI than those with lower productivity (small scale).

== Table 7 ==

Next, we perform two robustness checks. First, our specification of a dependent variable may suffer from an unexpected downer bias in coefficients for weighting matrices when the FDI type changes from pure VFDI to complex VFDI. From the theoretical point of view, such a change not only gives birth to new observations with non-zero sales but also may decrease the sales of observations which had non-zero sales in pure VFDI. Using terminology in section 3, we can say that such a change may decrease the sales of affiliates in country 2 though sales turn out to be positive in affiliates in country 3. This decrease would give rise to a downer bias in coefficients for weighting matrices. To avoid such a bias as easily as possible, we use as a dependent variable a binary variable, which takes unity if a firm locates an affiliate in a region (i.e., if the previous dependent variable has positive values) and zero otherwise. Here we employ probit estimation technique, which in a spatial context is examined in Beron and Vijverberg (2004). In particular, we use Newey's (1987) minimum chi-squared estimator to obtain consistent estimators (IVProbit). The results are reported in Tables 8 and 9, being unchanged with the baseline results.

== Tables 8 and 9 ==

Second, we restrict our sample only to affiliates categorized in VFDI in section 2. This restriction is a natural exercise to shed light on the contrast in mechanics between pure VFDI and complex VFDI. As argued in section 3, positive estimates of the weighting matrices should emerge only in complex VFDI. But their estimates still suffer from unexpected bias if sample includes affiliates categorized in the types of FDI other than VFDI, e.g. HFDI. Thus, to focus on the contrast between pure VFDI and complex VFDI, sample here is restricted to the affiliates categorized in VFDI. The results are provided in Tables 10 and 11. Although they are basically unchanged with the baseline results, results of column (5) in Table 11 look good. Both OLS and 2SLS produce positively significant coefficients in the weighting matrices. In sum, we can again confirm the validity of the mechanics of complex VFDI in Japanese FDI to East Asian countries and that MNEs with large scale are more likely to be engaged in the complex VFDI.

== Tables 10 and 11 ==

6. Concluding Remarks

In this paper, we statistically test the validity of mechanics of complex VFDI in Japanese machinery FDI to East Asia. Our simple illustration shows that, in complex VFDI, the affiliates' production activity in a country is positively related to that in neighboring countries with large differences in location advantages with the country. Furthermore, we illustrate that firms with high productivity are likely to choose not pure VFDI but complex VFDI strategy. Based on such illustrations, we estimate multiple-spatial lag model for Japanese machinery FDI to East Asia. As a result, our empirical results show that mechanics of the complex VFDI work in Japanese FDI to East Asia and that those work more strongly in the MNEs with higher productivity.

Our results tell us an important policy implication for developing countries' policy to attract the MNEs. Policy makers in developing countries have been afraid of the drain of multinational firms to developing countries with lower wages. For example, the policy makers in ASEAN countries tend to perceive China as a potential threat. To deter the drain of MNEs from own-countries, policy makers in such countries have believed it crucially important to reduce trade and investment barriers to potential investor countries. On the other hand, our results suggest that they should reduce the barriers not only to the investor countries but also to the countries that they regard as a threat. In short, it is important for countries with *medium*-level economic development to become hub-country in international production networks.

Appendix. Country List in Tables 1-4

North America	Asia	Europe
Canada	Bangladesh	Austria
United States	China	Belgium
	Hong Kong, China	CIS
	India	Czech
	Indonesia	Denmark
	Korea, Rep.	Finland
	Malaysia	France
	Myanmar	Germany
	Pakistan	Hungary
	Philippines	Ireland
	Singapore	Italy
	Sri Lanka	Netherlands
	Taiwan	Poland
	Thailand	Portugal
	Vietnam	Rumania
		Russian Federation
		Slovakia
		Spain
		Sweden
		Switzerland
		Turkish
		United Kingdom
		Yugoslavia

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Table 1. The Average Number of Affiliates by Region, Parent's Size, and Parent's Industry

	Affiliates in Asia				Affiliates in North America				Affiliates in Europe			
Parents' size	Small	Medium	Large	Total	Small	Medium	Large	Total	Small	Medium	Large	Total
1995												
General machinery	1.21	1.81	2.52	2.03	1.00	1.17	1.28	1.20	1.00	1.00	2.50	2.00
Electronic machinery and equipment	1.20	1.33	3.27	2.50	1.00	1.00	1.20	1.15	1.00		1.79	1.69
Information and communication devices	1.41	2.20	3.87	2.73	1.00	1.10	1.06	1.06	1.00	1.25	2.48	2.10
Automobile	1.00	1.25	2.78	2.31	1.00	1.00	1.12	1.08		1.00	1.96	1.92
Transport equipment		2.00	1.75	1.80		1.00	1.00	1.00			2.00	2.00
Precision instrument	1.33	1.11	1.67	1.38	1.00	1.00	1.13	1.09	2.00	1.00	1.25	1.30
Wholesale for machinery products	1.75	1.67	4.30	2.67	1.00	1.00	1.22	1.13	1.00	1.25	2.71	2.08
1998												
General machinery	1.33	1.90	2.91	2.17	1.09	1.18	1.32	1.23		1.17	2.52	2.06
Electronic machinery and equipment	1.38	1.83	3.30	2.47	1.00	1.00	1.21	1.15	1.00	1.00	2.00	1.80
Information and communication devices	1.63	1.92	4.24	2.80	1.00	1.10	1.17	1.14	1.00	1.33	2.56	2.19
Automobile	1.71	1.58	3.43	2.59	1.00	1.10	1.12	1.11	1.00	1.00	2.03	1.84
Transport equipment	1.00	1.00	2.50	1.38		1.00	1.00	1.00		1.00	4.00	2.50
Precision instrument	1.14	1.27	2.56	1.67	1.00	1.00	1.00	1.00	2.00		2.00	2.00
Wholesale for machinery products	1.71	1.83	4.67	2.70	1.00	1.00	1.45	1.26	1.00	1.50	4.09	3.12
2001												
General machinery	1.47	2.00	2.68	2.04	1.07	1.11	1.19	1.13	1.00	1.22	2.36	1.81
Electronic machinery and equipment	1.25	1.83	3.80	2.57	1.00	1.00	1.07	1.04	1.00	1.67	1.71	1.63
Information and communication devices	1.79	2.33	4.17	3.02	1.00	1.07	1.11	1.08	1.67	1.00	2.36	2.00
Automobile	1.29	1.47	3.79	2.74	1.00	1.07	1.15	1.11	1.00	1.00	1.95	1.82
Transport equipment	2.00	1.00	2.20	1.78	1.00		1.00	1.00			2.50	2.50
Precision instrument	1.17	1.46	2.10	1.62	1.00	1.00	1.00	1.00	2.00		2.13	2.11
Wholesale for machinery products	1.37	2.67	5.15	2.83	1.00	1.00	1.43	1.20	1.00	1.25	4.33	3.21

Source: Authors' calculation based on the METI survey

Note: Parents' size is measured by number of employment and "Small", "Medium", and "Large" indicates firms with less than 300 employees, more than 300 and less than 1,000 employees and more than 1,000 employees, respectively.

Table 2. The Ratio of VFDI Type-affiliates to All Manufacturing Affiliates by Affiliates' industry

	NAmerica	Asia	Europe
1995			
General machinery	14%	39%	16%
Electronic machinery and equipment	20%	44%	22%
Information and communication devices	36%	55%	24%
Transport equipment	17%	28%	25%
Precision instrument	34%	63%	40%
1998			
General machinery	21%	46%	25%
Electronic machinery and equipment	18%	50%	15%
Information and communication devices	25%	60%	20%
Transport equipment	16%	37%	16%
Precision instrument	45%	62%	58%
2001			
General machinery	21%	45%	22%
Electronic machinery and equipment	20%	47%	21%
Information and communication devices	19%	56%	17%
Transport equipment	22%	39%	19%
Precision instrument	24%	55%	22%

Source: Authors' calculation based on the METI survey

Table 3. The Ratio of Complex VFDI Type-affiliates in All VFDI Type-affiliates by Affiliates' industry

	NAmerica	Asia	Europe
1995			
General machinery	25%	30%	25%
Electronic machinery and equipment	9%	36%	10%
Information and communication devices	7%	39%	6%
Transport equipment	13%	16%	4%
Precision instrument	0%	32%	6%
1998			
General machinery	10%	28%	3%
Electronic machinery and equipment	9%	34%	0%
Information and communication devices	4%	36%	3%
Transport equipment	12%	18%	5%
Precision instrument	5%	33%	8%
2001			
General machinery	17%	20%	7%
Electronic machinery and equipment	8%	40%	0%
Information and communication devices	3%	42%	13%
Transport equipment	5%	22%	4%
Precision instrument	0%	31%	18%

Source: Authors' calculation based on the METI survey

Table 4. The Ratio of Complex VFDI Type-affiliates in VFDI Type-affiliates by Parent's Size

	NAmerica	Asia	Europe
1995			
Firms with less than 1,000 employees	25%	35%	33%
Firms with more than 1,000 employees	8%	32%	9%
1998			
Firms with less than 1,000 employees	5%	29%	0%
Firms with more than 1,000 employees	9%	31%	4%
2001			
Firms with less than 1,000 employees	14%	31%	13%
Firms with more than 1,000 employees	5%	35%	7%

Source: Authors' calculation based on the METI survey

Table 5. Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y	(1)	1							
GDP	(2)	0.00	1						
Risk	(3)	0.09	0.54	1					
Distance from JPN	(4)	0.04	-0.66	-0.26	1				
Wages	(5)	0.01	0.54	0.70	-0.29	1			
$\mathbf{W_D\ Y}$	(6)	0.40	-0.02	-0.03	0.03	0.04	1		
$\mathbf{W_G\ Y}$	(7)	0.37	-0.01	-0.06	-0.01	0.02	0.86	1	
$\mathbf{AW_D\ Y}$	(8)	0.43	-0.02	-0.02	0.02	0.03	0.97	0.87	1
$\mathbf{AW_G\ Y}$	(9)	0.40	0.00	-0.05	-0.01	0.01	0.85	0.97	0.91

Table 6. Baseline Results: Hypothesis 1

	(1)		(2)		(3)	
Estimation Method	OLS	2SLS	OLS	2SLS	OLS	2SLS
Explanatory Variables						
GDP	-0.046	-0.074	-0.039	-0.025	-0.063	-0.061
	[0.058]	[0.063]	[0.058]	[0.060]	[0.059]	[0.061]
Risk	2.772***	3.328***	2.678***	2.947***	2.852***	3.237***
	[0.125]	[0.147]	[0.125]	[0.129]	[0.126]	[0.132]
Distance from JPN	0.281***	0.495***	0.236***	0.183***	0.384***	0.413***
	[0.066]	[0.085]	[0.066]	[0.068]	[0.066]	[0.068]
Wages	-0.645***	-0.695***	-0.642***	-0.760***	-0.608***	-0.715***
	[0.044]	[0.049]	[0.044]	[0.046]	[0.045]	[0.046]
constant	-12.432***	-16.662***	-11.696***	-13.508***	-13.145***	-15.902***
	[1.336]	[1.520]	[1.338]	[1.380]	[1.354]	[1.400]
Weighting Matrices						
Distance	0.467***	-0.360*	0.652***	1.002***		
	[0.020]	[0.206]	[0.011]	[0.021]		
Gap	0.229***	1.380***			0.653***	1.025***
	[0.022]	[0.210]			[0.011]	[0.022]
Observation	18,450	18,450	18,450	18,450	18,450	18,450

Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table 7. Baseline Results: Hypothesis 2

	(4)		(5)		(6)		(7)	
Estimation Method	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Explanatory Variables								
GDP	-0.054	-0.029	-0.054	-0.062	-0.049	-0.046	-0.067	-0.067
	[0.057]	[0.074]	[0.058]	[0.058]	[0.058]	[0.058]	[0.058]	[0.058]
Risk	2.563***	4.177***	2.647***	2.808***	2.585***	2.662***	2.733***	2.851***
	[0.124]	[0.248]	[0.123]	[0.130]	[0.123]	[0.124]	[0.125]	[0.126]
Distance from JPN	0.287***	0.382***	0.282***	0.353***	0.244***	0.228***	0.378***	0.387***
	[0.065]	[0.096]	[0.065]	[0.073]	[0.065]	[0.065]	[0.066]	[0.066]
Wages	-0.571***	-1.046***	-0.598***	-0.608***	-0.600***	-0.634***	-0.571***	-0.603***
	[0.044]	[0.087]	[0.044]	[0.045]	[0.044]	[0.044]	[0.044]	[0.044]
constant	-11.051***	-22.293***	-11.531***	-12.812***	-11.021***	-11.529***	-12.338***	-13.189***
	[1.320]	[2.157]	[1.321]	[1.372]	[1.322]	[1.328]	[1.335]	[1.344]
Weighting Matrices								
Distance	0.631***	0.067						
	[0.104]	[0.734]						
Gap	-0.972***	3.867***						
	[0.109]	[0.747]						
*Scale * Distance*	-0.032**	0.049	0.054***	0.019	0.074***	0.088***		
	[0.014]	[0.077]	[0.003]	[0.017]	[0.001]	[0.002]		
*Scale * Gap*	0.144***	-0.309***	0.023***	0.070***			0.074***	0.090***
	[0.014]	[0.079]	[0.003]	[0.018]			[0.001]	[0.002]
Observation	18,450	18,450	18,450	18,450	18,450	18,450	18,450	18,450

Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table 8. Probit Results: Hypothesis 1

	(1)		(2)		(3)	
Estimation Method	Probit	IVProbit	Probit	IVProbit	Probit	IVProbit
Explanatory Variables						
GDP	-0.01	-0.024	-0.009	-0.001	-0.02	-0.02
	[0.024]	[0.028]	[0.024]	[0.025]	[0.024]	[0.025]
Risk	1.093***	1.375***	1.077***	1.217***	1.103***	1.309***
	[0.053]	[0.066]	[0.053]	[0.057]	[0.053]	[0.057]
Distance from JPN	0.077***	0.166***	0.071***	0.057**	0.114***	0.125***
	[0.027]	[0.035]	[0.027]	[0.029]	[0.027]	[0.029]
Wages	-0.286***	-0.303***	-0.285***	-0.346***	-0.265***	-0.318***
	[0.018]	[0.022]	[0.018]	[0.019]	[0.018]	[0.019]
constant	-6.129***	-8.147***	-6.018***	-7.077***	-6.221***	-7.651***
	[0.558]	[0.667]	[0.556]	[0.594]	[0.556]	[0.597]
Weighting Matrices						
Distance	1.422***	-2.035***	1.607***	3.033***		
	[0.065]	[0.773]	[0.039]	[0.100]		
Gap	0.243***	5.097***			1.467***	3.087***
	[0.069]	[0.779]			[0.041]	[0.100]
Observation	18,450	18,450	18,450	18,450	18,450	18,450

Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table 9. Probit Results: Hypothesis 2

	(4)		(5)		(6)		(7)	
Estimation Method	Probit	IVProbit	Probit	IVProbit	Probit	IVProbit	Probit	IVProbit
Explanatory Variables								
GDP	-0.011	-0.012	-0.014	-0.023	-0.013	-0.011	-0.021	-0.022
	[0.024]	[0.031]	[0.024]	[0.026]	[0.024]	[0.025]	[0.024]	[0.024]
Risk	1.048***	1.634***	1.079***	1.195***	1.068***	1.100***	1.100***	1.151***
	[0.054]	[0.113]	[0.054]	[0.059]	[0.053]	[0.054]	[0.053]	[0.054]
Distance from JPN	0.082***	0.150***	0.081***	0.143***	0.076***	0.074***	0.114***	0.115***
	[0.027]	[0.038]	[0.027]	[0.031]	[0.027]	[0.028]	[0.027]	[0.028]
Wages	-0.268***	-0.402***	-0.278***	-0.266***	-0.277***	-0.291***	-0.263***	-0.275***
	[0.018]	[0.039]	[0.018]	[0.019]	[0.018]	[0.018]	[0.018]	[0.018]
constant	-5.859***	-9.989***	-6.000***	-6.887***	-5.924***	-6.179***	-6.172***	-6.521***
	[0.565]	[0.956]	[0.561]	[0.616]	[0.560]	[0.573]	[0.560]	[0.573]
Weighting Matrices								
Distance	2.930***	-0.502						
	[0.342]	[2.368]						
Gap	-4.283***	9.484***						
	[0.364]	[2.456]						
*Scale * Distance*	-0.233***	0.016	0.177***	-0.160**	0.197***	0.245***		
	[0.047]	[0.253]	[0.009]	[0.073]	[0.005]	[0.008]		
*Scale * Gap*	0.582***	-0.503*	0.025***	0.406***			0.185***	0.248***
	[0.050]	[0.264]	[0.009]	[0.074]			[0.005]	[0.008]
Observation	18,450	18,450	18,450	18,450	18,450	18,450	18,450	18,450

Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table 10. Regression Results for VFDI affiliates: Hypothesis 1

	(1)		(2)		(3)	
Estimation Method	OLS	2SLS	OLS	2SLS	OLS	2SLS
Explanatory Variables						
GDP	-0.122*	-0.145**	-0.113*	-0.100	-0.139**	-0.140**
	[0.066]	[0.070]	[0.066]	[0.068]	[0.067]	[0.069]
Risk	2.747***	3.214***	2.642***	2.923***	2.813***	3.189***
	[0.142]	[0.161]	[0.142]	[0.147]	[0.143]	[0.149]
Distance from JPN	0.275***	0.449***	0.216***	0.153**	0.384***	0.414***
	[0.075]	[0.099]	[0.075]	[0.077]	[0.075]	[0.078]
Wages	-0.617***	-0.661***	-0.619***	-0.743***	-0.574***	-0.673***
	[0.050]	[0.056]	[0.050]	[0.052]	[0.051]	[0.052]
constant	-10.992***	-14.645***	-10.128***	-11.942***	-11.704***	-14.388***
	[1.518]	[1.691]	[1.522]	[1.573]	[1.536]	[1.587]
Weighting Matrices						
Distance	0.435***	-0.138	0.651***	1.010***		
	[0.023]	[0.234]	[0.012]	[0.025]		
Gap	0.265***	1.155***			0.660***	1.025***
	[0.024]	[0.236]			[0.013]	[0.025]
Observation	14,850	14,850	14,850	14,850	14,850	14,850

Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table 11. Regression Results for VFDI affiliates: Hypothesis 2

	(4)		(5)		(6)		(7)	
Estimation Method	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Explanatory Variables								
GDP	-0.132**	-0.105	-0.130**	-0.131**	-0.123*	-0.120*	-0.144**	-0.145**
	[0.065]	[0.084]	[0.065]	[0.066]	[0.066]	[0.066]	[0.066]	[0.066]
Risk	2.520***	4.140***	2.614***	2.688***	2.546***	2.616***	2.688***	2.783***
	[0.140]	[0.276]	[0.140]	[0.145]	[0.140]	[0.141]	[0.141]	[0.142]
Distance from JPN	0.284***	0.325***	0.274***	0.286***	0.224***	0.206***	0.378***	0.386***
	[0.074]	[0.114]	[0.074]	[0.082]	[0.074]	[0.074]	[0.074]	[0.075]
Wages	-0.534***	-1.032***	-0.569***	-0.585***	-0.576***	-0.607***	-0.534***	-0.557***
	[0.050]	[0.098]	[0.050]	[0.051]	[0.050]	[0.050]	[0.050]	[0.050]
constant	-9.497***	-20.583***	-10.039***	-10.592***	-9.429***	-9.862***	-10.845***	-11.529***
	[1.500]	[2.420]	[1.500]	[1.541]	[1.502]	[1.508]	[1.513]	[1.521]
Weighting Matrices								
Distance	0.478***	-0.325						
	[0.114]	[0.861]						
Gap	-0.847***	4.225***						
	[0.120]	[0.883]						
*Scale * Distance*	-0.016	0.118	0.050***	0.047***	0.073***	0.085***		
	[0.015]	[0.085]	[0.003]	[0.017]	[0.001]	[0.002]		
*Scale * Gap*	0.130***	-0.367***	0.026***	0.038**			0.074***	0.086***
	[0.016]	[0.088]	[0.003]	[0.018]			[0.001]	[0.002]
Observation	14,850	14,850	14,850	14,850	14,850	14,850	14,850	14,850

Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Figure 1. Domestic and Pure VFDI

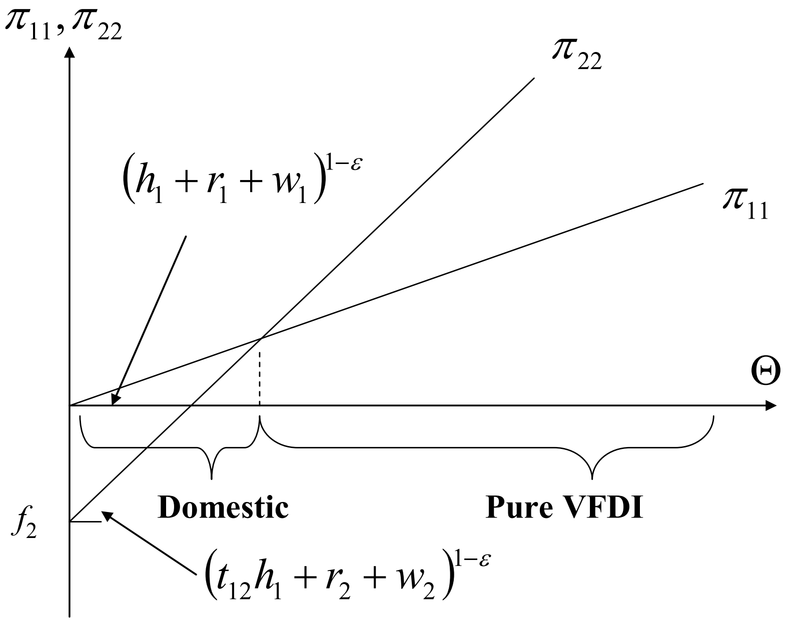

Figure 2. Domestic, Pure VFDI, and Complex VFDI