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How Does FDI in East Asia Affect Performance at Home?: Evidence from Electrical Machinery Manufacturing Firms

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Abstract: This paper pinpoints the impact of Japanese electronic machinery FDIs on productivity at home. Our analysis is based on the activity level of firms and not on their ready-made level. For example, if a firm has more than two kinds of activities such as upstream activity and downstream activity, we treat these activities as different. Our empirical results are consistent with their theoretical predictions: the horizontal FDI of an activity does not necessarily have the same significant positive impact on the productivity of domestic activities as the invested activity. On the other hand, the vertical FDI of an activity significantly enhances both the level and growth of productivity in domestic activities that have an input-output relationship with the invested activity.

***Keywords*:** Productivity; Firm performance; FDI and multinationals

***JEL Classification*:** F23; H32; O53

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1. Introduction

The impact of Japanese multinational firms' active advance into East Asian countries on their performance at home has received a great deal of attention. Japanese machinery firms have strewed their affiliates throughout East Asia and have formed international production/distribution networks. The present international production networks are fairly distinctive and highly developed in terms of their significance in each economy, the extensiveness of country coverage, and the sophistication of their structure consisting of both intra-firm and arm's-length transactions. However, such a formation of international production networks has forced Japanese firms to specialize in specific production processes such as the upstream process at home, thus shutting down the domestic plants of the relocated processes. In particular, the latter effect attracted much public attention during the hollowing-out of domestic industry. Around 2000, accompanied by the acceleration of Japanese firms' entry into China, its fear reached a peak in Japan.

There is a substantial body of empirical work analyzing whether foreign direct investment (FDI) enhances firm performance at home. In such work, the endogeneity of the productivity of FDI must be tackled. That is, since FDI firms by their nature have higher productivity, as found in previous studies such as Kimura and Kiyota (2006), it is ambiguous whether the higher productivity of FDI firms is attributed to investing or to original higher productivity. To tackle such endogeneity, two approaches are adopted in the literature: the instrumental variable method and propensity score matching method. In particular, availability of firm-level data encourages the latter method: Navaretti et al. (2004, 2006) for the Italian case; Hijzen et al. (2007) and Ito (2007) for the Japanese case; and Hijzen et al. (2006) and Navaretti et al. (2006) for the French case. Hijzen et al. (2006) and Navaretti et al. (2006) separately examined such an enhancement according to type of FDI, i.e., vertical FDI (VFDI) and horizontal FDI (HFDI). Navaretti et al. (2006) classified FDI to developing countries and that to developed countries as VFDI and HFDI, respectively. In Hijzen et al. (2006), VFDI is defined as investments by firms in comparatively disadvantaged industries to developing countries, while HFDI as those by firms in comparatively advantaged industries to developed countries.

However, the recent studies have not necessarily succeeded in detecting productivity enhancements of FDI firms at home. Hijzen et al. (2007), which analyzes the impact of Japanese FDI at firm-level, does not detect robust productivity improvement. Furthermore, some of the results in the previous studies are not consistent with theoretical prediction. From the theoretical point of view, the resulting impact of

HFDI on productivity at home is ambiguous. Its positive impact comes from excellent knowledge or technology for producing products in the host country, thereby enabling investing firms to produce the products at home more efficiently. The resulting impact of HFDI becomes positive when this positive impact is larger than the negative impact due to the loss of scale economy. On the other hand, the impact of VFDI should be positive because it is expected to force firms at home to relocate their resources and achieve improvements in their productivity. Contrary to these predictions, however, both Navaretti et al. (2006) and Hijzen et al. (2006) find a significant positive enhancement of productivity in French HFDI, but not in its VFDI.

The aim of this paper is to closely examine the impact of Japanese machinery FDI on the productivity of domestic activities. Our analysis is based on the activity level of firms, not on the firm level. For example, if a firm has more than two kinds of activities such as upstream activity (e.g., processing of parts and components) and downstream activity (e.g., assembling process), we treat these activities as different observations. The reason for the use of such activity data is because we suspect that the obscure impact on a firm's productivity in previous literature can be attributed to their use of firm-level data. Although multinational enterprises (MNEs) are typically large companies with multiple lines of businesses, the impact of FDI shows up in their limited lines. Therefore, even if such impact on the lines is positive, bad performance in the other lines might mask the improvement of the firms' productivity due to their investing abroad. Furthermore, the lines receiving such positive impact are qualitatively different between HFDI and VFDI. In HFDI, MNEs replicate a business line in a host country and are expected to get the positive effects on that business line at home. In VFDI, on the other hand, MNEs completely relocate some business lines to a host country and are expected to get the positive effects on remaining domestic lines. Our activity data can work as a sharper knife to pinpoint the impact of FDIs on the productivity of the related business lines.

The rest of this paper is organized as follows. The next section reviews the impact of HFDI and VFDI on productivity at home, and section 3 outlines our empirical methodology. In section 4 we provide our empirical results, and section 5 concludes.

2. Horizontal FDI and Vertical FDI

This section reviews the impact of FDI on the performance of domestic plants. First, we set our conceptual framework of HFDI and VFDI. Next, we illustrate their impact on domestic plants' performance.

2.1. Conceptual Framework of HFDI and VFDI

In the literature, the following two kinds of investments are considered: HFDI and VFDI. HFDI is a strategy to avoid broadly defined trade costs by setting up plants within the targeted market/country rather than by exporting from the home country. Thus, the HFDI firms locate the basically same production activity in both home and host countries. On the other hand, the VFDI exploits low price production factors of the host country. In VFDI, firms completely relocate a part of their production processes to the host country. The relocated processes are ones that intensively use the production factors of which prices are lower in the host country. As a result, at least from the theoretical point of view, production activities located in the host country exist also in the home country as in the case of HFDI but not in the case of VFDI. In addition, there is a difference in sales destination between HFDI and VFDI. The sales destination of affiliates is basically their host country in HFDI, but other countries in VFDI. Although the MNEs' motivation for investing abroad is diversified in the real world and thus all the affiliates cannot be necessarily classified into either VFDI or HFDI, this classification is still useful to analyze the MNEs' behavior.

In sum, we summarize the characteristics of HFDI and VFDI as follows.

***Characteristics* 1**: HFDI establishes foreign plants with the same activity as domestic plants, while VFDI establishes the foreign ones with different activities from those at home, particularly the activity with an input-output relationship with the home activity.

***Characteristics* 2**: HFDI is a strategy to relocate abroad the plants of which the main sales destination is the host country, while VFDI is a strategy to relocate those of which the main sales destination is not the host country, but the home country or other countries.

2.2. Impact of HFDI and VFDI at Home

The sources of the impact of investing abroad on the performance of home country plants are also qualitatively different between HFDI and VFDI. In this subsection, we summarize such impacts of HFDI and VFDI separately.

First, let us start with the impact of HFDI at home. Suppose that there is a country (host country) with the same level of factor prices as at home. We assume increasing returns to scale technology and iceberg costs for shipment of products between countries. Firms can supply their products to the other country by either exporting from

home or locating production plants within the host country. Firms make their choice based on the highest total profit, which is the sum of gross profits earned by selling at home and abroad. Exporting enables fixed cost savings by avoiding setting up production plants abroad, while HFDI saves on shipping costs. Therefore, firms employ HFDI if the fixed costs are low enough and the shipping costs are high enough.

HFDI changes a home plant's average cost. The quantity of production in the home plant unambiguously decreases because it stops producing goods designed for the host country.[1] This decrease obviously raises the average cost as depicted in Figure 1, where X_{pre} and X_{post} are the quantities of home production before and after investing, respectively. In this case, the home plant's productivity definitely decreases.[2] However, there may be knowledge/technology spillover from the foreign plant to the home plant as pointed out in previous studies, e.g., Navaretti et al. (2006). If such spillover effects exist and the home plant enjoys enough of a decrease in marginal costs, the average cost declines as depicted in figure 2. In sum, the impact of HFDI on a home plant's productivity depends on the existence and magnitude of knowledge/technology spillover from host countries.

=== Figures 1-2 ===

Second, the impact of VFDI at home is less ambiguous than that of HFDI. Suppose there is a country (host country) with location advantages in producing downstream products and a firm selling final products around the world. The firm establishes two kinds of plants at home or abroad, one producing downstream products and the other producing upstream products. Products in *each* production process are produced with increasing returns to scale technology. It is necessary to incur iceberg costs for the shipment of products between countries. Here we focus on VFDI in which the firm relocates a downstream plant to the host country. The firm decides to relocate it if the joint profit for an upstream plant at home and a downstream plant abroad exceeds the profit of the integrated production at home. The integrated production at home enables firms to save on the shipping costs of transporting upstream products from home to abroad, while VFDI can lead to a reduction in the cost of primary production factors due to advantageous location differentials. Therefore, firms employ VFDI if

[1] As mentioned above, firms choose HFDI when shipping costs are high enough. Thus, HFDI increases the production quantity of products for the (host) country's market because it is no longer necessary for firms to incur such high shipping costs.

[2] The home plant's fixed cost rises if the home plant pays a part of the fixed cost to establish a plant abroad; causing the home plant's productivity to decrease.

shipping costs are low enough and such differentials are large enough.

We restrict our attention only to the cost structure of an upstream plant at home. VFDI affects its average cost through two kinds of changes in its production quantity of upstream products. The one kind of change is a decrease in quantity because firms need to incur the expenses for transporting the upstream products from the home country to the host country. The other is an increase in the production quantity of upstream products because the cost savings in primary production factors for firms decrease the price of final products. Lower prices for final products increase their production quantity and also the production quantity of upstream products. As mentioned above, because firms choose VFDI if shipping costs are low enough and the cost savings for primary production factors are large enough; the net impact of the production quantity of upstream products becomes positive.[3] As a result, the average cost of a home upstream plant decreases as depicted in Figure 3, and thus its productivity rises.

=== Figure 3 ===

2.3. Level or Growth?

So far we have examined the impact of FDIs on the *level* of productivity at home plants. Indeed, almost all the previous studies have empirically investigated the impact on its level. However, FDIs might also affect the *growth* of productivity. On the one hand, knowledge/technological spillover in HFDI influences the *growth* of productivity. There are a large number of studies analyzing various kinds of spillover effects. For instance, the impact of MNEs' presence on indigenous firms' productivity has been examined (see, for example, Gorg and Greenaway, 2004; Crespo and Fontoura, 2007). In the literature, most of the papers found its impact on the growth of productivity to be positive. Since the main source of positive impact of HFDI is also knowledge/technological spillover, HFDI might affect not only the level but also the growth of productivity at home. On the other hand, in VFDI, Hijzen et al. (2008) pointed out the possibility of its offshoring impact affecting the growth of productivity. The impact of VFDI and offshoring is considered to be basically the same. Hijzen et al. (2008) claimed that specializing in skill-intensive production stages through offshoring generates higher growth in productivity due to larger learning-by-doing effects than in the case of no offshoring. Consequently, both HFDI and VFDI might affect not only the

[3] To show this conjecture, a formal model that incorporates MNEs' decision on investing is necessary though employing such a general model is beyond the scope of this subsection. See, for example, Navaretti and Venables (2004).

level but also the growth of productivity in plants at home. Thus, in the next section, we empirically investigate the impact of applying Japanese FDIs on both the level and growth of productivity at home.

3. Empirical Issues

In this section, we first explain our empirical methodology to examine the impact of FDIs on performance at home. Next we list our data sources and explain in simple terms how to construct our productivity measure.

3.1. Empirical Methodology

This paper investigates the impact of FDIs on home plant productivity at a detailed level. Our analytical unit is the production process, not the industry. For instance, we directly examine the impact of relocating a downstream plant abroad on productivity of an upstream plant at home. Such an analytical unit is called "activity" hereafter. However, high disaggregation prevented us from employing the matching method, which was often used in the previous studies listed in the introductory section. The use of this method is aimed at tackling the endogeneity problem; investors by nature have higher productivity than non-investors (selection-effect). The (nearest) matching method usually chooses a non-investing firm not only with the closest probability of investment but also in the same industry as the investing firm. However, our high disaggregation implies that the potential number of firms in the same industry/production process as investing firms is limited despite using one of the largest datasets available in Japan. Thus, lack of enough observations prevented us from reaching a good match. As a result, this paper conducts a regression analysis instead.

Following Castellani et al. (2007) and Hijzen et al. (2008), we specify a linear equation with a lagged dependent variable in order to control fluctuation by the elements not adequately measured by our productivity index. In this paper, we estimate two kinds of equations: a level equation and a growth equation. Specifically, the following equations are estimated:

$$TFP_{ij}(t) = \rho\, TFP_{ij}(t\text{-}1) + \beta_1\, Horizontal_{ij}(t\text{-}1) + \beta_2\, Vertical_{ij}(t\text{-}1) + \delta(t) + \eta_{ij} + \varepsilon_{ij}(t) \quad (1)$$

$$\Delta TFP_{ij}(t) = \lambda\, \Delta TFP_{ij}(t\text{-}1) + \gamma_1\, Horizontal_{ij}(t\text{-}1) + \gamma_2\, Vertical_{ij}(t\text{-}1) + \delta(t) + \eta_{ij} + \varepsilon_{ij}(t) \quad (2)$$

where $TFP_{ij}\,(t)$ and $\Delta TFP_{ij}\,(t)$ denote the level and the first difference, respectively, of

the productivity of firm i's activity j in year t. We employ total factor productivity index as a productivity measure, and its method of construction is explained later. $Horizontal_{ij}$ and $Vertical_{ij}$ represent the magnitude of firm i's HFDI and VFDI, respectively. We take the lagged dependent variable and the two FDI variables as predetermined. To control for the endogeneity of those predetermined variables, we employ the System GMM (general method of moments) proposed by Blundell and Bond (1998). We use the second and third lagged observations of both the dependent variable and the FDI variables as instruments.

In order to pinpoint the impact of FDIs on productivity of the related activities, we need to appropriately formulate two FDI variables. It is natural to follow the first characteristics in section 2.1. That is, *Horizontal* should embody the magnitude of production abroad in the same activity as the activity of the dependent variable, which in this case is activity j. On the other hand, *Vertical* should represent the magnitude of production abroad in activities having an input-output relationship with activity j. Suppose that an MNE with upstream and downstream activities at home has downstream activities in both Asia and North America and an upstream activity in North America.[4] Such an example is shown in Table 1. *A*-*E* represent the magnitude of the corresponding activity. In this setting, for upstream activity at home (*A*), *Horizontal* refers to *C*, while *Vertical* for the same activity is the sum of *D* and *E*.

=== Table 1 ===

Furthermore, we should adjust the scale of the two FDI variables in order to extract unexpected elements. As for the *Horizontal* variable, we divide by the magnitude of firm i's global production, including production at home, of activity j in order to measure the relative magnitude of production abroad in the activity concerned. In Table 1, for example, the horizontal variable for the upstream activity at home (*A*) is adjusted by the sum of *A* and *C*. On the other hand, as for the vertical variable, we divide by the magnitude of firm i's global production, including production at home, of industry, where "Industry" is the sum of upstream and downstream activities. That is, in Table 1 the vertical variable for upstream activity at home (*A*) is adjusted by the sum of *A*, *B*, *C*, *D*, and *E*.

In this paper, the magnitude of overseas activities is measured by the employment

[4] In this paper, developed countries include North American countries, Western European countries, Australia, and New Zealand. Asia includes South Korea, Taiwan, Hong Kong, Singapore, Malaysia, the Philippine, Thailand, Indonesia, and China.

level of overseas affiliates. Although data on overseas affiliates' sales is available, the prices are not reported in the survey. Besides, there is a possibility that some perform only cosmetic processing of the goods manufactured by their parents to circumvent trade barriers. The more appropriate variable might be the value added in each overseas affiliate. However, since the cost of intermediate input, which is necessary to calculate the value added, is frequently not reported, we used the employment figure as a proxy. As a result, we formalize two FDI variables as the followings:

$$Horizontal_{ij} = \frac{\sum_{r \in R_O} L^r_{ij}}{\sum_{r \in R} L^r_{ij}}, \quad Vertical_{ij} = \frac{\sum_{r \in R_O} \sum_{k \in S_j} L^r_{ik}}{\sum_{j \in S} \sum_{r \in R} L^r_{ij}}.$$

L^r_{ij} represents firm i's activity j's employment in country r. S denotes a set of all activities in the industry to which activity j belongs. R is a set of all countries: $R \in$ {Japan, advanced countries, East Asian countries, and other countries}. $R_O \in$ {advanced countries, East Asian countries, and other countries}. S_j denotes a set of activities having an input-output relationship with activity j. For example, if activity j is "electrical machinery, equipment and supplies", S_j is "electronic parts and devices". The list of all activities is presented in the next subsection.

Lastly, there are three points to be noted. First, one may worry about the skill heterogeneity across labor, particularly between developed and developing countries. For example, workers in OECD countries have a superior set of skills than those in East Asian countries. To take such heterogeneity into consideration to some extent, we also estimated which FDI variables were disaggregated according to destination. Second, our variables representing FDIs are continuous even though most of the previous studies used binary ones, i.e., taking unity if firms conduct FDIs and zero otherwise.[5] Our choice is based on the claim that spillover and division-of-labor benefits from FDIs should gradually start to work. That is, overseas affiliates have not always been engaged in full production activity from the time they first entered the host country. However, the remaining domestic activities can enjoy those benefits from the time they first engage in sufficient production activities. To take such a time lag into consideration, we employ continuous variables representing affiliates' activities. Third, as a cost of employing such continuous variables, we cannot distinguish the impact of the first time FDI from that of the second time FDI if MNEs set up their second affiliate before their first affiliate starts sufficient production activities. As a result, we measure affiliate's activities as the activities of *all* affiliates located in the region concerned rather than the

[5] Hijzen et al. (2008) also uses continuous variables.

activities of the first affiliate.[6]

3.2. Data Issues

Our primary data sources are the linked longitudinal data sets of "Census of Manufactures" and "Basic Survey of Overseas Business and Activities" during the period 1981-2003.[7] In the Census of Manufactures, data including location, number of employees, tangible assets, and the value of shipments is available on establishments located in Japan. The Basic Survey of Overseas Business and Activities contains data on Japanese overseas affiliates between 1985 and 2003. The information on parent firms of establishments/affiliates, e.g., the number of employees, can be obtained from the Basic Survey of Japanese Business Structure and Activities. We exclude plants with less than nine employees because they do not provide the information on capital that is indispensible for estimating the productivity measure, total factor productivity (TFP). Because capital data are not available in 2001 and 2002 for plants with less than 29 employees, our linked panel dataset is restricted to 1985-2000 and 2003.

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

$$\begin{aligned} TFP_{ijt} &= \left(\ln Q_{ijt} - \overline{\ln Q_t}\right) - \sum_{f=1}^{F} \frac{1}{2}\left(s_{ijft} + \overline{s_{ft}}\right)\left(\ln X_{ijft} + \overline{\ln X_{ft}}\right) \\ &+ \sum_{s=1}^{t}\left(\overline{\ln Q_s} - \overline{\ln Q_{s-t}}\right) - \sum_{s=1}^{t}\sum_{f=1}^{F} \frac{1}{2}\left(\overline{s_{fs}} + \overline{s_{fs-1}}\right)\left(\overline{\ln X_{fs}} - \overline{\ln X_{fs-1}}\right) \end{aligned} \quad , \tag{3}$$

where Q_{ijt}, s_{ijft} and X_{ijft} denote the gross output of firm i's *activity j* in year t, the cost share of input f for firm i's *activity j* in year t, and the input of factor f in firm i's *activity j* in year t, respectively. Variables with an upper bar denote the industry average of that variable. We define a hypothetical (representative) firm for each year by industry. Its input and output are calculated as the geometric means of values for all firms in a certain industry. The first two terms on the right hand side of the equation (3) denote the cross-sectional TFP index based on the Thiel = Tornqvist specification for each firm, for each year, relative to a hypothetical firm. Since this cross-sectional TFP index is not comparable between t and t-1, we adjust the cross sectional TFP index with the growth rate of TFP for a hypothetical firm as in the third and forth term in the equation. For more details on each variable, see Appendix B.

This paper focuses on the electronics and machinery manufacturing industry, in

[6] There seems to be an important link between FDI's impact on performance and the number of affiliates. However, examining such a link is beyond the scope of this paper.

[7] For the details on data construction, see Appendix A.

which the active FDIs can be observed. We aggregate plant-level data by activity, by year, and by country. Out of our five activities, four are categorized as downstream activities and one is an upstream activity. The classification of upstream or downstream is based on the input-output relationship between them, which is explored by employing the input-output tables maintained by the Ministry of Internal Affairs and Communications of Japan. First, we define upstream activities as ones in which the share of manufacturers' intermediate demand in total domestic demand is greater than around 90%. Such an activity in the electronics and machinery industry is "electronic parts and devices". Next, downstream activities of the upstream activity are defined as ones in which a share of the upstream activity in total inputs is greater than 10%. As a result, the downstream activities of "electronic parts and devices" are "Office, Service and Household machinery", "electronic equipment", "electronic data processing machines", and "communication equipment".

Table 2 shows the number of firms in 2000 by combination of home activity and foreign activity. For example, the number "113" indicates that there were 113 firms with both downstream activities at home and upstream activities abroad. The numbers of firms with activities concerned only in Asia are in parentheses. This table tells us three points. First, there are a lot of firms with the same activity both at home and abroad, compared to the number of firms with different activities at home and abroad. From our methodological point of view, i.e., the first characteristics in section 2.1, this might indicate that there are more HFDI firms than VFDI ones. Second, the ratio of HFDI firms to VFDI firms is at almost the same level between downstream (174/113) and upstream activities (124/81) at home. Based on the first characteristics, this implies that there are as many VFDIs of upstream activities as VFDIs of downstream activities. This contradicts our presumption that Japanese firms move labor-intensive downstream activities overseas while keeping capital-intensive upstream ones in Japan. However, this fact shows the production structure of the electronics industry is becoming much more complex than our expectation based on a simple-factor endowment story. Third, as is well known, most Japanese FDIs are directed toward East Asia. Thus, the above two points hold also for Japanese FDIs to East Asia.

=== Table 2 ===

4. Empirical Results

This section reports our estimation results of equations (1) and (2). The estimation for some other equations is also performed. Basic statistics of our variables are

presented in Table 3.

=== Table 3 ===

The results of equations (1) and (2) are reported in (I)-(IV) and (V)-(VIII), respectively, in Table 4. The results for two FDI variables are quite similar in both equations. That is, HFDI and VFDI have a positive impact on both the level and growth of productivity at home. The positive impact of HFDI might indicate the existence of the strong knowledge of spillover effects. On the other hand, while the positive impact of VFDI on productivity level implies benefits from the production process-wise vertical division of labor, the impact of VFDI on productivity growth may indicate benefits from strong learning-by-doing effects.

=== Table 4 ===

The results of the AR(2) test and Hansen's *J* test are disappointingly rejected in the level equation and are not consistent with the assumption of System GMM. Based on the rejection of the AR(2) test, we introduced both the second and third lagged dependent variables as independent variables in the level equation; the result is reported in (I'). The result of the AR(2) test is still not good, but it is not rejected at least at the 1% significance level. The coefficient for HFDI turns out to be insignificant, while that for VFDI is still significant but its magnitude is trivial. In the proceeding results for the level equation, we will focus on the results in the level equation with the second- and third-lagged dependent variables.

Next, we attempted to decompose the FDI variables. First, we decomposed VFDI into relocating downstream and upstream activities abroad. In (II') and (VI) of Table 4, *Vertical*, *Downstream* and *Upstream* variables are introduced instead. The former variable examines the impact of relocating downstream activity abroad on the productivity of upstream activity at home, while the latter variable examines the impact of relocating upstream activity abroad on the productivity of downstream activity at home. Interestingly, not only the *Downstream* coefficient but also the *Upstream* coefficient are estimated to be significantly positive. This implies that although we usually imagine developed countries' relocation of downstream activity to developing countries as VFDI, the relocation of upstream activity also yields benefits from the vertical division of labor. As confirmed in Table 2, there are many firms that locate upstream activities abroad and keep downstream ones at home. In this case, higher

productivity can be expected by scale economies coming from vertical specialization. In addition, in (II'), the coefficient for the *Horizontal* variable is again insignificant, indicating that the positive impact of HFDI on the level of productivity at home is not robust.

Second, based on the fact in Table 2 that most of the Japanese FDIs are directed toward East Asia, we extracted the impact of Japanese FDIs to East Asian countries. That is, in equations (1) and (2), the numerator of two FDI variables consists of only East Asian countries and not all foreign countries. This decomposition will also contribute to controlling, to some extent, the skill heterogeneity of labor. MNEs' activities in developed countries and other countries are controlled by introducing two variables; $FDI_{Developed}$ and FDI_{Others}. Their numerator is employment in those countries, and their denominator is the same formulation as that of *Vertical*. The results are reported in columns (III') and (IV') for the level equation and in columns (VII) and (VIII) for the growth equation. The results for VFDI-related variables are qualitatively unchanged: Japanese VFDI to East Asia yields positive impact on domestic activity remaining at home. On the other hand, coefficients for *Horizontal* are never significant. Since the source of positive impact of HFDI is the excellent knowledge that MNEs can obtain in host countries, the spillover of such knowledge would usually be available in developed countries. This argument would be consistent with the insignificant results of HFDI in East Asia.

Lastly, we adopt the more sophisticated classification of FDIs. Recalling the example presented in Table 1; our methodology to identify FDI type through the first characteristics takes the foreign upstream plant (*C*) as both HFDI for the home upstream plant (*A*) and as VFDI for the home downstream plant (*B*). That is, the effect of locating a plant abroad shows up in both *Horizontal* and *Vertical* if an MNE has both downstream and upstream plants in its home country (integrated MNEs). Such double counting would produce unexpected noise in coefficients for both *Horizontal* and *Vertical*. Although we believe that the influence of such double counting on our estimates is trivial since there are few integrated MNEs[8], further estimation might be invaluable.

To tackle this problem, we incorporated the second characteristics in section 2.1. We first classified each affiliate into either HFDI affiliate or VFDI affiliate according to the destination with the largest sales: an affiliate was defined as an HFDI affiliate if the destination with the largest sales was the host country; and as a VFDI affiliate if otherwise. Second, we aggregated affiliates' employment levels by firm's activity by

[8] The share of integrated MNEs in our sample is less than 10%.

FDI type by country by year. Such an aggregated employment is denoted by $L^r_{ij}{}^{FDI}$, $FDI \in \{HFDI, VFDI\}$. Naturally, it holds that $L^r_{ij} = L^r_{ij}{}^{HFDI} + L^r_{ij}{}^{VFDI}$. By using these variables, we again construct the two FDI variables as follows:

$$Horizontal_{ij} = \frac{\sum_{r \in R_O} L^{r,HFDI}_{ij}}{\sum_{r \in R} L^r_{ij}}, \quad Vertical_{ij} = \frac{\sum_{r \in R_O} \sum_{k \in S_j} L^{r,VFDI}_{ik}}{\sum_{j \in S} \sum_{r \in R} L^r_{ij}}.$$

This strict construction of *Horizontal* and *Vertical* enables us to examine the purer impact of HFDI and VFDI.

The results are reported in Table 5 and include two noteworthy points. First, all coefficients for *Horizontal* turned out to be insignificant. Although theoretical prediction of HFDI's impact is ambiguous, we conclude that HFDI does not have a significantly positive impact on both the level and growth of productivity at home. Second, as is consistent with theoretical prediction, we can say that VFDI has both a positive and robust impact on the level and growth of productivity at home. When we breakdown VFDI into *Upstream* and *Downstream*, the coefficients for both variables are positive, but only the upstream one is statistically significant. Increasing complexity in electronics products requires more and more variation in their components, which may be making it more and more difficult to achieve scale economies in upstream factories. The results in model (IV) and (VIII) may be attributed to such recent changes in electronics products.

=== Table 5 ===

5. Concluding Remarks

In this paper we have analyzed, in detail, the impact of Japanese electronic machinery FDI on the productivity of domestic activity. In contrast to previous studies, we have found consistent results: VFDI significantly enhances the productivity of the production process that remains in Japan, while HFDI does not. This result is consistent with theoretical understandings of the productivity impact of FDI. Thanks to a novel dataset at activity level, we can conclude that productivity impact is clearer in VFDI than HFDI. Some obscure results in the previous studies may be explained by their reliance on firm level data, which may be too broad for the observation of large multinational corporations.

We conclude this paper with some important avenues to the literature. It is important to take into account the more complicated nature of FDIs. Recently, FDI theories have been reconstructed in the framework of a three-country setting instead of the traditional

two-country setting (Ekholm et al. 2007; Grossman et al. 2006; Yeaple, 2003). In particular, traditional VFDI is conceptually divided into pure VFDI and complex VFDI. The former type of VFDI is a production process-wise division of labor between host and home countries, i.e., between two countries. The latter type is divided among more than two host countries and home country, i.e., among more than three countries. Although this paper does not distinguish between these two kinds of VFDI, it is natural for their impacts on the performance of domestic activity to be different between them. One interesting question is whether or not the performance of remaining domestic activity continues to rise as the partner's division of labor increases.

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Figure 1. Impact of HFDI on Home Plant's Average Cost

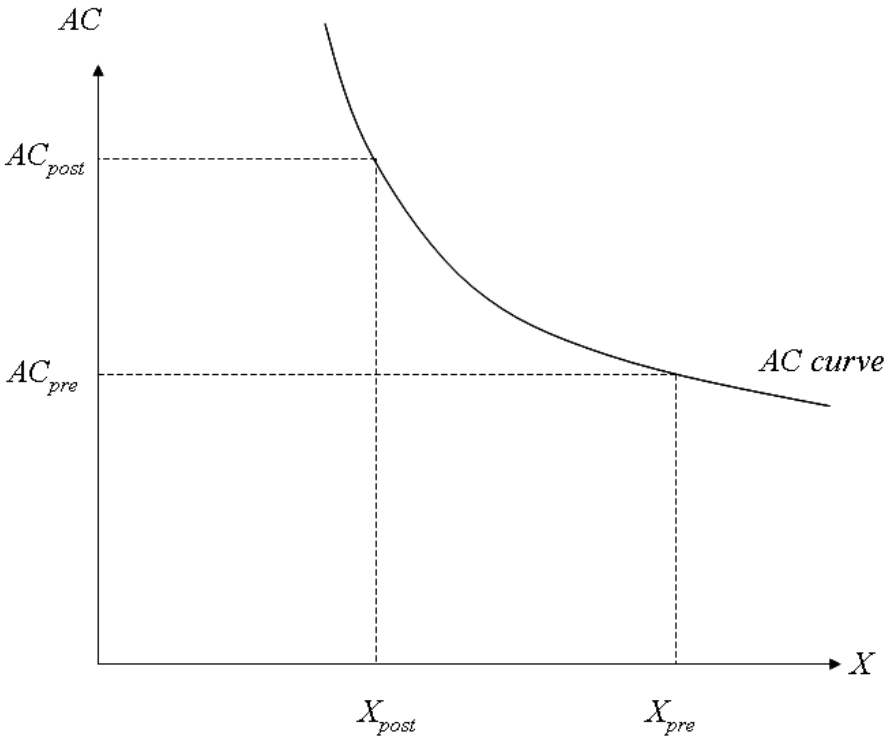

Figure 2. Impact of HFDI on Home Plant's Average Cost, with Spillover

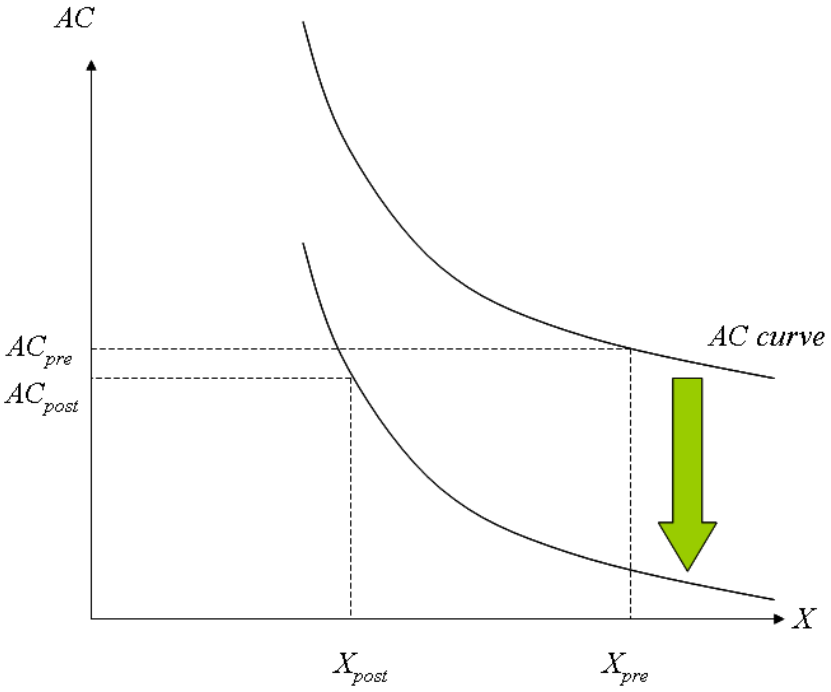

Figure 3. Impact of VFDI on Home Plant's Average Cost

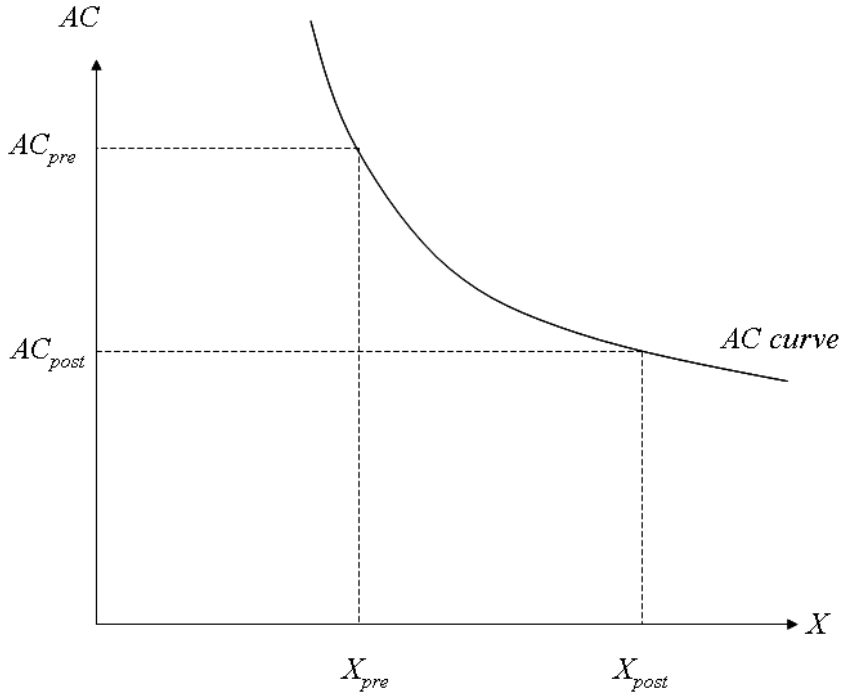

Table 1. Example

	Upstream	Downstream
Home	*A*	*B*
Asia		*D*
North America	*C*	*E*

Table 2. Comparison between Home and Abroad in 2000

		No Entry	Abroad	
			Downstream	Upstream
Home	Downstream	1249 (1275)	174 (148)	113 (107)
	Upstream	723 (737)	81 (69)	124 (112)

Source: The METI Survey

Notes: The numbers of firms with activities concerned only in East Asia are in parentheses. "No Entry" means non-MNEs (firms not investing in East Asia).

Table 3. Basic Statistics

	N	Mean	Sd	p10	p90
ΔTFP	32,897	0.949	0.695	0.000	1.785
TFP	32,897	0.024	0.243	-0.137	0.202
ΔEMP	32,897	5.082	1.225	3.714	6.733
EMP	32,897	0.002	0.294	-0.181	0.195
$\Delta SHIP$	32,897	12.671	1.673	10.744	14.926
$SHIP$	32,897	0.037	0.446	-0.285	0.351
$FDI_{Developed}$	32,897	0.085	1.285	0	0
FDI_{Others}	32,897	0.024	0.308	0	0
$Horizontal$	32,897	0.1	1.7	0	0
$Vetical$	32,897	0.030	0.663	0	0
$Upstream$	32,897	0.021	0.648	0	0
$Downstream$	32,897	0.009	0.143	0	0
$Horizontal_{Asia}$	32,897	0.019	0.103	0	0
$Vertical_{Asia}$	32,897	0.007	0.107	0	0
$Upstream_{Asia}$	32,897	0.004	0.080	0	0
$Downstream_{Asia}$	32,897	0.003	0.072	0	0

Table 4. Baseline Results

	Level				Level				Growth			
	(I)	(II)	(III)	(IV)	(I)'	(II)'	(III)'	(IV)'	(V)	(VI)	(VII)	(VIII)
Dependent Var. (t-1)	0.923	0.915	0.910	0.905	0.768	0.772	0.770	0.773	-0.158	-0.152	-0.154	-0.148
	[72.98]***	[75.98]***	[74.62]***	[73.33]***	[44.62]***	[46.16]***	[46.53]***	[46.98]***	[-9.38]***	[-9.08]***	[-9.28]***	[-8.79]***
Dependent Var. (t-2)					0.169	0.156	0.162	0.162				
					[8.60]***	[7.12]***	[7.60]***	[7.47]***				
Dependent Var. (t-3)					0.131	0.135	0.120	0.117				
					[7.63]***	[7.44]***	[6.47]***	[6.43]***				
$FDI_{Developed}$ (t-1)			-0.003	-0.003			-0.004	-0.004			-0.003	-0.003
			[-1.01]	[-1.07]			[-1.32]	[-1.13]			[-1.31]	[-1.30]
FDI_{Others} (t-1)			0.035	0.035			0.039	0.036			0.042	0.040
			[1.99]**	[1.99]**			[1.81]*	[1.65]*			[3.37]***	[3.07]***
Horizontal (t-1)	0.006	0.006			0.005	0.005			0.006	0.005		
	[1.86]*	[1.57]			[1.64]	[1.47]			[1.96]*	[1.67]*		
Vetical (t-1)	0.005				0.005				0.004			
	[1.98]**				[1.95]*				[1.77]*			
Upstream (t-1)		0.005				0.004				0.004		
		[2.34]**				[1.98]**				[2.01]**		
Downstream (t-1)		0.039				0.023				0.029		
		[5.35]***				[3.49]***				[4.79]***		
$Horizontal_{Asia}$ (t-1)			0.066	0.070			-0.015	-0.019			0.004	0.003
			[1.70]*	[1.79]*			[-0.57]	[-0.70]			[0.16]	[0.12]
$Vertical_{Asia}$ (t-1)			0.066				0.062				0.056	
			[6.48]***				[4.06]***				[5.15]***	
$Upstream_{Asia}$ (t-1)				0.071				0.076				0.067
				[5.18]***				[4.07]***				[5.43]***
$Downstream_{Asia}$ (t-1)				0.072				0.046				0.055
				[5.56]***				[6.03]***				[6.00]***
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	32,897	32,897	32,897	32,897	23,977	23,977	23,977	23,977	27,985	27,985	27,985	27,985
No. Firms' Activities	4246	4246	4246	4246	3242	3242	3242	3242	3682	3682	3682	3682
Hansen J (p-value)	0.000	0.000	0.000	0.000	0.014	0.061	0.102	0.218	0.288	0.647	0.495	0.667
AR(2) (p-value)	0.001	0.001	0.001	0.001	0.533	0.369	0.631	0.657	0.322	0.418	0.391	0.510

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table 5. The More Sophisticated Classification

	Level				Growth			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Dependent Var. (t-1)	0.783	0.784	0.772	0.776	-0.149	-0.149	-0.152	-0.156
	[49.92]***	[46.53]***	[46.69]***	[44.70]***	[-9.92]***	[-8.63]***	[-9.01]***	[-9.18]***
Dependent Var. (t-2)	0.161	0.154	0.162	0.153				
	[9.11]***	[7.49]***	[7.91]***	[6.90]***				
Dependent Var. (t-3)	0.111	0.128	0.117	0.125				
	[6.63]***	[6.69]***	[6.53]***	[6.83]***				
$FDI_{Developed}$ (t-1)			-0.004	-0.004			-0.002	-0.002
			[-1.27]	[-1.17]			[-1.25]	[-1.08]
FDI_{Others} (t-1)			0.039	0.038			0.042	0.040
			[1.85]*	[1.80]*			[3.26]***	[3.11]***
Horizontal (t-1)	-0.027	-0.041			-0.025	-0.026		
	[-0.92]	[-1.27]			[-0.82]	[-0.84]		
Vetical (t-1)	0.101				0.134			
	[1.90]*				[2.49]**			
Upstream (t-1)		0.152				0.199		
		[1.54]				[2.65]***		
Downstream (t-1)		0.097				0.109		
		[2.28]**				[2.31]**		
$Horizontal_{Asia}$ (t-1)			-0.004	-0.033			0.052	0.029
			[-0.10]	[-0.74]			[1.15]	[0.65]
$Vertical_{Asia}$ (t-1)			0.142				0.130	
			[2.33]**				[2.34]**	
$Upstream_{Asia}$ (t-1)				0.201				0.196
				[2.06]**				[2.20]**
$Downstream_{Asia}$ (t-1)				0.048				0.087
				[0.92]				[1.63]
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	23,977	23,977	23,977	23,977	27,985	27,985	27,985	27,985
No. Firms' Activities	3,242	3,242	3,242	3,242	3,682	3,682	3,682	3,682
Hansen J (p-value)	0.021	0.088	0.064	0.248	0.294	0.560	0.286	0.415
AR(2) (p-value)	0.583	0.364	0.626	0.441	0.403	0.461	0.405	0.365

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Appendix A. Data Construction

Our primary data source in this paper is the linked database of the Census of Manufactures (COM), the Basic Survey of Japanese Business Structure and Activities (BSJBSA) and the Survey of Oversea Business and Activity (SOBA) by the Ministry of Economy, Trade and Industry (METI). In this appendix, we introduce the basic information on these surveys and briefly explain the procedure of data construction.

A) The Census of Manufactures

The Census of Manufactures is one of the representative surveys of economic activity and its origin dates back to 1868, the first year of the Meiji Restoration. The Census covers all the establishments in manufacturing sectors listed in the Standard Industrial Classification for Japan. The Census is conducted on all establishments in calendar years ending in 0, 3, 5 and 8. For other years, the Census covers establishments with four or more employees. The Census consists of Form A for establishments with 30 or more employees, and the simpler Form B for establishments with 29 or fewer employees. The total number of establishments covered in 2003 was about 504,530, of which about 46,284 fell into the Form A category.

Major items in the Census are shipments, inventory, book value of equipment and structures, employment, cost of materials and energy usage. However, in Form B the availability of information on book value of equipment and structures, and depreciation are restricted. Establishments with nine or fewer employees are not required to report these items. Beginning with the year 2000, this information for establishments with 29 or fewer employees is available only every 5 years. For further information on the items in the Census, see "Directions in the Census of Manufactures"[9].

As of 2007, micro data sets for establishments with four or more employees are available after 1980[10]. Each establishment has a 10-digit identification number, which is composed of a two-digit prefecture code, three-digit city code and five-digit establishment code. Tracing changes in each code, we can construct panel data sets. Although the city code changes frequently, particularly when cities, towns or villages are amalgamated or abolished, it is easily tracked since such changes are listed in the website of the Ministry of Internal Affairs and Communications. Besides, establishment codes are revised every 5 years, e.g., 1980-1981, 1986-1987, 1991-1992, 1997-1998,

[9] Downloadable from the METI website:
http://www.meti.go.jp/english/statistics/tyo/kougyo/index.html

[10] Before 2000, data on establishments with less than four employees was managed and stored by prefectural governments, even in the case of censuses covering all establishments. Therefore, our panel data set is restricted to establishments with four or more employees.

and 2002-2003. Since code-matching tables exist for 1987, 1992, 1998, and 2003, we can construct a panel data set from 1981 to 2003[11].

B) The Basic Survey of Japanese Business Structure and Activities

The Basic Survey of Japanese Business Structure and Activities (BSJBSA) is the comprehensive firm-level survey conducted by the Ministry of Economy, Trade and Industry. This survey started in 1991, then in 1994, and annually afterwards. The main purpose of the survey is to capture statistically the overall picture of Japanese corporate firms in light of their activity diversification, globalization, and strategies on research and development and information technology. The strength of the survey is its sample coverage and reliability of information. The survey includes all firms with more than 50 employees and with capital of more than 30 million yen. The survey covers mining, manufacturing, and service industries, although some services industries, such as finance, insurance, and software services, are not included. The other feature of this survey is that each firm has their own identification number (hereafter, the BSJBSA code) throughout sample periods; thus making it is easy for researchers to construct panel data sets. The limitation of the survey is that information on financial and institutional features, such as keiretsu are not available and small firms with less than 50 workers (or with capital of less than 30 million yen) are excluded. The number of firms exceeds 20,000 annually. The questionnaire for the Survey consists of an "Outline of the company" (Table A1), "Business activity and employee" (Table A2), "Parent or Subsidiary Company" (Table A3), "Asset, Debt, Capital and Investment" (Table A4), "Description of Business" (Table A5), "Transaction" (Table A6), "Research and Development" (Table A7), and "Property and Transfer of Technology" (Table A8).

For analysis purposes, it might be better to extend the boundary of "firm", particularly in this paper, where our definition of a firm includes its wholly owned firms (subsidiaries). In Japan, manufacturing firms often relegate production activities to their subsidiaries. However, since the firm-level data in the BSJBSA is basically non-consolidated accounting, production activities by wholly or majority owned domestic affiliates are excluded from MNEs' productivity measurement[12]. Such

[11] The compilation of the micro data of the Census of Manufactures was conducted by a group of several researchers and members of the quantitative analysis database division at the Research Institute of Economy, Trade and Industry (RIETI): Kazushige Shimpo (Keio University), Kazuyuki Motohashi (The University of Tokyo), Toshiyuki Matsuura (Hitotsubashi University), Kyoji Fukao (Hitotsubashi University), Hyeog Ug Kwon (Nihon University), Mutsuharu Takahashi, and Tami Ohomori (RIETI). See also Motohashi (2002), Shimpo et al. (2004), Fukao et al. (2006) and Matsuura et al. (2007).

[12] According to Financial Statements prepared by Sony, domestic production of batteries,

exclusion might induce significant measurement error and lead to an incorrect observation. To address such an error, we extended the boundary of "firm" to include what is described above. We used the matching table between parent and subsidiary compiled by METI (2007). Note that this matching table is restricted to a public company and its majority owned subsidiary. This is because METI requests those subsidiaries whose parents are public companies to report the information on parent company. Thus, if parent company is not a public company, we cannot trace the relationship between parent company and its subsidiary. Using this matching table, we replaced 100%-owned firms' ID with parent firms' ID.

semiconductors and video cameras are operated by wholly owned affiliates.

Table A1 Outline of the company

(1) Name of Company			Telephone No.	
(2) Address of Headquarter				
(3) Capital or Investment of Fund	0101	Unit: Millions of Yen	Fill in the Foreign Capital Share.	Foreign Capital Share
(4) Legal Status and established year	0103	When were you established? ( )		

Table A2 Business activity and employee

(1) Number of Business Activity and Regular Employee

		# of Establishment	Regular Empl
Headquarter			
Administrative activity			
Survey and Planning	0201		
Information Technology	0202		
Research and Development	0203		
International Affair	0204		
Others (Administration, Accounting, and Personnel)	0205		
Total of Administrative Business Ⓐ	0206		
Business activity			
Mining	0207		
Manufacturing	0208		
Wholesale and Retail	0209		
Restaurant	0210		
Service Sector	0211		
Electricity and Gas Supply	0212		
Credit Card and Installment Finance Businesses	0213		
Information services	0214		
Language School, Cultural School, and Fitness Club	0215		
Other Business Activities	0216		
Total of Business Activity Ⓑ	0217		
Total (1) (Ⓐ + Ⓑ)	0218		

		# of Establishment	Regular Empl
Except for headquarter			
Mining	0219		
Manufacturing	0220		
Wholesale and Retail (store, branch of mining and	0221		
Restaurant	0222		
Service	0223		
Electricity and Gas Supply (except for manufacturing)	0224		
Laboratory	0225		
Information Services	0226		
Warehouse, Transportation, Delivery, etc	0227		
Credit Card and Installment Finance Businesses	0228		
Language School, Cultural School, and Fitness Club	0229		
Miscellaneous offices	0230		
Overseas Branches, Resident Offices	0231		
Total (2)	0232		
Loan Employees to Other Companies (3)	0233		
total (1)+(2)+(3)	0234		
In which Part-time Employees	0235		

(2) # of Other Workers

Division		# of
Temporary Staffs and Casual Workers	0236	
(Accepted) Dispatched Workers	0237	

Table A3 Parent or Subsidiary Company

(1) Holding of Subsidiary and Related Company

Shareholder Voting Right			Industry-classified Number	Number of Subsidiary and Related company				
				Domestic	Overseas	in which Asia	in which Europe	In which North America
Subsidiary	100%	0301						
	under 100%～over 50%	0302						
Related company	50% or less～20% or more	0303						

(2) Newly Established Subsidiary and Related Company

Fill in the number of subsidiaries and related companies which you have established or owned after April, 2005.

Division		Number of Newly Established (Owned)	
		Domestic	Overseas
Company Split-Up	0311		
Takeover of Company	0312		
Others (Other than those above)	0313		

(3) Name, Address, Type of Business and Rate of Shareholder Voting Right of Parent Company

Fill in the rate of shareholder voting right of parent company (, which possesses more than 50% of your company's voting right,) toward your company.

The rate of shareholder voting right of parent company toward your company ◎Fill in the figure up to the first decimal place.	0321	%
Fill in the securities code of parent company if the parent company is a listed company or a over-the-counter company.		
Name of Parent Company	Securities code 0322	
Address of Parent Company	Prefecture, city ◎Fill in the prefecture code if it is a domestic company. ◎Fill in the Country code if it is a overseas company.	0323
Business Sector of Parent Company	( ) ◎Fill the industry classification code.	

Table A4 Asset, Debt, Capital, and Investment

(1) Asset, Debt, and Capital

(Unit: Mill of Yen)

Asset			Debt and Capital		
Current Asset	0401		Current Debt	0410	
In which, Closing Inventory	0402		Capital Debt	0411	
Capital Asset	0403		Capital	0412	
Tangible Fixed Asset	0404				
In which, Machinery	0405		Profit Surplus	0414	
Intangible Fixed Asset	0406				
Investment and Other Assets	0407		**Total of Debt and Capital**	0416	
Deferred Asset	0408				
Total of Asset	0409				

(2) Investment to Related Company

(Unit: Mill of Yen)

Classification			
Domestic	Balance of Investment and Loan to Relat	0421	
	In which, Balance of Stock and Inves	0422	
	In which, Long-Term Loan	0423	
Overseas	Balance of Investment and Loan to Relat	0424	
	In which, Balance of Stock and Inves	0425	
	In which, Long-Term Loan	0426	

(3) Increase and Decrease of Tangible Fixed Asset

(Unit: Mill of Yen)

Classification		
Current Proceeds of Tangible Fixed Asset	0431	
In which, Machinery	0432	
Current Retirement Price of Tangible Fixed Asset	0433	

Table A5 Description of Business

(1) Sales Amount and Cost, etc.

(Unit: Mill of Yen)

Accounting Item		
Sales	0501	
Operating Cost	Sales Cost	0502
	Selling Expense and General Administration Cost	0503
Profit and Loss	Nonoperating Revenue	0504
	Nonoperating Expenditure	0505
Current Earnings (△Deficit)		0506
Current Net Earnings (△Deficit)		0507

(2) Subcontract Cost

Accounting Item	(Unit: Mill o		of which share of affiliated company(%)
Subcontract Cost	0508		

(3) Breakdown of Expenses (Special Notice)

(Unit: Mill of Yen)

Accounting Item		
Advertisement Expenses	0511	
Information Processing and Communication Expenses	0512	
Rent	0513	
In which, Lands and Buildings	0514	
Packing and Transportation Costs	0515	
ross Pay (Including Bonus and Retirement Bonus	0516	
Cost Depreciation	0517	
Tax and Dues	0518	
Interest Cost, etc.	0519	

(4) Lease Payment for Facilities used by Lease Contract

Accounting Item	(Unit: Mill of Yen)	
Lease Payment	0520	

Table A6 Transaction

(1) Sales and Purchase

Classification			Transaction Value	In which, Related Company
Sales	Total	0601		
	In which, Export	0602		
Purchase	Total	0603		
	In which, Import	0604		

(2) Direct Export and Import Value by Area

Area		Direct Export Value	Direct Import Value
Asia	0611		
Middle East	0612		
Europe	0613		
North America	0614		
Central and South America	0615		
Africa	0616		
Oceania	0617		
Total	0618		

(3) Direct Export and Import Value by Products

Product Classification		Direct Export Value	Direct Import Value
Food	0621		
Primary Material	0622		
Mineral Fuels	0623		
Chemical Products	0624		
Textile Products	0625		
Nonmetal and Mineral Products	0626		
Metal and its Products	0627		
General Machinery	0628		
Electrical Machinery	0629		
Transportation Equipment	0630		
Precision Instruments and Machinery	0631		
Other Products	0632		
Total	0633		

Table A7 Research and Development

Accounting Item			of which share of affilated company
Company-Owned Research and Development Cost	0801		
Consigned Research and Development Cost	0802		
Assigned Research Cost	0803		

Current Transaction Cost for Tangible Fixed Asset concerning R&D	0804	

Table A8 Property and Transaction of Technology

(1) Property and Use of Patent, etc.

Contents		Patent or Right in Possession (Item)	In which, those in Use (Item)	In which, those developed by Own Company (Item)
Patent	0901			
Model Utility Right	0902			
Design Right	0903			

(2) Transaction of Technology

Contents			Number of Items: Introduction	Number of Items: Donation	Amount of Payment	Amount Received
Patent	Domestic	0911				
	Overseas	0912				
Model Utility Right	Domestic	0913				
	Overseas	0914				
Design Right	Domestic	0915				
	Overseas	0916				
Copyright	Domestic	0917				
	Overseas	0918				
In which, Software	Domestic	0919				
	Overseas	0920				
Other Rights	Domestic	0921				
	Overseas	0922				

C) The Survey of Overseas Business and Activity

The Survey on Overseas Business and Activities (SOBA) is also the firm-level survey of the Ministry of Economy, Trade and Industry. The aim of this survey is to obtain basic information on the activities of foreign affiliates of Japanese firms. The survey covers all Japanese firms that have affiliates abroad. The survey consists of two parts. The first part is the Basic Survey which is more detailed and carried out once every three years. The second part is the Trend Survey which is comparatively rough and carried out in the years between the Basic Surveys. A foreign affiliate of a Japanese firm is defined as follows;

1. A foreign affiliate in which a Japanese corporation has invested capital of 10% or more
2. A foreign affiliate in which a "subsidiary", that is funded more than 50% by a Japanese corporation, has invested capital of more than 50%
3. A foreign affiliate in which a Japanese corporation and a subsidiary funded more than 50% by a Japanese corporation, have invested capital of more than 50%

Major items in the SOBA are establishment year, breakdown of sales and purchase, employment, cost, research and development, and so forth. For further information on the items in the SOBA, see "Survey Form for Oversea Affiliates" and "Guide for Completing the Survey".[13]

As of 2007, micro data sets for the SOBA are available between 1985 and 2003. Unfortunately there is no affiliate identification number in the SOBA. Therefore, we carried out the data linkage by using the information on affiliates location, name, establishment year, and so forth to construct the panel data set[14].

D) Development of linked-database

In this section, we report on our procedures for linking these three sources of data. At first, we linked plant data from the COM and firm data from the BSJBSA. Although both surveys are conducted by METI, each survey has its own respective firm identification (ID) codes, and there is no matching table between the codes in the COM and the codes in the BSJBSA. Therefore, we matched firms between the COM and the

[13] Downloadable from the METI web site:
http://www.meti.go.jp/english/statistics/tyo/kaigaizi/index.html.
[14] For details of the BSOBA panel dataset, see also Kiyota et al. (2008).

BSJBSA by referring to the firms' names, telephone numbers, and other information such as addresses. In addition, although firm ID numbers for the COM were available from 1994 to 2003, the firm ID numbers were drastically revised between 1996 and 1997. Thus, we needed to construct our own matching table by referencing the firm ID number to the number of continuing plants. Consequently, the result of the link between the COM and the BSJBSA seems to be good enough. The ratio of the number of matched plants data to the number of total manufacturing establishments reported in the BSJBSA is more than 95%.[15]

Next, the BSOBA was linked with the BSJBSA. First of all, since the METI revised parent firm codes every year for BSOBA 1995, we constructed a matching table for parent firm codes and the complete panel dataset. Second, based on the firms' information, we matched firms between the BSJBSA and the BSOBA. While the BSOBA covers almost all industries except for finance and insurance, the coverage of the BSJBSA is restricted to mining, manufacturing, wholesale and retail, and some service industries. Therefore, not all foreign affiliates in the BSOBA are linked with BSJBSA.

[15] Note that since the BSJBSA covers only firms with more than 50 employees and 30 million yen capital amounts, the establishments that belong to small enterprises, cannot be linked with firm-level data. The ratio of the number of matched plants to total number of plants in the COM is about 10%.

Appendix B. Construction of Variables in TFP Index

Output, intermediate input, labor input and deflator

The real value added is defined as real gross output minus real intermediate input. Real gross output is measured as the shipments deflated by the output deflator, and intermediate input as the cost of materials deflated by the input deflator. Labor input is measured by total number of employment multiplied by the spectral working hours from the System of National Accounts (Cabinet Office in Japan). The labor input is also employed in probit/multinominal logit as an independent variable. All output and input deflators are obtained from the JIP database 2006 (Fukao et al., 2006).

Capital stock

Following Fukao et al. (2006), we estimated capital stock with the nominal book values of tangible assets by multiplying the ratio of the net stock to the book value of industry-level capital. We used the same ratio as in Fukao et al. (2006).

Cost share

We need shares of labor cost, intermediate costs, and capital costs in total costs. Labor costs are defined as total salaries, and intermediate costs as the sum of raw materials, fuel, electricity and subcontracting expenses for consigned production. Capital costs are calculated by multiplying the real net capital stock with the user cost of capital, P_K. The latter is estimated as follows:

$$P_K = P_I\left(r_t + \delta - \dot{P}_I \Big/ P_I\right),$$

where P_I is the price of investment goods, r is the interest rate, and δ the depreciation rate. Data on the price of investment goods and the depreciation rate are calculated with the investment and capital stock matrix in the JIP database 2006.[16] Interest rates (10-year-bond yield) are from the Bank of Japan.

[16] The JIP database reports the investment and capital stock matrices for 108 industries and 39 types of assets. We calculated the weighted-average price index for the investment goods and the depreciation rate by industry.

Appendix C. Other Results

This appendix presents several additional results. First, we regressed for only firms with both downstream and upstream activities at home at time *t*-1 (Table C1). Second, we examined the impact on employment at home rather than on TFP (Table C2). Third, the impact on shipments at home is similarly examined (Table C3). In these tables, we used all available lagged observations of the predetermined variables. Fourth, we investigated the impact of FDI on TFP at home on the automobile sector (Tables C4-C7).

Table C1. Impact on TFP: Integrated Firms

	Level				Growth			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Dependent Var. $(t-1)$	0.806	0.797	0.788	0.785	-0.118	-0.127	-0.131	-0.130
	[24.29]***	[24.87]***	[23.15]***	[23.70]***	[-3.38]***	[-3.52]***	[-3.72]***	[-3.72]***
Dependent Var. $(t-2)$	0.112	0.111	0.108	0.111				
	[2.97]***	[2.97]***	[2.78]***	[2.91]***				
Dependent Var. $(t-3)$	0.100	0.099	0.098	0.092				
	[2.36]**	[2.57]**	[2.54]**	[2.52]**				
$FDI_{Developed}$ $(t-1)$			0.033	0.033			0.009	0.010
			[2.24]**	[2.41]**			[1.01]	[1.10]
FDI_{Others} $(t-1)$			0.026	0.026			0.012	0.010
			[1.34]	[1.34]			[0.75]	[0.64]
Horizontal $(t-1)$	-0.0004	-0.002			0.007	0.007		
	[-0.20]	[-1.18]			[1.02]	[0.95]		
Vetical $(t-1)$	0.004				0.002			
	[4.09]***				[2.74]***			
Upstream $(t-1)$		0.004				0.002		
		[4.94]***				[3.46]***		
Downstream $(t-1)$		0.027				-0.009		
		[1.58]				[-0.36]		
$Horizontal_{Asia}$ $(t-1)$			-0.048	-0.042			-0.007	0.005
			[-0.92]	[-0.83]			[-0.11]	[0.08]
$Vertical_{Asia}$ $(t-1)$			0.125				0.090	
			[2.04]**				[1.96]**	
$Upstream_{Asia}$ $(t-1)$				0.171				0.098
				[3.16]***				[1.98]**
$Downstream_{Asia}$ $(t-1)$				0.037				0.038
				[0.49]				[0.60]
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	3,949	3,949	3,949	3,949	4,553	4,553	4,553	4,553
No. Firms' Activities	701	701	701	701	793	793	793	793
Hansen *J* (p-value)	0.324	0.453	0.714	0.777	0.701	0.792	0.507	0.819
AR(2) (p-value)	0.268	0.328	0.359	0.347	0.028	0.067	0.072	0.073

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table C2. Impact on Employment at Home: Sophisticated Classification

	Level				Growth			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Dependent Var. $(t-1)$	0.962	0.963	0.963	0.964	-0.110	-0.107	-0.110	-0.111
	[304.21]***	[303.77]***	[305.47]***	[318.64]***	[-5.65]***	[-5.50]***	[-5.60]***	[-5.65]***
$FDI_{Developed}$ $(t-1)$			0.000	0.000			-0.001	-0.001
			[0.23]	[0.09]			[-0.59]	[-0.55]
FDI_{Others} $(t-1)$			0.007	0.007			0.003	0.004
			[0.97]	[1.06]			[0.28]	[0.35]
Horizontal $(t-1)$	0.092	0.090			-0.029	-0.023		
	[1.76]*	[1.70]*			[-0.65]	[-0.53]		
Vetical $(t-1)$	0.321				0.112			
	[3.49]***				[1.48]			
Upstream $(t-1)$		0.354				0.227		
		[2.59]***				[1.93]*		
Downstream $(t-1)$		0.178				-0.125		
		[2.04]**				[-1.51]		
$Horizontal_{Asia}$ $(t-1)$			0.045	0.032			-0.003	-0.017
			[0.77]	[0.56]			[-0.05]	[-0.32]
$Vertical_{Asia}$ $(t-1)$			0.360				0.066	
			[3.80]***				[0.75]	
$Upstream_{Asia}$ $(t-1)$				0.383				0.186
				[2.98]***				[1.41]
$Downstream_{Asia}$ $(t-1)$				0.207				-0.210
				[1.94]*				[-2.11]**
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	31,069	31,069	31,069	31,069	27,985	27,985	27,985	27,985
No. Firms' Activities	4,166	4,166	4,166	4,166	3,682	3,682	3,682	3,682
Hansen J (p-value)	0.071	0.989	0.990	1.000	0.320	1.000	1.000	1.000
AR(2) (p-value)	0.844	0.846	0.855	0.852	0.041	0.048	0.042	0.040

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table C3. Impact on Shipments at Home: Sophisticated Classification

	Level				Growth			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Dependent Var. (t-1)	0.980	0.980	0.980	0.980	-0.092	-0.089	-0.094	-0.095
	[587.37]***	[600.94]***	[610.31]***	[617.78]***	[-3.91]***	[-3.74]***	[-3.87]***	[-3.92]***
$FDI_{Developed}$ (t-1)			-0.001	-0.002			-0.002	-0.002
			[-0.56]	[-0.58]			[-1.15]	[-1.12]
FDI_{Others} (t-1)			0.029	0.029			0.023	0.023
			[1.84]*	[1.89]*			[1.73]*	[1.88]*
Horizontal (t-1)	0.109	0.107			-0.019	-0.014		
	[1.86]*	[1.75]*			[-0.38]	[-0.27]		
Vetical (t-1)	0.274				0.131			
	[3.00]***				[1.47]			
Upstream (t-1)		0.319				0.274		
		[2.10]**				[1.97]**		
Downstream (t-1)		0.108				-0.131		
		[1.13]				[-1.36]		
$Horizontal_{Asia}$ (t-1)			0.137	0.128			0.077	0.054
			[1.72]*	[1.66]*			[1.03]	[0.77]
$Vertical_{Asia}$ (t-1)			0.339				0.095	
			[3.48]***				[0.93]	
$Upstream_{Asia}$ (t-1)				0.411				0.298
				[3.11]***				[2.07]**
$Downstream_{Asia}$ (t-1)				0.098				-0.237
				[1.05]				[-2.47]**
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	31,069	31,069	31,069	31,069	27,985	27,985	27,985	27,985
No. Firms' Activities	4,166	4,166	4,166	4,166	3,682	3,682	3,682	3,682
Hansen J (p-value)	0.015	0.919	0.908	1.000	0.103	0.997	0.987	1.000
AR(2) (p-value)	0.355	0.354	0.360	0.356	0.338	0.380	0.323	0.317

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table C4. Comparison between Home and Abroad in 2000: Automobile Sector

		No Entry	Abroad	
			Downstream	Upstream
Home	Downstream	10 (10)	12 (12)	10 (9)
	Upstream	731 (748)	20 (14)	107 (85)

Source: The METI Survey

Notes: The numbers of firms with activities concerned only in East Asia are in parentheses. "No Entry" means non-MNEs (firms not investing in East Asia).

Table C5. Basic Statistics: Automobile Sector

	N	Mean	Sd	p10	p90
$\triangle TFP$	13,416	0.781	0.393	0.000	1.147
TFP	13,416	0.000	0.169	-0.138	0.130
$FDI_{Developed}$	13,416	0.285	14.757	0	0
FDI_{Others}	13,416	0.029	1.145	0	0
Horizontal	13,416	0.0	0.1	0	0
Vetical	13,416	0.011	0.132	0	0
Upstream	13,416	0.011	0.132	0	0
Downstream	13,416	0.000	0.005	0	0
$Horizontal_{Asia}$	13,416	0.018	0.086	0	0
$Vertical_{Asia}$	13,416	0.004	0.099	0	0
$Upstream_{Asia}$	13,416	0.004	0.099	0	0
$Downstream_{Asia}$	13,416	0.000	0.005	0	0

Table C6. Baseline Results of the Impact on TFP in Automobile Sector

	Level				Level				Growth			
	(I)	(II)	(III)	(IV)	(I)'	(II)'	(III)'	(IV)'	(V)	(VI)	(VII)	(VIII)
Dependent Var. (t-1)	0.891	0.889	0.899	0.899	0.721	0.719	0.722	0.723	-0.183	-0.193	-0.189	-0.189
	[47.67]***	[44.30]***	[49.36]***	[46.83]***	[28.80]***	[27.81]***	[27.95]***	[27.14]***	[-8.49]***	[-9.21]***	[-8.75]***	[-8.81]***
Dependent Var. (t-2)					0.178	0.181	0.176	0.176				
					[8.10]***	[8.25]***	[7.98]***	[7.94]***				
Dependent Var. (t-3)					0.115	0.115	0.116	0.115				
					[6.75]***	[6.77]***	[6.49]***	[6.68]***				
$FDI_{Developed}$ (t-1)			-0.0002	-0.0002			-0.001	-0.002			-0.001	-0.001
			[-0.33]	[-0.33]			[-1.77]*	[-1.94]*			[-1.61]	[-1.69]*
FDI_{Others} (t-1)			0.001	0.001			0.010	0.010			0.009	0.010
			[0.30]	[0.30]			[1.86]*	[2.05]**			[1.69]*	[1.77]*
Horizontal (t-1)	0.045	0.049			0.005	0.008			0.007	0.003		
	[2.38]**	[2.48]**			[0.40]	[0.60]			[0.50]	[0.24]		
Vetical (t-1)	0.004				0.007				0.006			
	[0.38]				[1.20]				[1.02]			
Upstream (t-1)		0.005				0.008				0.006		
		[0.42]				[1.25]				[1.06]		
Downstream (t-1)		0.405				-0.145				0.090		
		[1.68]*				[-0.60]				[0.40]		
$Horizontal_{Asia}$ (t-1)			0.040	0.048			-0.044	-0.038			-0.008	-0.006
			[1.66]*	[2.03]**			[-1.66]*	[-1.62]			[-0.30]	[-0.26]
$Vertical_{Asia}$ (t-1)			-0.005				0.012				0.009	
			[-0.36]				[1.39]				[0.98]	
$Upstream_{Asia}$ (t-1)				-0.005				0.012				0.008
				[-0.42]				[1.55]				[0.95]
$Downstream_{Asia}$ (t-1)				0.434				-0.184				0.020
				[0.68]				[-1.54]				[0.09]
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	13,416	13,416	13,416	13,416	10,871	10,871	10,871	10,871	12,071	12,071	12,071	12,071
No. Firms' Activities	1207	1207	1207	1207	1064	1064	1064	1064	1134	1134	1134	1134
Hansen J (p-value)	0.000	0.000	0.000	0.002	0.043	0.708	0.594	0.990	0.269	0.975	0.873	0.998
AR(2) (p-value)	0.000	0.000	0.000	0.000	0.446	0.479	0.414	0.418	0.164	0.092	0.128	0.126

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.

Table C7. Impact on TFP in Automobile Sector: the More Sophisticated Classification

	Level				Growth			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Dependent Var. (t-1)	0.726	0.744	0.726	0.724	-0.186	-0.184	-0.190	-0.190
	[28.49]***	[30.16]***	[27.45]***	[27.11]***	[-8.87]***	[-9.04]***	[-8.76]***	[-8.81]***
Dependent Var. (t-2)	0.181	0.166	0.174	0.175				
	[8.09]***	[7.56]***	[7.81]***	[7.83]***				
Dependent Var. (t-3)	0.100	0.101	0.114	0.114				
	[5.73]***	[5.96]***	[6.55]***	[6.50]***				
$FDI_{Developed}$ (t-1)			-0.002	-0.002			-0.002	-0.002
			[-2.07]**	[-2.15]**			[-1.91]*	[-1.92]*
FDI_{Others} (t-1)			0.011	0.011			0.011	0.011
			[2.18]**	[2.25]**			[2.00]**	[2.01]**
Horizontal (t-1)	0.015	0.008			-0.005	-0.001		
	[0.91]	[0.58]			[-0.36]	[-0.07]		
Vetical (t-1)	-0.006				0.010			
	[-0.16]				[0.34]			
Upstream (t-1)		0.001				0.006		
		[0.03]				[0.23]		
Downstream (t-1)		-0.080				-0.070		
		[-0.34]				[-0.38]		
$Horizontal_{Asia}$ (t-1)			-0.023	-0.025			-0.013	-0.010
			[-0.98]	[-1.00]			[-0.54]	[-0.43]
$Vertical_{Asia}$ (t-1)			-0.041				-0.014	
			[-0.85]				[-0.33]	
$Upstream_{Asia}$ (t-1)				-0.029				-0.023
				[-0.45]				[-0.63]
$Downstream_{Asia}$ (t-1)				-0.387				-0.275
				[-2.09]**				[-1.73]*
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	10,871	10,871	10,871	10,871	12,071	12,071	12,071	12,071
No. Firms' Activities	1,064	1,064	1,064	1,064	1,134	1,134	1,134	1,134
Hansen J (p-value)	0.311	0.972	0.670	0.991	0.716	0.999	0.747	0.995
AR(2) (p-value)	0.649	0.313	0.412	0.426	0.139	0.133	0.124	0.121

Notes: z-values are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively.