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Heterogeneity and the Structure of Exports and FDI: A cross-industry analysis of Japanese manufacturing

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Heterogeneity and the Structure of Exports and FDI: A cross-industry analysis of Japanese manufacturing

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Abstract

The fraction of exporters and multinational enterprises (MNEs) varies substantially across industries. We extend the firm heterogeneity model presented by Helpman et al. (2004) to derive testable predictions about the prevalence of these internationalized modes. The model indicates that intra-industry firm heterogeneity and R&D intensity play large roles in inter-industry variation of the fraction of internationalized firms. We investigate whether these factors as well as import tariffs affect the structure of exports and foreign direct investment (FDI) using Japanese industry-level data. We obtain results that are consistent with the model. First, industries with larger productivity dispersion have a larger fraction of MNEs and a larger fraction of the sum of exporters and MNEs. Second, MNEs are heavily concentrated in R&D-intensive industries. In addition, we reveal that industries with lower import tariffs have a larger fraction of exporters and MNEs.

Keywords: Firm heterogeneity; Multinationals; Exports; Foreign direct investment

JEL classification: F1, F23

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1 Introduction

Recent empirical research in international trade and foreign direct investment (FDI) provides firm-level evidence that firms that export or conduct FDI are relatively few. However, the fractions of exporters and multinational enterprises (MNEs) vary substantially across industries, and almost all industries have at least one exporter or MNE. Within each industry, the fraction of firms that export or conduct FDI ranges rather widely. For example, according to Bernard et al. (2007a), the number of firms exporting is nearly 40% in some US manufacturing industries but less than 10% in others.

These facts indicate that cross-industry differences are important to understand the structure of export and FDI. We explore why some industries have more exporters or MNEs than other industries. We focus on two cross-industry differences. First, industries differ in the degree of firm heterogeneity—many previous studies pointed out that firms differ within an industry—and second, industries differ in R&D intensity. We show that both factors contribute to substantial variation in the fraction of exporters and MNEs.

In this paper, we use a firm heterogeneity model presented by Helpman et al. (2004) to derive the theoretical relationship between firm heterogeneity and the fraction of internationalized firms. The firm heterogeneity model of Helpman et al. (2004) assumes that firms differ in productivity and must incur the fixed costs of exporting and FDI. They predict that only firms with enough productivity to cover the fixed cost of exporting can export. Since the fixed cost of FDI is larger than that of exporting, firms that conduct FDI must be more productive than firms that only export.

Based on the model of Helpman et al. (2004), we show that industries with a larger degree of productivity dispersion have a larger fraction of MNEs, a larger fraction of the sum of exporters and MNEs, and a larger ratio of MNEs to non-MNE exporters, although the effect of an increase in the dispersion of productivity on the fraction of exporters can be either positive or negative. In addition, we show that R&D-intensive industries have an advantage in conducting FDI. Our approach resembles Antràs and Helpman (2004, 2008), who focused on the prevalence of such organizational forms as foreign outsourcing and FDI; Helpman et al. (2004) focused on the relative magnitude of exports and FDI sales.

We also use Japanese industry-level data to examine the model's implications. Many previous empirical studies have confirmed that exporters are more productive than non-exporters (Bernard and Jensen, 1999), and that

MNEs are more productive than firms that only export (Tomiura, 2007). Such firm-level evidence supports the standard firm heterogeneity models of Melitz (2003) and Helpman et al. (2004). Helpman et al. (2004) also provide empirical evidence at the industry level that industries with larger productivity dispersion have smaller relative export sales over FDI sales as predicted by their theoretical model. However, no evidence exists that confirms the large role of firm heterogeneity and R&D intensity in the variation of fractions of internationalized firms across industries[*1].

The results support the predictions of our heterogeneous firm model that firm heterogeneity and R&D play key roles in the structure of international trade and FDI, and additionally reveal that import tariffs matter. First, industries with a larger degree of productivity dispersion have a larger fraction of MNEs, larger ratio of MNEs to non-MNE exporters, and larger fraction of the sum of exporters and MNEs. Second, MNEs are concentrated heavily in R&D-intensive industries. Third, we additionally test and confirm that lower import tariffs are associated with a higher fraction of internationalized firms. However, the positive relation between R&D intensity and the fraction of non-MNE exporters are not confirmed against our model's prediction.

The remainder of this paper is divided into five sections. In Section 2, we briefly describe the Japanese manufacturing data used in this paper and show that the variation of the fraction of exporters and MNEs is systematic. In Section 3, we use a version of Helpman et al. (2004) to derive predictions about the prevalence of internationalized modes. In Section 4, we introduce our estimation approach. In Section 5, we present the results of our empirical analysis. The summary and conclusion are presented in the final section.

2 A first glance at the data

There is tremendous variation in the fraction of exporters and MNEs across industries, as Bernard et al. (2007a) and Tomiura (2007) have shown. In

[*1] Kamata (2010) is another attempt to examine why the fraction of firms supplying their product to foreign markets varies across industries. Our study differs from his in several respects. First, we consider both exporting and FDI, while Kamata considers only exporting. Second, we use the model of Helpman et al. (2004), while he extends Bernard et al. (2007b) as well as Melitz (2003), since he focuses on the relation between the fractions of exporters and countries' comparative advantage. Third, we use Japanese data, while Kamata uses data from Chile, Colombia, India, and the United States. Fourth, we empirically examine the effect of dispersion, R&D intensity, and tariffs on the fraction of exporters and MNEs, while Kamata focuses on the effect of skill intensity on the fraction of exporters.

addition, this section reveals that this variation is systematic. First, the fraction of the sum of exporters and MNEs is higher in industries with a larger dispersion of sales. Second, the fraction of MNEs also is higher in industries with a larger dispersion of sales. Third, relative to all active firms, MNEs are heavily concentrated in R&D-intensive industries. This section unveils these patterns in the Japanese manufacturing industry-level data. The facts in this section motivate the theoretical model and more rigorous empirical analysis in the following sections.

This study uses the industry-level data for the period 1997–2005 based on the confidential firm-level data collected by the Ministry of Economy, Trade, and Industry (METI). METI conducts annual surveys called the Basic Survey of Japanese Business Structure and Activities (BSJBSA), which covers all firms with 50 employees or more and capital of 30 million yen or more. We focus on firms whose main business is manufacturing and exclude those whose main business is weapons and munitions because Japanese government prohibits the export of such products. Thus, 57 manufacturing industries were identified for our study. Table 5 provides three-digit METI industry codes and descriptions. In this section, we use the data averaged over nine years, 1997–2005.

Figure 1 illustrates that the fraction of the sum of exporters and MNEs in all active firms is higher in industries with a larger dispersion of the logarithm of sales in a cross section of 57 manufacturing industries. The x-axis measures the standard deviation of the logarithm of sales as the degree of dispersion of sales, and the y-axis the fraction of non-MNE exporters.

Figure 2 plots the fraction of MNEs across industries. The x-axis again measures the standard deviation of logarithm of sales. The figure reveals that industries with a larger dispersion of sales have higher fractions of MNEs. Figure 3 shows how the fraction of MNEs varies with the ratio of R&D expenditures to sales and demonstrates the third strong pattern: the fraction of MNEs is higher in R&D-intensive industries.

Figure 1: Dispersion and fraction of exporters and MNEs

Note: The data are on Japanese manufacturing firms, averaged over 1997–2005.

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

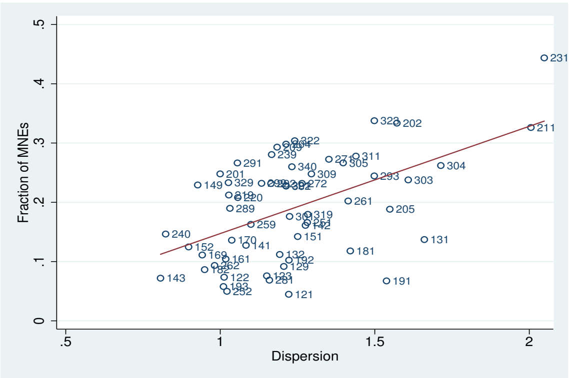

Figure 2: Dispersion and fraction of MNEs

Note: The data are on Japanese manufacturing firms, averaged over 1997–2005.

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

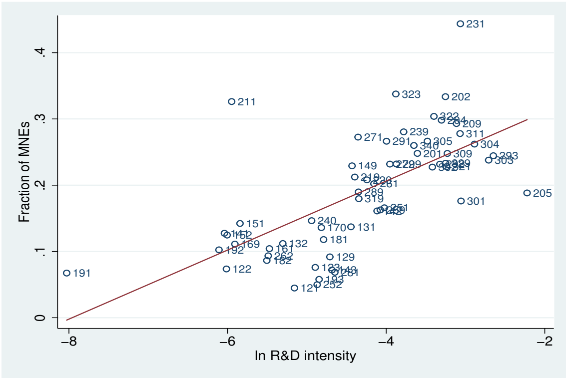

Figure 3: R&D intensity and fraction of MNEs

Note: The data are on Japanese manufacturing firms, averaged over 1997–2005.

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

3 Model

To explain why the fraction of exporters and MNEs systematically varies, we use a framework based on Helpman et al. (2004) and establish the relationship between intra-industry firm heterogeneity and the fraction of exporters and MNEs. We specify the model, which is a simplified version of Helpman et al. (2004) [*2], and extend it to generate predictions about the fraction of exporters and MNEs.

3.1 Setup

J countries are indexed by j, and S industries are indexed by s. A continuum of heterogeneous firms produces differentiated goods in each country and sector. The preferences are identical everywhere and given by a Cobb-

[*2] Our model and approach differ from those of Helpman et al. (2004) in several respects. We simplify the model, as Yeaple (2009) did. First, the model is not closed via a free-entry condition. Second, we do not solve for the full general equilibrium of the model. Rather, we present a partial-equilibrium analysis. We, therefore, take a reduced-form approach in our empirical analysis.

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, we temporarily consider a particular industry s and drop index s[*3]. 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. The empirical distribution of φ in each country $F(\varphi)$ is assumed to be Pareto with the shape parameter k; that is,

$$F(\varphi) = 1 - \left(\frac{b}{\varphi}\right)^k,\ \varphi \geq b \geq 0 \tag{4}$$

where b is a minimum value in an industry's productivity distribution. We assume that $k > \sigma + 1$, which ensures that the distribution of productivity draws have finite variances. k is an inverse measure of variance[*4], since the variance of Pareto distribution is given by

$$V(\varphi) = \frac{b^2 k}{(k-1)^2(k-2)},\ \text{for } k > 2.$$

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

[*4] We assume that k is given and do not consider what determines k. Recent studies suggest that demand structure is one of determinants of k. Syverson (2004) reveals high-substitutability industries exhibit less productivity dispersion.

The smaller the parameter k, the larger is the variance of productivity. The Pareto assumption is consistent with the evidence (see Helpman et al., 2004; Wakasugi et al., 2008). Note that we assume productivity distributions differ among industries.

After a firm observes a productivity draw from distribution $F(\varphi)$, it bears the fixed costs of domestic production rf^D if it chooses to enter the market. These are the costs of setting up production facilities, including a research institute in home country. r is an industry-specific measure of R&D intensity, and $r > 1$. A firm in an R&D-intensive industry must incur larger fixed costs due to R&D expenditure.

In this paper, we consider R&D intensity as industry specific because we use industry-level data in the empirical analysis. The range of R&D intensity is to some extent given for individual firms in an industry. For example, a firms in the pharmaceuticals and medicinal chemicals industry must incur more R&D expenditure because of the nature of products it produces than a firm in the meat and meat products industry.

In serving foreign markets, a 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 $\tau_i > 1$. 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. These fixed costs are assumed to be industry specific.

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

$$c(\varphi) = \begin{cases} \frac{zw_h}{\varphi} \text{ if it sells in home country } h \\ \frac{z\tau_i w_h}{\varphi} \text{ if it exports to a foreign country } i \\ \frac{zw_i}{\varphi} \text{ if it produces in a foreign country } i \end{cases} \tag{5}$$

where z is an industry-specific inverse measure of R&D intensity; that is, $z'(r) < 0$, and $z \in (0, 1)$. We assume that marginal cost for producing R&D intensive products is lower than that for less R&D intensive products[*5]. A firm in an R&D-intensive industry must invest more in developing a blueprint for a new product. Once it obtain a blueprint, it can produce relatively easily and supply its products to both domestic and foreign markets without additional fixed R&D expenditure.

[*5] Our model is static and do not consider the dynamic decision of R&D investment, which Ederington and McCalman (2008), Aw et al. (2008), Lileeva and Trefler (2007), and Costantini and Melitz (2008) examine.

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

$$\pi^D = (zw_h)^{1-\sigma} A_h \varphi^{\sigma-1} - rf^D \tag{6}$$

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 $\sigma > 1$.

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

$$\varphi^D = \left(\frac{rf^D}{(zw_h)^{1-\sigma} A_h} \right)^{\frac{1}{\sigma-1}} \tag{7}$$

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

$$\pi^X = (z\tau_i w_h)^{1-\sigma} A_i \varphi^{\sigma-1} - f^X \tag{8}$$

and the additional profit from FDI in country i is

$$\pi^I = (zw_i)^{1-\sigma} A_i \varphi^{\sigma-1} - f^I \tag{9}$$

Setting $\pi^X = 0$, we define the export cutoff as

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

We also define the FDI cutoff as

$$\varphi^I = \left[\frac{f^I - f^X}{A_i z^{1-\sigma} \left[w_i^{1-\sigma} - (\tau_i w_h)^{1-\sigma} \right]} \right]^{\frac{1}{\sigma-1}} \tag{11}$$

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

The optimal strategy of internationalization in an industry depends on each firm's productivity. First, 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, firms with productivity levels between the export cutoff and FDI cutoff ($\varphi \in (\varphi^X, \varphi^I)$) are "exporters," who supply their products to domestic markets and export them to foreign markets. Firms with productivity levels above the FDI cutoff ($\varphi > \varphi^I$) are "MNEs," who invest in a foreign country. Therefore, exporters are more productive than purely domestic firms, and MNEs, in turn, are more productive than exporters.

3.2 Prevalence of internationalized modes

In this section, we consider the relationship between the inter-industry variation of the fraction of internationalized firms and productivity dispersion. Helpman et al. (2004) derived the relationship between the relative magnitude of exports and local FDI sales and productivity dispersion and predicted that industries with higher dispersion levels of firm productivity have lower ratios of exports to FDI sales. They tested this prediction using US data with European firm-level data. Their results support the theoretical model's predicted link between intra-industry firm-level heterogeneity and relative export sales. However, except their own study, little evidence supports their prediction at the industry level.

Our approach is slightly different from Helpman et al.'s (2004) and more closely resembles that of Antras and Helpman (2004, 2008). We establish the relationship between inter-industry variation of the fraction of internationalized firms and intra-industry productivity dispersion. While Helpman et al. (2004) focused on the relative magnitude of export sales, we focused on the fraction of each internationalization mode of firms for two reasons. First, we do not have FDI local sales data per country, which is necessary to construct the relative magnitude of export sales. Second, we can easily obtain richer predictions than Helpman et al. (2004) by forecasting not only the relative fraction of exports over FDI but also the fractions of MNEs, and exporters and MNEs. Given the Pareto assumption (4), the fraction of purely domestic firms in all active firms can be written as

$$\delta^D = \frac{F(\varphi^X) - F(\varphi^D)}{1 - F(\varphi^D)} = 1 - \left(\frac{\varphi^D}{\varphi^X}\right)^k \tag{12}$$

where we exclude exited firms. Hence, the fraction of the sum of exporters and MNEs is

$$\delta^N = \frac{1 - F(\varphi^X)}{1 - F(\varphi^D)} = \left(\frac{\varphi^D}{\varphi^X}\right)^k \tag{13}$$

Since $\varphi^D < \varphi^X$, an increase in this fraction is driven by a decrease in k, which is generated by an increase in the dispersion of productivity. Next, the fraction of MNEs is

$$\delta^I = \frac{1 - F(\varphi^I)}{1 - F(\varphi^D)} = \left(\frac{\varphi^D}{\varphi^I}\right)^k \tag{14}$$

Since $\varphi^D < \varphi^I$, a decrease in k increases the fraction of MNEs. Similarly, the fraction of exporters equals

$$\delta^X = \frac{F(\varphi^I) - F(\varphi^X)}{1 - F(\varphi^D)} = \left(\frac{\varphi^D}{\varphi^X}\right)^k - \left(\frac{\varphi^D}{\varphi^I}\right)^k \tag{15}$$

The first term means the fraction of internationalized firms (exporters and MNEs), and the second term that of MNEs. Both increase when k decreases. Therefore, the effect of an increase in productivity dispersion on the fraction of exporters is ambiguous[*6]. However, we can derive the effect of an increase in productivity dispersion on MNEs per exporters. This ratio of MNEs to non-MNE exporters is

$$\delta^{IX} = \frac{\delta^I}{\delta^X} = \frac{1}{\left(\frac{\varphi^I}{\varphi^X}\right)^k - 1} \tag{16}$$

This ratio increases when k decreases.

In addition, we examine the change of R&D intensity, which is relevant in the next section's empirical analysis. From (10), (11), and $z'(r) < 0$,

$$\frac{\partial \varphi^X}{\partial r} < 0 \quad \text{and} \quad \frac{\partial \varphi^I}{\partial r} < 0. \tag{17}$$

Firms in R&D-intensive industries have lower cutoffs for both exporting and FDI. This suggests that R&D-intensive industries have a larger fraction of exporters and MNEs. In order to verify this intuition, we derive the following relationship from (7), (10), and (11):

$$\frac{\partial \left(\frac{\varphi^D}{\varphi^X}\right)}{\partial r} > 0, \quad \frac{\partial \left(\frac{\varphi^D}{\varphi^I}\right)}{\partial r} > 0, \quad \text{and} \quad \frac{\partial \left(\frac{\varphi^I}{\varphi^X}\right)}{\partial r} = 0. \tag{18}$$

Therefore, from (13), (14), and (16), we get

$$\frac{\partial \delta^I}{\partial r} > 0, \quad \frac{\partial \delta^N}{\partial r} > 0, \quad \text{and} \quad \frac{\partial \delta^{IX}}{\partial r} = 0. \tag{19}$$

[*6] Taking derivative of δ^X with respect to k, we obtain
$\frac{\partial \delta^X}{\partial k} = \frac{\partial \delta^N}{\partial k} - \frac{\partial \delta^I}{\partial k} = \left(\frac{\varphi^D}{\varphi^X}\right)^k \ln\left(\frac{\varphi^D}{\varphi^X}\right) - \left(\frac{\varphi^D}{\varphi^I}\right)^k \ln\left(\frac{\varphi^D}{\varphi^I}\right)$,
where both of the first and second terms are negative since $0 < \left(\frac{\varphi^D}{\varphi^I}\right)^k < \left(\frac{\varphi^D}{\varphi^X}\right)^k$ and $\ln\left(\frac{\varphi^D}{\varphi^I}\right) < \ln\left(\frac{\varphi^D}{\varphi^X}\right) < 0$. The sign of this derivative, therefore, is negative if a decrease in k raises the fraction of the sum of exporters and MNEs more than that of MNEs. In such a case, a decrease in k leads to an increase in the fraction of non-MNE exporters.

These results indicate that more R&D-intensive the industry have a greater number of FDI and internationalized firms relative to all active firms as comapred to less R&D-intensive industries. However, R&D intensity has no effect on the ratio of MNEs to non-MNE exporters. As a result, we obtain

$$\frac{\partial \delta^X}{\partial r} > 0 \tag{20}$$

because an increase in R&D intensity must lead to an increase in the fraction of non-MNE exporters when the ratio of MNEs to non-MNE exporters remains unchanged but the fraction of MNEs increases.

In summary, our analysis in this section can derive two sorts of predictions on the prevalence of exporters and multinationals:

1. An industry with a larger dispersion of productivity, that is, a smaller shape parameter of productivity distribution k, has a larger fraction of MNEs δ^I, a larger fraction of the sum of exporters and MNEs δ^N, and a larger ratio of MNEs to non-MNE exporters δ^{IX}.

2. An industry with larger R&D intensity r has a larger fraction of non-MNE exporters δ^X, a larger fraction of MNEs δ^I, and a larger fraction of the sum of exporters and MNEs δ^N. R&D intensity is not related to the ratio of MNEs to non-MNE exporters δ^{IX}.

4 Empirical specifications

In this section, we examine the model's prediction, using Japanese industry-level data[*7] for the period 1997–2005 from the METI survey (BSJBSA), which we describe in Section 2. Our aim is to empirically analyze the effect of our measure of firm-size dispersion, R&D intensity, and other variables on the following: (i) the fraction of exporters, (ii) the fraction of MNEs, (iii) the ratio of MNEs to non-MNE exporters, and (iv) the fraction of the sum of exporters and MNEs. We clarify the effect of the productivity dispersion on the fraction of exporters in our empirical analysis, although the model predicts that the effect can be either positive or negative.

[*7] We do not have access to firm-level data for this paper, although we have information about the number of foreign affiliates, dispersion of sales, and other industry-level variables. Appendix 1 explains the data and variables we use in this paper in more detail.

We estimate the following reduced-form specification:

$$\begin{aligned}\delta_{srt} &= \mu + \chi_{sr} + \lambda_r \cdot year_t + \beta_1 \ln DISPERSE_{st} \\ &\quad + \beta_2 \ln RDINT_{st} + \beta_3 \ln KAPINT_{st} + \beta_4 \ln SKINT_{st} \\ &\quad + \beta_5 \ln ADINT_{st} + \epsilon_{srt}\end{aligned} \tag{21}$$

where μ is constant, $\delta_{srt} \in (\delta^X, \delta^I, \delta^{IX}, \delta^N)$, and s, r, and t are indexes of industries, regions, and years, respectively. Each firm in the survey reports its value of export sales per region (Asia, North America, Europe, and other regions)[*8] and its number of foreign affiliates per region[*9]. Then, for each region each firm can be classified as one of three types: "purely domestic," "non-MNE exporter," or "MNE." We have the number of firms of these three types per region by industry for 1997–2005 and can calculate δ_{srt}. We approximate δ^{IX} as MNEs/(non-MNE exporters +1) because some pairs of industries and regions have no exporters. $DISPERSE_{st}$ is our measure of the extent of productivity dispersion across firms within industry s in year t. We use the standard deviation of the logarithm of firm sales across all firms within an industry as a measure of the dispersion of firm productivity, following Helpman et al. (2004) and Yeaple (2006). $RDINT_{st}$ is the ratio of R&D expenditures to sales (R&D intensity). Our hypothesis is that $\beta_1 > 0$ in the regression of the fraction of MNEs (δ^I) and the fraction of the sum of exporters and MNEs (δ^N), as well as the ratio of MNEs to non-MNE exporters (δ^{IX}). We also predict that $\beta_2 > 0$ in the regression of δ^I and δ^N.

χ_{sr} is the pair of industry s and region r-specific effects, λ_r is an indicator variable for region r, and $year_t$ is an indicator variable for year t. Since cutoffs are functions of trade costs[*10], wages, and market sizes, these variables also affect the fractions of internationalized firms that we estimate. Since these factors are specific to a country or a country-and-industry pair, proxying them is difficult because we do not have the number of internationalized firms per country. We, therefore, added the fixed effects of an industry-and-region pair and the interaction of region dummies with year dummies to the estimation equations in order to alleviate the effects of trade costs, wages, and market sizes.

Finally, we included capital intensity ($KAPINT_{st}$), the number of skilled workers per total employment (skill intensity, $SKINT_{st}$), and the ratio of

[*8]List of countries by regions are given in Table 6.

[*9]The Middle East, Central and South America, Africa, and Oceania are all classified as "the other regions" in our data.

[*10]While we have import tariff data, we do not have any data on variable trade costs of Japanese firms when they export their goods.

Table 1: Descriptive Statistics

Variable	N	Min	Mean	Max	S.D.
Non-MNE exporters/All	513	0.00	0.14	0.42	0.10
Exporters/All	513	0.00	0.29	0.89	0.19
MNEs/All	513	0.03	0.20	0.56	0.10
MNEs/Non-MNE exporters	513	0.38	1.85	12.50	1.44
Exporters and MNEs/All	513	0.05	0.34	0.89	0.18
ln DISPERSE	513	-0.47	0.19	0.82	0.21
ln KAPINT	513	0.97	2.86	5.51	0.76
ln RDINT	512	-10.29	-4.37	-2.12	1.21
ln SKINT	505	-8.44	-2.21	-1.07	1.08
ln ADINT	513	-7.89	-5.40	-2.76	1.11
ln TARIFF	492	-3.91	-0.78	2.81	2.05

advertisement expenditures to sales (advertisement intensity, $ADINT_{st}$) in regression to control for the omitted industry characteristics. All of these variables were constructed from the METI survey. The descriptive statistics for all variables are shown in Table 1.

5 Results

We first discuss the results shown in Table 2 where we estimated the coefficients by the fixed effect model in columns (1), (3), (5), and (7) and by the random effect model in columns (2), (4), (6), and (8). The dependent variables in columns (1)–(2), (3)–(4), (5)–(6), and (7)–(8) are the fractions of non-MNE exporters, MNEs, MNEs per non-MNE exporters, and the sum of exporters and MNEs, respectively. Since $\delta_N = \delta_X + \delta_I$, the coefficient estimates in columns (7)–(8) equal the sum of the coefficients in columns (1)–(2) and (3)–(4). The p-values of the Hausman test indicate that the random effects estimates are not much different from fixed effects estimates and that the null hypothesis of exogeneity of the industry-and-region pair effects cannot be rejected. Furthermore, the p-values of the Breusch and Pagan Lagrange Multiplier test for random effects show that the random effects model is desirable compared with ordinary least squares (OLS). Random effect estimates are supported when we use other specifications in this paper.

Table 2: Heterogeneity and the fractions of internationalized firms (Japan, 1997–2005)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Exporters		MNEs		MNEs/Exporters		Exporters and MNEs	
Estimation method	FE	RE	FE	RE	FE	RE	FE	RE
ln DISPERSE	0.048	0.051*	0.069***	0.083***	0.694	0.826**	0.117***	0.128***
	[0.032]	[0.029]	[0.024]	[0.023]	[0.494]	[0.365]	[0.029]	[0.030]
ln RDINT	-0.001	0.008***	0.005*	0.008***	0.052	-0.068	0.004	0.011**
	[0.003]	[0.003]	[0.003]	[0.002]	[0.071]	[0.054]	[0.005]	[0.004]
ln KAPINT	-0.004	-0.002	0.003	0.003	0.031	-0.048	-0.002	0.000
	[0.009]	[0.008]	[0.007]	[0.006]	[0.111]	[0.089]	[0.011]	[0.010]
ln SKINT	0.000	0.001	0.000	0.001	-0.034	-0.038	0.001	0.001
	[0.000]	[0.001]	[0.000]	[0.000]	[0.035]	[0.035]	[0.001]	[0.001]
ln ADINT	-0.001	-0.002	-0.006**	-0.006***	-0.084**	-0.033	-0.007**	-0.008***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.041]	[0.033]	[0.003]	[0.002]
Observations	2016	2016	2016	2016	2016	2016	2016	2016
Number of Clusters	57	57	57	57	57	57	57	57
Within R-squared	0.075	0.064	0.039	0.038	0.036	0.032	0.095	0.091
Between R-squared	0.019	0.255	0.227	0.279	0.000	0.130	0.204	0.268
Overall R-squared	0.020	0.229	0.206	0.258	0.002	0.103	0.183	0.252
p-value								
BPL test		0.000		0.000		0.000		0.000
Hausman test		1.000		1.000		1.000		0.790

Notes: Robust standard errors are shown in brackets. Dependent variables in column (1)–(2), (3)–(4), (5)–(6), and (7)–(8) are the fraction of non-MNE exporters, the fraction of MNEs, the ratio of MNEs to non-MNE exporters, and the fraction of the sum of exporters and MNEs, respectively. The interaction of region dummies with year dummies and constant are suppressed. *** Significant at 1%. **5%. *10%.

First, the coefficients on the log of dispersion are positive in all eight columns and statistically significant in all columns except columns (1) and (5). These estimated signs show that industries with higher dispersion of productivity have a larger fractions of MNEs and a larger fractions of the sum of exporters and MNEs. All of these estimated signs are consistent with the theoretical predictions. Since the estimated signs are significantly positive in columns (3)–(4) and (7)–(8), the results support our main prediction that industries with higher dispersion have more MNEs and internationalized firms relative to all active firms.

Although the coefficient on the log of dispersion in column (5) is not significant, the estimated signs in columns (5) and (6) are consistent with the theoretical implications derived in Section 3 that predicted that industries with a higher level of productivity dispersion have a larger ratio of MNEs to non-MNE exporters.

In addition, the positive coefficients on dispersion in columns (1)–(2) suggest that industries with a larger dispersion of productivity have a larger fraction of non-MNE exporters, although the coefficient in column (1) is not significant. This corresponds to the Ricardian type of comparative advantage that a more productive industry has more exporters.

In summary, the results show that industries with a higher degree of dispersion have a higher fraction of both MNEs and sum of exporters and MNEs. They are also consistent with our theoretical prediction that industries with a higher degree of dispersion have a higher fraction of non-MNE exporters, and higher ratio of MNEs to non-MNE exporters.

Second, the coefficients on R&D intensity are positive and significant in columns (3)–(4). This implies that R&D plays an important role in FDI, as predicted by the theory. In other words, the knowledge from R&D gives firms in R&D-intensive industries an advantage in producing their products in foreign countries because they can apply their knowledge to their production even in different locations.

The coefficients on R&D intensity in columns (5)–(6) are insignificant. This result accords with our prediction that R&D does not affect the ratio of MNEs to non-MNE exporters since R&D raises the fractions of both non-MNE exporters and MNEs. Moreover, the positive coefficients on R&D intensity in columns (7)–(8) are consistent with our prediction that R&D-intensive industries have larger fraction of the sum of exporters and MNEs.

In column (2) the coefficient on R&D intensity is positive and significant, as predicted by our model. On the other hand, in column (1) it is negative, which is puzzling. We need to reexamine our model in a future study. In particular, we should reconsider our assumption that the marginal cost of an R&D-intensive product is lower regardless of exporting and production in foreign countries.

Third, such control variables as capital intensity and skill intensity are not significant in all columns. It is interesting that these traditional Heckscher-Ohlin types of comparative advantage do not affect the structure of exporting and FDI.

Fourth, in the meantime, the coefficients of advertisement intensity are significant in some columns. In particular, they are significantly negative in columns (3)–(4) and (7)–(8). Our theory does not provide any explanation, but this result suggests that Japanese manufacturing has an advantage in less advertisement-intensive products such as intermediate goods which producers, and not consumers, purchase.

5.1 Effect of import tariff

In this section, we empirically examine the effect of import tariffs τ_h applied to foreign goods on the fraction of exporters and MNEs. Although our partial equilibrium model does not capture the link between import tariffs and the fractions, we consider potential paths from import tariffs to the fractions of internationalized firms. Melitz (2003) shows that a decline in variable trade costs τ raises the entry cutoff φ^D and lowers the export cutoff φ^X:

$$\frac{\partial \varphi^D}{\partial \tau} > 0 \text{ and } \frac{\partial \varphi^X}{\partial \tau} < 0.$$

We consider how these two changes of cutoffs affect the fractions, assuming that $\tau_h = \tau_i = \tau$.

First, a decline in import tariff forces low-productivity firms to exit by increased competition with foreign exporters and raises the entry cutoff. This results in an increase in the average productivity in an industry. Bernard et al. (2006) empirically show this effect. The exit of low-productivity firms raises the fractions of non-MNE exporters, MNEs, and the sum of exporters and MNEs because of a decline in the fraction of non-internationalized firms. This does not affect the ratio of MNEs to non-MNE exporters since the numbers of both non-MNE exporters and MNEs do not change. We call this first path—the effect of the rise of the entry cutoff— the "entry cutoff effect."

Second, the decline in export cutoff facilitates non-exporting firms to start exporting. This causes the fractions of both exporters and the sum of exporters and MNEs to go up, but does not affect the fraction of MNEs. Therefore, this lowers the ratio of MNEs to non-MNE exporters. We call this second path the "export cutoff effect," which is caused by a decline in foreign tariff. Therefore, our analysis based on Japanese import tariff data will partially reflect this effect if Japanese import tariffs are correlated with foreign tariffs[*11].

Based on these two paths, we predict that a decline in import tariff raises the fractions of both non-MNE exporters and the sum of exporters and MNEs:

$$\frac{\partial \delta^X}{\partial \tau} < 0 \text{ and } \frac{\partial \delta^N}{\partial \tau} < 0. \quad (22)$$

We also predict that a decline in import tariff raises the fraction of MNEs when the entry cutoff effect exists:

$$\frac{\partial \delta^I}{\partial \tau} < 0. \quad (23)$$

In addition, when the export cutoff effect exists, a decline in import tariff lowers the ratio of MNEs to non-MNE exporters:

$$\frac{\partial \delta^{IX}}{\partial \tau} > 0. \quad (24)$$

We can summarize our prediction on the relationship between import tariff and the fractions of exporters and MNEs as follows.

1. A decrease in import tariff τ increases the fractions of both non-MNE exporters δ^X and the sum of exporters and MNEs δ^N.
2. A decrease in import tariff τ raises the fraction of MNEs δ^I when an entry cutoff effect exists.
3. A decrease in import tariff τ leads to a decrease in the ratio of MNEs to non-MNE exporters δ^{IX} when an export cutoff effect exists.

Our use of import tariff data may underestimate the export cutoff effect, that is, the third relationship.

We estimate the following equation:

$$\begin{aligned} \delta_{srt} \quad = \quad & \mu + \chi_{sr} + \lambda_r \cdot year_t + \gamma_1 \ln TARIFF_{st-1} \\ & + \gamma_2 \ln DISPERSE_{st} + \gamma_3 \ln RDINT_{st} \\ & + \gamma_4 \ln KAPINT_{st} + \gamma_5 \ln SKINT_{st} \\ & + \gamma_6 \ln ADINT_{st} + \epsilon_{srt}, \end{aligned} \quad (25)$$

[*11] Bernard et al. (2006) also use the import tariff to examine this kind of effect.

where $TARIFF_{st-1}$, which is an import-weighted average tariff applied to the import of foreign goods in industry s in year $t-1$ in Japan, is taken from Nicita and Olarreaga (2007)[*12] where the data are described in more detail. We use import tariff data, following Bernard et al. (2006). This variable is lagged by one year to avoid reverse causality.

This estimation has two potential problems. First, as already mentioned, our use of import tariff data may lead to an underestimation of the export cutoff effect, that is, the effect of decline in export cutoff on the fractions if the import tariff does not correlate with foreign tariffs that Japanese firms face when they export. Second, our estimation results may reflect the reverse causality that government gives higher protection to less-productive industries with small fractions of internationalized firms. The instrumental variable method can alleviate this endogeneity problem. However, we do not have adequate instrumental variables. Therefore, we should carefully examine the estimation results.

Table 3 reports the estimation results obtained when we included import tariff as well as dispersion as key explanatory variables[*13]. The result reveals that import tariffs are significantly and negatively associated with all fractions except the ratio of MNEs to non-MNE exporters in line with our hypothesis.

The negative and significant tariff coefficients in column (3)–(4) provide evidence of the entry cutoff effect. The negative and highly significant effects of tariffs on the fractions of non-MNE exporters and the sum of exporters and MNEs are consistent with our hypothesis. However, the mixed results of columns (5)–(6) do not fully support the export cutoff effects. This may be because our use of Japanese import tariff leads to underestimation of export cutoff effects.

Other results, in particular the results of dispersion, R&D intensity, capital intensity, and advertisement intensity, are almost similar to those in Table 2. Only the estimated coefficient of skill intensity on the fraction of MNEs in column (4) turned to be significantly positive.

In sum, our results are consistent with the entry cutoff effect that a decline in variable trade costs forces low-productivity firms to exit. Our use of import tariff data does not provide satisfactory evidence on export cutoff

[*12]We make a concordance to match the 3-digit ISIC industries to the METI code industries.

[*13]Del Gatto et al. (2008) reveal that more trade-open industries have smaller dispersion of costs across firms. In order to check the potential bias, we also estimate equations that exclude our mearsure of dispersion. We obtain qualitatively similar estimation results even when we exclude dispersion from explanatory variables.

Table 3: Tariff and the fractions of internationalized firms (Japan, 1997–2005)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Exporters		MNEs		MNEs/Exporters		Exporters and MNEs	
Estimation method	FE	RE	FE	RE	FE	RE	FE	RE
ln TARIFF	-0.012**	-0.024***	-0.011*	-0.013***	-0.161	0.119*	-0.023**	-0.033***
	[0.006]	[0.005]	[0.006]	[0.004]	[0.136]	[0.065]	[0.011]	[0.008]
ln DISPERSE	0.049	0.051*	0.071***	0.083***	0.718	0.855**	0.120***	0.130***
	[0.031]	[0.028]	[0.024]	[0.023]	[0.498]	[0.366]	[0.028]	[0.028]
ln RDINT	-0.002	0.006**	0.005*	0.008***	0.049	-0.050	0.003	0.009**
	[0.003]	[0.003]	[0.003]	[0.002]	[0.071]	[0.049]	[0.005]	[0.004]
ln KAPINT	-0.005	-0.004	0.003	0.002	0.028	-0.037	-0.002	-0.002
	[0.009]	[0.008]	[0.007]	[0.006]	[0.111]	[0.084]	[0.011]	[0.010]
ln SKINT	0.000	0.001	0.001	0.001*	-0.032	-0.039	0.001*	0.001**
	[0.001]	[0.001]	[0.000]	[0.000]	[0.035]	[0.035]	[0.001]	[0.001]
ln ADINT	-0.001	-0.002	-0.006**	-0.006***	-0.085**	-0.041	-0.007**	-0.007***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.039]	[0.033]	[0.003]	[0.002]
Observations	2016	2016	2016	2016	2016	2016	2016	2016
Number of Clusters	57	57	57	57	57	57	57	57
Within R-squared	0.078	0.068	0.042	0.041	0.037	0.032	0.101	0.098
Between R-squared	0.145	0.296	0.218	0.279	0.005	0.153	0.248	0.306
Overall R-squared	0.132	0.277	0.202	0.259	0.001	0.119	0.233	0.292
p-value								
BPL test		0.000		0.000		0.000		0.000
Hausman test		1.000		1.000		1.000		1.000

Notes: Robust standard errors are shown in brackets. Dependent variables in column (1)–(2), (3)–(4), (5)–(6), and (7)–(8) are the fraction of non-MNE exporters, the fraction of MNEs, the ratio of MNEs to non-MNE exporters, and the fraction of the sum of exporters and MNEs, respectively. The interaction of region dummies with year dummies and constant are suppressed. *** Significant at 1%. **5%. *10%.

effect to show that a decline in variable trade costs facilitate exporting. Our simple analysis cannot fully avoid the reverse causality result that government applies lower import tariff to products where Japanese manufacturing has comparative advantage. In the future analyses, more rigorous methods should be employed.

5.2 Robustness check

In this section, we use alternative specifications as a robustness check. We examine whether dispersion and tariff affect the fraction of exporters including multinational exporters. While we used the fraction of non-MNE exporters as a dependent variable in previous analyses, we now examine our predictions by using the fraction of the sum of non-MNE exporters and multinational exporters as a dependent variable.

The estimation results are shown in Table 4. The results are almost similar to those in Tables 2 and 3 but differ in three ways. First, the coefficients of the dispersion and R&D intensity are positive and highly significant—consistent with our model's prediction—while in Tables 2 and 3 fixed effect estimates are not significant. Second, the tariff coefficients are negative and insignificant in column (3). Third, skill intensity and advertisement intensities turn out to be significant in some columns. These changes result from the incorporation of multinational exporters into the fraction of exporters, and therefore imply that multinational exporters tend to be more productive, more R&D intensive, and more skill intensive than non-MNE exporters and are, perhaps, less vulnerable to trade costs.

6 Concluding remarks

In this paper, we examined the link between firm heterogeneity and the prevalence of exporting and FDI. In addition, we extend the standard heterogeneity model of Helpman et al. (2004) to explain the roles of R&D in export and FDI, though the Helpman et al. (2004) model cannot capture it. In particular, we develop a model where the marginal cost of the R&D-intensive product is lower, although a firm that invests in R&D incurs larger fixed costs.

Our model yields two testable implications. First, industries with larger productivity dispersion have (i) a larger fraction of firms that conduct FDI, (ii) a larger ratio of MNEs to non-MNE exporters, and (iii) a larger fraction of the sum of exporters and MNEs. Second, R&D-intensive industries have an advantage in exporting and FDI. Most empirical results accord with both

Table 4: The fraction of exporters (Japan, 1997–2005)

	(1)	(2)	(3)	(4)
Dep. Var.	Exporters		Exporters	
Estimation method	FE	RE	FE	RE
ln TARIFF			-0.030	-0.050***
			[0.020]	[0.014]
ln DISPERSE	0.131***	0.148***	0.136***	0.150***
	[0.044]	[0.046]	[0.043]	[0.044]
ln RDINT	0.012*	0.026***	0.012*	0.023***
	[0.007]	[0.007]	[0.007]	[0.006]
ln KAPINT	0.003	0.007	0.003	0.004
	[0.020]	[0.017]	[0.020]	[0.017]
ln SKINT	0.001	0.002*	0.002*	0.002**
	[0.001]	[0.001]	[0.001]	[0.001]
ln ADINT	-0.007	-0.010**	-0.007	-0.009*
	[0.005]	[0.005]	[0.005]	[0.005]
Observations	2016	2016	2016	2016
Number of Clusters	57	57	57	57
Within R-squared	0.227	0.218	0.234	0.225
Between R-squared	0.392	0.476	0.438	0.476
Overall R-squared	0.342	0.437	0.408	0.455
p-value				
BPL test		0.000		0.000
Hausman test		0.130		0.500

Notes: Robust standard errors are shown in brackets. The dependent variable is the fraction of exporters including multinational exporters. The interaction of region dummies with year dummies and constant are suppressed. *** Significant at 1%. **5%. *10%.

implications of the model and additionally revealed that highly protected industries have a smaller fraction of internationalized firms. However, our empirical analysis do not provide sufficient evidence for our prediction that R&D-intensive industries have a larger fraction of non-MNE exporters. This suggests a need for a model that is more consistent with the data.

Our results also shed light on the traditional source of comparative advantage, such as capital intensity and skill intensity. In particular, most of our estimation results show that capital intensity and skill intensity have no significant effect on the fraction of internationalized firms. This suggests that these variables are less important in the structure of export and FDI than firm heterogeneity and R&D intensity.

We conclude that firm heterogeneity as well as R&D intensity and government trade policies play crucial roles in the structure of foreign trade and investment. Greater dispersion in productivity across firms within a single industry is associated with more FDI, as predicted in our model, and also with more exporting. In addition, R&D-intensive industries have a larger fraction of MNEs. Furthermore, higher import tariffs are negatively associated with the fractions of both exporters and MNEs.

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Appendix 1: Data

In this appendix, we describe our data sources. The supplementary appendix contains our data set.

Our industry-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 Japan 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 38,688, the number of enterprises that submitted a response in 2006 is 30,752—the survey aimed to obtain data on the previous financial year, 2005. The response rate is therefore 79.5%. The response rate in our sample period, 1997–2005, is stable. The survey covers both manufacturing and non-manufacturing industries, but our paper focused on manufacturing firms only. The number of firms whose main business is manufacturing is 12,763. These firms in the BSJBSA account for 76.8% of product sales in 1998, compared with the result from the Basic Survey of Commercial and Manufacturing Structure and Activity, which has no firm-size threshold, and was conducted only once, in 1998, by METI. Although this suggests that our data set potentially underevaluates firm heterogeneity, we do not have any data source that provides the data of dispersion.

Table 5 provides a list of industries with their fraction of exporters and MNEs. Table 6 shows a list of countries by regions.

We also used Nicita and Olarreaga's (2007) "Trade, Production, and Protection Database, 1976–2004" to obtain import tariff data.

The variables used in this paper are as follows.

1. Dispersion: the standard deviation of the logarithm of firm sales across all firms within an industry in each year.

2. Capital intensity: fixed tangible asset per worker.

3. R&D intensity: the ratio of research and development expenditure to total sales.

4. Skill intensity: skilled workers per total employment. "Skilled workers" is defined as workers in the headquarter section, while total employment includes both skilled workers and "unskilled workers," defined as workers in the operations section.

5. Advertisement intensity: the ratio of advertisement expenditure to total sales.

6. Tariff: an import-weighted average tariff applied to the import of foreign goods in industry s in year $t-1$ in Japan. This variable is lagged by one year in the estimation.

Table 5: The fraction of exporters and multinationals (Japan, 2005)

Industry			fraction of				
code	description	# of firms	Non-MNE Exporters	MNEs	Exporters	Exporting MNEs	Non-exporting MNEs
121	Meat and meat products	260	1.9	5.0	3.5	1.6	3.4
122	Fish and fish products	198	3.5	9.1	9.6	6.1	3.0
123	Grain mill products	43	7.0	9.3	9.3	2.3	7.0
129	Other food products	900	4.9	11.0	8.7	3.8	7.2
131	Beverages and tobacco products	155	11.6	17.4	21.3	9.7	7.7
132	Prepared animal feeds	43	2.3	16.3	14.0	11.7	4.6
141	Spinning	23	8.7	13.0	13.0	4.3	8.7
142	Weaving	77	10.4	24.7	26.0	15.6	9.1
143	Dyeing	75	4.0	5.3	6.7	2.7	2.6
149	Other textiles	106	15.1	24.5	33.0	17.9	6.6
151	Knitted and crocheted fabrics and articles	197	3.6	23.9	9.1	5.5	18.4
152	Other wearing apparel	73	6.8	12.3	9.6	2.8	9.5
161	Sawmilling and planing of wood	120	3.3	14.2	8.3	5.0	9.2
169	Other products of wood	22	9.1	13.6	13.6	4.5	9.1
170	Furniture	153	3.9	17.0	11.8	7.9	9.1
181	Paper and paper products	102	6.9	15.7	13.7	6.8	8.9
182	Corrugated paper and paperboard	288	5.2	12.5	12.8	7.6	4.9
191	Publishing of newspapers	83	1.2	6.0	2.4	1.2	4.8
192	Publishing	134	6.0	11.9	9.7	3.7	8.2
193	Printing	610	3.0	6.6	7.0	4.0	2.6
201	Chemical fertilizer and inorganic chemistry	108	11.1	32.4	38.0	26.9	5.5
202	Organic chemistry	190	24.2	38.4	56.3	32.1	6.3
204	Soap and detergents	129	20.9	35.7	51.9	31.0	4.7
205	Pharmaceuticals and medicinal chemicals	228	29.4	21.1	46.9	17.5	3.6
209	Other chemical products	274	29.2	37.6	60.9	31.7	5.9
211	Refined petroleum products	24	29.2	29.2	54.2	25.0	4.2
219	Other petroleum products	25	28.0	40.0	64.0	36.0	4.0
220	Plastic products	710	10.6	28.0	29.2	18.6	9.4
231	Rubber tires and tubes	11	27.3	45.5	72.7	45.4	0.1
239	Other rubber products	147	15.6	32.7	42.9	27.3	5.4
240	Leather and fur	29	20.7	24.1	31.0	10.3	13.8
251	Glass and glass products	120	14.2	21.7	30.8	16.6	5.1
252	Cement, lime and plaster	189	1.6	5.8	4.8	3.2	2.6
259	Other non-metallic mineral products	185	19.5	18.9	35.1	15.6	3.3
261	Basic iron and steel	195	11.8	20.5	22.1	10.3	10.2
262	Casting of iron and steel	213	10.3	14.6	18.3	8.0	6.6
271	Non-ferrous metals	55	20.0	29.1	43.6	23.6	5.5
272	Casting of non-ferrous metals	263	16.3	26.6	39.2	22.9	3.7
281	Structural metal products	301	5.6	9.0	9.3	3.7	5.3
289	Other fabricated metal products	687	15.6	25.9	34.5	18.9	7.0
291	Machinery for metallurgy	255	27.5	35.3	58.8	31.3	4.0
292	Other special purpose machinery	443	25.1	28.0	48.3	23.2	4.8
293	Office machinery	141	14.9	26.2	35.5	20.6	5.6
299	Other general purpose machinery	771	23.7	30.9	49.9	26.2	4.7
301	Industrial electricity machinery	427	15.2	24.4	35.4	20.2	4.2
302	Household electrical appliances	130	13.1	30.0	37.7	24.6	5.4
303	Communication equipment	247	17.4	30.4	40.1	22.7	7.7
304	Applied electronic apparatus	218	20.6	28.9	45.0	24.4	4.5
305	Electronic components	707	16.5	32.1	43.8	27.3	4.8
309	Other electrical equipment	257	24.9	27.2	47.5	22.6	4.6
311	Motor vehicles	916	9.0	35.9	36.1	27.1	8.8
319	Other transport equipment	239	15.9	23.8	36.8	20.9	2.9
321	Medical equipment	110	34.5	25.5	55.5	21.0	4.5
322	Optical instruments	75	29.3	36.0	61.3	32.0	4.0
323	Watches and clocks	15	6.7	40.0	46.7	40.0	0.0
329	Other precision instruments	180	39.4	27.8	65.6	26.2	1.6
340	Other manufacturing	326	21.8	27.9	42.6	20.8	7.1
	Total	13202	14.2	23.5	31.7	17.5	6.0

Table 6: List of Countries by Region

Region	Code	Name	Region	Code	Name
Asia	101	India	Europe	399	Other Western Europe
Asia	102	Pakistan	Europe	399	Monaco
Asia	103	Bangladesh	Europe	399	Andorra
Asia	104	Sri Lanka	Europe	399	Azores (Portugal)
Asia	105	Myanmar	Europe	399	Gibraltar (U. K.)
Asia	106	Malaysia	Europe	399	San Marino
Asia	107	Singapore	Europe	399	Liechtenstein
Asia	108	Thailand	Europe	399	Vatican City
Asia	109	Indonesia	Europe	401	CIS
Asia	110	Macao	Europe	401	Russia
Asia	111	Philippines	Europe	401	Azerbaijan
Asia	112	Laos	Europe	401	Armenia
Asia	113	Hong Kong	Europe	401	Uzbekistan
Asia	114	Taiwan	Europe	401	Kazakhstan
Asia	115	Vietnam	Europe	401	Kyrgyzstan
Asia	116	South Korea	Europe	401	Tajikistan
Asia	117	Nepal	Europe	401	Turkmenistan
Asia	118	Brunei	Europe	401	Georgia
Asia	119	China	Europe	401	Ukraine
Asia	199	Other Asia	Europe	401	Belarus
Asia	199	Cambodia	Europe	401	Moldova
Asia	199	Maldives	Europe	402	Poland
Asia	199	East Timor	Europe	403	Czech Republic
Asia	199	Bhutan	Europe	404	Slovakia
Asia	199	North Korea	Europe	405	Hungary
Asia	199	Mongolia	Europe	406	Albania
Middle East	201	Iran	Europe	407	Romania
Middle East	202	Israel	Europe	408	Bulgaria
Middle East	203	Kuwait	Europe	499	Other Eastern Europe
Middle East	204	Lebanon	Europe	499	Estonia
Middle East	205	Saudi Arabia	Europe	499	Latvia
Middle East	206	United Arab Emirates	Europe	499	Lithuania
Middle East	207	Afghanistan	North America	501	United States
Middle East	208	Bahrain	North America	502	Canada
Middle East	209	Qatar	North America	599	Other North America
Middle East	210	Syria	North America	599	Saint Pierre and Miquelon (France)
Middle East	211	Iraq	Central and South America	601	Mexico
Middle East	212	Oman	Central and South America	602	Panama
Middle East	299	Other Middle East	Central and South America	603	El Salvador
Middle East	299	Yemen	Central and South America	604	Brazil
Middle East	299	Jordan	Central and South America	605	Argentina
Middle East	299	Gaza	Central and South America	606	Paraguay
Europe	301	United Kingdom	Central and South America	607	Chile
Europe	302	France	Central and South America	608	Peru
Europe	303	Germany	Central and South America	609	Dominican Republic
Europe	304	Belgium	Central and South America	610	Venezuela
Europe	305	Ireland	Central and South America	611	Bolivia
Europe	306	Switzerland	Central and South America	612	Bahamas
Europe	307	Portugal	Central and South America	613	Colombia
Europe	308	Netherlands	Central and South America	614	Guatemala
Europe	309	Italy	Central and South America	615	Ecuador
Europe	310	Luxembourg	Central and South America	616	Nicaragua
Europe	311	Spain	Central and South America	617	Costa Rica
Europe	312	Greece	Central and South America	618	Trinidad and Tobago
Europe	313	Malta	Central and South America	619	Bermuda (U. K.)
Europe	314	Austria	Central and South America	620	Puerto Rico (U.S.)
Europe	315	Norway	Central and South America	621	Honduras
Europe	316	Former Yugoslavia	Central and South America	622	Suriname
Europe	316	Serbia	Central and South America	623	Jamaica
Europe	316	Montenegro	Central and South America	624	Guyana
Europe	316	Bosnia and Herzegovina	Central and South America	625	Cayman Islands (U. K.)
Europe	316	Republic of Macedonia	Central and South America	626	Uruguay
Europe	316	Croatia	Central and South America	699	Other Central America
Europe	316	Slovenia	Central and South America	699	Belize
Europe	317	Denmark	Central and South America	699	Canal Zone
Europe	318	Iceland	Central and South America	699	Turks and Caicos Islands (U. K.)
Europe	319	Sweden	Central and South America	699	Barbados
Europe	320	Turkey	Central and South America	699	Cuba
Europe	321	Finland	Central and South America	699	Haiti
Europe	322	Cyprus	Central and South America	699	Virgin Islands (U.S.)

Table 6: List of Countries by Region (Continued)

Region	Code	Name
Central and South America	699	Netherlands Antilles
Central and South America	699	French West Indies
Central and South America	699	Grenada
Central and South America	699	St Lucia
Central and South America	699	Antigua and Barbuda
Central and South America	699	British Virgin Islands
Central and South America	699	Dominica
Central and South America	699	Montserrat (U. K.)
Central and South America	699	St. Christopher and Nevis
Central and South America	699	Anguilla (U. K.)
Central and South America	699	Saint Vincent and the Grenadines
Central and South America	699	French Guiana
Central and South America	699	Falkland Islands (U. K.)
Africa	701	Egypt
Africa	702	Morocco
Africa	703	Zimbabwe
Africa	704	Liberia
Africa	705	Tanzania
Africa	706	Sudan
Africa	707	Nigeria
Africa	708	Cote d'Ivoire
Africa	709	Madagascar
Africa	710	Kenya
Africa	711	Ethiopia
Africa	712	Zambia
Africa	713	Uganda
Africa	714	Ghana
Africa	715	Cameroon
Africa	716	Democratic Republic of the Congo
Africa	717	Rwanda
Africa	718	Gabon
Africa	719	Sierra Leone
Africa	720	Gambia
Africa	721	Mauritania
Africa	722	Senegal
Africa	723	Swaziland
Africa	724	Libya
Africa	725	Guinea-Bissau
Africa	726	Niger
Africa	727	Tunisia
Africa	799	Other Africa
Africa	799	Ceuta and Melilla (Spain)
Africa	799	Algeria
Africa	799	Western Sahara
Africa	799	Togo
Africa	799	Benin
Africa	799	Mali
Africa	799	Burkina Faso
Africa	799	Cape Verde
Africa	799	Canary Islands (Spain)
Africa	799	Chad
Africa	799	Central African Republic
Africa	799	Equatorial Guinea
Africa	799	Republic of the Congo
Africa	799	Burundi
Africa	799	Angola
Africa	799	Sao Tome and Principe
Africa	799	St. Helena (U. K.)
Africa	799	Djibouti
Africa	799	Somalia
Africa	799	Seychelles
Africa	799	Mozambique
Africa	799	Mauritius
Africa	799	Réunion (France)
Africa	799	Namibia
Africa	799	Republic of South Africa
Africa	799	Lesotho
Africa	799	Malawi
Africa	799	Botswana
Africa	799	British Indian Ocean Territory
Africa	799	Comoros
Africa	799	Eritrea
Oceania	801	Australia
Oceania	802	Fiji
Oceania	803	New Zealand
Oceania	804	New Caledonia
Oceania	805	Papua New Guinea
Oceania	806	Samoa
Oceania	899	Other Oceania
Oceania	899	Other Australia
Oceania	899	Cook Islands (NZ)
Oceania	899	Tokelau (NZ)
Oceania	899	Niue (NZ)
Oceania	899	Vanuatu
Oceania	899	Solomon Islands
Oceania	899	Tonga
Oceania	899	Kiribati
Oceania	899	Pitcairn Islands (U. K.)
Oceania	899	Nauru
Oceania	899	French Polynesia
Oceania	899	Guam (U.S.)
Oceania	899	American Samoa
Oceania	899	Northern Mariana Islands (U.S.)
Oceania	899	Marshall Islands
Oceania	899	Palau
Oceania	899	Micronesia (FSM)
Oceania	899	Tuvalu
Oceania	899	Other American Oceania

Note: Middle East, Central and South America, Africa, and Oceania are classified as "the other regions."