Firm Heterogeneity and the Structure of Export and FDI

Evidence from Japanese Manufacturing Industries

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Abstract

The fraction of exporters and that of multinational enterprises (MNEs) vary substantially across industries. We use firm heterogeneity model presented in Helpman at al. (2004) to derive the testable predictions on the prevalence of these internationalized modes. The model indicates that the intra-industry firm heterogeneity and R&D intensity play the large role in the inter-industry variation of the fraction of internationalized firms. We investigate whether these factors as well as import tariff affect the structure of export and foreign direct investment (FDI), using Japanese industry-level data. We obtain results which are consistent with the model. First, industries with larger productivity dispersion have the larger fraction of non-MNE exporters, the larger fraction of MNEs, the larger relative fraction of MNEs over non-MNE exporters, and the larger fraction of exporters and MNEs. Second, MNEs are heavily concentrated in R&D intensive industries. In addition, we reveal that lower import tariff raises the fraction of exporters and that of MNEs in line with Melitz (2003). The model fits better the data for internationalization to North America and Europe than that for internationalization to Asia.

JEL: F1, F23

1. Introduction

The fraction of exporters and that of multinational enterprises (MNEs) vary substantially across industries, while almost all industries have at least one exporter or MNE. Recent empirical research in international trade and foreign direct investment (FDI) provides firm-level evidence that firms that export or conduct FDI are relatively rare. However, the fraction of firms that export or conduct FDI within each industry category ranges rather widely. For example, according to Bernard et al. (2007), the fraction of firms exporting reaches nearly forty percent in some U.S. manufacturing industries, while it is less than ten percent in other industries.

In this paper we use firm heterogeneity model presented in Helpman at al. (2004) to derive the theoretical relationship between firm heterogeneity and the fraction of internationalized firms. Firm heterogeneity models of Helpman et al. (2004) assumes that firms differ in productivity and that firms must incur fixed cost of exporting and FDI. They predict that only firms that are productive enough to cover fixed cost of exporting can export. Since 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 at al. (2004), we show that industries with the larger degree of productivity dispersion have the larger fraction of MNEs, the larger fraction of the sum of exporters and MNEs, and the larger relative fraction of MNEs over exporters, although the effect of an increase in dispersion of productivity on the fraction of exporters can be either positive or negative. In addition, we show that R&D intensive industries where fixed cost of FDI is relatively small have the advantage in conducting FDI. Our approach is similar with Antras and Helpman (2004, 2008) which focused on the prevalence of organizational forms such as foreign outsourcing and FDI, while Helpman et al. (2004) focused on the relative magnitude of exports and FDI sales.

We also use Japanese industry-level data to examine the implication of the model. A large number of previous empirical studies have confirmed that exporters are more productive than non-exporters (Bernard and Jensen, 1999), while MNEs are more productive than firms that only export (Tomiura, 2007). These firm-level evidences support standard firm heterogeneity models of Melitz (2003) and Helpman et al. (2004). In addition, 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, there is no evidence which confirms the large role of firm heterogeneity in the variation of the fraction of internationalized firms across industries.

The results support the predictions of our heterogeneous firm model that firm heterogeneity and R&D play a key role in the structure of international trade and FDI and additionally reveal that import tariff matters. First, industries with the larger degree of productivity dispersion have the larger fraction of exporters, the larger fraction of MNEs, the larger relative fraction of MNEs over exporters, and the 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 the reallocation effect that lower import tariff raise the fraction of internationalized firms.

We split sample into two subsamples and show that the predictions of the model are completely consistent with the data for the developed regions, North America and Europe, but the prediction on the fraction of MNEs is only weakly supported by the data for the less developed regions, Asia. Moreover, the prediction on the relative fraction of MNEs over exporters is contradicted with the result for Asia. The reason may be that vertical FDI to save production cost is prevalent in Asia.

The remainder of this paper is divided into four 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 that of MNEs are systematic. In section 3, we use a version of Helpman et al. (2004) to derive predictions over the prevalence of internationalized modes. In section 4, we introduce the estimation approach. In section 5, we present the results of our empirical analysis. The summary and conclusion are presented in final section.

2. A first glance at the data

There is tremendous variation in the fraction of exporters and that of MNEs across industries as Bernard et al. (2007) and Tomiura (2007) have shown. In addition to this, this section reveals that this variation is systematic. First, the fraction of exporters is higher in industries with larger dispersion of sales. Second, the fraction of MNEs is also higher in industries with larger dispersion of sales. Third, relative to all active firms, MNEs is heavily concentrated in R&D intensive industries. This section unveils these patterns in the Japanese manufacturing industry-level data. The facts in this section will 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 which was constructed from the confidential firm-level data collected by the Ministry of Economy, Trade, and Industry (METI). The METI conducts annual surveys of *the Basic Survey of Japanese Business Structure and Activities* (*Kigyo Katsudo Kihon Chosa* in Japanese) which covers all firms with employees of 50 or more and capital of thirty million yen or more. We focus on the firms whose main-line-of-business is a manufacturing industry. We exclude firms whose main-line-of-business is the weapons and ammunition industry because there is a law in Japan which prohibits the export of this industry's products. There remain 57 industries in the manufacturing. Appendix 1 provides three-digit METI industry code and description. In this section we use the data averaged over nine years: 1997-2005.

Figure 1 illustrates the first fact. The fraction of exporters in all active firms is higher in industries with larger dispersion of logarithm of sales in a cross section of 57 manufacturing industries. The X-axis measures the standard deviation of logarithm of sales, while the Y-axis measures the fraction of non-MNE exporters. Next, Figure 2 plots the fraction of MNEs across industries. The X-axis again measures the standard deviation of logarithm of sales. Figure 2 reveals the second fact that industries with larger dispersion of sales have the higher fraction of MNEs. Finally, Figure 3 shows how the fraction of MNEs varies with the ratio of R&D expenditure to sales and demonstrates the third strong pattern that the fraction of MNEs is higher in R&D intensive industries.

3. The model

In order to explain why the fraction of exporters and that of MNEs systematically vary, 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 that of MNEs. We specify the model which is simplified version of Helpman et al. (2004) and generate predictions about the fraction of exporters and that of MNEs.

3.1 Set-up

There are J countries indexed by j and S industries indexed by s. A continuum of heterogeneous firms produces differentiated goods in each country and sector. The preferences are the same everywhere and given by a Cobb-Douglas aggregate over industry-specific CES consumption indices C_{js}:

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

where $x_{js}(\omega)$ is the quantity of goods ω 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 $\sigma = 1/(1-\alpha) > 1$. The parameter θ_s indicate share of each industry in total expenditure and satisfy $\sum_s \theta_s = 1$, $0 < \theta_s < 1$. Then country *j*'s demand for product ω in industry *s* is

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

where Y_j is 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

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

Now we consider particular industry *s* and drop the index *s* for time being. Each firm is capable of producing a single good using a single input called labor. The price of labor 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*, i.e.

$$(2) \qquad F(\varphi) = 1 - \left(\frac{b}{\varphi} \right)^k, \text{ for } \varphi \geq b > 0,$$

where b is minimum value. We assume that $k > \sigma + 1$, which ensures that the distribution of productivity draws have finite variances. The smaller the parameter *k* is, the larger the variance of productivity is. The Pareto assumption is consistent with the evidence (see Helpman et al. 2004; Wakasugi et al. 2008).

After a firm observes productivity draw from a distribution $F(\varphi)$, a firm bears the fixed costs of domestic production f_D if it chooses to enter. It sells its product in home country. In serving foreign markets, a firm faces proximity-concentration trade-off. If the firm chooses to export, it bears additional fixed costs f_X per foreign market and faces domestic wage w_j and incurs iceberg transport cost $\tau_i > 1$. On the other hand, if it chooses to serve a foreign market via FDI, it bears additional fixed costs f_I, in every foreign market. In this case, the firm may avoid transport cost and face the local labor cost w_i.

A firm from country *j* with productivity φ that sells its product will face marginal costs of

$$c(\varphi)=\begin{cases} w_j/\varphi & \text{if it sells in home country j} \\ \tau_i w_j/\varphi & \text{if it exports to foreign country i} \\ w_i/\varphi & \text{if it produces in foreign country i} \end{cases}$$

As is well-known, a firm facing demand curve (1) will optimally charge a price of $p(\varphi)=c(\varphi)/\alpha$. The profit from domestic market is

$$\pi_D = w_j^{1-\sigma} A_j \varphi^{\sigma-1} - f_D$$

where $A_j = (1-\alpha)\alpha^{\sigma-1}\theta Y_j P_j^{\sigma-1}$ is the mark-up adjusted demand level in an industry and in country *j*. We can regard $\varphi^{\sigma-1}$ as productivity index, since $\sigma > 1$.

Setting $\pi_D = 0$, we define the entry cutoff for domestic production

$$\text{(3)} \qquad \varphi_D \equiv \left(\frac{f_D}{w_j^{1-\sigma} A_j} \right)^{\frac{1}{\sigma-1}}.$$

Firms with productivity below this cutoff ($\varphi < \varphi_D$) do not enter the industry, while firms with productivity above this cutoff ($\varphi \geq \varphi_D$) enter the industry and sell their products in home country.

Similarly, the additional profit from export to country *i* is

$$\pi_X = (\tau_i w_j)^{1-\sigma} A_i \varphi^{\sigma-1} - f_X$$

and the additional profit from FDI in country *i* is

$$\pi_I = (w_i)^{1-\sigma} A_i \varphi^{\sigma-1} - f_I .$$

Setting $\pi_X = 0$, we define the export cutoff

(4) $$\varphi_X \equiv \left[\frac{f_X}{(\tau_i w_j)^{1-\sigma} A_i}\right]^{\frac{1}{\sigma-1}}.$$

We also define the FDI cutoff

(5) $$\varphi_I \equiv \left[\frac{f_I - f_X}{A_i (w_i)^{1-\sigma}\left[1-\left(\frac{\tau_i w_j}{w_i}\right)^{1-\sigma}\right]}\right]^{\frac{1}{\sigma-1}},$$

setting $\pi_X = \pi_I$. Following Helpman et al. (2004), we assume

$$\left(\frac{w_i}{w_j}\right)^{\sigma-1} f_I > (\tau_i)^{\sigma-1} f_X > f_D.$$

These conditions ensure that $\varphi_D < \varphi_X < \varphi_I$. The optimal strategy of internationalization depends on each firm's productivity. First, firms with productivity levels between the entry cutoff and the export cutoff ($\varphi \in (\varphi_D, \varphi_X)$) supply their products to domestic market only and they neither export nor conduct FDI. These firms are "purely domestic firms". Second, firms with productivity levels between the export cutoff and the FDI cutoff ($\varphi \in (\varphi_X, \varphi_I)$) are "exporters". They supply their products to domestic market and export their products to foreign market. Firms with productivity levels above the FDI cutoff ($\varphi > \varphi_I$) are "MNEs." They invest in a foreign country. Therefore, exporters are more productive than purely domestic firms and MNEs are, in turn, more productive than exporters.

3.2 The prevalence of internationalized modes

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

Our approach is slightly different from that of Helpman et al. (2004) and similar with that of Antras and Helpman (2004, 2008). We establish the relationship between the inter-industry variation of fraction of internationalized firms and intra-industry productivity dispersion. While Helpman et al. (2004) focus on the relative magnitude of export sales, we focus on the fraction of each internationalization mode of firms for two reasons. First, we do not have the data of FDI local sales per country which is necessary to construct relative magnitude of export sales. Second, we can easily derive richer predictions than Helpman et al. (2004). We derive the prediction not only about relative fraction of export over FDI but also about the fraction of MNEs and that of exporter and MNEs.

Given the Pareto assumption (2), the fraction of purely domestic firms in all active firms can be written

$$\delta_D = \frac{F(\varphi_X) - F(\varphi_D)}{1 - F(\varphi_D)} = 1 - \left(\frac{\varphi_D}{\varphi_X}\right)^k,$$

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

$$(6) \qquad \delta_N = 1 - \delta_D = \left(\frac{\varphi_D}{\varphi_X}\right)^k.$$

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

$$(7) \qquad \delta_I = \frac{1 - F(\varphi_I)}{1 - F(\varphi_D)} = \left(\frac{\varphi_D}{\varphi_I}\right)^k.$$

Since $\varphi_D < \varphi_I$, a decrease in *k* result in an increase in the fraction of MNEs. Similarly, the fraction of exporters is equal to

(8) $$\delta_X = \frac{F(\varphi_I) - F(\varphi_X)}{1 - F(\varphi_D)} = \left(\frac{\varphi_D}{\varphi_X}\right)^k - \left(\frac{\varphi_D}{\varphi_I}\right)^k .$$

First term means the fraction of internationalized firms (exporters and MNEs), while second term means the fraction of MNEs. Both of them increase when *k* decreases. Therefore, the effect of the increase in productivity dispersion on the fraction of exporters is ambiguous. However, we can derive the effect of an increase in productivity dispersion on MNEs per exporters. This relative fraction of MNEs over exporters is

(9) $$\delta_{IX} = \frac{\delta_I}{\delta_X} = \frac{1}{\left(\frac{\varphi_I}{\varphi_X}\right)^k - 1} .$$

This relative fraction increases when *k* decreases.

In addition, we examine the change of fixed cost of FDI over fixed cost of exporting which is relevant in empirical analysis in the next section. As shown in Appendix 2, a decline in fixed cost of FDI f_I relative to fixed cost of exporting f_X increases the fraction of MNEs and the relative fraction of MNEs over exporters, while it decreases the fraction of non-MNE exporters. In our proximity-concentration setting, relative magnitude of f_I over f_X inversely represents corporate level economy of scale. We assume that R&D intensity represents corporate level economy of scale. Therefore, those industries in which corporate level economy of scale, i.e. R&D is important prefer FDI to export.

In summary, our analysis yields two testable implications. First, industries with larger level of productivity dispersion have (i) the larger fraction of MNEs, (ii) the larger relative fraction of MNEs over exporters, and (iii) the larger fraction of the sum of exporters and MNEs. While the effect of productivity dispersion on the last is the similar with the one Helpman et al. (2004) have derived and tested, the effect on first two are new and not tested by any other studies. Second, those industries in which R&D plays a key role have the advantage in conducting FDI.

4. Empirical specifications

Our aim is to empirically analyze the effect of our measure of firm-size dispersion, corporate level economy of scale, and other variables on (i) the fraction of exporters, (ii) the fraction of MNEs, (iii) the relative fraction of MNEs over 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 empirical analysis, although the model predicts the effect can be either positive or negative.

In this section, we also empirically examine the effect of a decline in import tariff which is applied to foreign goods on the fraction of exporters and that of MNEs. Although our partial equilibrium model do not capture the link between import tariff and the fractions, Melitz (2003) have shown that a decline in variable trade costs forces low-productivity firms to exit and results in increase in average productivity in an industry. If this so-called reallocation effect exists as Bernard et al. (2006) empirically have shown, the lower import tariff makes more low-productivity firms exit and increases the fraction of exporters and that of MNEs.

We estimate the following reduced form specification:

(10)
$$\delta_{srt} = \mu + \chi_{sr} + \lambda_r \cdot year_t + \beta_0 \ln DISPERSE_{st} + \beta_1 \ln TARIFF_{st-1} + \beta_2 \ln RDINT_{st} + \beta_3 \ln KAPINT_{st} + \beta_4 \ln SKINT_{st} + \beta_5 \ln ADINT_{st} + \varepsilon_{srt},$$

where μ is constant, $\delta_{srt} \in (\delta_X, \delta_N, \delta_I, \delta_{IX})$, and *s*, *r*, and *t* index industries, regions, and years, respectively. For each firm in our sample, we observe its value of export sales per each region (Asia, North America and Europe) and its number of foreign affiliates per each region. Using these data, for each region we can identify each firm as one of the three types: "purely domestic firm," "Non-MNE exporter," and "MNE." We approximate δ_{IX} as MNEs / (non-MNE exporters +1) because there are some pairs of industry and region which have no exporters. $DISPERSE_{st}$ is our measure of the extent of productivity dispersion across firms within an industry *s* in year *t*. We use the standard deviation of 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). We use R&D intensity as measures of corporate level economy of scale which negatively reflect the fixed costs of FDI relative to the fixed cost of exporting. $TARIFF_{st-1}$ is import-weighted average tariff which is applied to the import of foreign goods in industry *s* in year *t-1* in Japan and is taken from Nicita and Olarreaga (2007)[1] where the data are described in more detail. This variable is lagged by one year in order to avoid reverse causality.

χ_{sr} is a fixed effect of the pair of industry *s* and region *r*, λ_r is an indicator variable for region *r*, and $year_t$ is also an indicator variable for year *t*. $KAPINT_{st}$, $SKINT_{st}$, and $ADINT_{st}$ are capital intensity, skill intensity, and advertisement intensity,

1 We make a concordance to match 3-digit ISIC industries to the METI code industries.

respectively.

Since cutoffs are function of trade costs[2], wages, and market sizes as shown in Appendix 2, these variables also affect the fractions of internationalized firms which we estimate. As for these factors specific to country or the pair of country and industry, it is difficult to proxy them because we do not have the number of internationalized firms per country. We, therefore, have added the fixed effects of the pair of industry and region and the interaction of region dummies with year dummies to estimation equations.

Finally, we have included capital intensity, number of skilled workers per total employment (skill intensity), and the ratio of advertisement expenditures to sales (advertisement intensity) in regression in order to control for omitted industry characteristics. All of these variables were constructed from the METI survey. Descriptive statistics for all variables are shown in Table 1.

5. Results

We first discuss the results shown in Table 2 where we estimate coefficients by fixed effect model. Dependent variables in column (1), (2), (3), and (4) are the fraction of non-MNE exporters, the fraction of MNEs, MNEs per non-MNE exporters, and the fraction of the sum of exporters and MNEs, respectively. Since $\delta_N = \delta_X + \delta_I$, the coefficient estimates in column (4) are equal to the sum of the coefficients in columns (1) and (2). First, the coefficients on log of dispersion are positive in all four columns and statistically significant in all columns except column (3). Although the coefficient in column (3) is not significant, the estimated sign is consistent with the theoretical implications derived in the section 3 which predict that industries with higher level of productivity dispersion have the larger fractions of internationalized firms. Since the estimated sign shows that industries with higher dispersion of productivity have the larger fraction of MNEs, that of MNEs over non-MNE exporters, and that of exporters and MNEs, the results all support theoretical predictions. The positive coefficient of dispersion in column (2) provides the evidence that industries with larger dispersion of productivity have the larger fraction of non-MNE exporters. Second, the coefficients on R&D intensity are positive and significant in columns (2)-(4). This implies that corporate level economy of scale plays the important roles in doing FDI as predicted by the theory.

Third, import tariff significantly decreases all fractions in line with Melitz (2003). This suggests that protection by government prevents low-productivity firms from exiting and lowers the fraction of exporters and that of MNEs. The result of Column (3) reveals that the

[2] While we have the import tariff data, we do not have any data on variable trade costs which Japanese firms face when they export their goods.

reallocation effect is strongly pronounced in the case of MNEs, compared with that of exporters.

Forth, control variables such as capital intensity, skill intensity, and advertisement intensity are significant in some columns. In particular, the negative and significant coefficient of capital intensity in column (1) implies that more capital intensive industries have fewer exporters. This result is very surprising because it is contradicted with traditional endowment-driven theories of trade which predicts a relatively capital-abundant country like Japan should be relatively more likely to export in capital-intensive industries in which it possesses comparative advantage. In addition, the coefficients on skill intensity are positive in columns (2)-(4) and significant in columns (2) and (4). This indicates that MNEs needs more skilled worker in home country and is consistent with earlier findings by Head and Ries (2002). The p-values of Hausman tests support validity of our choice of fixed effect model in column (1) and (3).

As a robustness check, Table 3 reports the random effects estimates of coefficients together with the p-value of BPL tests. The coefficients on log of dispersion are positive and now significantly different from zero at the 1 percent significance level in all columns. The p-values of Hausman test in column (3) and (4) of Table 2 and the p-values of BPL test in column (3) and (4) of Table 3 indicate that random effect estimate are preferable in the regression of the relative fraction of MNEs over non-MNE exporters, although the both fixed and random effects model yield positive coefficient on dispersion and implies that industries with higher level of productivity dispersion have the larger relative fraction of MNEs over non-MNE exporters. Other estimates are qualitatively similar with fixed effects estimates, although the coefficients on R&D intensity turned to be significantly negative in column (3) and positive and significant in column (1).

Next, we divide the sample into two subsamples based on the level of regional development, and estimate equation (10) in each subsample. First, we estimate the specifications (10) on a subsample in which exclude the fraction of firms exporting to or doing FDI in Asia. The benefit of considering this sample is that we can focus on the horizontal FDI which our model analyzed while most FDI in Asia seem to be vertical one to save the production cost. Now, our restricted sample contains the fraction of firms exporting to or doing FDI in North America and Europe only.

The coefficients obtained by estimating the fixed effects model on the subsample are shown in Table 4. Dispersion is found to have a significant effect on the fraction of internationalized firms in all four columns as partly predicted by the theory. Column (1) again confirms that industries with larger degree of productivity dispersion have the larger fraction of non-MNE exporters while capital intensive industries have fewer exporters. The result also shows that R&D intensive industries tend to have more MNEs in line with the model. The estimated coefficients of import tariff are significantly negative in all columns except column (3). This again suggests that increased competition brought by lower tariff may induce low-productivity firms to shut down and raise the fraction of exporters and that of MNEs.

The main qualitative difference in the results in Table 4 compared to those of the analysis of full sample is that the coefficient of dispersion on the relative fraction of MNEs over exporters turned to be significantly different from zero at 10 % significance level in the subsample. Another difference is that the capital intensity turned to affect positively and significantly the fraction of MNEs. This indicates that more capital intensive industries do more FDI. This result is interesting, but our theoretical model offers no guidance concerning their interpretations. We do not report the results of random effects because they are little different from fixed effects counterparts.

Finally, we focus on the sample of the fraction of firms internationalizing to Asia and estimate the same specifications on this subsample. The results of fixed effect estimates are shown in Table 5. In contrast to the result of the sample of the fraction of firms internationalizing to North America and Europe, the coefficient of dispersion on MNEs is insignificant in column (2) in Table 5 and that on MNEs per non-MNE exporters is negative and insignificant in column (3). This result is consistent with the idea that vertical FDI is prevalent in Asia. Although the coefficient of import tariff on the fraction of exporters changes to be insignificant, unreported random effect estimate is negative and significant. In addition, the coefficient of capital intensity on the fraction of MNEs changes to be insignificantly negative. This suggests that firms in less capital intensive industries tend to have stronger incentive to expand their activities to Asia. The reason may be that vertical FDI are active in labor intensive industries because labor intensive industries can save wage cost more in Asia than capital intensive industries.

6. Concluding remarks

In this paper, we examine the link between firm heterogeneity and the prevalence of exporting and FDI. Using a standard heterogeneity model of Helpman et al. (2004), we derived two testable implications. First, industries with larger productivity dispersion have (i) the larger fraction of firms that conduct FDI, (ii) the larger relative fraction of MNEs over exporters, and (iii) the larger fraction of the sum of exporters and MNEs. Second, R&D intensive industries have advantage in conducting FDI. The empirical results accord with all of two implications of the model and additionally revealed that (iv) the fraction of exporters is larger in industries with larger degree of productivity dispersion.

In addition, we empirically examine whether highly protected industries have the smaller fraction of internationalized firms. The result confirms that lower import tariff increases the fraction of exporters and that of MNEs. This suggests that protection by government may prevent firms from supplying their products to foreign markets.

Our results also shed light on the industry characteristics associated with export and FDI. FDI is prevalent in skill intensive industries. It indicates that FDI is prevalent in those industries in which skilled workers play a key role. A particularly interesting result is that exporting is more prevalent in less capital insensitive industries, while factor endowment theory predicts the converse.

For the purpose of comparison, we estimated the model separately for different sets of regions. We separate Asia where vertical FDI is prevalent from North America and Europe. The coefficients of dispersion on the fraction of MNEs are positive for both Asia and developed regions but are statistically significant for only the developed region. Moreover, the coefficient of dispersion on MNEs per exporters is negative for Asia. This result suggests that in Asia vertical FDI is more prevalent and FDI is not substitute for exporting.

We conclude that within-industrial heterogeneity as well as R&D intensity and government trade policy plays an important role in the structure of foreign trade and investment. That is, 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 intensity is associated with the larger fraction of MNEs. Furthermore, lower import tariff positively affects both the fraction of exporters and that of MNEs.

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Figure 1. Dispersion and the fraction of exporters

Figure 2. Dispersion and the fraction of MNEs

Figure 3. R&D intensity and the fraction of MNEs

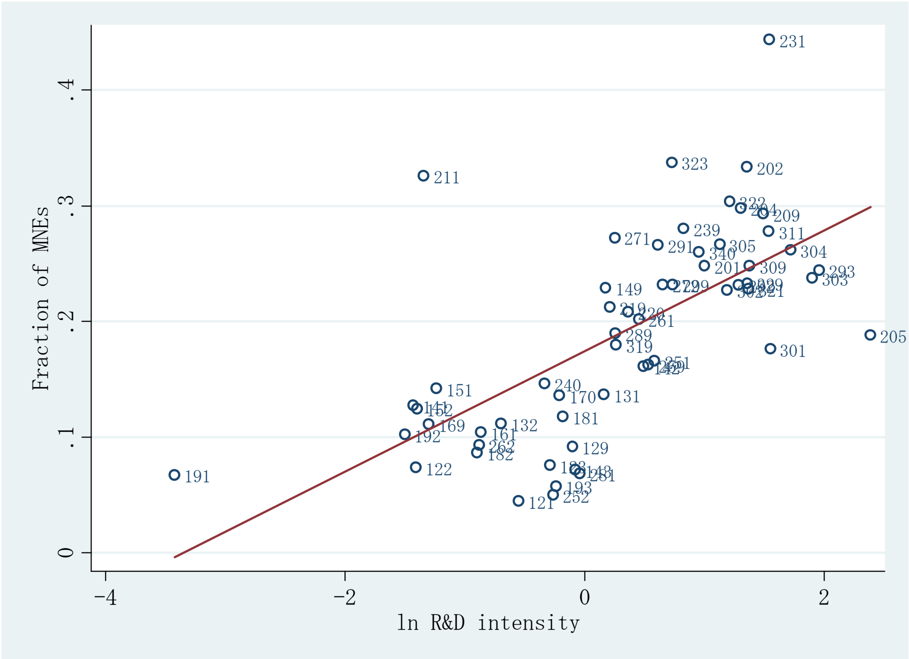

Table 1

Descriptive Statistics					
Variable	Mean	S. D.	N	Min	Max
Non-MNE exporters / All	0.143	0.100	513	0.000	0.417
MNEs / All	0.202	0.098	513	0.031	0.556
MNEs / Non-MNE exporters	1.851	1.438	513	0.375	12.500
Exporters and MNEs / All	0.345	0.180	513	0.047	0.889
ln S. D. of ln Sales	1.247	0.280	513	0.626	2.270
ln Capital intensity	2.859	0.761	513	0.968	5.511
ln R&D intensity	0.236	1.210	512	-5.688	2.484
ln Skill intensity	-2.205	1.076	505	-8.442	-1.066
ln Ad. Intensity	-5.397	1.111	513	-7.893	-2.755
ln Tariff	-0.780	2.046	492	-3.912	2.806

Table 2

The fraction of internationalized firms (Japan, 1997-2005): Fixed effect model				
	(1)	(2)	(3)	(4)
Dep. Var.	Non-MNE Exporters	MNEs	MNEs per Non-MNE Exporters	Exporters and MNEs
ln Dispersion (Sales)	0.035***	0.044***	0.336	0.079***
	[0.011]	[0.011]	[0.248]	[0.014]
ln Capital intensity	-0.009**	0.005	0.101	-0.004
	[0.004]	[0.005]	[0.104]	[0.006]
ln R&D intensity	-0.002	0.010***	0.123**	0.008**
	[0.003]	[0.003]	[0.060]	[0.003]
ln Skill intensity	0.00	0.003***	0.035	0.003***
	[0.001]	[0.001]	[0.022]	[0.001]
ln Ad. Intensity	0.002	-0.009***	-0.105**	-0.007**
	[0.002]	[0.002]	[0.048]	[0.003]
ln Tariff	-0.006***	-0.014***	-0.101**	-0.020***
	[0.002]	[0.002]	[0.051]	[0.003]
Observations	1449	1449	1449	1449
Number of Clusters	165	165	165	165
R-squared	0.09	0.08	0.05	0.13
F	62.51	38.18	14.34	87.42
p-value				
Hausman test	0.00	0.00	1.00	1.00

Notes: Coefficients are estimated by fixed effect model. Standard errors in brackets. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Dependent variables in column (1), (2), (3), and (4) are the fraction of nonmultinational exporters, the fraction of multinationals, multinationals per nonmultinational exporters, and the fraction of the sum of exporters and multinationals, respectively. Constant and the interaction of region dummies with year dummies are suppressed.

Table 3

The fraction of internationalized firms (Japan, 1997-2005): Random effect model				
	(1)	(2)	(3)	(4)
Dep. Var.	Non-MNE Exporters	MNEs	MNEs per Non-MNE Exporters	Exporters and MNEs
ln Dispersion (Sales)	0.035***	0.071***	0.580***	0.094***
	[0.010]	[0.010]	[0.183]	[0.013]
ln Capital intensity	-0.005	0.002	-0.074	-0.002
	[0.004]	[0.004]	[0.069]	[0.005]
ln R&D intensity	0.009***	0.014***	-0.069*	0.019***
	[0.002]	[0.002]	[0.039]	[0.003]
ln Skill intensity	0.00	0.003***	0.022	0.004***
	[0.001]	[0.001]	[0.022]	[0.001]
ln Ad. Intensity	-0.001	-0.008***	-0.029	-0.009***
	[0.002]	[0.002]	[0.038]	[0.003]
ln Tariff	-0.010***	-0.009***	0.026	-0.021***
	[0.002]	[0.002]	[0.025]	[0.002]
Observations	1449	1449	1449	1449
Number of Clusters	165	165	165	165
R-squared	0.375	0.564	0.215	0.528
p-value				
BPL test	0.00	0.00	0.00	0.00

Notes: Coefficients are estimated by random effect model. Standard errors in brackets. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Dependent variables in column (1), (2), (3), and (4) are the fraction of nonmultinational exporters, the fraction of multinationals, multinationals per nonmultinational exporters, and the fraction of the sum of exporters and multinationals, respectively. Constant and the interaction of region dummies with year dummies are suppressed.

Table 4

Internationalization to Europe and North America (Japan, 1997-2005): Fixed effect model				
	(1)	(2)	(3)	(4)
Dep. Var.	Non-MNE	MNEs	MNEs per	Exporters
	Exporters		Non-MNE Exporters	and MNEs
ln Dispersion (Sales)	0.020*	0.023**	0.467*	0.043***
	[0.012]	[0.009]	[0.255]	[0.013]
ln Capital intensity	-0.010*	0.016***	0.173*	0.006
	[0.005]	[0.004]	[0.105]	[0.005]
ln R&D intensity	-0.002	0.009***	0.118*	0.007**
	[0.003]	[0.002]	[0.062]	[0.003]
ln Skill intensity	0.00	0.002	-0.004	0.005**
	[0.002]	[0.002]	[0.041]	[0.002]
ln Ad. Intensity	0	-0.003*	-0.154***	-0.003
	[0.002]	[0.002]	[0.049]	[0.003]
ln Tariff	-0.008***	-0.005**	-0.037	-0.013***
	[0.003]	[0.002]	[0.056]	[0.003]
Observations	966	966	966	966
Number of Clusters	110	110	110	110
R-squared	0.15	0.08	0.1	0.19
F	47.07	48.44	10.41	101.4
p-value				
Hausman test	0.00	0.06	0.00	0.00

Notes: Coefficients are estimated by fixed effect model. Standard errors in brackets. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Dependent variables in column (1), (2), (3), and (4) are the fraction of nonmultinational exporters, the fraction of multinationals, multinationals per nonmultinational exporters, and the fraction of the sum of exporters and multinationals, respectively. Constant and the interaction of region dummies with year dummies are suppressed.

Table 5

Internationalization to Asia (Japan, 1997-2005): Fixed effect model				
	(1)	(2)	(3)	(4)
Dep. Var.	Non-MNE	MNEs	MNEs per	Exporters
	Exporters		Non-MNE Exporters	and MNEs
ln Dispersion (Sales)	0.057***	0.000	-0.200	0.057**
	[0.022]	[0.021]	[0.553]	[0.026]
ln Capital intensity	-0.009	-0.008	0.041	-0.017
	[0.009]	[0.009]	[0.228]	[0.011]
ln R&D intensity	-0.004	0.015***	0.134	0.011*
	[0.005]	[0.005]	[0.134]	[0.006]
ln Skill intensity	0.00	-0.002	0.011	0
	[0.004]	[0.003]	[0.090]	[0.004]
ln Ad. Intensity	0.006	-0.004	0.04	0.003
	[0.004]	[0.004]	[0.107]	[0.005]
ln Tariff	0	-0.012**	-0.286**	-0.012**
	[0.005]	[0.005]	[0.122]	[0.006]
Observations	483	483	483	483
Number of Clusters	55	55	55	55
R-squared	0.05	0.49	0.04	0.44
F	74.07	55.29	13.13	116.2
p-value				
Hausman test	1.00	0.07	0.09	0.00

Notes: Coefficients are estimated by fixed effect model. Standard errors in brackets. *** Significant at 1%. ** Significant at 5%. * Significant at 10%. Dependent variables in column (1), (2), (3), and (4) are the fraction of nonmultinational exporters, the fraction of multinationals, multinationals per nonmultinational exporters, and the fraction of the sum of exporters and multinationals, respectively. Constant and year dummies are suppressed.

Appendix 1

Industry Description and Classification

Code	Description
121	Meat and meat products
122	Fish and fish products
123	Grain mill products
129	Other food products
131	Beverages and tobacco products
132	Prepared animal feeds
141	Spinning
142	Weaving
143	Dyeing
149	Other textiles
151	Knitted and crocheted fabrics and articles
152	Other wearing apparel
161	Sawmilling and planing of wood
169	Other products of wood
170	Furniture
181	Paper and paper products
182	Corrugated paper and paperboard
191	Publishing of newspapers
192	Publishing
193	Printing
201	Chemical fertilizer and inorganic chemistry
202	Organic chemistry
204	Soap and detergents
205	Pharmaceuticals and medicinal chemicals
209	Other chemical products
211	Refined petroleum products
219	Other petroleum products
220	Plastic products
231	Rubber tyres and tubes
239	Other rubber products
240	Leather and fur
251	Glass and glass products
252	Cement, lime and plaster
259	Other non-metallic mineral products
261	Basic iron and steel
262	Casting of iron and steel
271	Non-ferrous metals
272	Casting of non-ferrous metals
281	Structural metal products
289	Other fabricated metal products
291	Machinery for metallurgy
292	Other special purpose machinery
293	Office machinery
299	Other general purpose machinery
301	Industrial electricity machinery
302	Household electrical appliances
303	Communication equipment
304	Applied electronic apparatus
305	Electronic components
309	Other electrical equipment
311	Motor vehicles
319	Other transport equipment
321	Medical equipment
322	Optical instruments
323	Watches and clocks
329	Other precision instruments
340	Other manufacturing

Appendix 2

Using the definition of cutoffs (3)-(5), we can rewrite the fractions (6)-(9) as

(A-1) $$\delta_N = \left[\tau_i^{1-\sigma} \left(\frac{A_i}{A_j} \right) \left(\frac{f_D}{f_X} \right) \right]^{\frac{k}{\sigma-1}}$$

(A-2) $$\delta_I = \left[\left\{ \left(\frac{w_i}{w_j} \right)^{1-\sigma} - \tau_i^{1-\sigma} \right\} \left(\frac{A_i}{A_j} \right) \left(\frac{f_D}{f_I - f_X} \right) \right]^{\frac{k}{\sigma-1}}$$

(A-3) $$\delta_X = \left(\frac{f_D}{w_j^{1-\sigma} A_j} \right)^{\frac{k}{\sigma-1}} \left[\left(\frac{(\tau_i w_j)^{1-\sigma} A_i}{f_X} \right)^{\frac{k}{\sigma-1}} - \left(\frac{(w_i - \tau_i w_j)^{1-\sigma} A_i}{f_I - f_X} \right)^{\frac{k}{\sigma-1}} \right]$$

(A-4) $$\delta_{IX} = 1 \Bigg/ \left(\left[\left(\frac{f_I - f_X}{f_X} \right) \frac{(\tau_i w_j)^{1-\sigma}}{\left(w_i^{1-\sigma} - (\tau_i w_j)^{1-\sigma} \right)} \right]^{\frac{k}{\sigma-1}} - 1 \right)$$

We examine the corporate level economy of scale which negatively reflects the relative magnitude of f_I over f_X. From (A-2)-(A-4), a decline in f_I relative to f_X increases the fraction of MNEs and the relative fraction of MNEs over exporters, while it decreases the fraction of non-MNE exporters.