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Multinationals in the Services and Manufacturing Sectors: A firm-level analysis using Japanese data

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Abstract

Using Japanese firm-level data, I investigate multinational enterprises (MNEs) in the services and manufacturing sectors. I examine whether MNEs are more productive than non-MNEs in the services sector as they are in the manufacturing sector. I employ the Kolmogorov-Smirnov (KS) test to compare the overall distribution of productivity by internationalized status, after estimating the productivity premia of MNEs. The results indicate that MNEs are more productive than non-MNEs in the services sector as they are in the manufacturing sector and suggest that the standard firm heterogeneity model can well explain foreign direct investment (FDI) by firms in the services sector.

Keywords: services, firm heterogeneity, multinationals, exports, and foreign direct investment.
JEL Classification: F1; F23; L8

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1 Introduction

Multinational services firms such as McDonald's and Sheraton are establishing presence more aggressively in all over the world than ever before. However, little is known about MNEs in the services sector, while those in the manufacturing sector are subjects of many studies. Facing shrinking domestic market due to decreasing population, Japanese services firms as well as policy makers have begun to explore foreign markets. It is important to investigate the determinants of foreign engagement by services firms.

Several recent studies have discussed trade and foreign direct investment (FDI) in the services sector[*1]. Francois and Hoekman (2010) provided a comprehensive overview of internationalization in the services sector. Data on trade and FDI in the services sector is limited but has been increasing recently. Francois et al. (2009) have constructed a database on trade and FDI in the services sector. Using data on firm-level exports and imports from the United Kingdom, Breinlich and Criscuolo (2011) found several stylized facts for services traders and concluded that existing heterogeneous firm models[*2] for goods trading can be applied to services trading. In addition, Buch and Lipponer (2007) provided evidence that MNEs are more productive than exporters in the German banking industry. This evidence is consistent with the standard firm heterogeneity model of exports and FDI provided by Helpman et al. (2004). Ito (2007) surprisingly suggested that the standard firm heterogeneity model of exporting and FDI in manufacturing were better suited to services firms than manufacturing firms in Japan. She, however, underestimated firm heterogeneity since she analyzed large firms only.

The purpose of this study is to examine the relationship between firm productivity and foreign engagement in both the services and manufacturing sectors, using extensive firm-level data from Japan. The data is collected from a survey conducted by the Japanese Ministry of Economy, Trade, and Industry (METI).

[*1] Markusen (1989) is an earlier study of services in trade literature. While my study focuses on firm-level internationalization, several empirical studies employ aggregated data. Kimura and Lee (2006), Kolstad and Villanger (2008), and Ramasamy and Yeung (2010) examine the determinants of exports and FDI in services, using aggregated data.

[*2] Melitz (2003), Helpman et al. (2004), and Bernard et al. (2007b) are standard theoretical papers. Bernard et al. (2007a) provide a concise survey of recent studies.

2 Model

To explain the relationship between firm productivity and foreign engagement, I briefly describe a simple model that is based on a standard firm heterogeneity model of exporting and FDI by Helpman et al. (2004)[*3].

2.1 Setup

J countries are indexed by j, and S industries are indexed by s. For simplicity, I assume that both services and manufacturing industries are included in S. A continuum of heterogeneous firms produces differentiated goods in each country and sector. The preferences are identical everywhere and are given by a Cobb-Douglas aggregate over industry-specific CES consumption indices C_{js}:

$$u_j = \prod_s C_{js}^{\theta_s},\ C_{js} = \left[\int_{\omega \in \Omega_{js}} x_{js}(\omega)^{\alpha} \, d\omega \right]^{\frac{1}{\alpha}},\ 0 < \alpha < 1 \tag{1}$$

where $x_{js}(\omega)$ is the quantity of goods consumed, Ω_{js} is the set of goods available in industry s in country j, and the parameter α determines the elasticity of substitution across products, which is $\sigma = 1/(1-\alpha) > 1$. Parameter θ_s indicates the total expenditure share of each industry and satisfies $\sum_s \theta_s = 1$. Then, country j's demand for product in industry s is

$$x_{js}(\omega) = \frac{p_{js}(\omega)^{-\sigma} \theta_s Y_j}{P_{js}^{1-\sigma}}, \tag{2}$$

where Y_j is the gross national expenditure in country j, $p_{js}(\omega)$ is the price of good ω in industry s in country j, and P_{js} is the price index in industry s in country j, given by

$$P_{js} = \left[\int_{\omega \in \Omega_{js}} p_{js}(\omega)^{1-\sigma} \, d\omega \right]^{\frac{1}{1-\sigma}}. \tag{3}$$

Next, I temporarily consider a particular industry s and drop index s[*4]. Each firm is capable of producing a single good using a single input, labor,

[*3] I employ a simplified version of Helpman et al. (2004), as Yeaple (2009) did. My model and approach differ from those of Helpman et al. (2004) in several respects. First, my model is not closed by a free-entry condition. Second, I do not consider the full general equilibrium of the model. Rather, I present a partial-equilibrium analysis.

[*4] We omit description of the mechanism of how a firm chooses to enter an industry.

whose price in country j is w_j. Firms are heterogeneous in terms of their productivity φ.

After a firm observes a productivity draw from distribution $F(\varphi)$, it bears the fixed costs of domestic production f^D if it chooses to enter the domestic market. These are the costs of setting up production or services-providing facilities in the home country.

To serve foreign markets, manufacturing firms can choose either exporting their goods from the home country or FDI, that is, supplying their goods from foreign local plants, while services firms are assumed to only have the choice of FDI[*5]. In serving foreign markets, a manufacturing firm faces a proximity-concentration trade-off. If the firm chooses to export, it bears additional fixed costs f^X per foreign market, faces domestic labor costs i.e., wage w_h, and incurs an iceberg transport cost, $\tau_i^X > 1$. On the other hand, if it chooses to serve a foreign market by FDI, it bears additional fixed costs f^I in every foreign market. In this case, the firm may avoid transport costs and face a local labor cost w_i. A services firm also bears additional fixed costs f^I in every foreign market to serve a foreign market by FDI.

A firm from country h that sells its product will face the marginal costs of

$$c(\varphi) = \begin{cases} \frac{w_h}{\varphi} \text{ if it sells in home country } h, \\ \frac{\tau_i w_h}{\varphi} \text{ if it exports to a foreign country } i, \text{ and} \\ \frac{w_i}{\varphi} \text{ if it produces in a foreign country } i. \end{cases} \tag{4}$$

Services firms cannot choose to export since τ is assumed to be prohibitively high for them.

A firm facing a demand curve (2) will optimally charge a price $p(\varphi) = c(\varphi)/\alpha$. The profit from the domestic market is

$$\pi^D = (w_h)^{1-\sigma} A_h \varphi^{\sigma-1} - f^D, \tag{5}$$

where $A_h = (1-\alpha)\alpha^{\sigma-1}\theta Y_h P_h^{\sigma-1}$ is the markup-adjusted demand level in an industry and country h. We regard $\varphi^{\sigma-1}$ as the productivity index, since $\sigma > 1$.

2.2 Cut-offs

Setting $\pi^D = 0$, I define the entry cut-off for domestic production as

$$\varphi^D = \left(\frac{f^D}{(w_h)^{1-\sigma} A_h} \right)^{\frac{1}{\sigma-1}}. \tag{6}$$

[*5]I do not include the case of exporting by services firms because my dataset does not contain services exports.

Firms with productivity below this cut-off ($\varphi < \varphi^D$) do not enter the industry, but firms with productivity above the cut-off ($\varphi \geq \varphi^D$) enter the industry and sell their products in their home countries.

Similarly, the additional profit from exports to country i is

$$\pi^X = (\tau_i w_h)^{1-\sigma} A_i \varphi^{\sigma-1} - f^X, \tag{7}$$

and the additional profit from FDI in country i is

$$\pi^I = (w_i)^{1-\sigma} A_i \varphi^{\sigma-1} - f^I. \tag{8}$$

Setting $\pi^X = 0$, I define the export cut-off as

$$\varphi^X = \left[\frac{f^X}{(\tau_i w_h)^{1-\sigma} A_i} \right]^{\frac{1}{\sigma-1}}. \tag{9}$$

None of the services firms can exceed the export cut-off since the cut-off is significantly high enough for them. I also define the FDI cut-off for manufacturing firms as

$$\varphi^{I,M} = \left[\frac{f^I - f^X}{A_i \left[w_i^{1-\sigma} - (\tau_i w_h)^{1-\sigma} \right]} \right]^{\frac{1}{\sigma-1}}, \tag{10}$$

where setting $\pi^X = \pi^I$. Following Helpman et al. (2004), for manufacturing firms, I assume $\left(\frac{w_i}{w_h}\right)^{\sigma-1} f^I > \tau_i^{\sigma-1} f^X > f^D$, which ensure $\varphi^D < \varphi^X < \varphi^{I,M}$ if $A_h = A_i$.

On the other hand, for services firms, I define the FDI cut-off as

$$\varphi^{I,S} = \left[\frac{f^I}{A_i w_i^{1-\sigma}} \right]^{\frac{1}{\sigma-1}}, \tag{11}$$

which is from $\pi^I > 0$. For services firms, I assume $\left(\frac{w_i}{w_h}\right)^{\sigma-1} f^I > f^D$ in order to ensure $\varphi^D < \varphi^{I,S}$ if $A_h = A_i$.

The optimal strategy of internationalization in an industry depends on each firm's productivity as shown in Figure 1. First, manufacturing firms with productivity levels between entry and export cut-offs ($\varphi \in (\varphi^D, \varphi^X)$) supply their products to domestic markets only, withour exporting or conducting FDI. These firms are "purely domestic." Second, manufacturing firms with productivity levels between the export cut-off and FDI cut-off ($\varphi \in (\varphi^X, \varphi^{I,M})$) are "exporters," who supply their products to domestic

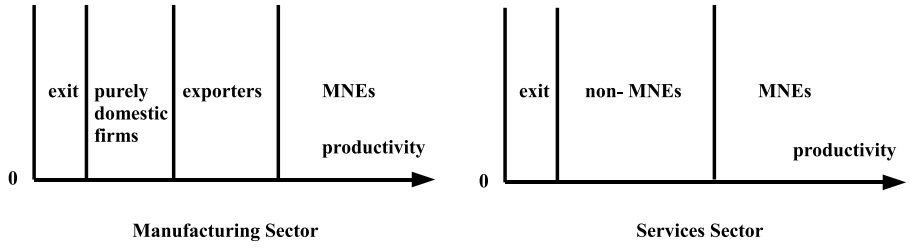

Figure 1: productivity ordering

markets and export them to foreign markets. Firms with productivity levels above the FDI cut-off ($\varphi > \varphi^{I,M}$) are "MNEs," who invest in a foreign country. Therefore, exporters are more productive than purely domestic firms, and MNEs, in turn, are more productive than exporters.

Similarly, services firms with productivity levels between the entry cut-off and FDI cut-off ($\varphi \in (\varphi^D, \varphi^{I,S})$) supply their products to domestic markets only and do not conduct FDI. These firms are purely domestic, non-MNEs. Moreover, firms with productivity levels above the FDI cut-off ($\varphi > \varphi^{I,S}$) are MNEs. In both services and manufacturing sectors, MNEs are the most productive and purely domestic firms are the least productive.

3 Data and preliminary results

3.1 Data

This section provides some basic facts about Japanese MNEs. I use firm-level data from the Basic Survey of Japanese Business Structure and Activities (BSJBSA) by the METI. In this study, I refer to this survey as "the METI survey." The survey covers both manufacturing and non-manufacturing industries. The targets of the METI survey are firms with more than 50 employees and more than 30 million yen in capital. The survey, therefore, excludes small firms. Nevertheless, it is the most comprehensive for my study among the surveys currently available in Japan, and it has been used by many studies including Nishimura et al. (2005), Kimura and Kiyota (2006), and Wakasugi et al.(2008). A more detailed explanation is provided in the Appendix 1.

Table 1 presents the distribution of Japanese firms in the data across three sectors: (i) agriculture and related industries, (ii) manufacturing, and (iii) services. The number of firms in the whole sample is 29,355 for the

Table 1: Distribution of firms (Japan, 2008)

	Agriculture and related industries	Manufacturing	Services	Total
Number of firms	51	13,624	15,680	29,355
share of each sector	0.2%	46.4%	53.4%	100.0%
fraction of firms				
with domestic affiliates	49.0%	36.6%	36.7%	36.7%
with foreign affiliates	9.8%	23.7%	10.5%	16.6%
in North America	x	9.3%	3.4%	6.1%
in Europe	x	5.3%	1.8%	3.4%
in Asia	x	21.4%	9.1%	14.8%
in other region	x	2.5%	1.0%	1.7%

Note: Figures for less than four firms are replaced by "x."

year 2008, the latest year in our data. The manufacturing sector accounts for 46.4% of it, while the services sector accounts for 53.4%. The share of agriculture and related industries accounts for only 0.2%. I, therefore, restrict my analysis to the manufacturing and services sectors. Table 2 provides a list of industries in both sectors.

Table 1 also reveals that in the sample, the fraction of MNEs in the services sector, which is only 10.5%, is much lower than that in the manufacturing sector, 36.6%. The *Establishment and Enterprise Census 2006*[*6] also shows that the fraction of MNEs in the services sector is lower than that in the manufacturing sector. In the sample, the fraction of MNEs in the services sector is lower than that in manufacturing sector in all four host regions: North America, Europe, Asia, and other region[*7]. The most popular destination is Asia for both manufacturing and services sectors with the fraction of MNEs investing in this region being 21.4% and 9.1%, respectively. The second most popular destination is North America again for both sectors, followed by Europe. The fraction of MNEs investing in these two regions is less than 10% for both sectors, which indicates that Asia is clearly the most popular destination.

Table 2 provides the list of industries with the number of firms and the fractions of exporters and MNEs in my data. The fraction of MNEs varies across industries within sector. The publishing and printing industry, for

[*6]This census is conducted by the Japanese Ministry of Internal Affairs and Communications.

[*7]Middle East, Central and South America, Africa, and Oceania are classified as "other regions" in the METI survey.

example, has a much smaller fraction of MNEs than other manufacturing industries, while the wholesale trade industry has a much larger fraction of MNEs than other services industries[*8].

3.2 The measurement of firm productivity

This section explains the measure of total factor productivity (TFP) used later in this study. I obtain Japanese parent firms' TFP from an estimated two-digit industry-specific production function, using Levinsohn and Petrin (2003) techniques. I use transportation and package costs to proxy unobserved productivity shocks[*9]. For output, I use Japanese parent firms' real value added, which is deflated using an industry-level deflator. The value added in my data reflects parent firms' domestic and export sales but not foreign affiliates' sales in host countries. I employ Japanese parent firms' hours worked (L)[*10] and fixed tangible assets (K), as inputs.

Following Arnold and Hussinger (2010), I use the relative TFP obtained by dividing the TFP estimates by the average TFP in the respective industry and year, since I compare the TFP for various industries.

3.3 Premia

I examine the difference between non-MNEs and MNEs in terms of several firm characteristics. First, I present a graph comparing firm productivity by sector and internationalized status. Then, I estimate the premia of MNEs by ordinary least squares (OLS), following many previous studies such as Bernard and Jensen (1999).

Figure 2 presents the average productivity of non-MNEs and MNEs by sectors. Figure 2 shows that on average, MNEs are more productive than non-MNEs in both the manufacturing and services sectors. This fact suggests that productivity is important for firms when considering investing abroad even in the services sector, and that the standard firm heterogeneity model can well explain FDI in the services sector. Figure 2 also shows that the average productivity of both non-MNEs and MNEs in the manufacturing sector is higher than their counterparts in the services sector. As a whole, Figure 2 shows that firms in the services sector are less productive than

[*8] Although this study does not investigate the reason why the fraction varies across industries, Tanaka (2011) shows that firm heterogeneity and R&D play an important role in the substantial variation of fraction of MNEs in the Japanese manufacturing sector.

[*9] My data does not contain materials or fuels.

[*10] Unlike previous studies, I use hours worked as labor rather than the number of workers. Appendix 1 provides more detailed explanation.

Table 2: List of industries (Japan, 2008)

Industry code	description	N. of firms	fraction of exporters	fraction of MNEs
Agriculture and related industries				
1–3	agriculture, forestry, and fishing	14	0.000	0.000
4	mining	37	0.027	0.135
Manufacturing				
5	food products and beverages	1704	0.101	0.100
6	textiles	258	0.240	0.209
7	wearing apparel	282	0.181	0.209
8	wood and products of wood	143	0.091	0.105
9	furniture	139	0.187	0.194
10	paper and paper products	397	0.149	0.139
11	publishing, printing	844	0.064	0.070
12	leather	34	0.324	0.176
13	rubber products	156	0.436	0.327
14	chemicals and chemical products	941	0.527	0.324
15	coke, refined petroleum and plastics products	809	0.314	0.269
16	other non-metallic mineral products	468	0.250	0.152
17	basic iron and steel	439	0.207	0.166
18	non-ferrous metals	350	0.394	0.294
19	fabricated metal products	1025	0.270	0.228
20	machinery and equipment	1709	0.518	0.304
21	electrical machinery and apparatus	1954	0.404	0.292
22	motor vehicles	1256	0.331	0.340
23	precision instruments	333	0.619	0.309
24	other manufacturing industries	383	0.449	0.295
Services				
25	construction	376	0.098	0.072
26	electricity, gas and water supply	123	0.016	0.114
27	wholesale trade	5728	0.247	0.165
28	retail trade	3522	0.029	0.043
29	finance and insurance	86	0.000	0.058
30	real estate	56	0.036	0.089
31	transport	133	0.015	0.098
32	telecommunications	53	0.000	0.113
33	education, health, and research	119	0.092	0.092
34	business services	2493	0.053	0.087
35	personal service activities	2991	0.027	0.085
	Total	29355	0.209	0.166

Note: Exporters includes MNE exporters.

those in manufacturing, but greater heterogeneity exists within the services sector as in the manufacturing sector, that is, MNEs in services are more productive than non-MNEs.

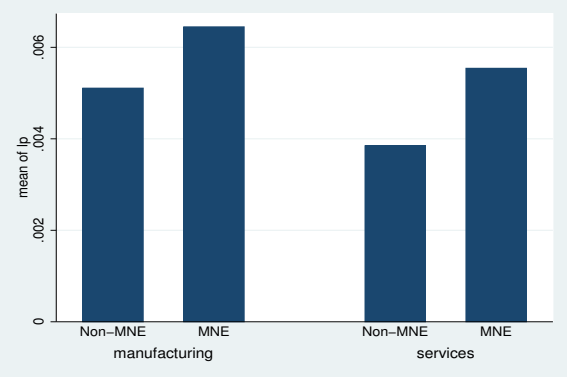

Figure 2: Mean of labor productivity

Note: The data are for Japanese firms in 2008. The graph displays the mean level of labor productivity for MNEs and non-MNEs.

Data Source: The Ministry of Economy, Trade, and Industry (METI), the Basic Survey of Japanese Business Structure and Activities.

Next, I estimate the premia of MNEs and services firms, using the estimation equation used in Bernard et al. (2010a). I regress labor productivity and other firm characteristics (Z_i) on dummy variables. Appendix 1 explains variables in more detail. I employ the following specification:

$$\ln Z_i = \alpha + \beta_1 D_i^S + \beta_2 MNE_i + \beta_3 (D_i^S \cdot MNE_i) + \epsilon_i, \tag{12}$$

where Z_i denotes firm characteristics[*11], D_i^S and MNE_i are dummies for services firms and current MNE status respectively, and ϵ_i is an error term. Equation (12) can be rewritten as

$$\ln Z_i = \begin{cases} \alpha + \epsilon_i \text{ for non-MNEs in manufacturing sector,} \\ \alpha + \beta_2 + \epsilon_i \text{ for MNEs in manufacturing sector,} \\ \alpha + \beta_1 + \epsilon_i \text{ for non-MNEs in services sector, and} \\ \alpha + \beta_1 + \beta_2 + \beta_3 + \epsilon_i \text{ for MNEs in services sector.} \end{cases} \tag{13}$$

[*11]As firm characteristics, I use labor productivity, R&D intensity, sales, labor, capital intensity, intangible asset intensity, foreign share, and non-regular ratio. Labor productivity, sales, labor, capital intensity, and intangible asset intensity are in logarithms.

Table 3: Premia (1): Japan, 2008

	(1) ln labor productivity	(2) R&D/sales	(3) ln sales	(4) ln L
D^S	-0.259*	-0.003**	0.144	0.199
	[0.140]	[0.001]	[0.272]	[0.136]
MNE	0.233***	0.011***	1.316***	0.934***
	[0.057]	[0.002]	[0.085]	[0.061]
$MNE \cdot D^S$	0.050	-0.007***	-0.069	-0.295*
	[0.064]	[0.002]	[0.119]	[0.163]
Observations	29124	29304	29304	29304
R-squared	0.069	0.025	0.116	0.092

Notes: Standard errors are shown in brackets. Constants are suppressed. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

The result in Figure 2 suggests that $\beta_1 < 0$ and $\beta_2 > 0$ in the regression of labor productivity but cannot predict the sign of β_3, which shows the difference between MNEs in services and manufacturing sectors.

Tables 3 and 4 report the results of (12)[*12]. First, the MNE premia, β_2, are positive and significant for every characteristic except the ratio of non-regular to total labor. The largest premia are found in sales, 1.316 log points, followed by labor, 0.934 log points (2.54). MNEs are, therefore, 3.73 times ($\exp(1.316) \approx 3.73$) larger than non-MNEs in terms of sales and 2.54 times larger in terms of labor. These results indicate that MNEs are on average far larger than non-MNEs. In addition, column (1) presents positive MNE premia in labor productivity. This result supports the model's prediction that MNEs are more productive than non-MNEs in both the services and manufacturing sectors.

Second, the services premia, β_1, are negative and significant in labor productivity, R&D intensity, and capital intensity, while the services premium is significantly positive in intangible asset intensity.

Finally, the coefficient of interaction term of MNEs and services dummies are negatively significant in R&D intensity and labor, while positively significant in intangible assets intensity. The results suggest that differences between services and manufacturing MNEs exist in R&D intensity,

[*12]The results controlling for firm size (L) are qualitatively similar with the results in Tables 3 and 4.

Table 4: Premia (2): Japan, 2008

	(1) ln K/L	(2) ln intangible assets/L	(3) foreign share	(4) non-regular L/L
D^S	-1.071***	0.321***	-0.001	0.058
	[0.278]	[0.093]	[0.007]	[0.050]
MNE	0.460***	0.709***	0.091***	-0.022
	[0.060]	[0.098]	[0.010]	[0.019]
$MNE \cdot D^S$	-0.180	0.196*	-0.009	-0.035
	[0.158]	[0.113]	[0.021]	[0.024]
Observations	28977	26625	29259	29304
R-squared	0.124	0.04	0.028	0.025

Notes: Standard errors are shown in brackets. Constants are suppressed. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

intangible asset intensity, and labor, although my model does not provide explanation of these results. In addition, the MNE premia in the services sector in terms of labor productivity is not significantly different from that in the manufacturing sector. This suggests that labor productivity is not the major reason for the lower fraction of MNEs in the services sector, compared with the manufacturing sector.

4 Empirical strategy: Kolmogorov-Smirnov test

This study adopts the nonparametric one-sided and two-sided Kolmogorov-Smirnov (KS) tests[*13] to examine the relationship between firm productivity and foreign engagement, following previous studies such as Girma et al. (2004) and Arnold and Hussinger (2010). These tests allow to compare and rank the distributions of measures of firm performance, based on the concept of first order stochastic dominance. Following Delgado et al. (2001), many studies in trade literature have employed KS tests. The KS test is a stricter test of productivity differences than just comparing mean levels of productivity, since it considers all moments of the distribution.

Let $F_1(\varphi)$ and $F_2(\varphi)$ denote two cumulative distribution functions (CDF) for two comparison groups. The first-order stochastic dominance of $F_1(\varphi)$

[*13]The Kolmogorov-Smirnov (KS) test can be implemented by the command, "ksmirnov" in Stata. I thank Yasuyuki Todo and Jens M. Arnold for providing me this information.

relative to $F_2(\varphi)$ is defined as $F_1(\varphi) - F_2(\varphi) \leq 0$ uniformly in $\varphi \in \mathbb{R}$, with strict inequality for some φ. Graphically, this implies that $F_1(\varphi)$ lies entirely to the right (higher-productivity side) of $F_2(\varphi)$.

First, by the two-sided KS statistic, I test the hypothesis that $F_1(\varphi)$ and $F_2(\varphi)$ are identical. The null and alternative hypotheses can be expressed as

$$\begin{aligned} H_0 &: F_1(\varphi) - F_2(\varphi) = 0 \quad \text{for all } \varphi \in \mathbb{R} \\ \text{vs.} \quad H_1 &: F_1(\varphi) - F_2(\varphi) \neq 0 \quad \text{for some } \varphi \in \mathbb{R}. \end{aligned} \tag{14}$$

Second, the one-sided KS test examines the following hypotheses:

$$\begin{aligned} H_0 &: F_1(\varphi) - F_2(\varphi) \leq 0 \quad \text{for all } \varphi \in \mathbb{R} \\ \text{vs.} \quad H_1 &: F_1(\varphi) - F_2(\varphi) > 0 \quad \text{for some } \varphi \in \mathbb{R}. \end{aligned} \tag{15}$$

If I can reject the null hypothesis for the two-sided test, but not for the one-sided test, I can conclude that $F_1(\varphi)$ stochastically dominates $F_2(\varphi)$.

The KS test statistics for the two-sided test is given by

$$KS_2 = \sqrt{\frac{nm}{N}} \max_{1 \leq i \leq N} |F_{1,n}(\varphi_i) - F_{2,m}(\varphi_i)|, \tag{16}$$

where n and m are the sample sizes from the empirical distributions of $F_1(\varphi)$ and $F_2(\varphi)$, respectively, and $N = n + m$. The KS test statistics for the one-sided test is

$$KS_1 = \sqrt{\frac{nm}{N}} \max_{1 \leq i \leq N} \{F_{1,n}(\varphi_i) - F_{2,m}(\varphi_i)\}. \tag{17}$$

The limiting distributions of both test statistics are known under the assumption of independently drawn samples as described in Darling (1957)[*14]. Following previous studies such as Delgado et al. (2002), I test the hypothesis separately for each year from 2001 to 2008, since the independence assumption is likely to be violated if I use pooled observations from several years for the KS test.

[*14] Smirnov (1939) proposed these statistics. Kolmogorov (1933) and Smirnov (1939) showed that under the assumption that all the observations are independent, the limiting distribution of KS_2 is given by

$$\lim_{n \to \infty} P(KS_2 > \upsilon) = -2 \sum_{k=1}^{\infty} (-1)^k \exp(-2k^2 \upsilon^2)$$

and that of KS_1 is given by

$$\lim_{n \to \infty} P(KS_1 > \upsilon) = \exp(-2\upsilon^2)$$

under H_0.

5 Results

Using the KS tests[*15], this section examines whether exporters are more productive than purely domestic firms in the manufacturing sector and whether MNEs are more productive than non-MNEs in both manufacturing and services sectors.

5.1 Manufacturing sector

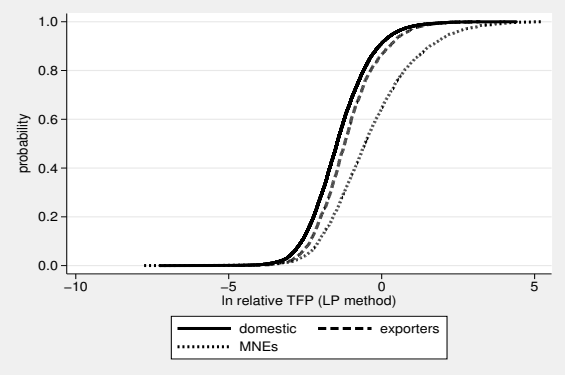

Figure 3: Internationalized status and CDF of productivity in the manufacturing sector

Note: The data are for Japanese firms in 2008.

Data Source: The Ministry of Economy, Trade, and Industry (METI), the Basic Survey of Japanese Business Structure and Activities.

I first examine productivity ordering in the manufacturing sector and then in the services sector. Figure 3 presents the CDF of the relative TFP by each firm type in the manufacturing sector. The TFP distribution of purely domestic firms lies entirely to the left (lower-productivity) side of that of MNEs. The distribution of non-MNE exporters lies between the distribution of purely domestic firms and that of MNEs. These support the theoretical prediction of productivity ranking.

I further examine the productivity ranking by the KS tests. Table 5 shows the results of KS tests with the number of each firm type. First,

[*15]Following Wakasugi et al. (2008), I have conducted statistical tests because, while the METI survey is a compulsory survey, its response rate is around 80%. I have also confirmed the results by examining graphs of the CDFs.

Table 5: Kolmogorov-Smirnov tests statistics for manufacturing

	Purely domestic firms vs. Non-MNE exporters			
	N. of firms		Statistic	
year	D	X	Two-sided H_0: equality	One-sided H_0: D < X
2001	8921	1898	0.113	-0.001
	(66.2)	(14.1)	[0.000]	[0.994]
2002	8561	1885	0.092	-0.001
	(65.1)	(14.3)	[0.000]	[0.999]
2003	8103	1799	0.095	0.000
	(64.0)	(14.2)	[0.000]	[1.000]
2004	8494	1921	0.101	-0.001
	(63.0)	(14.3)	[0.000]	[0.998]
2005	8228	1873	0.113	-0.001
	(62.3)	(14.2)	[0.000]	[0.999]
2006	8061	1877	0.108	0.000
	(62.1)	(14.5)	[0.000]	[1.000]
2007	8444	1943	0.106	0.000
	(62.2)	(14.3)	[0.000]	[1.000]
2008	8468	1922	0.115	-0.001
	(62.2)	(14.1)	[0.000]	[0.998]

Notes: KS tests for purely domestic firms (D) vs. non-MNE exporters (X). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

column 3 of Table 5 presents the result of two-sided KS test for the equality of the distributions between purely domestic firms and non-MNE exporters. Asymptotic p-values are almost zero for all years, and I can reject the null hypothesis, that is, the equality of the distributions.

Second, column 4 of Table 5 presents the results of one-sided test. The null hypothesis is that the productivity distribution of non-MNE exporters stochastically dominates the productivity distribution of purely domestic firms. I cannot reject the null hypothesis at any reasonable significance level for all years. From both the two- and one- sided KS tests, I can conclude that non-MNE exporters are more productive than purely domestic firms as predicted by the theory.

Next, I examine whether the productivity distribution of MNEs stochastically dominates that of non-MNE exporters. If MNEs are more productive than non-MNE exporters, I can conclude that by transitivity, MNEs are more productive than purely domestic firms, and therefore, they are the most productive among the three firm types.

Table 6: KS tests statistics for manufacturing

	Non-MNE exporters vs. MNEs			
	N. of firms		Statistic	
			Two-sided	One-sided
year	X	I	H_0: equality	H_0: X < I
2001	1898	2651	0.292	0.000
	(14.1)	(19.7)	[0.000]	[1.000]
2002	1885	2712	0.296	-0.001
	(14.3)	(20.6)	[0.000]	[0.995]
2003	1799	2758	0.301	0.000
	(14.2)	(21.8)	[0.000]	[1.000]
2004	1921	3057	0.268	-0.001
	(14.3)	(22.7)	[0.000]	[0.998]
2005	1873	3106	0.257	0.000
	(14.2)	(23.5)	[0.000]	[1.000]
2006	1877	3034	0.259	-0.001
	(14.5)	(23.4)	[0.000]	[0.996]
2007	1943	3186	0.260	-0.001
	(14.3)	(23.5)	[0.000]	[0.998]
2008	1922	3234	0.257	-0.003
	(14.1)	(23.7)	[0.000]	[0.977]

Notes: KS tests for non-MNE exporters (X) vs MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

The results for the two- and one-sided tests are shown in columns 3 and 4 of Table 6. First, I can reject the null hypothesis for the equality of distributions between non-MNE exporters and MNEs for all years. Second, I can not reject the null hypothesis that productivity distribution of MNEs stochastically dominates that of non-MNE exporters. These two results indicate that MNEs outperform non-MNE exporters over the entire productivity distributions.

The above results in Tables 5 and 6 support the theoretical prediction that exporters and MNEs are more productive than purely domestic firms and that MNEs are the most productive among them.

5.2 Services sector

Next, I examine the theoretical prediction that MNEs are more productive than non-MNEs even in the services sector, using the same methodology. Figure 4 presents the TFP distributions for the year 2008 for both MNEs and non-MNEs. The graph supports the theoretical prediction on productivity ranking. The CDF of MNEs lies entirely to the right of the one

corresponding to non-MNEs.

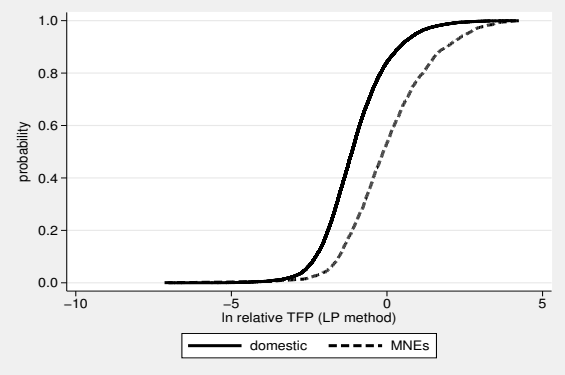

Figure 4: Internationalized status and CDF of productivity in the services sector

Note: The data are for Japanese firms in 2008.

Data Source: The Ministry of Economy, Trade, and Industry (METI), the Basic Survey of Japanese Business Structure and Activities.

Table 7 confirms the theoretical prediction more formally. Column 3 of Table 7 presents the results of the two-sided KS tests, which test the null hypothesis for the equality of distributions between non-MNEs and MNEs. The null hypothesis is rejected at 1% significance level for all years. From the result in column 4 of Table 7, I cannot reject the null hypothesis that the productivity distribution of MNEs stochastically dominates that of non-MNEs. I, therefore, can conclude that MNEs are more productive than non-MNEs even in the services sector.

6 Number of FDI destinations

This section examines the relationship between the number of FDI destinations and firm productivity. As shown in Yeaple (2009), the firm heterogeneity model based on Helpman et al. (2004) predicts a "pecking order" such that firms with higher productivity have their affiliates in a larger number of countries, while less productive firms invest in a smaller number of countries. In other words, firms with higher productivity can enter even less attractive countries because their productivity will exceed the cut-off productivity for a larger number of countries, while less productive firms can enter more attractive countries only.

Table 7: KS tests statistics for services

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
year	N	I	Two-sided H_0: equality	One-sided H_0: N < I
2001	13334	1275	0.403	0.000
	(91.3)	(08.7)	[0.000]	[1.000]
2002	12998	1324	0.388	0.000
	(90.8)	(09.2)	[0.000]	[1.000]
2003	12569	1346	0.396	0.000
	(90.3)	(09.7)	[0.000]	[1.000]
2004	13296	1522	0.380	0.000
	(89.7)	(10.3)	[0.000]	[1.000]
2005	12928	1488	0.358	0.000
	(89.7)	(10.3)	[0.000]	[1.000]
2006	13388	1503	0.360	0.000
	(89.9)	(10.1)	[0.000]	[1.000]
2007	13862	1596	0.355	0.000
	(89.7)	(10.3)	[0.000]	[1.000]
2008	14035	1645	0.354	-0.003
	(89.5)	(10.5)	[0.000]	[0.978]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

The METI survey asks a firm whether it has a subsidiary in the following four foreign regions: Asia, North America, Europe, and other regions. Therefore, the number of FDI destinations vary across firms from zero to four in our data[*16]. The majority of firms do not have their foreign subsidiaries. For these non-MNEs, the number of FDI destinations is zero. Among MNEs, one-region MNEs, i.e., MNEs with subsidiaries in one foreign region, are the majority. Four-region MNEs, i.e., MNEs with subsidiaries in four foreign regions, are a minority.

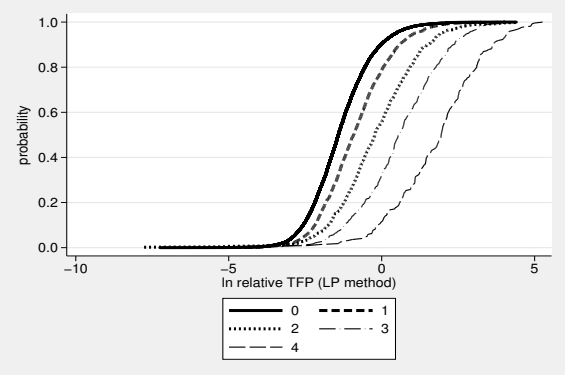

Figure 5: The number of FDI Destinations and CDF of productivity in the manufacturing sector

Note: The data are for Japanese firms in 2008.

Data Source: The Ministry of Economy, Trade, and Industry (METI), the Basic Survey of Japanese Business Structure and Activities.

Figure 5 and 6 present the TFP distribution by the number of FDI destinations in the manufacturing and services sectors, respectively, for the year 2008. Both figures show that the more destinations firms invest in, the higher-productivity ranges they are distributed over. The TFP distribution of non-MNEs is located on the left side of that of MNEs. The distribution of four-region MNEs are located on the right side of those of the other types of MNEs. These results are consistent with the theoretical prediction that the most productive firms can enter even the least attractive foreign regions, while the less productive firms can enter more attractive regions only. The results from the KS tests also confirm the theoretical prediction[*17].

[*16] Appendix 2 provides the number and share of each MNE type.

[*17] The results are shown in Table 9–12 of Appendix 2.

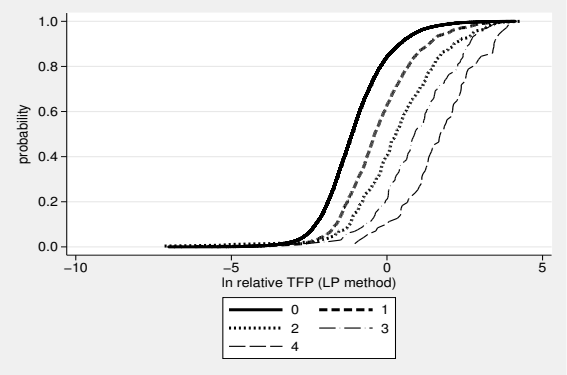

Figure 6: The number of FDI Destinations and CDF of productivity in the services sector

Note: The data are for Japanese firms in 2008.

Data Source: The Ministry of Economy, Trade, and Industry (METI), the Basic Survey of Japanese Business Structure and Activities.

7 Robustness check

This section conducts a number of robustness checks. First, this section focuses on a more narrowly defined services sector, while the above analysis employs a broader definition. In the above analysis, the services sector includes not only pure services industries but also wholesale and retail industries as shown in Table 2. I focus on data on the personal services activities industry, since firms in this industry are assumed to provide direct services to foreign consumers[*18]. Figure 7 presents the CDF of productivity by MNE status in the personal services industry and supports the model's prediction that MNEs are more productive than non-MNEs.

I also conduct the KS tests to examine whether MNEs are more productive than non-MNEs in the personal services industry. The results are shown in Table 8. I can reject the null hypothesis of the two-sided tests but cannot reject that of the one-sided tests at conventional levels for all years. These results are consistent with the theory and the previous results.

[*18]Appendix 3 provides the results from the other five services industries. Almost all results are consistent with the model's prediction. I exclude three industries, that is, construction (25), real estate (30), and transport (31), since these industries are not primary targets of the METI survey, and since only firms with sales in the industry targeted by the survey are included in the survey. I also exclude two industries with small

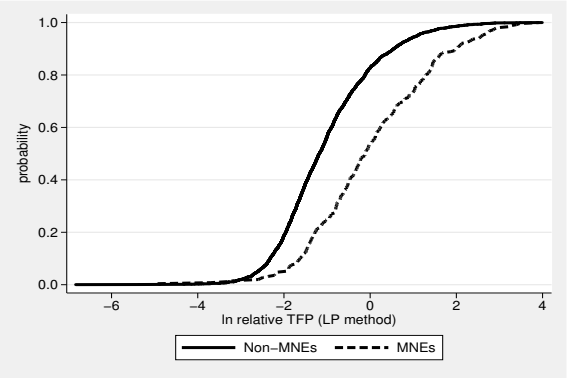

Figure 7: Internationalized status and CDF of productivity in the personal services industry

Note: The data are for Japanese firms in 2008.

Data Source: The Ministry of Economy, Trade, and Industry (METI), the Basic Survey of Japanese Business Structure and Activities.

Table 8: KS tests statistics for personal services

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	H_0: N < I
2001	2334	148	0.468	-0.002
	(94.0)	(06.0)	[0.000]	[0.998]
2002	2308	170	0.413	-0.004
	(93.1)	(06.9)	[0.000]	[0.996]
2003	2234	172	0.399	-0.009
	(92.9)	(07.1)	[0.000]	[0.977]
2004	2360	206	0.418	-0.003
	(92.0)	(08.0)	[0.000]	[0.997]
2005	2273	201	0.376	-0.002
	(91.9)	(08.1)	[0.000]	[0.998]
2006	2416	219	0.390	0.000
	(91.7)	(08.3)	[0.000]	[1.000]
2007	2637	247	0.337	0.000
	(91.4)	(08.6)	[0.000]	[1.000]
2008	2737	254	0.354	-0.003
	(91.5)	(08.5)	[0.000]	[0.995]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

As a second robustness check, I conduct the KS tests using labor productivity instead of TFP. The results are similar to the previous results and support theoretical predictions. Third, the results excluding firms with employees in the manufacturing or mining sections from the sample yield the same results as the previous ones. Finally, I have replicated the results using only MNEs whose foreign subsidiaries have the same industry code as the Japanese parent firm.

8 Concluding remarks

This study is the first attempt in examining the relationship between firm productivity and foreign engagement in both the manufacturing and services sectors. Little is known about the determinants of foreign engagement by firms in the services sector, while many previous studies have focused on exporting and FDI by firms in the manufacturing sector. This study reveals that MNEs in the services sector are more productive than non-MNEs as they are in the manufacturing sector. This result suggests that firms in the services sector must incur huge costs for foreign engagement as those in the manufacturing sector do, and that only a minority of productive firms in the services sector can incur these costs and supply foreign consumers with their services.

However, this study does not address two important issues: (i) exports of services and (ii) indirect exports by wholesalers. First, this study does not consider services exports, which Breinlich and Criscuolo (2011) have studied. This is because the METI survey used in this study does not contain data on export of services. The METI survey will provide data on export of services in a few years. I will then examine exports of services.

Second, the fraction of firms exporting goods, exporters of goods, is relatively high, 24.7%, in the wholesale industry, while those of the other services industries is less than 10%, as shown in Table 2. This fact partially reflects indirect exports by wholesalers who export goods produced by manufacturing firms[*19], as emphasized by recent studies such as Ahn et al. (2011), Akerman (2010), and Bernard et al. (2010a, b)[*20]. I will consider the role

sample size: finance and insurance (29) and telecommunications (32).

[*19]The high fraction of goods-exporters in the wholesale industry also reflects the imperfect classification of industries. Some firms, for example, Panasonic, conduct both wholesale and manufacturing activities. These complex firms can potentially be classified as belonging to the wholesale industry because the METI survey assigns a firm to an industry by asking from what category of business line it obtains its largest sales.

[*20]Rauch and Watson (2004) and Antràs and Costinot (2010) also consider this issue.

of wholesalers and other services firms in trade in a separate paper[*21].

[*21] Lööf (2010) and Muûls and Pisu (2009) have already analyzed trade by services firms including wholesalers.

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References

[1] Ahn, JaeBin, Amit K. Khandelwal, and Shang-Jin Wei (2011) "The Role of Intermediaries in Facilitating Trade," *Journal of International Economics*, 84(1): 73–85 .

[2] Antràs, Pol and Arnaud Costinot (2010) "Intermediated Trade," forthcoming in *Quarterly Journal of Economics*.

[3] Akerman, Anders (2010) "A Theory on the Role of Wholesalers in International Trade based on Economies of Scope," *Research Papers in Economics*, Department of Economics, Stockholm University, available at `http://people.su.se/~ank/`.

[4] Arnold, Jens M. and Katrin Hussinger. (2010) "Exports versus FDI in German Manufacturing: Firm Performance and Participation in International Markets," *Review of International Economics*, 18(4): 595–606.

[5] Bernard, Andrew B., M. Grazzi, and C. Tomasi. (2010a) "Intermediaries in International Trade: Direct versus Indirect Modes of Export," *National Bank of Belgium Working Paper*, No.199.

[6] Bernard, Andrew B. and J. Bradford Jensen. (1999) "Exceptional Exporter Performance: Cause, Effect, or Both?" *Journal of International Economics*, 47(1):1–25.

[7] Bernard, Andrew B., J. Bradford Jensen, Stephen J. Redding and Peter K. Schott. (2007a) "Firms in International Trade." *Journal of Economic Perspectives*, 21(3):105–130.

[8] Bernard, Andrew B., Stephen J. Redding, and Peter K. Schott. (2007b) "Comparative Advantage and Heterogeneous Firms," *Review of Economic Studies*, 74(1): 31–66.

[9] Bernard, Andrew B., Stephen J. Redding, and Peter K. Schott. (2010b) "Wholesalers and Retailers in US Trade," *American Economic Review: Papers & Proceedings*, 100(2): 408–413.

[10] Breinlich, Holger and Chiara Criscuolo. (2011) "International Trade in Services: A Portrait of Importers and Exporters," *Journal of International Economics*, 84: 188–206.

[11] Buch, Claudia M. and Alexander Lipponer. (2007) "FDI versus Exports: Evidence from German Banks," *Journal of Banking & Finance*, 31(3):805–826.

[12] Darling, Donald A. (1957) 'The Kolmogorov-Smirnov, Cramer-von Mises Tests," *The Annals of Mathematical Statistics*, 28(4): 823–838.

[13] Delgado, Miguel, Jose C. Farinas, and Sonia Ruano. (2002) "Firm Productivity and Export Markets: A Nonparametric Approach," *Journal of International Economics* 57: 397–422.

[14] Francois, Joseph and Bernard Hoekman. (2010) "Services Trade and Policy," *Journal of Economic Literature*, 48: 642-692.

[15] Francois, Joseph, Olga Pindyuk, and Julie Woerz. (2009) "Trends in International Trade and FDI in Services," *IIDE Discussion paper*, 200908-02.

[16] Girma, Sourafel, Holger Gorg, and Eric Strobl. (2005a) "Exports, International Investment, and Plant Performance: Evidence from a Non-Parametric Test," *Economics Letters*, 83: 317–24.

[17] Girma, Sourafel, Richard Kneller, and Mauro Pisu. (2005b) "Exports versus FDI: An Empirical Test," *Review of World Economics*, 141: 193–218.

[18] Head, Keith and John Ries. (2001) "Overseas Investment and Firm Exports." *Review of International Economics*, 9(1): 108–122.

[19] Head, Keith and John Ries. (2003) "Heterogeneity and the FDI versus Export Decision of Japanese Manufacturers." *Journal of the Japanese and International Economies*, 17:448–467.

[20] Helpman, Elhanan, Marc J. Melitz and Stephen Ross Yeaple. (2004) "Export Versus FDI with Heterogeneous Firms". *American Economic Review*, 94(1): 300–316.

[21] Ito, Yukiko. (2007) "Choice for FDI and Post-FDI Productivity," *RIETI Discussion Paper Series*, No.07-E-049.

[22] Kimura, Fukunari and Kozo Kiyota. (2006) "Exports, FDI, and Productivity of Firm: Dynamic Evidence from Japanese Firms. *Review of World Economics*, 142(4):695-719.

[23] Kimura, Fukunari and Hyun-Hoon Lee. (2006) "The Gravity Equation in International Trade in Services." *Review of World Economics*, 142(1): 92–121.

[24] Kolmogorov, Andrey. (1933) "Sulla Determinazione Empirica di una Legge Distribuzione," *Giornale dell 'Istituto Italiano Degli Attuari* 4: 83–91.

[25] Kolstad, Ivar and Espen Villanger. (2008) "Determinants of Foreign Direct Investment in Services," *European Journal of Political Economy*, 24(2): 518–533.

[26] Levinsohn, James and Amil Petrin. (2003) "Estimating Production Functions Using Inputs to Control for Unobservables." *The Review of Economic Studies*, 70: 317–341.

[27] Lööf, Hans. (2010) "Are Services Different Exporters?," *Applied Economics Quarterly*, 56(1): 99-117.

[28] Markusen, James R. (1989) "Trade in Producer Services and in Other Specialized Intermediate Inputs," *American Economic Review*, 79(1): 85–95.

[29] Melitz, Marc J. (2003) "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6): 1695–1725.

[30] Morikawa, Masayuki. (2010) "Labor Unions and Productivity: An Empirical Analysis using Japanese Firm-Level Data," *Labour Economics*, 17(6): 1030–1037.

[31] Muûls, Mirabelle and Mauro Pisu. (2009) "Imports and Exports at the Level of the Firm: Evidence from Belgium," *The World Economy*, 32(5): 692–734.

[32] Nishimura, Kiyohiko G., Takanobu Nakajima and Kozo Kiyota. (2005) "Does the Natural Selection Mechanism still Work in Severe Recessions?: Examination of the Japanese Economy in the 1990s," *Journal of Economic Behavior & Organization*, 58(1): 53–78.

[33] Ramasamy, Bala and Matthew Yeung. (2010) "The Determinants of Foreign Direct Investment in Services," *The World Economy*, 33(4): 573–596.

[34] Rauch, James E., and Joel Watson. (2004) "Network Intermediaries in International Trade," *Journal of Economics and Management Strategy*, 13(1): 69–93.

[35] Smirnov, Vladimir Ivanovich. (1939)"On the Estimation of the Discrepancy between Empirical Curves of Distribution for Two Independent Samples," *Moscow University Mathematics Bulletin* 2: 3–14.

[36] Tanaka, Ayumu. (2011) "Heterogeneity and the Structure of Exports and FDI: A Cross-Industry Analysis of Japanese Manufacturing," *RIETI Discussion Paper*, No. 11-E-001.

[37] Wagner, Joachim. (2006) "Export Intensity and Plant Characteristics: What Can We Learn from Quantile Regression?," *Review of World Economics*, 142(1): 195–203.

[38] Wakasugi, Ryuhei, Yasuyuki Todo, Hitoshi Sato, Shuichiro Nishioka, Toshiyuki Matsuura, Banri Ito, and Ayumu Tanaka. (2008) "Internationalization of Japanese Firms: New Findings Based on Firm-Level Data," *RIETI Discussion Paper*, No. 08-E-036.

[39] Yeaple, Stephen Ross. (2009) "Firm Heterogeneity and the Structure of U.S. Multinational Activity," *Journal of International Economics*, 78: 206–215.

Appendix 1: Data

This appendix describes the data sources.

The firm-level data are from *the Basic Survey of Japanese Business Structure and Activities* (BSJBSA), which is an annual survey conducted by the Ministry of Economy, Trade, and Industry (METI). METI requires all firms in the selected industries with more than 50 employees and more than 30 million yen in capital to respond to the survey. While the number of target enterprises is 38,042, the number of enterprises that responded in 2009 is 32,265[*22]—the survey aimed to obtain data on the previous financial year, 2008. The response rate is therefore 84.8%. The response rate in our sample period, 2001–2008, is almost stable.

The variables used in this study are as follows.

1. Labor (L): the number of total working hours of all kinds of workers in Japan by firm. Labor does not include number of hours worked by employees in foreign affiliates. I use hours rather than the number of workers, because working hours substantially vary across three kinds of workers which the survey contains: regular employees, part-time workers, and dispatched workers. Moreover, firms in the services sector employ more part-time workers than those in the manufacturing sector. I constructed the total working hours as the number of each type of workers multiplied by its average working hours. The industry average hours for regular employees and part-time workers are provided by the Ministry of Health, Labor and Welfare's *Monthly Labor Survey*, while the country average hours for dispatched workers are calculated as yearly wage divided by hourly wage, both of which are taken from the *General Survey on Dispatched Workers*.

2. Capital intensity (K/L): fixed tangible asset (K) per hour worked (L).

3. Intangible assets/L: intangible assets per hour.

4. Real sales: Sales divided by deflator. The industry deflator is taken from the Cabinet Office's *System of National Accounts (SNA) Statistics* as shown in Morikawa (2010). Sales includes both domestic and export sales, while they do not include local sales by foreign affiliates.

5. R&D intensity (R&D/sales): the ratio of research and development expenditure to total sales.

[*22] `http://www.meti.go.jp/statistics/tyo/kikatu/result-2/h21kakuho/pdf/riyochu.pdf`

6. Labor productivity: real value added per hour worked. Value added are calculated as the sum of operating profit, depreciation cost, total wage, welfare costs, rents, and taxes. Operating profit is defined as sales minus operating cost, where the operating cost is the sum of cost of sales and SGA (Selling and General Administrative expenses).

7. Foreign share: foreign share of capital.

8. Non-reg. L/L: the ratio of sum of non-regular workers' hours worked over L. Non-regular workers consist of part-time workers and dispatched workers.

9. TFP: total factor productivity. I estimate TFP as the residual of Cobb-Douglas production function with K and L inputs. I use real value added as the output. Production function coefficients are estimated separately for two-digit industries, using Levinsohn and Petrin (2003) method. I use transportation and package costs to proxy unobserved productivity shocks.

Appendix 2: Number of FDI destinations (KS tests)

Table 9: KS tests statistic: purely domestic firms vs. one-region MNEs

	Manufacturing				Services			
	N. of firms		Statistic		N. of firms		Statistic	
			Two-sided	One-sided			Two-sided	One-sided
year	N	I_1	H_0: equality	H_0: $N < I_1$	N	I_1	H_0: equality	H_0: $N < I_1$
2001	10819	1627	0.291	0.000	13334	849	0.355	0.000
	(80.3)	(12.1)	[0.000]	[0.999]	(91.3)	(05.8)	[0.000]	[1.000]
2002	10446	1685	0.280	-0.001	12998	889	0.344	0.000
	(79.4)	(12.8)	[0.000]	[0.998]	(90.8)	(06.2)	[0.000]	[1.000]
2003	9902	1731	0.272	0.000	12569	893	0.351	0.000
	(78.2)	(13.7)	[0.000]	[1.000]	(90.3)	(06.4)	[0.000]	[1.000]
2004	10415	1921	0.254	0.000	13296	1044	0.338	0.000
	(77.3)	(14.3)	[0.000]	[1.000]	(89.7)	(07.0)	[0.000]	[1.000]
2005	10101	1996	0.262	0.000	12928	1024	0.315	0.000
	(76.5)	(15.1)	[0.000]	[1.000]	(89.7)	(07.1)	[0.000]	[1.000]
2006	9938	1930	0.259	-0.001	13388	1030	0.320	0.000
	(76.6)	(14.9)	[0.000]	[0.997]	(89.9)	(06.9)	[0.000]	[1.000]
2007	10387	2044	0.257	-0.001	13862	1131	0.316	0.000
	(76.5)	(15.1)	[0.000]	[0.996]	(89.7)	(07.3)	[0.000]	[1.000]
2008	10390	2067	0.239	-0.001	14035	1165	0.322	-0.003
	(76.3)	(15.2)	[0.000]	[0.993]	(89.5)	(07.4)	[0.000]	[0.973]

Notes: KS tests for non-MNEs (N) vs. MNEs with subsidiaries in one region (I_1). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

Table 10: KS tests statistic: one-region MNEs vs. two-region MNEs

	Manufacturing				Services			
	N. of firms		Statistic		N. of firms		Statistic	
			Two-sided	One-sided			Two-sided	One-sided
year	I_1	I_2	H_0: equality	H_0: $I_1 < I_2$	I_1	I_2	H_0: equality	H_0: $I_1 < I_2$
2001	1627	492	0.332	-0.004	849	234	0.250	-0.003
	(12.1)	(03.7)	[0.000]	[0.990]	(05.8)	(01.6)	[0.000]	[0.996]
2002	1685	494	0.307	-0.001	889	245	0.238	-0.010
	(12.8)	(03.8)	[0.000]	[1.000]	(06.2)	(01.7)	[0.000]	[0.962]
2003	1731	469	0.279	-0.001	893	262	0.257	-0.003
	(13.7)	(03.7)	[0.000]	[1.000]	(06.4)	(01.9)	[0.000]	[0.997]
2004	1921	550	0.297	-0.001	1044	265	0.253	0.000
	(14.3)	(04.1)	[0.000]	[1.000]	(07.0)	(01.8)	[0.000]	[1.000]
2005	1996	535	0.287	-0.003	1024	262	0.298	-0.004
	(15.1)	(04.1)	[0.000]	[0.994]	(07.1)	(01.8)	[0.000]	[0.994]
2006	1930	531	0.313	-0.003	1030	258	0.258	-0.004
	(14.9)	(04.1)	[0.000]	[0.992]	(06.9)	(01.7)	[0.000]	[0.994]
2007	2044	543	0.301	-0.005	1131	257	0.260	0.000
	(15.1)	(04.0)	[0.000]	[0.980]	(07.3)	(01.7)	[0.000]	[1.000]
2008	2067	548	0.244	-0.005	1165	273	0.239	-0.009
	(15.2)	(04.0)	[0.000]	[0.978]	(07.4)	(01.7)	[0.000]	[0.963]

Notes: KS tests for MNEs with subsidiaries in one region (I_1) vs. MNEs with subsidiaries in two regions (I_2). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

Table 11: KS tests statistic: two-region MNEs vs. three-region MNEs

	Manufacturing				Services			
	N. of firms		Statistic		N. of firms		Statistic	
			Two-sided	One-sided			Two-sided	One-sided
year	I_2	I_3	H_0: equality	H_0: $I_2 < I_3$	I_2	I_3	H_0: equality	H_0: $I_2 < I_3$
2001	492	371	0.479	0.000	234	130	0.415	-0.004
	(03.7)	(02.8)	[0.000]	[1.000]	(01.6)	(00.9)	[0.000]	[0.997]
2002	494	378	0.475	0.000	245	129	0.370	-0.004
	(03.8)	(02.9)	[0.000]	[1.000]	(01.7)	(00.9)	[0.000]	[0.995]
2003	469	384	0.477	0.000	262	136	0.429	-0.003
	(03.7)	(03.0)	[0.000]	[1.000]	(01.9)	(01.0)	[0.000]	[0.997]
2004	550	405	0.493	0.000	265	152	0.424	-0.002
	(04.1)	(03.0)	[0.000]	[1.000]	(01.8)	(01.0)	[0.000]	[0.999]
2005	535	417	0.505	0.000	262	135	0.453	0.000
	(04.1)	(03.2)	[0.000]	[1.000]	(01.8)	(00.9)	[0.000]	[1.000]
2006	531	385	0.484	0.000	258	141	0.404	0.000
	(04.1)	(03.0)	[0.000]	[1.000]	(01.7)	(00.9)	[0.000]	[1.000]
2007	543	391	0.468	0.000	257	140	0.392	-0.005
	(04.0)	(02.9)	[0.000]	[1.000]	(01.7)	(00.9)	[0.000]	[0.994]
2008	548	397	0.433	-0.001	273	135	0.383	-0.001
	(04.0)	(02.9)	[0.000]	[1.000]	(01.7)	(00.9)	[0.000]	[1.000]

Notes: KS tests for MNEs with subsidiaries in two regions (I_2) vs. MNEs with subsidiaries in three regions (I_3). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

Table 12: KS tests statistic: three-region MNEs vs. four-region MNEs

	Manufacturing				Services			
	N. of firms		Statistic		N. of firms		Statistic	
			Two-sided	One-sided			Two-sided	One-sided
year	I_3	I_4	H_0: equality	H_0: $I_3 < I_4$	I_3	I_4	H_0: equality	H_0: $I_3 < I_4$
2001	371	161	0.313	0.000	130	62	0.269	-0.002
	(02.8)	(01.2)	[0.000]	[1.000]	(00.9)	(00.4)	[0.000]	[0.997]
2002	378	155	0.293	0.000	129	61	0.246	-0.008
	(02.9)	(01.2)	[0.000]	[1.000]	(00.9)	(00.4)	[0.000]	[0.972]
2003	384	174	0.292	0.000	136	55	0.244	-0.002
	(03.0)	(01.4)	[0.000]	[1.000]	(01.0)	(00.4)	[0.000]	[0.998]
2004	405	181	0.295	0.000	152	61	0.253	0.000
	(03.0)	(01.3)	[0.000]	[1.000]	(01.0)	(00.4)	[0.000]	[1.000]
2005	417	158	0.286	-0.002	135	67	0.281	-0.003
	(03.2)	(01.2)	[0.000]	[0.995]	(00.9)	(00.5)	[0.000]	[0.995]
2006	385	188	0.325	-0.002	141	74	0.253	-0.003
	(03.0)	(01.4)	[0.000]	[0.996]	(00.9)	(00.5)	[0.000]	[0.995]
2007	391	208	0.319	-0.003	140	68	0.269	0.000
	(02.9)	(01.5)	[0.000]	[0.990]	(00.9)	(00.4)	[0.000]	[1.000]
2008	397	222	0.291	-0.004	135	72	0.254	-0.007
	(02.9)	(01.6)	[0.000]	[0.981]	(00.9)	(00.5)	[0.000]	[0.972]

Notes: KS tests for MNEs with subsidiaries in three regions (I_3) vs. MNEs with subsidiaries in four regions (I_4). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

Appendix 3: Results from individual industries

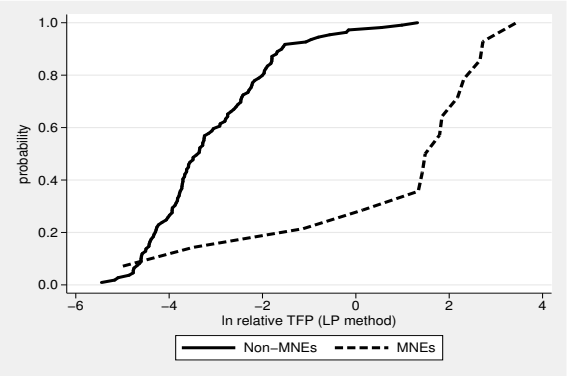

Figure 8: Internationalized status and CDF of productivity in the electricity, gas and water supply industry (26): Japan, 2008

Table 13: KS tests statistic for electricity, gas and water supply: 26

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	H_0: N < I
2001	96	6	0.958	0.000
	(94.1)	(05.9)	[0.000]	[1.000]
2002	98	7	0.959	0.000
	(93.3)	(06.7)	[0.000]	[1.000]
2003	97	10	0.990	0.000
	(90.7)	(09.3)	[0.000]	[1.000]
2004	103	12	0.829	0.000
	(89.6)	(10.4)	[0.000]	[1.000]
2005	99	12	0.806	0.000
	(89.2)	(10.8)	[0.000]	[1.000]
2006	102	14	0.769	-0.062
	(87.9)	(12.1)	[0.000]	[0.911]
2007	115	15	0.788	0.000
	(88.5)	(11.5)	[0.000]	[1.000]
2008	109	14	0.775	-0.044
	(88.6)	(11.4)	[0.000]	[0.953]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

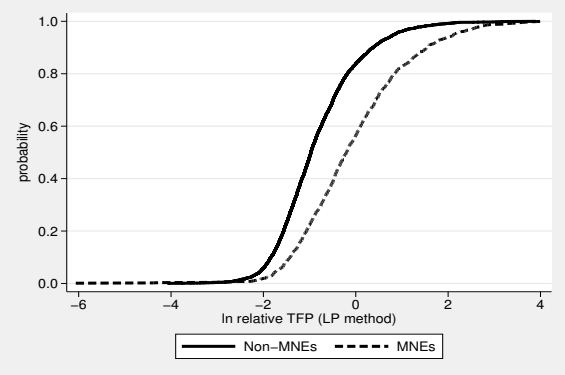

Figure 9: Internationalized status and CDF of productivity in the wholesale trade industry (27): Japan, 2008

Table 14: KS tests statistic for wholesale trade: 27

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
year	N	I	Two-sided H_0: equality	One-sided H_0: N < I
2001	5406	845	0.366	0.000
	(86.5)	(13.5)	[0.000]	[1.000]
2002	5158	864	0.348	-0.003
	(85.7)	(14.3)	[0.000]	[0.991]
2003	4904	863	0.357	0.000
	(85.0)	(15.0)	[0.000]	[1.000]
2004	4992	956	0.349	0.000
	(83.9)	(16.1)	[0.000]	[1.000]
2005	4824	923	0.323	0.000
	(83.9)	(16.1)	[0.000]	[1.000]
2006	4721	908	0.334	-0.001
	(83.9)	(16.1)	[0.000]	[0.998]
2007	4839	941	0.339	0.000
	(83.7)	(16.3)	[0.000]	[1.000]
2008	4784	944	0.313	-0.003
	(83.5)	(16.5)	[0.000]	[0.984]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

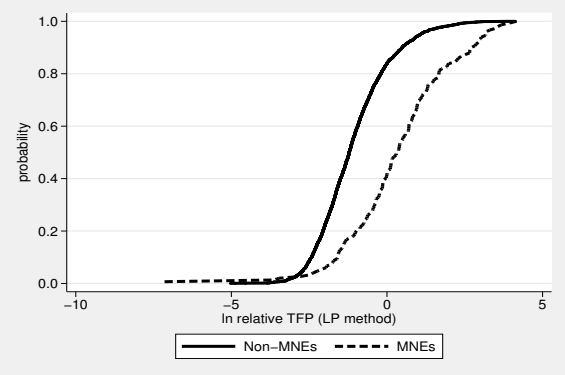

Figure 10: Internationalized status and CDF of productivity in the retail trade industry (28): Japan, 2008

Table 15: KS tests statistic for retail trade: 28

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
year	N	I	Two-sided H_0: equality	One-sided H_0: N < I
2001	3499	135	0.511	0.000
	(96.3)	(03.7)	[0.000]	[1.000]
2002	3363	128	0.495	0.000
	(96.3)	(03.7)	[0.000]	[1.000]
2003	3234	119	0.462	0.000
	(96.5)	(03.5)	[0.000]	[1.000]
2004	3473	124	0.421	0.000
	(96.6)	(03.4)	[0.000]	[1.000]
2005	3404	134	0.404	0.000
	(96.2)	(03.8)	[0.000]	[1.000]
2006	3308	133	0.462	0.000
	(96.1)	(03.9)	[0.000]	[1.000]
2007	3398	150	0.425	0.000
	(95.8)	(04.2)	[0.000]	[1.000]
2008	3372	150	0.470	-0.013
	(95.7)	(04.3)	[0.000]	[0.951]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

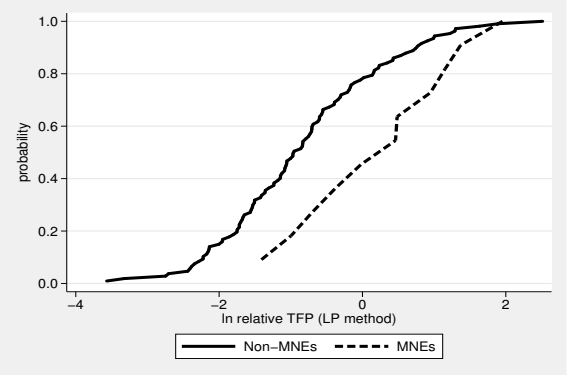

Figure 11: Internationalized status and CDF of productivity in the education, health, and research industry (33): Japan, 2008

Table 16: KS tests statistic for education, health, and research: 33

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	H_0: N < I
2001	33	4	0.568	0.000
	(89.2)	(10.8)	[0.200]	[1.000]
2002	56	5	0.514	0.000
	(91.8)	(08.2)	[0.176]	[1.000]
2003	49	6	0.588	0.000
	(89.1)	(10.9)	[0.049]	[1.000]
2004	65	7	0.641	0.000
	(90.3)	(09.7)	[0.011]	[1.000]
2005	68	6	0.657	0.000
	(91.9)	(08.1)	[0.017]	[1.000]
2006	93	8	0.655	-0.033
	(92.1)	(07.9)	[0.004]	[0.984]
2007	86	11	0.471	-0.067
	(88.7)	(11.3)	[0.027]	[0.918]
2008	108	11	0.419	-0.009
	(90.8)	(09.2)	[0.060]	[0.998]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

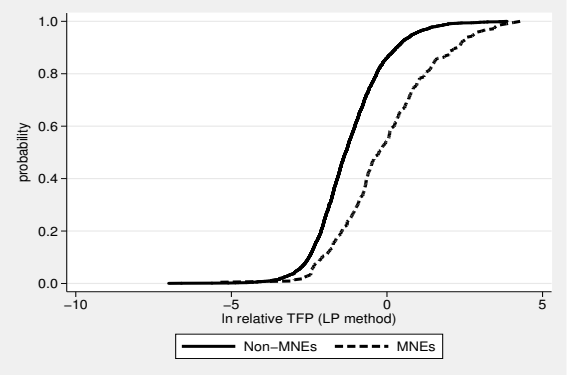

Figure 12: Internationalized status and CDF of productivity in the business services industry (34): Japan, 2008

Table 17: KS tests statistic for business services: 34

	Non-MNEs vs. MNEs			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	H_0: N < I
2001	1235	84	0.489	0.000
	(93.6)	(06.4)	[0.000]	[1.000]
2002	1290	96	0.519	0.000
	(93.1)	(06.9)	[0.000]	[1.000]
2003	1360	122	0.493	0.000
	(91.8)	(08.2)	[0.000]	[1.000]
2004	1564	157	0.430	0.000
	(90.9)	(09.1)	[0.000]	[1.000]
2005	1570	154	0.424	-0.003
	(91.1)	(08.9)	[0.000]	[0.997]
2006	2009	163	0.386	0.000
	(92.5)	(07.5)	[0.000]	[1.000]
2007	2160	183	0.404	0.000
	(92.2)	(07.8)	[0.000]	[1.000]
2008	2277	216	0.349	-0.003
	(91.3)	(08.7)	[0.000]	[0.996]

Notes: KS tests for non-MNEs (N) vs. MNEs (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.