Multinationals in 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 services sector, as well as those in manufacturing sector. I examine whether multinationals are more productive than non-multinationals in the services sector as in the manufacturing sector. I employ Kolmogorov-Smirnov (KS) test to compare overall distribution of productivity by internationalized status, after estimating premia of multinationals. The results indicate that multinationals are more productive than non-multinationals in services sector as in manufacturing sector and they, therefore, suggest that the standard firm heterogeneity model can well explain foreign direct investment by firms in services sector.

Keywords: Services; Firm heterogeneity; Multinationals; Exporting; Foreign direct investment
JEL Classification: F1, F23, L8

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1 Introduction

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

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

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

2 Model

To explain the relationship between firm productivity and foreign engagement, I briefly describe a simple model which is based on a standard firm

[*1] Markusen (1989) is an early study of services in trade literature. While my paper focus 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 determinant 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 concise survey of recent studies.

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 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 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 called labor 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

[*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 via a free-entry condition. Second, I do not solve for the full general equilibrium of the model. Rather, I present a partial-equilibrium analysis.

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

market. These are the costs of setting up production or services-providing facilities in home country.

To serve foreign markets, manufacturing firms can choose either exporting their goods from home country or FDI, that is supplying their goods from foreign local plant, while services firms are assumed to be able to choose only FDI. 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 wage w_h, and incurs 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 cost and face 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 marginal costs of

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

Services firms can not choose exporting since τ is assumed to be prohibitively high for them.

A firm facing demand curve (2) will optimally charge a price of $p(\varphi) = c(\varphi)/\alpha$. 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 a productivity index, since $\sigma > 1$.

2.2 Cutoffs

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

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

Firms with productivity below this cutoff ($\varphi < \varphi^D$) do not enter the industry, but firms with productivity above the cutoff ($\varphi \geq \varphi^D$) 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 cutoff as

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

None of services firms can exceed the export cutoff since the cutoff is high enough for them. I also define the FDI cutoff 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 cutoff 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 cutoff and export cutoff ($\varphi \in (\varphi^D, \varphi^X)$) only supply their products to domestic markets and neither export nor conduct FDI. These firms are "purely domestic." Second, manufacturing firms with productivity levels between the export cutoff and FDI cutoff ($\varphi \in (\varphi^X, \varphi^{I,M})$) are "exporters," who supply their products to domestic markets and export them to foreign markets. Firms with productivity levels above the FDI cutoff ($\varphi > \varphi^{I,M}$) are "multinationals," who invest in a foreign country. Therefore, exporters are more productive than purely domestic firms, and multinationals, in turn, are more productive than exporters.

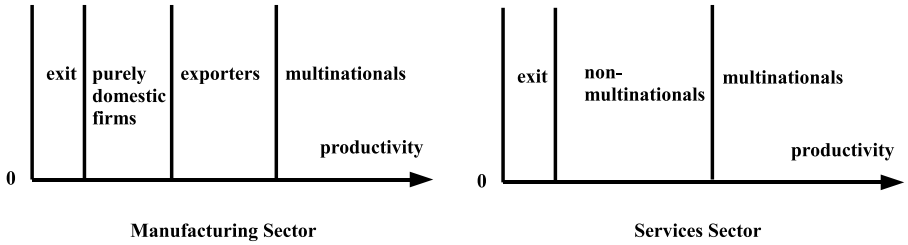

Figure 1: productivity ordering

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

3 Data and preliminary results

3.1 Data

This section shows some basic facts in Japanese multinationals. I use a firm-level data from the Basic Survey of Japanese Business Structure and Activities (BSJBSA) by the METI. In this paper, I call this "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 but it is the most comprehensive for my study among the surveys available in Japan at the moment and used by many studies including Nishimura et al. (2005), Kimura and Kiyota (2006), and Wakasugi et al.(2008). The more detailed explanation is provided in the Appendix 1.

Table 1 presents distribution of Japanese firms in the data across three sectors: (i) agriculture, etc, (ii) manufacturing, and (iii) services. In 2008, the latest year in our data, the number of firms in the whole sample is 29,355. Manufacturing sector account for 46.4% of it, while services sector account for 53.4%. The share of Agriculture, etc accounts for only 0.2%. I, therefore, restrict my analysis on the manufacturing and services sectors. Table 2 provides the list of industries of both sectors.

Table 1: Distribution of firms (Japan, 2008)

	Agriculture, etc	Manufacturing	Services	Total
N. 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."

Table 1 also reveals that the fraction of multinationals in services sector, which is only 10.5%, is much lower than those in manufacturing sector, 36.6%. This difference is remarkable since the fraction of firms with domestic affiliates are almost same between these two sectors.

The fraction of multinationals in services sector is lower than that in manufacturing sector in every four host regions: North America, Europe, Asia, and other region. Most popular destination is Asia for both manufacturing and services sectors with the fraction of multinationals investing in that region 21.4% and 9.1%, respectively. The second popular destination is North America again for both sectors, followed by Europe. The fraction of multinationals investing these two region is less than 10% in both sectors, which indicates that Asia is the far most popular destination.

Table 2 provides the list of industries with the number of firms and the fractions of exporters and multinationals in my data. The fraction of multinationals varies across industries within sector. The publishing and printing industry, for example, has much smaller fraction of multinationals than other manufacturing industries, while the wholesale trade industry has much larger fraction of multinationals than other services industries[*5].

3.2 The measurement of firm productivity

This section explains the measure of total factor productivity (TFP) used later in this paper. I obtain Japanese parent firms' TFP from a two-digit industry-specific production function estimated using Levinsohn and Petrin

[*5] Although this paper does not investigate the reason why the fraction varies across industries, Tanaka (2011) shows that firm heterogeneity and R&D play large role in the substantial variation of fraction of multinationals in Japanese manufacturing.

Table 2: List of industries (Japan, 2008)

Industry code	description	N. of firms	fraction of exporters	fraction of multinationals
Agriculture, etc				
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 manu.	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 multinational exporters.

(2003) techniques. I use cost for transportation and package to proxy unobserved productivity shocks[*6]. For output, I use Japanese parent firms' real value added, which is deflated by 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' hour worked (L)[*7] and fixed tangible assets (K), as inputs.

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

3.3 Premia

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

Figure 2 presents average productivity of non-multinationals and multinationals by sectors. Figure 2 shows that on average multinationals are more productive than non-multinationals in both manufacturing and services sectors. This fact suggests that productivity is important for firms to invest abroad even in services sector and that the standard firm heterogeneity model can well explain FDI in services sector. Figure 2 also shows that average productivity of both non-multinationals and multinationals in manufacturing is higher than its counterparts in services sector. As a whole, Figure 2 shows that firms in services sector are less productive than those in manufacturing but great heterogeneity exists within services sector as in manufacturing sector, that is, multinationals in services are more productive than non-multinationals.

Next, I estimate the premia of multinationals and services firms, using the estimation equation used in Bernard et al. (2010a). I regress labor productivity as well as other firm characteristics 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 are firm characteristics[*8], D_i^S and MNE_i is a dummy for services

[*6] My data does not contain materials nor fuels.

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

[*8] As firm characteristics, I use labor productivity, R&D intensity, sales, labor, capital

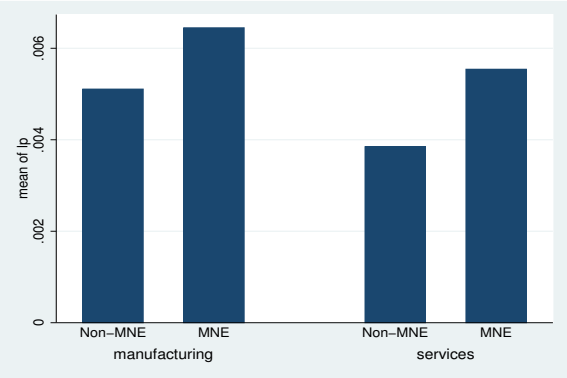

Figure 2: Mean of labor productivity

Note: The data are on Japanese firms in 2008. The graph displays multinationals enterprises' (MNEs) mean level of labor productivity and non MNEs' one.

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

firms and current multinational status respectively, and ϵ_i is an error term. Equation (12) can be rewritten as

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

The result of Figure 1 suggests that $\beta_1 < 0$ and $\beta_2 > 0$ but can not predict the sign of β_3, which will show the difference between multinationals in services and manufacturing sectors.

Table 3 and 4 report the results of (12). First, the multinational premia, β_2, are positive and significant for every characteristics except the ratio of non-regular to total labor. The largest premia are found in sales, 1.316 log points (3.7%), followed by labor, 0.934 log points (2.5%). Both of results indicate that multinationals are on average far larger than non-multinationals. In addition, column (1) presents positive multinational premia in labor productivity. This result supports the model's prediction that multinationals are more productive than non-multinationals in both services and manufacturing sectors.

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.

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.

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 multinationals 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 multinationals exist in R&D intensity, intangible asset intensity, and labor, although my model does not provide explanation of these results. In addition, the multinational premia of services in terms of labor productivity is not significantly different from manufacturing's one. This implies that labor productivity is not the major reason for lower fraction of multinationals 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[*9] to examine the relationship between productivity and exporting and FDI, following previous studies such as Girma et al. (2004) and Arnold and Hussinger (2010). These tests allow me 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. 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. First-order stochastic dominance of $F_1(\varphi)$ 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 means 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:

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

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

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 reject the null 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[*10]. Following the previous studies such as Delgado et al. (2002), I test hypothesis separately for each year from 2001–2008 since the independence assumption is likely to be violated if I use pooled observations from several years for the KS test.

5 Results

Using the KS tests[*11], this section examines whether exporters are more productive than purely domestic firms in the manufacturing sector and whether

[*10] 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

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

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

multinationals are more productive than non-multinationals in both manufacturing and services sectors.

5.1 Manufacturing sector

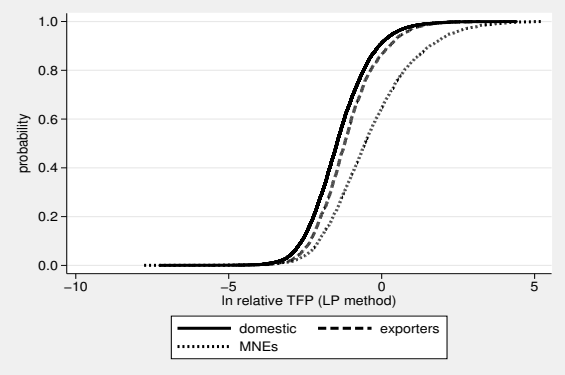

Figure 3: Internationalized status and CDF of productivity in the manufacturing sector

Note: The data are on Japanese firms in 2008.

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

I examine productivity ordering in manufacturing sector and then that in services sector. Figure 3 presents the cumulative distribution function (CDF) of the relative TFP by each firm type in manufacturing sector. The TFP distribution of purely domestic firms lies in the left side, while that of multinationals lies in the right side. The distribution of non-MNE exporters lies between purely domestic firms' and multinationals' distributions. 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, 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

Table 5: Kolmogorov-Smirnov tests statistics for manufacturing

	Purely domestic firms vs. Non-MNE exporters			
	N. of firms		Statistic	
			Two-sided	One-sided
year	D	X	H_0: equality	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: Notes: Kolmogorov-Smirnov 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.

firms. I can not reject the null hypothesis at any reasonable significance level for all years. From both two- and one- sided KS test, 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 multinationals stochastically dominates that of non-MNE exporters. If multinationals are more productive than non-MNE exporters, I can conclude that by transitivity, multinationals are more productive than purely domestic firms and therefore they are the most productive among three firm types.

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

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

5.2 Services sector

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

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

Table 6: Kolmogorov-Smirnov tests statistics for manufacturing

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

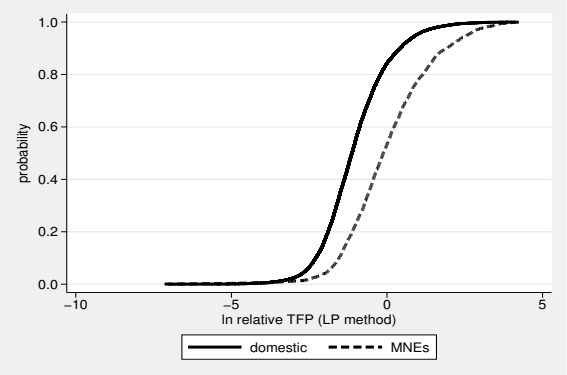

Figure 4: Internationalized status and CDF of productivity in the services sector

Note: The data are on 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: Kolmogorov-Smirnov tests statistics for services

	Non-multinationals vs. Multinationals			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

6 Number of FDI destinations

This section examines the relationship between number of FDI destinations and firm productivity. As shown in Yeaple (2009), the firm heterogeneity model based on Helpman et al. (2004) predict 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 cutoff productivity for a larger number of countries, while less productive firms can enter more attractive countries only.

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[*12]. Vast majority of firms do not have their foreign subsidiaries. For these non-multinationals, the number of FDI destinations is zero. Among multinationals, one-region multinationals, i.e., multinationals with subsidiaries in one foreign region, are the majority. Four-region multinationals, i.e., multinationals with subsidiaries in four foreign regions, are tiny minority.

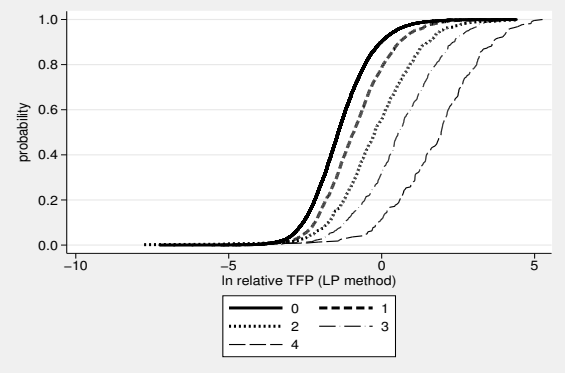

Figure 5: Number of FDI Destinations and CDF of productivity in the manufacturing sector

Note: The data are on Japanese firms in 2008.

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

[*12]The Appendix 2 provides the number and share of each multinational type.

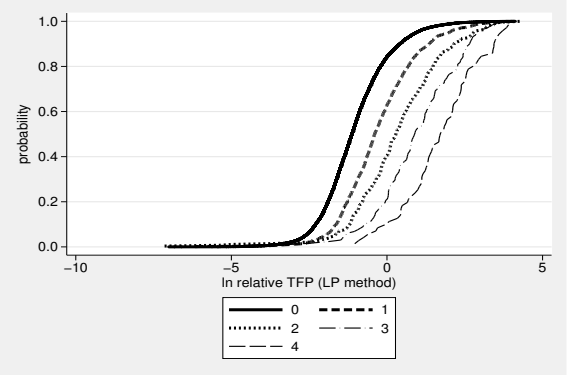

Figure 6: Number of FDI Destinations and CDF of productivity in the services sector

Note: The data are on 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 invests in, the higher-productivity ranges they are distributed over. The TFP distribution of non-multinationals are located in the left side of the multinationals' ones. The distribution of four-region multinationals are located in the right side of other types of multinationals' ones. These results are consistent with the theoretical prediction that the most productive firms can enter even the least attractive foreign regions, while less productive firms can enter more attractive regions only. The results from the KS tests also confirm the theoretical prediction[*13].

7 Robustness check

This section conducts robustness check. While the above analysis employs broad definition of the services sector, this section focuses on more narrowly defined services sector. In the above analysis, the services sector includes not only pure services industries but also wholesale and retail industries as shown in Table 2. In this section, I focus on data on the personal services activities industry, since firms in personal services industry are assumed to provide

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

directly foreign consumers with their services[*14]. Figure 7 presents CDF of productivity by multinational status in the personal services industry and supports the model's prediction that services multinationals are more productive than non-multinationals.

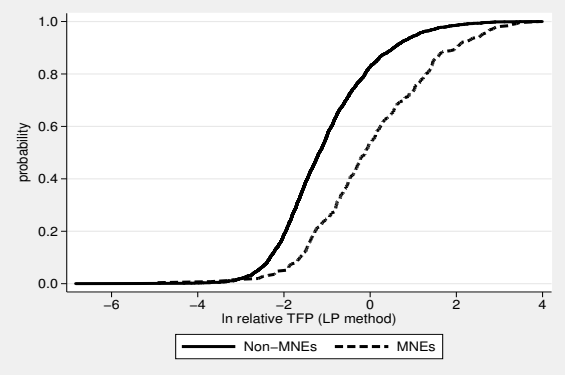

Figure 7: Internationalized status and CDF of productivity in the personal services industry

Note: The data are on Japanese firms in 2008.

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

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

8 Concluding remarks

This paper is a first attempt to examine the relationship between both manufacturing and services firm productivity and its foreign engagement. Little is known about the determinants of services firms' foreign engagement, while

[*14]Appendix 3 provides the results from 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 only firms with sales in the industry targeted by the survey are happened to be included in the survey. I also exclude two industries with small sample size: finance and insurance (29) and telecommunications (32).

Table 8: Kolmogorov-Smirnov tests statistics for personal services

	Non-multinationals vs. Multinationals			
	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

many previous studies have focused on the manufacturing firms' exporting and FDI. This paper reveals that multinationals in the services sector are more productive than non-multinationals as in the manufacturing sector. This result suggests that services firms must incur huge costs for foreign engagement as manufacturing firms do and that only tiny minority of productive services firms can incur these costs and supply foreign consumers with their services.

This paper does not address two important issues: (i) exports of services and (ii) indirect exports by wholesalers. First, this paper does not consider services exports, which Breinlich and Criscuolo (2010) have studied. This is because the METI survey used in this paper does not contain data on exports of services. The METI survey will provide data on exports of services a few years later. I will examine exports of services.

Second, the fraction of firms exporting goods, goods-exporters, is relatively high, 24.7%, in the wholesale industry, while those of the other services industries are less than 10%, as shown in Table 2 of Appendix 1. This fact partially reflects indirect exports that wholesalers export goods produced by manufacturing firms[*15], as emphasized by recent studies such as Ahn et al. (2010), Akerman (2010), and Bernard et al. (2010a, b)[*16]. I will consider the role of wholesalers and other services firms in trade in a separate paper[*17].

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

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

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

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Appendix 1: Data

In this appendix, we describe our data sources.

Our 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 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 submitted a response in 2009 is 32,265[*18]—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 paper are as follows.

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

[*18] `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 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 cost for transportation and package to proxy unobserved productivity shocks.

Appendix 2: Number of FDI destinations (KS tests)

Table 9: Kolmogorov-Smirnov tests statistic: purely domestic firms vs. one-region multinationals

	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises 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: Kolmogorov-Smirnov tests statistic: one-region multinationals vs. two-region multinationals

	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: Kolmogorov-Smirnov tests for multinational enterprises with subsidiaries in one region (I_1) vs. multinational enterprises 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: Kolmogorov-Smirnov tests statistic: two-region multinationals vs. three-region multinationals

	Manufacturing				Services			
	N. of firms		Statistic		N. of firms		Statistic	
year	I_2	I_3	Two-sided H_0: equality	One-sided H_0: $I_2 < I_3$	I_2	I_3	Two-sided H_0: equality	One-sided 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: Kolmogorov-Smirnov tests for multinational enterprises with subsidiaries in two regions (I_2) vs. multinational enterprises 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: Kolmogorov-Smirnov tests statistic: three-region multinationals vs. four-region multinationals

	Manufacturing				Services			
	N. of firms		Statistic		N. of firms		Statistic	
year	I_3	I_4	Two-sided H_0: equality	One-sided H_0: $I_3 < I_4$	I_3	I_4	Two-sided H_0: equality	One-sided 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: Kolmogorov-Smirnov tests for multinational enterprises with subsidiaries in three regions (I_3) vs. multinational enterprises 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

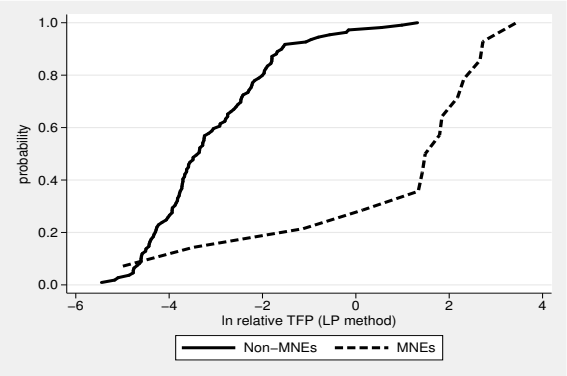

Figure 8: Internationalized status and CDF of productivity in the electricity, gas and water supply industry (26): Japan, 2008

Table 13: Kolmogorov-Smirnov tests statistic for electricity, gas and water supply: 26

	Non-multinationals vs. Multinationals			
	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

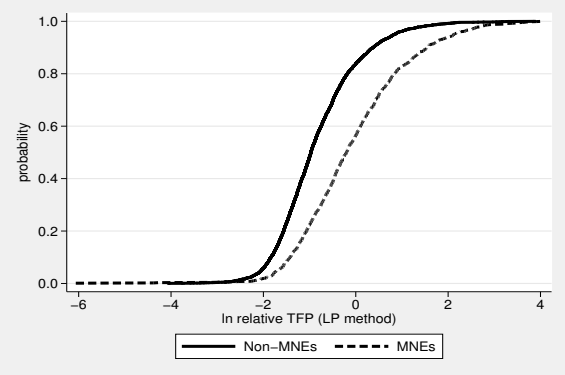

Figure 9: Internationalized status and CDF of productivity in the wholesale trade industry (27): Japan, 2008

Table 14: Kolmogorov-Smirnov tests statistic for wholesale trade: 27

	Non-multinationals vs. Multinationals			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

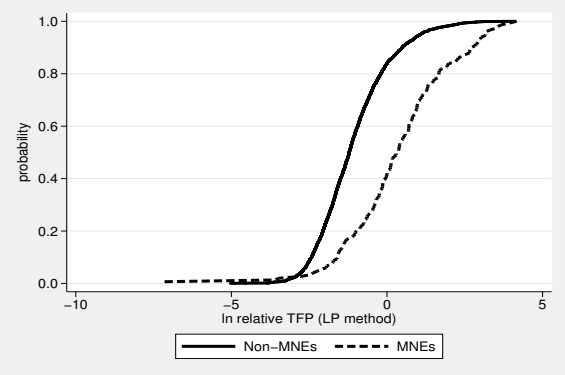

Figure 10: Internationalized status and CDF of productivity in the retail trade industry (28): Japan, 2008

Table 15: Kolmogorov-Smirnov tests statistic for retail trade: 28

	Non-multinationals vs. Multinationals			
	N. of firms		Statistic	
			Two-sided	One-sided
year	N	I	H_0: equality	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

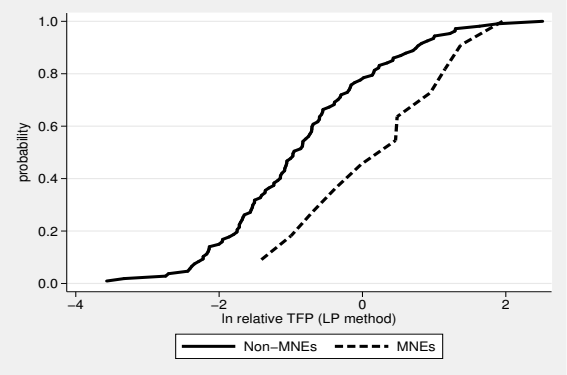

Figure 11: Internationalized status and CDF of productivity in the education, health, and research industry (33): Japan, 2008

Table 16: Kolmogorov-Smirnov tests statistic for education, health, and research: 33

	Non-multinationals vs. Multinationals			
	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.

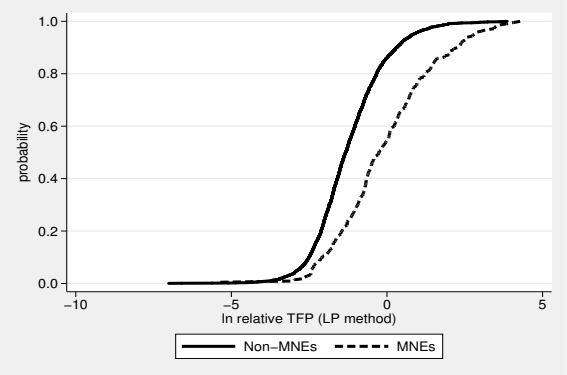

Figure 12: Internationalized status and CDF of productivity in the business services industry (34): Japan, 2008

Table 17: Kolmogorov-Smirnov tests statistic for business services: 34

	Non-multinationals vs. Multinationals			
	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: Kolmogorov-Smirnov tests for non-multinational enterprises (N) vs. multinational enterprises (I). Asymptotic P-values are shown in brackets. The share of each firm type in all types is shown in parenthesis.