Foreign Outsourcing, Exporting, and FDI: A Productivity Comparison at the Firm Level

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Revised: November 30, 2006; First version: August 13, 2004.

Abstract

This paper documents how productivity varies with globalization modes, based on a firm-level data set covering all manufacturing industries in Japan without any firm-size threshold. Only a small fraction of firms outsource, export, or invest abroad. Foreign outsourcers and exporters tend to be less productive than the firms active in FDI or in multiple globalization modes, but more productive than domestic firms. This productivity ordering is robust even when firm size, factor intensity and/or industry are controlled for. This paper also finds that outsourcers are on average less capital-intensive than other globalized firms.

JEL Classifications: F12; F23; D20; F14.

Keywords: foreign outsourcing; exporting; FDI; heterogeneity; firm-level data; productivity

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1. Introduction

Cross-border business activities in various forms have been facilitated by trade liberalization and the development of information technology. The globalization of firms is by no means universally observed, however. Even within industrialized countries, the vast majority of firms sell all their output to domestic consumers, have no affiliates overseas, and outsource exclusively to domestic suppliers. This paper uses firm-level data to document the extent to which firms engage in global activities and to evaluate how productivity varies with the choice of globalization modes.

Theoretical models have recently incorporated inter-firm heterogeneity into the firm's globalization decision. When firms are heterogeneous, the optimal choice differs across firms. Antràs and Helpman (2004) formalize how a firm sources abroad either through foreign outsourcing (FO) or foreign direct investment (FDI). In their model, the high-productivity firms source overseas by engaging in FDI; the low-productivity firms acquire intermediates only within the home country; and the firms with medium productivity choose FO. Global activities, especially FDI, require larger fixed entry costs, but bring in higher gross profits for productive firms.[1] On the other hand, Helpman, Melitz, and Yeaple (2004) analyze the decision to serve foreign markets through exporting or FDI. Their model predicts the following pattern in the access to foreign markets; only the most productive firms find it profitable to produce offshore by FDI; the firms with medium productivity serve foreign markets by exporting; the least productive firms serve only the domestic market. These theories of organizational mode choice have deepened our understanding of trade and FDI from the aggregate sector level to the fundamental firm level.

Empirical studies on the globalization decisions of heterogeneous firms remain limited, however, partly because of constraints in the availability of micro data. Though several studies

[1] Grossman and Helpman (2004) predict different ordering in their model with monitoring efforts.

have examined the exporting-FDI choice,[2] we are aware of no studies weighing the relative importance between FO and FDI.[3] "A firm-level data analysis is needed to answer this question, and no such analysis is available at this point in time" (Antràs and Helpman, 2004: p.553). This paper compares the firm's productivity across globalization modes by using firm-level data on FDI, export, and foreign outsourcing (explicitly distinguished from domestic outsourcing). The sample covers 118,300 firms without any firm-size threshold, across all manufacturing industries in Japan.

This firm-level data set has another advantage, as FO data are consistently derived from the same survey as the export and FDI data. Given that the same firm makes sales and acquisition decisions as a single optimizing unit, it is important to encompass both within an integrated empirical framework. As Grossman et al. (2005) and Yeaple (2003) imply, firms active in a globalization mode are likely to engage in other globalization modes to take advantage of the globalization effects in reducing costs, expanding outputs, and raising the returns from other global activities.[4] This paper investigates the complementarity among various globalization modes by exploiting the comprehensive breadth of our data set.

The rest of this paper is organized as follows. Section 2 describes the data. Section 3 documents the allocation of firms across eight different globalization modes. Section 4 compares the productivity of the firms. Section 5 closes with final remarks.

2. Description of data

[2] See Bernard et al. (2005), Brainard (1997), Girma et al. (2005), Head and Ries (2003), and Helpman et al. (2004), for example.

[3] Görg et al. (2004) estimate the relationship between intermediate imports and the productivity of exporters and foreign-owned firms in Ireland. They do not analyze the globalization mode decision or outward FDI, however.

[4] Yeaple (2003) examines firms simultaneously engaged in vertical and horizontal FDI. Grossman et al. (2005) examine foreign and domestic outsourcing. Head and Ries (2003) formalize firms exporting to some countries and investing in others.

2.1. Data source

This paper extracts firm-level data from *The Basic Survey of Commercial and Manufacturing Structure and Activity* (Sho-Kogyo Jittai Kihon Chosa in Japanese).[5] The survey covers 118,300 firms in all manufacturing industries. No firm-size threshold is imposed, irrespective of the firm's involvement in global activities. The only previous dataset to come close to matching this sample size was that by Bernard, Eaton, Jensen, and Kortum (hereinafter BEJK) (2003) on about 200,000 plants derived from U.S. *Census of Manufacturers*. Thus, this survey is regarded as an accurate overall representation of the whole of manufacturing in Japan. As the survey was conducted only once at 1998, the data set is in a cross-section format.

The survey contains various corporate data, such as sales, employment, capital, direct exports, and FDI. As unique data on FO, the survey directly asks sample firms whether they "contract out manufacturing or processing tasks to other firms overseas." As firms (suppliers, subcontractors) overseas and those within the home country are separated in this questionnaire, foreign outsourcing thus defined is explicitly distinguished from domestic outsourcing.[6]

2.2. Measures of productivity

Before reporting empirical results, this section discusses various measures for productivity. This paper begins with labor productivity, defined by VA (value-added) per-worker, as it certainly is one of the most frequently used measures. The comparison after subtracting costs is essential when outsourcers are involved. If we depend on gross output (sales) per-worker, vertically integrated firms (exporters or investors) appear to be less productive than outsourcers even with

[5] Though the original firm-level data cannot be publicly disclosed, any researcher can gain access to the same data set by obtaining official individual permission from the government in advance.
[6] Though it does not cover FO of non-production services, this definition is more appropriate than intermediate import data in excluding intermediates purchased in the marketplace. Tomiura (2005) explains the survey's definition in detail and compares it with other FO measures.

identical sales and labor productivity, because outsourcers employ fewer workers in-house. Hence, the principal productivity measure in this paper is, in logarithms,

$$\theta = \ln(VA/L) = \ln[(Sales - Cost)/L], \quad (1)$$

where L is the number of regular employees. *Cost* denotes "the cost of goods sold," or cost of sales, which is the only cost data available in the survey.[7] This paper will also report sales per-worker (before subtracting cost) for a robustness check.

Second, this paper uses Total Factor Productivity (TFP), an ideal measure for evaluating the contribution of capital. The use of cross-section data, however, makes it practically impossible to estimate the true TFP for each firm. As an alternative, this paper adopts an approximate TFP:[8]

$$ATFP = \ln\frac{Q}{L} - \frac{1}{3}\ln\frac{K}{L}. \quad (2)$$

Both value-added and sales are used as Q in calculating ATFP. K denotes tangible fixed assets. This paper uses ATFP only for a robustness check purpose because ATFP is merely a practical approximation of the true TFP and cannot be calculated for the vast number of surveyed firms (21,950 firms, all with capital recorded as zero or unreported).

Third, as another robustness check, this paper compares the firm size (L) and the home market share.[9] These indices are available for all firms, measured with relatively decent accuracy, and informative since they increase monotonically with underlying productivity in standard theoretical models.[10]

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7 This accounting cost concept covers not only outsourcing payment, but also production wages, a component of value-added rather than economic costs. As globalized firms tend to pay higher wages (e.g., Bernard and Jensen, 1999), however, the productivity premium of globalized firms based on this definition should be a conservative estimate.

8 This productivity proxy adjusts labor productivity by capital intensity, with the importance of capital as weight. See Head and Ries (2003), for example, for ATFP.

9 Home market share is defined as the share of the firm's sales in the domestic market for each 2-digit industry.

10 Yeaple (2005) uses home market share and provides a convincing case for it in this context. Head and Ries (2003) also use firm size in the domestic market along with ATFP.

3. Share of firms

3.1. Overall comparisons

This section classifies firms by their choice of globalization modes. Table 1 presents the percentage share of each type of firms among the total number surveyed. All firms with cost data are included (98% of surveyed firms). *O* denotes firms outsourcing to foreign suppliers, and *X* denotes exporters. FDI firms, *I*, are identified based on ownership of foreign affiliates, but only if they own shares of at least 20% (to represent FDI in manufacturing affiliates as opposed to FDI in sales branches or portfolio investment). The eight categories in the table are disjoint, i.e. mutually exclusive. *IO*, for example, represents firms that outsource and invest abroad but never export. We note the following points from this table.

First of all, about 90% of the firms are "domestic" (involved in none of these three activities). This level of share is overwhelming, though some of these firms may be linked with global economies through other channels, such as raw material imports or international portfolio investment.[11] Moreover, far fewer than 1% of the firms engage in all three globalization modes simultaneously. This finding may suggest that fixed entry costs for globalization are non-negligible.

Second, the exporters account for a relatively high share in globalized firms. This may reflect the difference in entry costs across various globalization channels. We must note, however, that if the survey had captured FO of non-production services, the share of FO firms would have far exceeded that of FDI firms.

Third, 64% of investors are active in other globalization modes (exporting and/or

[11] This low share of globalized firms is a conservative estimate. Firms with no less than 50 employees are surveyed with certainty, while those with less than 50 (those more likely to be domestic firms) are sampled with a probability of less than one.

outsourcing). The most frequent globalization mode among FDI firms is *XI* rather than *I*. On the other hand, exporting is the only globalization channel for 69% of exporters, while foreign outsourcing is the only globalization channel for 64% of foreign outsourcers. These figures indicate that firms may find it difficult to own affiliates overseas unless they have accumulated experience in exporting or foreign outsourcing.

This paper differs from previous work in identifying outsourcers and in distinguishing overlaps among the three globalization modes. However, the results on exporters and investors are generally consistent with the existing evidence.[12] For example, Bernard et al. (2005) report that 4.2% of firms surveyed in the U.S. at 2000 were exporters without FDI. This share is in a comparable range with 4.65% (*X*+*OX*) in Table 1.[13]

3.2. Inter-industry comparisons

In contrast with the previous table, which combines all firms, Table 2 disaggregates firms by industry.[14] Several notable differences in the percentage share of firms among industries emerge from this table.

First, the extent of globalization varies considerably across industries. The chemical industry (20) has the lowest percentage of domestic firms, at just over 80%, followed by the four machinery industries (general machinery, electric machinery, precision instruments, and transport equipment). Among these machinery industries, electric machinery and transport equipment industries have the highest share of the most globalized category of firms, *OXI*. Around 8% of the globalized firms in these two industries are active in all three modes. At the

[12] BEJK (2003) find a higher share of exporters in the U.S. from plant data, yet the exporters are more likely to be multi-plant firms than domestic firms. Head and Ries (2003) report that 43% of Japanese firms are *XI*, but their sample is limited to 1,070 publicly listed firms.
[13] They define "multinational exporters" as firms with non-zero exports to related parties.
[14] Disaggregation on 3-digit industries is available upon request.

other end of the spectrum, the industries with the five highest percentages of domestic firms (94-97%) are timber and wooden products (16), beverage, tobacco and feed (13), food manufacturing (12), furniture and fixture (17), and ceramic, stone and clay (25). All of these industries are generally presumed to have high trade costs.

Inter-industry differences are also apparent if we compare different globalization modes. Apparel (15) ranks high in *O* and *IO* but low in *X* and *XI*, while chemical products (20) rank high in *X* and *XI* but low in *O* and *IO*. While food manufacturing (12) and beverage, tobacco and feed (13) are among the least globalized industries, with particularly low percentages of *O*, about a quarter of globalized firms within these industries choose *I*. The printing and publishing industry (19), on the other hand, depends mostly on *X* and engages in very little *I*. These industry characteristics are generally consistent with our daily observations.[15]

Finally, there appear to be *complementarities* between different globalization modes, as indicated by Yeaple (2003) and Grossman et al. (2005). An industry with a high share of exporters, for example, tends to have a high share of investors (e.g., chemical products, electric machinery). Table 3 summarizes the correlation matrix across three-digit industries. The inter-industry correlation between *I* and *XI* is as high as 0.80.[16] The clearly positive, though weaker, correlation is also observed for outsourcing (*O* and *OX*, *IO*).

4. Productivity comparisons

4.1. Overall comparisons

Table 4 compares alternative measures of productivity. The average productivity is expressed as

[15] Antràs and Helpman (2004), for example, contrast Intel, a firm which assembles most of its microchips in-house, with Nike, a firm which outsources most of its manufacturing. Head and Ries (2003) refer to food manufactures as examples of *I* firms.

[16] The correlation rises to 0.897 when calculated between all exporters (*X*+*OX*+*XI*+*OXI*) and all investors (*I*+*XI*+*IO*+*OXI*).

a percentage logarithm difference from the productivity of domestic firms: $100\left(\bar{\theta}^{XI} - \bar{\theta}^{Dom}\right)$ for *XI* firms, for example, where $\bar{\theta}$ indicates the mean productivity.

A comparison of various measures suggests the following. First, the gap between global and domestic firms is substantially wider in firm size than in productivity. Globalized firms are larger than domestic firms by at least 70% in *O* and by more than 300% in *XI* and *OXI*.[17] Similar regularity is also exhibited in the comparison of home market shares, which are adjusted for size differences directly due to global activities.

Second, the productivity gap is considerably larger in sales per-worker, but remains generally substantial even after cost is subtracted: the difference in value-added labor productivity from domestic firms is at least 10% for *X* versus more than 60% for *XI* and *OXI*, except when *X* is measured by value-added ATFP.[18] Given that the choice of productivity measure has no significant effect on the productivity ordering of globalization modes, the following sections of this paper concentrate on the value-added labor productivity.

The same table also shows the capital-labor ratio since the labor productivity is inevitably affected by *K/L*. On average, domestic firms are the least capital-intensive and investors are the most capital-intensive. Outsourcers are more labor-intensive than other globalized firms. This finding of labor-intensiveness of outsourcers is consistent with the theoretical prediction by Antràs (2003).[19]

Several findings should be noted on the comparisons across various globalization modes. First, the average productivity of domestic firms is distinctively lower than that of any

[17] From a different Japanese firm-level data set, Head and Ries (2003) report that domestic firms are 19-33% smaller and *XI* firms are 105-332% larger than *X* firms in size.
[18] Note that the surveyed cost, which is subtracted from productivity, includes production wages.
[19] Investment cost sharing is relatively easier in physical capital, while hiring/managing workers requires local knowledge/management. Motivated by these observations, Antràs (2003) shows that outsourcing contracts (compared with vertical integration) lose their attractiveness as the capital-labor ratio rises.

globalized firms. The magnitude of value-added labor productivity advantage of exporters (from 10% for *X* to 68% for *XI*) is also roughly in line with the existing evidence (e.g., BEJK (2003) find a gap of 33% in the U.S. by combining *X* together with *XI*, *OX*, and *OXI*).

Second, investors are on average more productive than other globalized firms, while exporters appear the least productive among globalized firms. The finding of higher productivity of FDI firms than exporters is in line with previous results (e.g., Girma et al., 2005).[20] The finding of higher productivity of FDI firms compared with outsourcers provides rare and direct evidence in support of the theoretical prediction by Antràs and Helpman (2004).

Third, the firms active in multiple globalization modes, especially *OXI* and *XI*, tend to be particularly productive. The comparison of *XI* with *X* or *I* is consistent with the result by Head and Ries (2003). As far as the author knows, no previous studies have identified *OXI* firms.

4.2. Productivity comparisons conditional on firm size and factor intensity

This section controls for the firm size or capital intensity in comparing productivity, as firm size and capital intensity are both supposed to be critical in determining the globalization of firms.[21] This paper investigates whether the high average productivity we observe in globalized firms stems solely from their capital intensity or large size.

This paper sorts all of the firms by firm size, and allocates them into approximately 300 bins, as defined by BEJK (2003).[22] This paper also controls for *K/L* by a similar procedure. Table 5 displays the percentage logarithm deviations from domestic firms, after subtracting the average of each bin. See the Appendix for the definitions of bins.

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[20] Head and Ries (2003) find that the size measure strongly supports the theory, while ATFP result in Japan is mixed. They depend, however, on a limited sample of publicly listed firms.

[21] This paper does not analyze the relation with skills since the survey contains no data on skills or occupations.

[22] BEJK (2003) assign plants into 500 bins, but the size of their bins are approximately the same as ours because their sample size is more than twice as large.

As the most notable result from Table 5, this paper finds that the firm's globalization cannot be reliably predicted solely by the size or factor intensity of the firm. The control for the firm size still leaves non-negligible (15-48%) productivity gaps (demonstrated in row (A))[23]. The productivity premium remains considerable (13-35%) for all modes except *X*,[24] even after controlling for the firm's capital-labor ratio (see row (B)).[25] The firm-size gap contracts somewhat but remains very large (39-292%) for all eight globalization channels, even after controlling for the differences in productivity (see row (C)).

While Table 5 sums over all firms, more disaggregated results are provided in Table 6. The regularities in this table shed some doubt on the standard simplifying assumption that entry costs for globalization are the same across all firms. The productivity advantage required for many globalization channels tends to be more substantial among smaller-sized firms. This result is plausible, as high labor productivity is only one of several attributes of large firms which facilitate globalization. Other attributes, such as strong headquarter functions, rich retained earnings, and established distribution networks and consumer recognition, for example, make it easier for large firms to expand globally. Similarly, though less obviously, the productivity differential appears wider among less capital-intensive firms, and the firm size necessary for globalization with the exception of outsourcing appears larger among firms with higher productivity.

4.3. Intra- and inter-industry productivity comparisons

[23] The control for the firm size is effective only for *I*, *XI*, and *OXI*. This may be because FDI firms are especially large, as reported in row (C) of Table 4.

[24] BEJK (2003) report the U.S. exporter's premium as 9-20% in labor productivity, controlling for *K/L*. Bernard and Jensen (1999) report it as 4-18% in TFP. Neither of them distinguishes *OX*, *XI*, and *OXI* firms among exporters, however.

[25] The control for *K/L* significantly decreases the productivity gap. The numerator in our productivity, however, is approximately equal to the economic profit plus capital depreciation, which is inevitably affected by capital intensity.

The previous section disaggregated firms by size or capital intensity, but not by industry, an equally important attribute in predicting the firm's globalization choice. Accordingly, this section investigates the productivity premium of globalized firms within and across industries.

Table 7 reports intra-industry variations. Firms are disaggregated into 75 three-digit industries, each of which is further divided into 10 bins according to the firm size or capital intensity.[26] The figures in the table are the results after subtracting the average of each industry or of each intra-industry bin.

Table 7 demonstrates that the industry characteristics, firm size, and factor intensity are insufficient to predict the globalization choice of each firm. Row (A) shows that the productivity premium expands rather than contracts in most globalization modes when firms in the same industry are compared. Row (B) confirms that the firm size differential within each industry helps little in predicting the firm's globalization pattern. As we see in row (C), a substantial productivity premium (16-40%) remains even with the tightest controls both for industry and capital intensity, except in the case of mode *X*.

Table 8 compares the intra-industry productivity premium of globalized firms relative to domestic firms across all industries.[27] The figures in this table are the industry disaggregation of those in row (A) of Table 7. Again, globalized firms are more productive than domestic firms in many industries. The average productivity of *I* and *XI* firms, for example, is higher than that of domestic firms in every industry.[28] Similarly, the productivity premiums of *O, IO,* and *OXI* firms are positive in all industries except one.[29]

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[26] The 3-digit classification is the most detailed level in the survey. The effect of industry control is stronger in BEJK (2003), with 458 four-digit industries.

[27] Result with 75 three-digit industries is available upon request.

[28] In textile and apparel industries, low-productivity firms are involved in exporting. The small overall productivity premium for *X* must be strongly influenced by these two industries. Given that they are typical declining industries, many traditional exporters may continue exporting even after they no longer sustain a productivity advantage.

[29] The productivity advantage for *I* and *OXI* is very high in food and beverage industries, which are

These results, controlling for industries, confirm that intra-industry, inter-firm heterogeneity is important in describing a firm's globalization pattern.

4.4. Distribution of productivity

Though the previous sections have compared the average productivity, this section explores inter-firm distributions within each globalization mode. Table 9 summarizes the basic statistics for the logarithm labor productivity. Three points are to be noted. First, relatively large cross-section variations compel us to avoid depending exclusively on average values and to investigate the distribution within each globalization category. Second, the difference in standard deviation indicates that most of the *XI* and *OXI* firms are all very productive, whereas the firms globalized only through exporting distribute over a wide range of productivity. Finally, the median is larger than the mean in all globalization modes, suggesting that firms are distributed with a long tail over the low-productivity range.

Figures 1 to 3 plot the distributions of productivity (the percentage share of firms within each productivity interval), each of which is an empirical counterpart of the probability density function (pdf). See the Appendix for details on the construction of the intervals.[30] Two graphs are shown for every case: the upper one of which is for the productivity relative to the overall mean, while the lower one of which normalizes each firm's productivity by the mean productivity in its 3-digit industry.

Figure 1 compares domestic firms with the most globalized group of firms (*OXI*). *OXI* firms are distributed heavily in relatively high productivity ranges. Thus, this paper finds again that *OXI* firms are more productive than domestic firms. The comparison of the two graphs in

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characterized by inactive globalization (see Table 2). This finding suggests that industry-specific factors such as trade costs raise entry costs for globalization.

[30] The number of intervals chosen is 18, exactly the same as in BEJK (2003), to facilitate comparisons. The same 18 intervals are applied to all cases.

Figure 1 demonstrates that controlling for industry only negligibly affects the productivity distributions, corroborating the result from BEJK (2003) on exporters.

Next, Figure 2 provides distributional information on firms globalized through only one mode. Domestic firms are shown again to provide a benchmark. *I* firms are concentrated heavily over high-productivity ranges, whereas *X* firms are distributed widely over very low-productivity ranges. *O* firms are located somewhere between. Judging from the bottom graph, the control of industry appears to slightly tighten the distributions.

Figure 3 plots firms active in two globalization modes. The productivity distribution of *XI* firms shifts considerably to the right of that of other firms. Again, the productivity advantage of globalized firms survives even when looking at disaggregated industries.

These productivity distributions described here confirm our previous findings. Higher productivity of investors compared with exporters and domestic firms is in line with the existing evidence from inter-firm distributions.[31] This paper also confirms the robustness of our finding that FDI firms are more productive than FO firms even if the comparison is based on cross-firm distributions.

5. Concluding remarks

This paper has demonstrated that FDI firms are distinctively more productive than foreign outsourcers and exporters, which in turn are more productive than domestic firms. This ordering is consistent with theory and has been confirmed to be robust even after controlling for industry, firm size, and factor intensity. Thus, this paper has provided direct evidence in support of the empirical relevance of the heterogeneous firm model in international trade.

These findings are informative as a detailed description of firm heterogeneity. The

[31] Girma et al. (2005) find, in the case of U.K., that the productivity distribution of multinational plants stochastically dominates that of exporters, which in turn dominates that of non-exporters.

causality between a firm's productivity and its choice of globalization mode, however, will need to be analyzed if similar firm-level data become available in the longitudinal form.

Acknowledgement

The Ministry of General Affairs of Japan granted me access to the government micro-data files by issuing official approvals. Kei Nara and Mutsuharu Takahashi assisted me in accessing the data. Seiichi Katayama encouraged me to initiate this research. Earlier versions of this paper were presented at the Econometric Society World Congress and international conferences held by Kobe University and Yokohama National University. Helpful comments from participants, especially Craig Parsons and Stephen Yeaple, are acknowledged. The author is deeply grateful to the Editor (Jonathan Eaton) and two anonymous referees for their valuable comments. This research was partly supported by the Japan Economic Research Promotion Foundation and Grant-in-Aid for Scientific Research C16530152. Any remaining errors are my own.

Appendix Construction of bins/intervals

[The construction of the bins] All firms with cost data are sorted by *L* and allocated into approximately 300 size bins. Each bin cannot include exactly the same number of firms, as the firms with exactly the same number of employees are assigned into the same bin. The productivity bins, grouped according to productivity levels, follow the same definition. In sorting by *K/L*, all the firms lacking data on capital or with capital recorded as zero are grouped into the same bin. The industries with severely limited numbers of firms (Industry Nos. 203, 211, 219, and 231) are not divided into 10 bins. The thresholds for the bins is available upon request. The value $\frac{1}{N_X}\sum_i\left[\theta_i - \bar{\theta}(b(i))\right]$ is displayed in the tables for *X* firms, for example. Firms are indexed by *i*. N_X is the number of *X* firms, while *b(i)* denotes the firm-size bin to which firm *i* belong. $\bar{\theta}(b)$ is the mean over the firms belonging to this bin *b*.

[The definition of productivity intervals for pdf] Firms are first sorted by productivity level (after subtracting the mean) within each globalization mode. Next, the domestic firms in the top and bottom 1% in the overall mean case are assigned to the top and bottom intervals, respectively. The productivity range between these two thresholds is equally divided into 16 intervals. The same 18 intervals thus constructed are applied to all cases.

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Table 1 Percentage of firms

O	*X*	*I*	*OX*	*XI*	*IO*	*OXI*	*Domestic*
1.71	4.35	1.08	0.30	1.23	0.25	0.42	90.65

Notes: The percentages shown above are of the total number of firms. Categories are mutually exclusive.

Table 2 Percentage within each industry

INDUSTRY	*O*	*X*	*I*	*OX*	*XI*	*IO*	*OXI*	*Dom*	# of firms
12. Food manufacturing	0.39	2.04	1.05	0.02	0.27	0.07	0.06	96.09	12,228
13. Beverage, tobacco & feed	0.36	1.89	0.79	0.03	0.27	0.09	0.03	96.53	3,288
14. Textile	1.38	4.04	0.95	0.05	0.49	0.19	0.12	92.78	5,886
15. Apparel & textile products	2.37	2.82	1.35	0.20	0.22	0.67	0.07	92.30	8,594
16. Timber & Wooden products	0.96	1.26	0.68	0.07	0.05	0.19	0.02	96.77	4,276
17. Furniture & fixture	1.63	1.17	0.78	0.04	0.21	0.28	0.04	95.86	2,826
18. Paper & pulp products	1.78	3.21	0.76	0.16	0.57	0.16	0.00	93.36	3,147
19. Printing & publishing	2.14	4.84	0.73	0.13	0.23	0.21	0.13	91.59	5,330
20. Chemical products	0.91	10.27	2.01	0.39	5.06	0.11	0.50	80.76	3,633
21. Petroleum & coal products	1.12	5.34	2.25	0.00	3.37	0.00	0.28	87.64	356
22. Plastic products	1.39	3.24	1.83	0.08	1.57	0.30	0.38	91.20	4,965
23. Rubber products	2.06	3.33	0.76	0.17	1.18	0.42	0.63	91.45	2,374
24. Leather & fur products	3.48	1.74	0.62	0.17	0.17	0.17	0.06	93.61	1,783
25. Ceramic, stone & clay	0.91	3.09	0.64	0.03	0.70	0.10	0.15	94.38	5,958
26. Iron & steel	1.86	5.13	1.57	0.25	1.16	0.17	0.29	89.57	2,416
27. Nonferrous metals	1.43	4.86	1.59	0.11	2.54	0.21	0.63	88.64	1,892
28. Metal products	1.75	4.04	0.91	0.25	0.83	0.10	0.19	91.93	10,780
29. General machinery	2.45	7.26	0.92	0.76	2.27	0.21	0.91	85.20	11,166
30. Electric machinery	2.31	6.36	1.23	0.71	2.29	0.39	1.18	85.53	12,185
31. Transport equipment	1.84	4.98	1.64	0.39	2.58	0.42	0.96	87.19	5,964
32. Precision instruments	2.20	7.40	0.54	0.95	1.48	0.18	0.84	86.41	3,906
34. Miscellaneous	2.94	4.42	1.16	0.57	1.32	0.59	0.59	88.40	3,872

Notes: The percentage of firms within each industry is shown, except in the last column. The ordnance industry (33) is merged into general machinery (29).

Table 3 Inter-industry correlation

	O	*X*	*I*	*OX*	*XI*	*IO*	*OXI*	*Dom*
O	1							
X	0.091	1						
I	–0.254	0.582	1					
OX	0.585	0.415	–0.176	1				
XI	–0.185	0.772	0.801	0.118	1			
IO	0.561	–0.103	–0.117	0.262	–0.158	1		
OXI	0.353	0.307	0.006	0.449	0.104	0.197	1	
Dom	–0.168	–0.945	–0.697	–0.420	–0.011	–0.879	–0.407	1

Notes: The correlation is for the share in the number of firms across 75 three-digit industries.

Table 4 Alternative measures of productivity

	O	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
(A) *Q/L* (value-added)	23.27	10.04	39.92	41.94	67.68	34.06	62.70
(B) *Q/L* (sales)	50.58	45.22	86.69	81.35	104.56	80.96	109.08
(C) Firm size (*L*)	70.54	145.34	224.82	173.31	322.27	186.01	341.45
(D) Home Market Share	87.03	119.70	318.66	210.89	348.72	283.20	390.41
(E) TFP (value-added)	10.34	–8.20	5.83	22.93	27.37	10.70	25.12
(F) TFP (sales)	28.02	18.13	40.69	50.79	52.39	45.85	59.82
(G) *K/L*	21.00	41.41	86.26	40.95	105.03	53.48	96.48

Notes: The percentage logarithm difference from domestic firms is shown. Firms without capital data are excluded from rows (E)-(G).

Table 5 Conditional comparisons

	O	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
(A) Productivity gap within size bins	25.70	14.51	35.75	42.65	47.79	33.23	34.83
(B) Productivity gap within K/L bins	16.06	–1.80	13.20	30.44	35.42	18.06	33.89
(C) Size gap within productivity bins	38.52	102.73	172.78	132.54	271.03	134.09	292.07

Notes: The mean of each bin is subtracted. The percentage log deviation from domestic firms is shown.

Table 6 Gap within bins

Size bins	*O*	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
$1 \leq L \leq 5$	49.55	19.31	57.50	68.56	101.41	156.90	74.56
$6 \leq L \leq 19$	32.81	24.34	72.02	70.36	71.02	64.75	55.65
$20 \leq L \leq 99$	21.94	20.67	36.48	45.81	65.00	43.00	49.22
$100 \leq L$	14.97	11.96	38.40	35.79	52.21	16.99	39.36

K/L bins	*O*	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
K=0 or No *K* data	55.97	15.85	n. a.	65.37	71.03	112.38	103.83
$K / L < 1$	39.82	–9.28	25.97	53.21	93.97	83.79	99.66
$1 \leq K / L < 2.75$	14.24	–10.35	11.63	20.80	35.92	18.19	26.63
$2.75 \leq K / L \leq 7.45$	10.93	–4.29	6.36	35.23	29.38	12.08	28.68
$7.45 < K / L$	7.16	4.71	18.54	25.95	38.69	15.55	37.23

Productivity bins	*O*	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
$\theta \leq 0$	64.83	109.65	137.15	137.27	150.78	158.19	185.07
$0 < \theta \leq 1.2040$	43.33	86.98	146.03	144.84	209.23	118.06	206.75
$1.2040 < \theta \leq 1.8052$	42.23	96.01	143.23	102.66	230.12	136.73	249.14
$1.8052 < \theta$	31.56	123.50	217.65	153.72	317.18	144.66	353.41

Notes: The mean of each bin is subtracted, as in Table 5. The upper two panels display productivity, while the bottom panel displays firm size. All figures are in % log relative to domestic firms.

Table 7 Productivity gaps conditional on industries

	O	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
(A) Within industries	26.94	8.46	41.31	46.21	65.47	45.19	70.85
(B) Within industries (size bins)	28.48	9.83	41.36	47.73	59.26	51.78	70.25
(C) Within industries (*K/L* bins)	16.69	–3.25	15.83	30.68	35.99	23.30	40.14

Notes: The mean of the respective industry and bin is subtracted. There are 75 three-digit industries and 10 bins within each industry.

Table 8 Productivity gap within each industry

INDUSTRY	*O*	*X*	*I*	*OX*	*XI*	*IO*	*OXI*
12. Food manufacturing	31.79	0.39	68.95	18.80	122.43	108.43	136.11
13. Beverage, tobacco & feed	57.41	49.36	110.66	–7.16	161.58	175.70	202.66
14. Textile	29.29	–26.55	24.84	77.80	48.70	46.54	81.67
15. Apparel & textile prdcts	80.92	–51.81	51.96	93.94	86.23	69.66	95.50
16. Timber & Wooden prdcts	23.02	–7.93	54.65	47.70	9.94	27.38	–34.02
17. Furniture & fixture	7.10	–4.78	17.80	82.07	5.24	1.27	169.58
18. Paper & pulp products	36.00	22.09	55.69	47.07	58.86	90.89	n. a.
19. Printing & publishing	8.01	–6.82	58.34	35.20	73.62	24.15	30.78
20. Chemical products	5.28	50.28	63.54	73.65	95.06	100.07	119.32
21. Petroleum & coal prdcts	18.37	33.73	76.92	n. a.	86.83	n. a.	89.14
22. Plastic products	0.39	–1.11	15.97	–33.99	45.61	48.58	29.18
23. Rubber products	21.85	22.97	43.47	47.86	71.58	3.04	75.89
24. Leather & fur products	59.92	0.20	78.90	100.47	77.26	70.21	84.98
25. Ceramic, stone & clay	9.24	20.31	58.77	60.37	47.75	70.42	85.90
26. Iron & steel	–13.10	–2.69	17.26	–27.61	26.80	6.42	47.81
27. Nonferrous metals	20.24	15.18	20.13	27.80	46.96	–15.87	45.76
28. Metal products	15.21	–4.38	36.25	25.98	32.83	29.31	36.35
29. General machinery	3.46	17.60	10.52	39.31	59.04	7.63	51.16
30. Electric machinery	28.60	10.90	40.93	45.55	82.94	43.28	84.45
31. Transport equipment	17.88	–6.59	22.92	34.38	45.04	7.77	50.32
32. Precision instruments	36.11	36.90	23.34	51.86	83.32	59.79	74.39
34. Miscellaneous manufact.	45.56	36.60	41.72	91.42	60.45	57.13	109.74

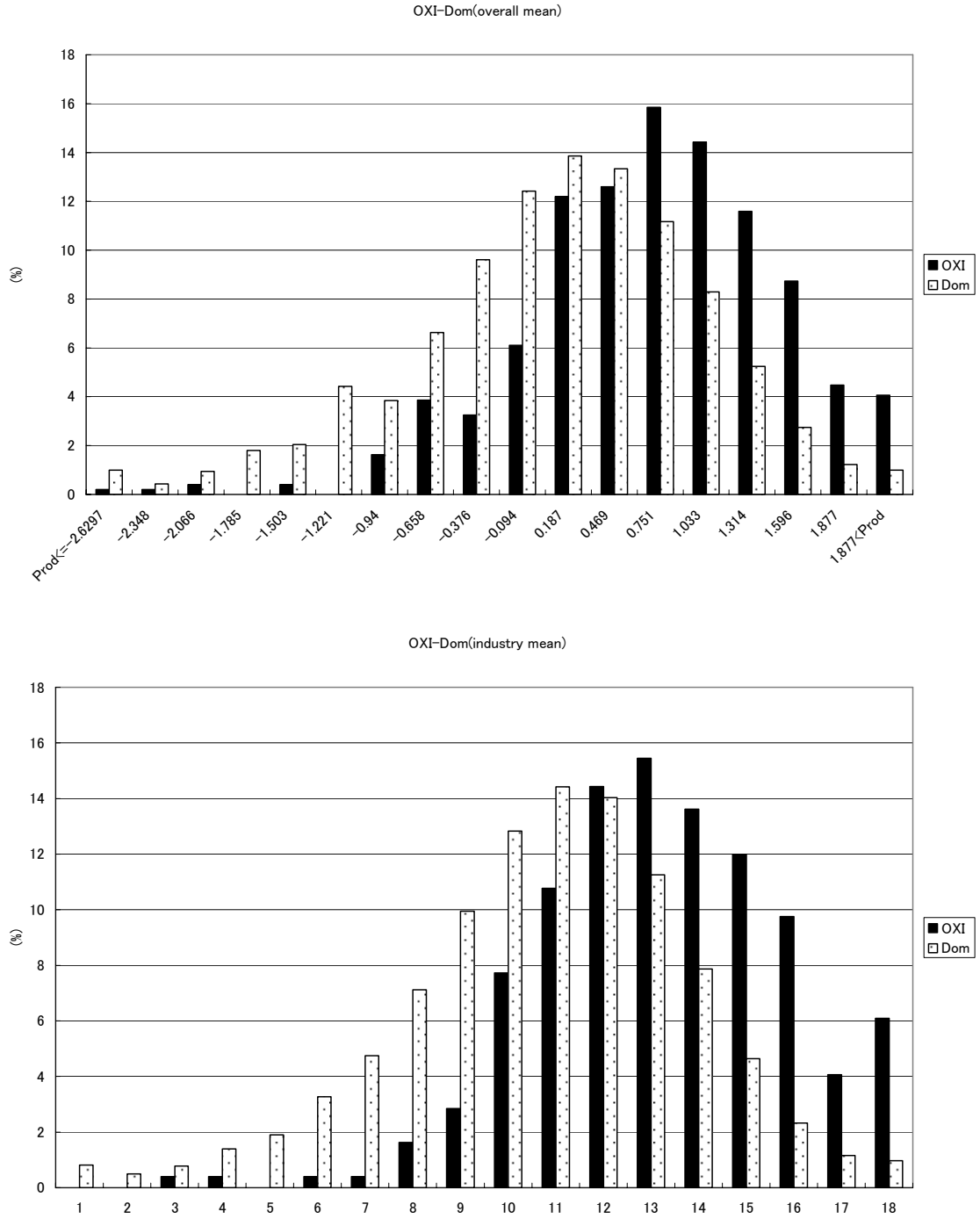
Notes: The percentage log difference from domestic firms within each industry is shown.

Table 9 Summary statistics

	O	*X*	*I*	*OX*	*XI*	*IO*	*OXI*	*Dom*
AVERAGE	1.45	1.32	1.62	1.64	1.89	1.56	1.84	1.22
MEDIAN	1.48	1.45	1.67	1.72	1.93	1.62	1.87	1.29
ST. DEV.	0.86	1.05	0.93	0.86	0.75	0.96	0.79	0.91

Figure 1

Productivity distribution (*OXI* vs. *Domestic*)



Notes: The intervals of logarithm productivity are on the horizontal axis. The percentage of firms is on the vertical axis. The overall mean is subtracted from each firm's productivity in the top graph, while the 3-digit industry mean is subtracted in the bottom graph. The same 18 productivity intervals are applied to all cases.

Figure 2

Productivity distribution (*O*, *X*, *I* vs. *Domestic*)

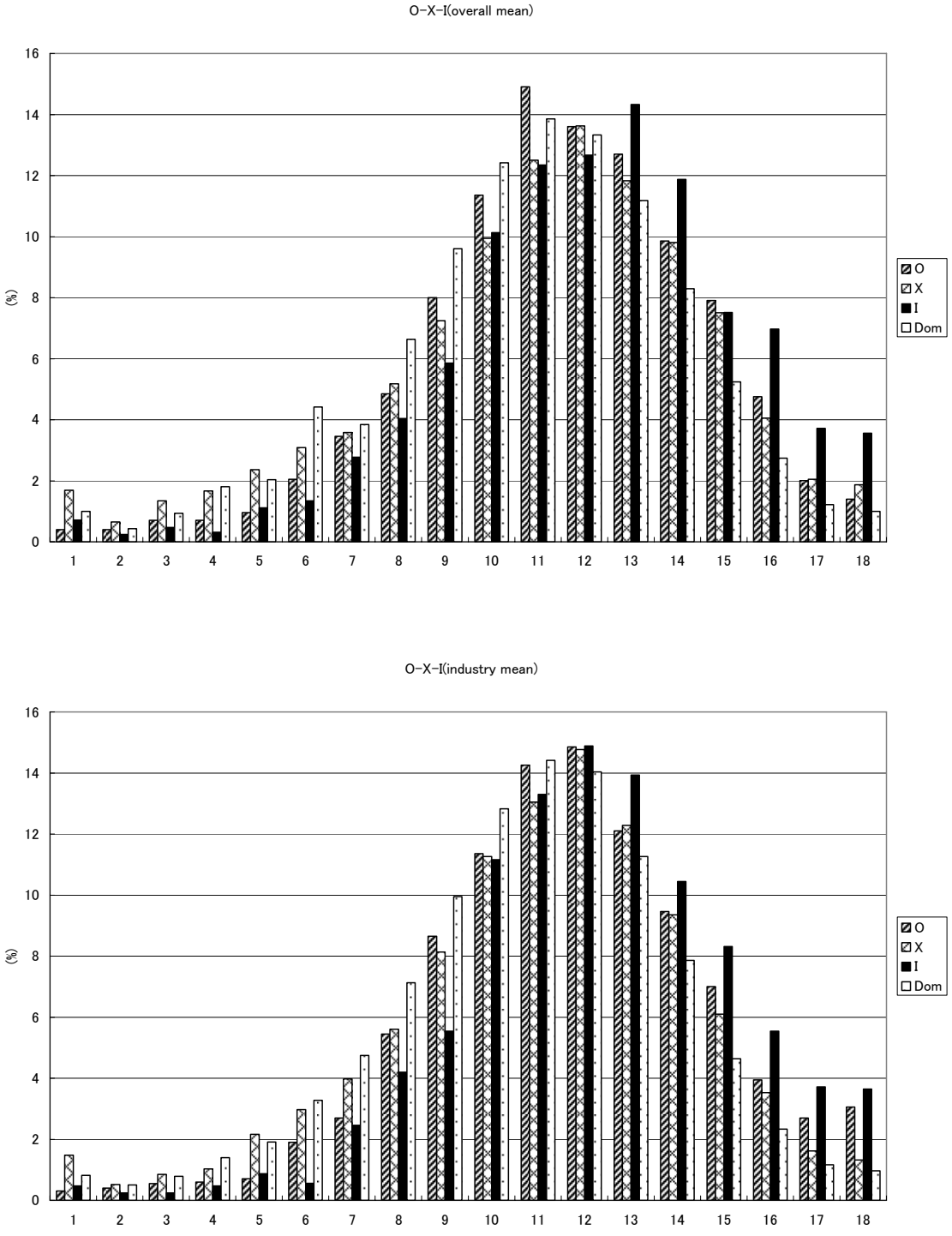


Figure 3

Productivity distribution (*OX*, *XI*, *IO* vs. *Domestic*)