Exports, FDI, and Productivity:
Evidence from Japanese Manufacturing Firms

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Abstract

This paper employs nonparametric tests and Japanese firm level data to examine the hypothesis put forward by Helpman, Melitz and Yeaple (2003) and Head and Ries (2003) that firms engaging in FDI are more productive than other firms. We find that the productivity distribution of foreign firms operating in Japan dominates that of Japanese multinationals, which dominates that of exporters, which in turn dominates that of non-exporters, thus confirming the theoretical predictions.

Keywords: Export, FDI, TFP, nonparametric Kolmogorov-Smirnov test

JEL classifications: F14, F23, D21

1. Introduction

What determines whether firms choose to serve overseas markets through exports or foreign direct investment (FDI)? This is a question that has received considerable research attention in recent years, and a frequently cited model in this context is the one developed by Helpman, Melitz and Yeaple (2003) (referred to as HMY hereafter). Concentrating on the choice between exports and horizontal FDI, i.e., investment in a foreign production facility to serve customers in the foreign market, a basic idea underlying the model is that FDI involves higher sunk costs but lower per-unit costs than exporting. Introducing heterogeneous firms into the model, the authors suggest that only relatively productive firms will serve foreign markets, and among these, only the most productive will do so through FDI.

Similarly, Head and Ries (2003) developed and tested a theoretical model which predicts that firms choosing FDI are more productive than firms choosing exporting. Based on data on 1,070 large Japanese firms, their empirical results suggest that firms using both FDI and exports to serve foreign markets are more productive than firms that only export. Furthermore, they predict that more productive firms invest primarily in high income countries.

The purpose of this paper is to empirically test the hypothesis put forward by HMY and the prediction of Head and Ries's (2003) model. The approach we employ is to conduct nonparametric two-sided and one-sided Kolmogorov-Smirnov tests. The first to apply this method to examine the link between exports and productivity were Delgado, Farinas and Ruano (2002). It has subsequently been used by Girma, Kneller and Pisu (2003) and Girma, Görg and Strobl (2004) to compared differences in the productivity distribution among firms classified according to whether they serve overseas markets through exports or FDI or whether they do not.

The remainder of the paper is organized as follows. Section 2 provides a description of the data used. Section 3 presents the empirical methodology employed and reports our results. Finally,

Section 4 concludes.

2. Data

For our empirical analysis, we use the firm-level data underlying the *Basic Survey of Japanese Business Structure and Activities* conducted by the Ministry of Economy, Trade and Industry (METI). The survey covers all firms with at least 50 employees and 30 million yen of paid-in capital in the Japanese manufacturing, mining and commerce sectors. In our analysis, we focus on manufacturing firms only. Our data cover the period 1994-2001.

The survey provides information on whether a firm exports and/or relies on FDI to serve overseas markets and whether it is domestically- or foreign-owned. We define firms as relying on FDI when they have subsidiaries abroad and foreign-owned firms in Japan are defined as those in which one or several foreigners hold 33.4% of paid-in capital. Therefore, we can distinguish four groups of firms: domestically-owned firms that neither export nor rely on FDI, domestically-owned firm that only export, Japanese multinationals (i.e. domestically-owned firms that have foreign subsidiaries; they may also be exporters), and foreign-owned firms.

Dividing our data on manufacturing firms into 30 industry categories and using the level of total factor productivity (TFP) as a proxy for firm performance,[1] we calculate each firm's relative TFP level vis-à-vis the industry average.[2] Following Good, Nadiri and Sickles (1997) and Aw, Chen and Roberts (1997), we define the TFP level of firm *f* in year *t* in a certain industry in comparison with the TFP level of a hypothetical representative firm in year 0 in that industry by

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[1] See Fukao and Kwon (2005) for a description of the data and the methodology of calculating TFP.
[2] See Fukao and Kwon (2005) for details on the industry classifications.

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$$\ln TFP_{f,t} = (\ln Y_{f,t} - \overline{\ln Y_t}) - \sum_{i=1}^{n} \frac{1}{2}(S_{i,f,t} + \overline{S_{i,t}})(\ln X_{i,f,t} - \overline{\ln X_{i,t}})$$
$$+ \sum_{s=1}^{t}(\overline{\ln Y_s} - \overline{\ln Y_{s-1}}) - \sum_{s=1}^{t}\sum_{i=1}^{n} \frac{1}{2}(\overline{S_{i,s}} + \overline{S_{i,s-1}})(\overline{\ln X_{i,s}} - \overline{\ln X_{i,s-1}}) \qquad (1)$$

Table 1 provides summary statistics of the TFP level for the four groups of companies and the number of observations for each group.

3. Empirical Strategy and Results

In order to test the hypothesis put forward by HMY, we conduct nonparametric two-sided and one-sided Kolmogorov-Smirnov tests. The nonparametric Kolmogorov-Smirnov test requires three assumptions: (1) the samples are random samples; (2) the two samples are mutually independent; and (3) the measurement scale is at least ordinal. As Delgado, Farinas and Ruano (2002) have shown, a limitation of this test is that it cannot be applied to panel data that do not independently deal with repeated observations for different years.

We define two cumulative distribution functions, F and G. G corresponds to the group of interest, for example domestically-owned exporters, and F to the comparison group, for example Japanese multinationals. In order to compare the performance of firms in different groups, we test the following hypotheses:

(Two-Sided Test)

Ho: F(x) = G(x) for all x from $-\infty$ to $+\infty$

H1: F(x) $\neq$ G(x)   for at least one value of x

(One-Sided Test A)

Ho: F(x)≤G(x) for all x from -∞ to +∞

H1: F(x)>G(x)   for at least one value of x

This tests the hypothesis that 'F tends to be smaller than G.'

(One-Sided Test B)

Ho: F(x)≥G(x) for all x from -∞ to +∞

H1: F(x)<G(x)   for at least one value of x

This tests the hypothesis that 'F tends to be larger than G.'

The two-sided test allows us to determine whether both distributions are identical or not, while the one-sided tests permit us to determine whether or not a distribution dominates the other. If the null hypotheses in the two-sided test and the one-sided test A are rejected and the null of the one-sided test B is not rejected, this implies that the distribution of F is to right of G. In this case, F is said to stochastically dominate G.

Table 2 reports the results of the nonparametric Kolmogorov-Smirnov test on the productivity differentials between groups. Like previous empirical studies which found productivity differentials between exporters and firms which only serve the domestic market (see, e.g., Bernard and Jensen, 1995), we find that the TFP distribution of exporters stochastically dominates that of non-exporters in all periods. This finding contradicts the result reported by Girma, Görg and Strobl (2004), who found no difference in productivity between exporters and non-exporters.

Our results, except for the year 2000, also indicate that Japanese multinationals are more productive than firms which only export. Therefore, our results support the HMY hypothesis which predicts that the most productive firms become multinationals, reasonably productive firms rely on exports, and the least productive firms sell only to the domestic market. We can also confirm Head

and Ries's (2003) prediction that the productivity of foreign firms is higher than that of Japanese

multinational firms.[3] Summarizing our results, the ordering that we obtain regarding the distribution

of the TFP level of the four groups of firms is consistent with the predictions of recent theoretical

models and with the empirical evidence for other countries: the productivity distribution of foreign

firms operating in Japan dominates that of Japanese multinationals, which dominates that of

exporters, which in turn dominates that of non-exporters.

In order to examine whether there are systematic differences in the international activities of

medium-sized and large firms, we split our observations by firm size. The group of small and

medium-sized firms consists of firms with 300 or fewer employees, while the group of large firms

consists of firms with more than 300 employees. The result for small and medium-sized firms is

shown in Table 3, while that for large firms is shown in Table 4. In contrast with the results for the

whole sample, the results shown in Table 3 indicate that the productivity distribution of Japanese

multinationals does not dominates that of exporters in every year of the sample period. In the later

years, exporters are more productive than Japanese multinationals. Hence, the ordering of the

distribution of the TFP level in the case of small and medium-sized firms is not fully in line with the

theoretical models and empirical evidence of earlier studies. These results suggest that the ordering

based on firms' productivity levels according to internalization can differ for small and

medium-sized firms in Japan's manufacturing sectors. Possibly, this pattern is related to the 'export

boom' caused by the rapid growth of the Chinese economy.

Finally, looking at the results for large firms (Table 4), we find that the dominance of the

productivity distribution of multinationals over exporters is not statistically significant in four out of

eight years. However, a reversal of the ordering is observed only in 2000. These results are identical

with those for the whole sample with the exception that the hypothesis that exporters and Japanese

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[3] These findings are in line with other studies comparing the productivity of domestic and
foreign-owned firms in Japan, such as Kimura and Kiyota (2004) and Fukao, Ito and Kwon (2005).

multinationals have an identical productivity distribution is accepted for the years 1998, 1999, and 2001.

4. Conclusion

This paper investigated the hypotheses put forward by Helpman, Melitz and Yeaple (2003) and Head and Ries (2003) employing nonparametric methods and using Japanese firm level data. The results obtained are in accordance with these models as well as the empirical evidence for other countries when we used the whole sample and the sub-sample consisting of large-sized firms. They suggest that relatively productive firms will choose to export, while the most productive firms will further choose FDI. On the other hand, in the sub-sample of small and medium-sized firms, we did not find a substantial difference in productivity between multinationals and exporters.

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Table 1. Summary statistics of TFP level

All firms	Domestic firms	Exporting firms	Japanese MNEs	Foreign firms
No. of Obs.	76206	16238	16626	1783
Mean	-0.0429	-0.0044	0.0050	0.0605
Std. Dev.	0.1341	0.1258	0.1211	0.1675
Min.	-4.5105	-2.6053	-3.4664	-2.6287
Max.	1.4505	1.2589	0.7455	0.5759
Large firms				
No. of Obs.	11292	4664	9426	712
Mean	-0.0076	0.0274	0.0263	0.0727
Std. Dev.	0.1253	0.1155	0.1139	0.1664
Min.	-2.0339	-1.5565	-3.4664	-0.8462
Max.	0.8183	1.2589	0.7260	0.5091
Small firms				
No. of Obs.	64914	11574	7200	1074
Mean	-0.0491	-0.0172	-0.0229	0.0523
Std. Dev.	0.1346	0.1275	0.1246	0.1676
Min.	-4.5105	-2.6053	-2.2034	-2.6287
Max.	1.4505	0.9126	0.7455	0.5759

Table 2. Two-sample Kolmogorov-Smirnov tests comparing productivity between groups by year

Year	F vs. G	Number of observations				F=G		F<=G		G<=F	
		Domestic firms	Exporting firms	Japanese MNEs	Foreign firms						
1994	Exporters vs. Domestic					0.0854***	(0.000)	0.0854***	(0.000)	-0.0002	(1.000)
	MNEs vs. Exporters	9766	1873	1807	225	0.0893***	(0.000)	0.0893***	(0.000)	-0.0064	(0.928)
	Foreign vs. Japanese MNEs					0.2649***	(0.000)	0.2649***	(0.000)	-0.0106	(0.956)
1995	Exporters vs. Domestic					0.1281***	(0.000)	0.1281***	(0.000)	-0.0009	(0.997)
	MNEs vs. Exporters	10029	2171	1929	197	0.0947***	(0.000)	0.0947***	(0.000)	-0.0035	(0.975)
	Foreign vs. Japanese MNEs					0.2757***	(0.000)	0.2757***	(0.000)	-0.0272	(0.767)
1996	Exporters vs. Domestic					0.1304***	(0.000)	0.1304***	(0.000)	-0.0012	(0.995)
	MNEs vs. Exporters	9785	2116	2098	180	0.0995***	(0.000)	0.0995***	(0.000)	-0.0042	(0.964)
	Foreign vs. Japanese MNEs					0.3115***	(0.000)	0.3115***	(0.000)	-0.0182	(0.896)
1997	Exporters vs. Domestic					0.1524***	(0.000)	0.1524***	(0.000)	-0.0003	(1.000)
	MNEs vs. Exporters	9944	1850	2111	168	0.0822***	(0.000)	0.0822***	(0.000)	-0.0032	(0.980)
	Foreign vs. Japanese MNEs					0.2475***	(0.000)	0.2475***	(0.000)	-0.0165	(0.919)
1998	Exporters vs. Domestic					0.1293***	(0.000)	0.1293***	(0.000)	-0.0008	(0.998)
	MNEs vs. Exporters	9886	1754	2148	251	0.0937***	(0.000)	0.0937***	(0.000)	-0.0078	(0.890)
	Foreign vs. Japanese MNEs					0.2283***	(0.000)	0.2283***	(0.000)	-0.0264	(0.731)
1999	Exporters vs. Domestic					0.1447***	(0.000)	0.1447***	(0.000)	-0.0003	(1.000)
	MNEs vs. Exporters	9581	1790	2186	266	0.0906***	(0.000)	0.0906***	(0.000)	-0.0032	(0.980)
	Foreign vs. Japanese MNEs					0.2575***	(0.000)	0.2575***	(0.000)	-0.0202	(0.824)
2000	Exporters vs. Domestic					0.2004***	(0.000)	0.2004***	(0.000)	-0.0001	(1.000)
	MNEs vs. Exporters	8366	2873	1898	236	0.0961***	(0.000)	0.0004	(1.000)	-0.0961***	(0.000)
	Foreign vs. Japanese MNEs					0.3547***	(0.000)	0.3547***	(0.000)	-0.0118	(0.943)
2001	Exporters vs. Domestic					0.1569***	(0.000)	0.1569***	(0.000)	-0.0003	(1.000)
	MNEs vs. Exporters	8849	1811	2449	263	0.0488***	(0.007)	0.0488***	(0.007)	-0.008	(0.876)
	Foreign vs. Japanese MNEs					0.2718***	(0.000)	0.2718***	(0.000)	-0.041	(0.450)

Notes: The values in parentheses are p-values. *** Significant at the 1% level.

Table 3. Two-sample Kolmogorov-Smirnov tests comparing productivity between groups by year (Small and medium-sized firm

Year	F vs. G	Number of observations				F=G		F<=G		G<=F	
		Domestic firms	Exporting firms	Japanese MNEs	Foreign firms						
1994	Exporters vs. Domestic	8190	1334	667	122	0.071***	(0.000)	0.071***	(0.000)	-0.0015	(0.995)
	MNEs vs. Exporters					0.0495	(0.226)	0.0472	(0.138)	-0.0495	(0.113)
	Foreign vs. Japanese MNEs					0.3737***	(0.000)	0.3737***	(0.000)	-0.0067	(0.991)
1995	Exporters vs. Domestic	8538	1561	718	116	0.1152***	(0.000)	0.1152***	(0.000)	-0.0018	(0.992)
	MNEs vs. Exporters					0.0291	(0.798)	0.0123	(0.862)	-0.0291	(0.434)
	Foreign vs. Japanese MNEs					0.3473***	(0.000)	0.3473***	(0.000)	-0.0044	(0.996)
1996	Exporters vs. Domestic	8351	1537	785	104	0.1036***	(0.000)	0.1036***	(0.000)	-0.001	(0.995)
	MNEs vs. Exporters					0.0227	(0.952)	0.0219	(0.607)	-0.0227	(0.586)
	Foreign vs. Japanese MNEs					0.4009***	(0.000)	0.4009***	(0.000)	-0.0071	(0.991)
1997	Exporters vs. Domestic	8466	1380	831	95	0.1411***	(0.000)	0.1411***	(0.000)	-0.0005	(0.999)
	MNEs vs. Exporters					0.0544*	(0.093)	0.0322	(0.341)	-0.0544**	(0.047)
	Foreign vs. Japanese MNEs					0.3392***	(0.000)	0.3392***	(0.000)	-0.0045	(0.997)
1998	Exporters vs. Domestic	8461	1311	869	156	0.110***	(0.000)	0.110***	(0.000)	-0.0005	(0.999)
	MNEs vs. Exporters					0.0527	(0.110)	0.0527*	(0.055)	-0.0418	(0.160)
	Foreign vs. Japanese MNEs					0.2851***	(0.000)	0.2851***	(0.000)	-0.0094	(0.977)
1999	Exporters vs. Domestic	8162	1345	907	174	0.1257***	(0.000)	0.1257***	(0.000)	-0.0002	(1.000)
	MNEs vs. Exporters					0.0549*	(0.077)	0.0431	(0.134)	-0.0549**	(0.038)
	Foreign vs. Japanese MNEs					0.3371***	(0.000)	0.3371***	(0.000)	-0.0206	(0.883)
2000	Exporters vs. Domestic	7085	1701	1301	144	0.1506***	(0.000)	0.1506***	(0.000)	-0.0007	(0.999)
	MNEs vs. Exporters					0.0984***	(0.000)	0.0011	(0.998)	-0.0984***	(0.000)
	Foreign vs. Japanese MNEs					0.3994***	(0.000)	0.3994***	(0.000)	-0.0071	(0.987)
2001	Exporters vs. Domestic	7661	1405	1122	163	0.1415***	(0.000)	0.1415***	(0.000)	-0.0001	(1.000)
	MNEs vs. Exporters					0.0572**	(0.034)	0.0024	(0.993)	-0.0572**	(0.017)
	Foreign vs. Japanese MNEs					0.3053***	(0.000)	0.3053***	(0.000)	-0.0304	(0.769)

Notes: The values in parentheses are p-values. *** Significant at the 1% leve

Table 4. Two-sample Kolmogorov-Smirnov tests comparing productivity between groups by year (Large firms)

Year	F vs. G	Number of observations				F=G		F<=G		G<=F	
		Domestic firms	Exporting firms	Japanese MNEs	Foreign firms						
1994	Exporters vs. Domestic	1576	539	1140	103	0.0759**	(0.020)	0.0759***	(0.010)	-0.0001	(1.000)
	MNEs vs. Exporters					0.0809**	(0.017)	0.0809***	(0.008)	-0.013	(0.883)
	Foreign vs. Japanese MNEs					0.2323***	(0.000)	0.2323***	(0.000)	-0.0266	(0.875)
1995	Exporters vs. Domestic	1491	610	1211	81	0.1127***	(0.000)	0.1127***	(0.000)	0.000	(1.000)
	MNEs vs. Exporters					0.0888***	(0.003)	0.0888***	(0.002)	-0.0102	(0.920)
	Foreign vs. Japanese MNEs					0.2798***	(0.000)	0.2798***	(0.000)	-0.0576	(0.605)
1996	Exporters vs. Domestic	1434	579	1313	76	0.1452***	(0.000)	0.1452***	(0.000)	-0.0021	(0.996)
	MNEs vs. Exporters					0.0668*	(0.056)	0.0668**	(0.028)	-0.011	(0.907)
	Foreign vs. Japanese MNEs					0.3184***	(0.000)	0.3184***	(0.000)	-0.0473	(0.725)
1997	Exporters vs. Domestic	1478	470	1280	73	0.1503***	(0.000)	0.1503***	(0.000)	-0.0046	(0.985)
	MNEs vs. Exporters					0.0707*	(0.064)	0.0707**	(0.032)	-0.0231	(0.693)
	Foreign vs. Japanese MNEs					0.2575***	(0.000)	0.2575***	(0.000)	-0.0518	(0.690)
1998	Exporters vs. Domestic	1425	443	1279	95	0.1403***	(0.000)	0.1403***	(0.000)	-0.0073	(0.965)
	MNEs vs. Exporters					0.0647	(0.127)	0.0647*	(0.064)	-0.0412	(0.328)
	Foreign vs. Japanese MNEs					0.2513***	(0.000)	0.2513***	(0.000)	-0.0724	(0.395)
1999	Exporters vs. Domestic	1419	445	1279	92	0.1473***	(0.000)	0.1473***	(0.000)	-0.0033	(0.993)
	MNEs vs. Exporters					0.0626	(0.150)	0.0626*	(0.075)	-0.0434	(0.288)
	Foreign vs. Japanese MNEs					0.2754***	(0.000)	0.2754***	(0.000)	-0.017	(0.951)
2000	Exporters vs. Domestic	1281	1172	597	92	0.1769***	(0.000)	0.1769***	(0.000)	-0.0008	(0.999)
	MNEs vs. Exporters					0.0604	(0.111)	0.0025	(0.995)	-0.0604*	(0.056)
	Foreign vs. Japanese MNEs					0.307***	(0.000)	0.307***	(0.000)	-0.0326	(0.844)
2001	Exporters vs. Domestic	1188	406	1327	100	0.1601***	(0.000)	0.1601***	(0.000)	-0.0043	(0.989)
	MNEs vs. Exporters					0.0377	(0.769)	0.0313	(0.545)	-0.0377	(0.413)
	Foreign vs. Japanese MNEs					0.3182***	(0.000)	0.3182***	(0.000)	-0.064	(0.466)

Notes: The values in parentheses are p-values. *** Significant at the 1% level