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Firm Heterogeneity and the Choice of Internationalization Modes: Statistical Evidence from Japanese Firm-level Data

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Abstract

This paper examines how productivity heterogeneity affects the sorting of export and foreign direct investment (FDI) of Japanese firms in North America and Europe. The statistical analysis based on the firm-level data of 12,000 Japanese firms presents new and interesting results: the ranking of productivity corresponds to the mode of internationalization from export to FDI; the productivity of Japanese firms with exports to North America is similar to the productivity of firms with exports to Europe, and the productivity of Japanese FDI firms in North America is also similar to the productivity of FDI firms in Europe; and further the productivity of firms internationalizing in both North America and Europe is remarkably higher than that of firms internationalizing in either North America or Europe, regardless the modes of internationalization, export or FDI. These results conclude that the internationalization modes of Japanese firms in North America and Europe are completely consistent with the theoretical prediction of the HMY model and the fixed costs are critical for determining their choice of internationalization modes.

JEL: F10, F14, F23

Keywords: firm heterogeneity, productivity cutoff, export, FDI, internationalization

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1. Introduction

There is a complex integration strategy among Japanese multinational firms exporting to or investing in the Northern and Southern countries. It is also a fact that more than half of FDI by Japanese multinationals is in the North. Exports and FDI in North America and Europe are a major part of Japanese exports and FDI. Even if Japanese firms are increasing the export and FDI in the Southern countries, it is still important to note the organizational forms of multinationals exporting to and investing in countries in the North.

Melitz (2003) presented a theoretical transmission channel on the impact of trade on industry structure and performance through intra-industry reallocations across firms with the use of an industry model that incorporates firm-level heterogeneity. Theoretical and empirical studies by Helpman, Melitz and Yeaple (2004; hereafter HMY), assuming horizontal FDI, show that productivity sorts the modes of firm's internationalization, export or FDI, under given variable and fixed costs and market size. Their theoretical findings indicate that firms with the lowest productivity supply only the domestic market, firms with higher productivity export, and firms with the highest productivity switch their choice of internationalization mode from export to FDI. These findings are supported by empirical results based on U.S. industry data, which confirms that the higher the firm heterogeneity in productivity, the lower the relative share of exports to foreign production. Grossman, Helpman, and Szeidl (2006), who characterized an industry by the size of the fixed costs of maintaining foreign subsidiaries for production, the costs of transportation, and the consumer demand, derived the equilibrium organizational forms for heterogeneous firms that differ in their productivity levels[1]. In their model, firms headquartered in a northern country supply differentiated final goods to two national markets, one in the north and one in the south, and they present many possible organizational forms that vary among firms according to different combinations of fixed costs, transportation costs, variables costs, and the relative size of the markets. Following the theoretical analysis by Grossman et al., a few empirical studies have been conducted on the choice of internationalization modes in multiple-country cases.

Following the theoretical studies, we find a wealth of empirical examinations on the

[1] The theoretical analysis by Grossman, Helpman, and Szeidl (2006) presents the theoretical pattern of internationalization modes by combining productivity, fixed costs, and transportation costs under the assumption of two heterogeneous countries, north and south.

modes of internationalization. Bernard, Redding and Schott (2006) and Bernard and Jensen (2007) show that U.S. firms with the lowest productivity supply for only the domestic market, those with higher productivity export, and those with the highest productivity invest abroad. Mayer and Ottaviano (2007) provided similar evidence for European firms. Mayer and Ottaviano show that the internationalization of Belgian firms coincides with the productivity rank predicted by the HMY model. As for Japanese firms, Head and Ries (2003) and Tomiura (2007) looked at the sorting pattern of internationalization with respect to productivity by analyzing firm-level data. These empirical investigations examined the modes of internationalization of multinationals to all countries in the world, but did not focus specifically on either northern or southern countries.

This paper, by using Japanese firm-level data, aims to identify whether the order of internationalization modes of Japanese multinationals is determined by productivity level and is consistent with the HMY model, by concentrating on export and FDI of firms in North America and Europe. The reason why we concentrate on the northern regions is to exclude the mixed effects of the combination of variables on the sorting by productivity. Even in Northern regions with similar variable and fixed costs, firms actually export to or conduct FDI in multiple destinations. This paper investigates whether the relationship between productivity and the sorting pattern of internationalization is affected by the increase in the number of destinations.

In the case of export and FDI in North America or Europe, the results of empirical investigation in this paper clearly present that the internationalization modes are ordered by productivity. They fully support the theoretical prediction of the HMY model regarding the sorting pattern of firms' internationalization based on productivity. The paper also finds that the sorting of internationalization modes is similar between firms exporting to or investing in North America and firms in Europe. Furthermore, we observe that the productivity of firms internationalized in both North America and Europe shows a higher level compared to the productivity of firms internationalized to either North America or Europe.

The remainder of this paper is organized as follows: in Section 2 we present the framework for analyzing the relation between firm heterogeneity in productivity and the internationalization modes in multiple northern regions, twisting the HMY model; Section 3 introduces statistical facts on the average productivity of Japanese firms corresponding to the

choice of internationalization modes; Section 4 presents the results of empirical examinations and shows that the internationalization modes of Japanese firms are sharply ranked by productivity but the internationalization in multiple regions is statistically different from internationalization in a single region; Section 5 discusses what factors affect the difference in productivity-cutoff for export and FDI between multiple and single regions. In section 6, we conduct an alternative test to confirm the accuracy of the estimated results in Section 4. Section 7 concludes the paper.

2. Modes of internationalization: a framework for analysis

2.1 Basic model

The analytical framework of this paper relies on the HMY model. Suppose that differentiated goods are supplied to the market under the demand drawn from the following CES type utility function,

$$(1) \qquad u = \left[\int_{l\in D} x(l)^{\alpha} dl\right]^{1/\alpha} \quad , \quad 0<\alpha<1 ,$$

where $x(l)$ is demand for goods *l*, D is a set of the goods that can be purchased, and α presents a parameter to determine the elasticity of substitution between goods, $\varepsilon = 1/(1-\alpha)$, and $\varepsilon > 1$.

The demand in country *j* of these goods *l* is expressed by the following equation,

$$(2) \qquad x_j(l) = \frac{p_j(l)^{-\varepsilon} Y_j}{P_j^{1-\varepsilon}} ,$$

where Y_j is the total expenditure of country *j*, $p_j(l)$ is the price of goods *l* , and P_j is the price index of Country *j*. The price index P_j is given by the following equation,

$$(3) \qquad P_j = \left[\int_{l\in D} p_j(l)^{1-\varepsilon} dl\right]^{1/(1-\varepsilon)} ,$$

Firms produce the differentiated goods using labor as only one production input.

The HMY model supposes that there are three different channels through which firms can obtain profits: the supply in home country, exports, and overseas production. The same production technology is used for all three channels. Their model assumes that the export channel is accompanied by both transportation costs and fixed costs, while FDI has fixed costs but no transportation costs. Fixed costs for exports and overseas production are expressed by f_j^X and f_j^I, respectively. The marginal cost for production in country *j*, C_j, is expressed by $C_j = w_j a$, where *a* is the labor input coefficient, and w_j is the wage rate of country *j*. The reciprocal number of the input coefficient, *1/a*, expresses the labor productivity of the firm. In the case of export, the marginal cost for production of exported goods is rewritten as $C_j = \tau_j w_j a$ because export accompanies the transportation cost τ_j, defined as the iceberg type. We assume that $\tau_j > 1$.

Under the above assumptions, the prices of the goods that firms supply in country j are expressed as follows:

$$p_j(a) = \frac{C_j}{\alpha} \tag{4}$$

If we assume that the fixed cost for domestic production is zero, the profits of firms are expressed as follows, respectively:

For the case of supply for home market in country *i*,

$$\pi_i(a) = (1-\alpha)\left(\frac{w_i a}{\alpha P_i}\right)^{1-\varepsilon} Y_i \tag{5-1}$$

In the case of exports to country *j*,

$$\pi_j^X(a) = (1-\alpha)\left(\frac{\tau_j w_i a}{\alpha P_j}\right)^{1-\varepsilon} Y_j - f_j^X \tag{5-2}$$

In the case of overseas production in country *j*,

(5-3) $$\pi_j^I(a) = (1-\alpha)\left(\frac{w_j a}{\alpha P_j}\right)^{1-\varepsilon} Y_j - f_j^I$$

By denoting $\theta = a^{1-\varepsilon}$, $\frac{(1-\alpha)}{(\alpha P_k)^{1-\varepsilon}} Y_k = B_k$, $w_l^{1-\varepsilon} = W_l$, and $T_m = \tau_m^{1-\varepsilon}$ for *k, l, m=i, j,* equations (5-1) to (5-3) are rewritten as follows:

(6-1) $$\pi_i(\theta) = W_i B_i \theta$$

(6-2) $$\pi_j^X(\theta) = W_i T_j B_j \theta - f_j^X$$

(6-3) $$\pi_j^I(\theta) = W_j B_j \theta - f_j^I$$

Under this framework, for the case in which firms export or conduct FDI in one region, we induce the following proposition 1 on the modes of internationalization sorted by the productivity-cutoff by comparing the profits between $\pi_j^X(\theta)$ and $\pi_j^I(\theta)$ under the assumption that the fixed costs for FDI are larger than those for export as follows:

$$\frac{f_j^I}{f_j^X} > \left(\frac{W_j}{W_i}\right)\left(\frac{1}{T_j}\right).$$

Proposition 1.

If $\frac{f_j^X}{B_j W_i T_j} < \theta < \frac{(f_j^I - f_j^X)}{B_j(W_j - W_i T_j)}$, *firms with the productivity* θ *supply for domestic market and export. If* $\theta \geq \frac{(f_j^I - f_j^X)}{B_j(W_j - W_i T_j)}$, *firms with the productivity* θ *switch their mode of internationalization from export to foreign production.*

The internationalization modes corresponding to the productivity cutoff are depicted in Figure 1.

Figure 1

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2.2 Multiple regions

There are many firms which export or make FDI in multiple regions. Here, we twist the HMY model to investigate what internationalization modes in two regions the firms choose corresponding to their productivity. Let us assume that firms are exporting to or conducting FDI in two foreign markets, region 1 and region 2. The profits of the firms are expressed as follows: For the case of supply in the home market,

(7-1) $\pi^{D}(\theta) = W_i B_i \theta$

For the case of exports to two regions,

(7-2) $\pi_1^{X}(\theta) + \pi_2^{X}(\theta) = W_i(T_1 B_1 + T_2 B_2)\theta - f_{1+2}{}^{X}$

For the case of FDI in two regions,

(7-3) $\pi_1^{I}(\theta) + \pi_2^{I}(\theta) = (W_1 B_1 + W_2 B_2)\theta - f_{1+2}{}^{I}$

where f_{1+2}^{X} and f_{1+2}^{I} are the fixed costs of firms with exports to and FDI in both region 1 and 2.

For the case in which firms export or conduct FDI in both regions, we induce the following proposition on the modes of internationalization sorted by the productivity-cutoff by comparing the profits between $\pi_1^{X}(\theta) + \pi_2^{X}(\theta)$ and $\pi_1^{I}(\theta) + \pi_2^{I}(\theta)$.

Proposition 2.

If $\frac{f_{1+2}^{X}}{W_i(T_1B_1+T_2B_2)} < \theta < \frac{(f_{1+2}^{I}-f_{1+2}^{X})}{[(W_1-W_iT_1)B_1+(W_2-W_iT_2)B_2]}$, *firms with the productivity* θ *supply for domestic market and export to both regions. If* $\theta \geq \frac{(f_{1+2}^{I}-f_{1+2}^{X})}{[(W_1-W_iT_1)B_1+(W_2-W_iT_2)B_2]}$, *firms with the productivity* θ *switch their mode of internationalization from export to foreign production.*

3. Modes of internationalization: statistical facts

3.1 Northern vs. southern regions

North America, Europe and East Asia are three major regions where Japanese firms both export and conduct FDI. Among these three regions, East Asia has a different wage rate and different per capita income in comparison with North America and Europe, while North America and Europe are both similar to Japan in factor prices and income. Transportation costs from Japan are also different between East Asia and North America or Europe. Wakasugi et al (2008) find that the productivity distributions of Japanese exporters and FDI firms are not clearly sorted. This is in contrast to the European exporters and FDI firms whose productivity distributions are sharply different. The internationalization of European firms coincides with the rank of productivity as predicted by the HMY model.[2] However, when we disaggregate the productivity distributions of firms with export and FDI by the destinations, East Asia and northern regions, we find the productivity distributions of firms with export to and FDI in northern regions are different from East Asia. As Figure 2 shows, the productivity distributions of Japanese exporters and FDI firms in East Asia overlap. However, Figure 3 presents the productivity distributions of Japanese exporters and FDI firms in North America and Europe are different. The latter case is consistent with the prediction of HMY model.

Two different features of productivity distribution suggest that the careful handling of region-specific factors including wage, transportation costs, market size, and fixed costs is important for sorting the internationalization modes by productivity. Nevertheless, we find few empirical examinations controlling for the dispersion of these variables among different regions since it is not easy to incorporate a variety of variable costs, fixed costs and market size in the

[2] Refer to Mayer and Ottaviano (2007).

sorting of internationalization modes due to productivity heterogeneity.[3]

Figure 2 and Figure 3

3.2 Distribution of firms in North America and Europe

We analyze the distribution of Japanese firms internationalizing in two regions, North America and Europe. The matrix in table 1 shows the distribution of firms corresponding to the internationalization modes: only domestic supply, export and FDI[4] in 2005. The statistical data, taken from the "Basic Survey of Japanese Business Structure and Activities",[5] are based on firm-level data of 12,000 Japanese manufacturing firms with either more than 30 million yen in capital stock or more than 50 employees.

Table 1

Among Japanese firms, 78.07% (9,762 firms) have entered neither North America nor Europe; roughly only 20% of firms are internationalized in North America or Europe. The percentage of internationalized firms is not large. Just 9.63% (1,204 firms) of firms export to and 9.72% (1,216 firms) conduct FDI in North America, while the figures for firms with exports and FDI in Europe are 10.41% (1,302 firms) and 5.59% (669 firms), respectively. Although the share of exporting firms is equivalent between North America and Europe, a greater number of firms have FDI in North America than Europe. Moreover, it is notable that 5.98% (748 firms) of firms export to both regions and 4.73% (591 firms) have FDI in both. The share of these firms is

[3] Aw and Lee (2008) look at Taiwanese firms that internationalize to two different areas, the U.S. represents the north and China the south. Their findings suggest that the productivity of firms investing in China is higher than an exporter's productivity, the productivity of firms investing in North America is higher than that for firms investing in China, and the productivity of firms internationalizing to both countries is the highest. But their examination is based on only a small number of firms in limited industries. Their analysis, as based on the countries among which the variable costs, transportation costs and fixed costs vary, is not clear when it comes to identifying what factors actually affect the relationship between productivity and the sorting pattern of internationalization.

[4] FDI includes not only the case of pure FDI but also both FDI and exports.

[5] The analysis hereafter uses the firm-level data of the "Basic Survey of Japanese Business Structure and Activities." We acknowledge the Research Institute of Economy, Trade and Industry (RIETI), and the Statistics Department, Ministry of Economy, Trade and Industry (METI) for granting their permission to use these data.

[7] The calculation of TFP is based on the results by Wakasugi et al. (2008).

significantly larger than that of firms with exports or FDI in either North America or Europe.

3.3 Comparison of productivity

Although it is not easy to directly observe the productivity-cutoff corresponding to each mode of internationalization, it is possible to observe the average productivity of firms corresponding to each mode in the box of table 1. Here, we calculate the average productivity of firms corresponding to each mode of internationalization. The productivity is defined by the total factor productivity (TFP) of the firm. In the TFP calculation we use the Cobb-Douglas type production function estimated by the method of Olley and Pakes (1998).[7]

Figure 4 shows the statistics of average TFP of firms corresponding to each mode of internationalization in Table 1. From Figure 4, we find the following interesting statistical facts:

(1) the productivity of internationalizing firms exceeds the productivity of domestic firms.
(2) the productivity is almost equal between firms exporting to North America and those exporting to Europe.
(3) the productivity of FDI makers in Europe exceeds the productivity of an exporter.
(4) the productivity of firms exporting to both regions is far higher than that of firms exporting to either one of two regions.
(5) the productivity of firms with FDI in both regions is far higher than that of firms with FDI in either one of two regions, but not both.

Figure 4

These observations, (1), (2) and (3) provide statistical evidence that the internationalization of Japanese firms in North America and Europe is consistent with the HMY model if the rank of average productivity is assumed to reflect the ranking of productivity-cutoff. However, (4) and (5) are puzzles, if it is assumed that North America and Europe are identical regions for internationalization of Japanese firms. Little attention has been attracted to them so far in the HMY model.

4. Empirical test: modes of internationalization and productivity

4.1 Estimation method and data

The purpose of our research is to investigate whether these statistical facts are consistent with the theoretical prediction of the HMY model. The average TFP corresponding to each box in table 1 relates not only to the mode of a firm's internationalization but also other variables including industry-specific or firm-specific factors. In this section, we statistically investigate (i) whether the difference in firm-level productivity matches with the order of internationalization modes, and whether the relation between productivity and the modes of internationalization supports the theoretical prediction of the HMY model after controlling for firm- and industry-specific factors, and (ii) whether the productivity of internationalizing firms in two regions significantly differs from the productivity of firms internationalizing in a single region.

Estimation is based on the following equation:

$$\ln TFP_i = \alpha + \sum_{s=1}^{8} \beta_s D_{i,s} + \gamma_1 \ln(K_i / L_i) + \gamma_2 [\ln(K_i / L_i)]^2 + \gamma_3 \ln(R\,\&\,D_i / Sales_i) + \gamma_4 (SL_i / L_i) + \gamma \ln(Age_i) + \sum_m \delta_m H_{i,m} + \varepsilon_i \quad (8)$$

$$s = 1, 2 \cdots, 8, \quad m = 1, \cdots, n$$

The dependent variable, $\ln TFP_i$ is the logarithm of firm i's TFP, which is defined by $TFP_i = \frac{Y_i}{K_i^{\alpha} L_i^{\beta}}$, and D_{is} presents a dummy variable indicating the following internationalization modes:

(i) $D_{i,1} = 1,\ D_{i,s} = 0 \ for\ s \neq 1$, for the case of export only to North America

(ii) $D_{i,2} = 1,\ D_{i,s} = 0 \ for\ s \neq 2$, for the case of export only to the Europe

(iii) $D_{i,3} = 1,\ D_{i,s} = 0 \ for\ s \neq 3$, for the case of export to both North America and Europe

(iv) $D_{i,4} = 1,\ D_{i,s} = 0 \ for\ s \neq 4$, for the case of local production only in North America

(v) $D_{i,5} = 1,\ D_{i,s} = 0 \ for\ s \neq 5$, for the case of local production only in Europe

(vi) $D_{i,6} = 1,\ D_{i,s} = 0 \ for\ s \neq 6$, for the case of the local production in North America and export to Europe

(vii) $D_{i,7} = 1,\ D_{i,s} = 0 \ for\ s \neq 7$, for the case of local production in Europe and export to

North America

(viii) $D_{i,8}=1$, $D_{i,s}=0$ $for\ s\neq 8$, for the case of local production in both North America and Europe.

K_i / L_i is the capital labor ratio, $R\&D_i / Sales_i$ is the ratio of R&D expenditures to total sales, SL_i / L_i is the ratio of skilled workers to total workers, Age_i is the firm's period of operation. These variables control for firm-specific factors other than productivity.[8] $H_{i,m}$ is the dummy variable of industry *m* to which firm *i* belongs, α is the constant term, and ε_i is the error term.

The coefficient of each dummy variable β presents the degree to which the productivity of internationalizing firms exceeds the productivity of domestic firms. The estimation is conducted by the ordinary least squares method (OLS). The estimation is conducted on firm-level data maintained by the METI on 12,000 Japanese manufacturing firms: "Basic Survey of Japanese Business Structure and Activities" in 2005. TFP, the dependent variable, is calculated by the method of Olley and Pakes (1998).

4.2 Estimated results

Table 2 shows the estimated results. Every estimated coefficient for each dummy variable presents a high statistical significance of one percent. They are summarized as follows:

(1) both the productivity of firms with exports to either North America or Europe and the productivity of firms with FDI in either North America or Europe are significantly higher than the productivity of firms supplying to only the domestic market.

(2) the productivity of firms with FDI is higher than the productivity of firms with exporting.

(3) the productivity of firms internationalizing in both regions, North America and Europe, is higher than the productivity of firms internationalizing in only one region, either North America or Europe, regardless of the modes of internationalization, export or FDI.

(4) the productivity of firms with FDI in both North America and Europe is significantly higher than the productivity of firms that export to both regions.

[8] The inclusion of the variables to control for firm-specific factors is also seen in previous studies, i.e., Aw and Lee (2008).

Table 2

Based on the estimated results, we further statistically test whether the productivity of firms internationalizing to North America significantly differs from the productivity of firms internationalizing to Europe. Table 3 shows the difference in two coefficients between North America and Europe in export and FDI, and its standard error.

Table 3.

From the statistical test, we conclude that (i) there is no significant difference in the productivity between firms with export to North America and firms with export to Europe; (ii) there is no significant difference in the productivity between firms with FDI in North America and firms with FDI in Europe. The results of (i) and (ii) express that the productivity of firms internationalizing in North America is not different from the productivity of firms internationalizing in Europe. Further, we conclude that (iii) there is a significant difference in productivity between firms that export to two regions and firms that export to only one region, either North America or Europe; and (iv) there also exists a significant difference in productivity between firms with FDI in two regions and firms with FDI in only one region, either North America or Europe.

The estimated results clearly present that the modes of internationalization of Japanese firms are ordered by productivity: from only domestic supply to export to North America or Europe; export to both North America and Europe; and to FDI in both North America and Europe.

If region 1 and 2 are completely identical for exporters and FDI firms, that is, if $W_1 = W_2$, $T_1 = T_2$, $B_1 = B_2$, $f_1^X = f_2^X$, $f_{1+2}^X = f_1^X + f_2^X$, $f_1^I = f_2^I$ and $f_{1+2}^I = f_1^I + f_2^I$, the model for internationalization of firms in two regions expressed in (7-1)-(7-3) is completely the same as the model expressed by (6-1)-(6-3). Then, the modes of internationalization of firms in multiple regions according to productivity-cutoff must be identical to those in a single region. But, in spite of the symmetrical features between North

America and Europe for the internationalization of Japanese firms as shown in (i) and (ii), we find that the productivity of firms internationalizing to both regions is significantly higher than the productivity of firms internationalizing to only one region, as presented by (iii) and (iv). This fact is surprising although it attracted very little attention in previous research. The estimated results (3) and (4) suggest that the assumptions of $f_{1+2}^{X} = f_1^{X} + f_2^{X}$ and $f_{1+2}^{I} = f_1^{I} + f_2^{I}$ are not applicable to the internationalization modes of Japanese firms in both North America and Europe. We need further explanation on such assumptions.

5. Productivity and fixed costs: interpretation

In this section, we discuss why the productivity of firms with internationalization in both regions exceeds the productivity of firms in only one region. In the case of export, by applying the estimated results in section 4 to the productivity cutoff for exporting in section 2 and comparing the productivity-cutoff for exporting between both regions and one region, we find that the fixed costs denominated by market size and transportation costs increase as the number of export regions increases:

$$(9) \qquad \frac{f_{1+2}^{X}}{T_1B_1 + T_2B_2} > \frac{f_1^{X}}{T_1B_1} \text{ and } \frac{f_{1+2}^{X}}{T_1B_1 + T_2B_2} > \frac{f_2^{X}}{T_2B_2}.$$

The estimated results in the previous section show that the productivity of firms exporting to North America is almost equal to the productivity of firms exporting to Europe. They indicate:

$$(10) \qquad \frac{f_1^{X}}{T_1B_1} = \frac{f_2^{X}}{T_2B_2}$$

From (9) and (10), we obtain $f_{1+2}^{X} > f_1^{X} + f_2^{X}$. That is, if the productivity-cutoff for export is identical between North America and Europe as suggested above, the difference in fixed costs between f_{1+2}^{X} and $(f_1^{X} + f_2^{X})$ is crucial in determining the difference in productivitycutoff between firms with export to single and multiple regions. In other words, it is

predicted that the fixed costs for exporting to both regions increase disproportionately larger than the sum of the fixed costs for exporting to either region.

In the case of FDI, also by applying the estimated results in the section 4 to the productivity cutoff for FDI in section 2 and comparing the productivity-cutoff for FDI between both regions and one region, we find that the fixed costs denominated by market size and transportation costs increase with an increase in number of FDI regions:

$$(11) \qquad \frac{(f_{1+2}^{I} - f_{1+2}^{X})}{[B_1(W_1 - W_i T_1) + B_2(W_2 - W_i T_2)]} > \frac{f_1^{I} - f_1^{X}}{B_1(W_1 - W_i T_1)}$$

$$\text{and} \quad \frac{(f_{1+2}^{I} - f_{1+2}^{X})}{[(W_1 - W_i T_1)B_1 + B_2(W_2 - W_i T_2)]} > \frac{f_2^{I} - f_2^{X}}{B_2(W_2 - W_i T_2)}$$

The estimated results show that the productivity of FDI firms in North America is almost identical to the productivity of FDI firms in Europe. They indicate:

$$(12) \qquad \frac{f_1^{I} - f_1^{X}}{B_1(W_1 - W_i T_1)} = \frac{f_2^{I} - f_2^{X}}{B_2(W_2 - W_i T_2)}$$

From (11) and (12), we obtain $(f_{1+2}^{I} - f_{1+2}^{X}) > (f_1^{I} - f_1^{X}) + (f_2^{I} - f_2^{X})$. That is, if the productivity-cutoff for FDI is identical between North America and Europe, the difference in fixed costs between $(f_{1+2}^{I} - f_{1+2}^{X})$ and $(f_1^{I} - f_1^{X}) + (f_2^{I} - f_2^{X})$ is crucial in determining the difference in productivitycutoff between firms with FDI in a single region and those in two regions. We predict that the fixed costs for FDI in both regions increase disproportionately larger than the fixed costs for FDI in either region.

Such a disproportionate increase of the fixed costs is caused by several factors which are not easily observable. The higher cost to coordinate exports to multiple markets or foreign subsidiaries in multiple regions is thought to be a reason for such a disproportional increase of fixed costs with an increase in the number of regions.

6. Alternative Test

In order to confirm the estimated results in the previous section, we conduct an alternative test to investigate the relationship between the modes of internationalization and productivity, based on the Multinomial Logit model. Here, we examine whether the order of productivity level coincides with the choice of modes of internationalization to North America and Europe. The potential choices are defined by the modes in table 1.

We assume that the profit of firm *i*, π_{is} is expressed by the following equation.

$$(13) \qquad \pi_{is} = \alpha_{0,s} + \sum_{j} \beta_{j,s} Z_{i,j,s} + \sum_{m=1}^{n} \delta_{m,s} H_{i,m,s} + \varepsilon_{is}, \quad s = 1,2,\cdots,9, \quad m = 1,2,\cdots,n$$

where π_{is} is the profit of firm *i* under the internationalization strategy *s*, and α_0 is the constant term. $Z_{i,j,s}$ are firm-specific factors that affect the choice of internationalization modes. For firm-specific factors we use the capital-labor ratio, skilled labor intensity, and R&D intensity, other than TFP. $\beta_{j,s}$ is the parameter corresponding to each variable; $H_{i,m}$ is a dummy variable indicating the industry *m* to which firm *i* belongs; δ_m is the parameter indicating the degree to which industrial characteristics affect the choice of internationalization mode; and ε_{is} is an error term.

The internationalization modes which firms choose are categorized as follows:
(i) domestic supply only; (ii) export only to North America; (iii) export only to Europe; (iv) export to both North America and Europe; (v) local production with FDI only in North America; (vi) local production only in Europe; (vii) export to Europe and local production in North America; (viii) export to North America and local production in Europe; and (ix) local production in both North America and Europe. We assume that the firm chooses the optimal mode of internationalization among the potential choices so as to maximize its profit, ceteris paribus. That is, the actual choice of internationalization mode by firm is observed from the statistical data as a result of the profit-maximizing strategy of the firm.

If we assume that the error terms in equation (13) conform to the Weibull distribution, the probability of the choice of internationalization modes is expressed by a Multinomial Logit Model. Consequently, the probability that firm *i* chooses internationalization strategy *s* is expressed as follows:

$$(14) \qquad P_i^s = \frac{\exp\left[\alpha_{0,s} + \sum_j \beta_{j,s} Z_{i,j,s} + \sum_{m=1}^{n} \delta_{m,s} H_{i,m,s}\right]}{\sum_{s=1}^{9} \exp\left[\alpha_{0,s} + \sum_j \beta_{j,s} Z_{i,j,s} + \sum_{m=1}^{n} \delta_{m,s} H_{i,m,s}\right]}$$

When we assume zero profit for the firm that supplies only in the domestic market, the probability of firm *i* choosing internationalization mode *s* is rewritten as follows:

$$(15) \qquad P_i^s = \frac{\exp\left[\tilde{\alpha}_{0,s} + \sum_j \tilde{\beta}_{j,s} Z_{i,j,s} + \sum_{m=1}^{n} \tilde{\delta}_{m,s} H_{i,m,s}\right]}{1 + \sum_{s=1}^{8} \exp\left[\tilde{\alpha}_{0,s} + \sum_j \tilde{\beta}_{j,s} Z_{i,j,s} + \sum_{m=1}^{n} \tilde{\delta}_{m,s} H_{i,m,s}\right]}$$

Table 4.

Table 4 presents the estimated results showing:

(1) TFP significantly affects the probability of choosing every mode of internationalization;

(2) the estimated coefficient for FDI is higher than that for export, which completely supports the theoretical prediction of the HMY model and is consistent with the results shown in figure 4;

(3) the coefficient of TFP corresponding to export to both regions is higher than that for export to a single region, and the coefficient of TFP corresponding to FDI in both regions is also higher than that in a single region.

All the estimated results on the relationship between productivity and the choice of modes of internationalization under a Multinomial Logit Model are consistent with the results of figure 4 in section 4. Our alternative test completely supports the results of estimation in section 4.

7. Conclusion

This paper examines statistically whether the theoretical prediction of the HMY model

is consistent with the relationship between the productivity level and the modes of internationalization of Japanese firms to North America and Europe. The results of the empirical analysis, based on the firm-level data of 12,000 Japanese firms, show that the mode of internationalization shifts from domestic supply to export, and from export to FDI as the productivity of firms increases. This completely coincides with the theoretical prediction of the HMY model. In addition to the stylized facts of internationalization modes, the results of our analysis show that the productivity of firms internationalizing in both regions, North America and Europe, is far higher than the productivity of firms internationalizing in a single region, regardless of export or FDI. Our empirical analysis shows that the productivity of Japanese firms with FDI in two regions is the highest among the modes of internationalization to North America and Europe. This fact is new and did not attract attention before now. There are few empirical studies to identify the relation between the increase in the number of countries or regions for export and FDI and productivity order. Our examination suggests that the difference in fixed costs between single and multiple destinations is a factor to cause the difference in productivity cutoff.

We focused on only the northern regions in order to test how the HMY model fits the internationalization modes of Japanese firms. Our analysis is beneficial to control for the effects of various factors including different wage and transportation costs. Although North America and Europe are major regions in which Japanese firms internationalize, they are also internationalizing in East Asia, where wage and transportation costs are completely different from those in North America and Europe. The introduction of regional heterogeneity, although it would further complicate the combination of productivity and modes of internationalization, is requested for generalizing the conclusions of this paper.

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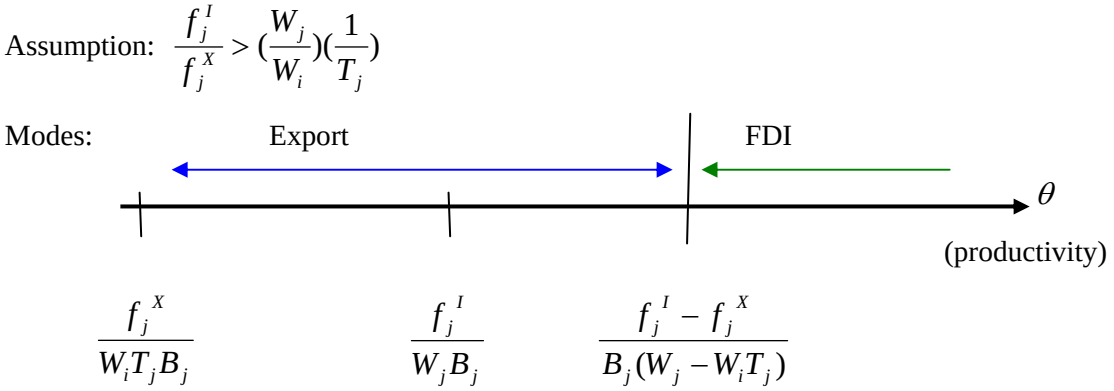
Figure 1. Productivity cutoff and modes of internationalization



Note: EX is export, NA is North America, EU is Europe, and "Both" means both North America and Europe. The same abbreviations are used in figures and tables.

Figure 2. Productivity distribution of Japanese exporters and FDI firms: Asia

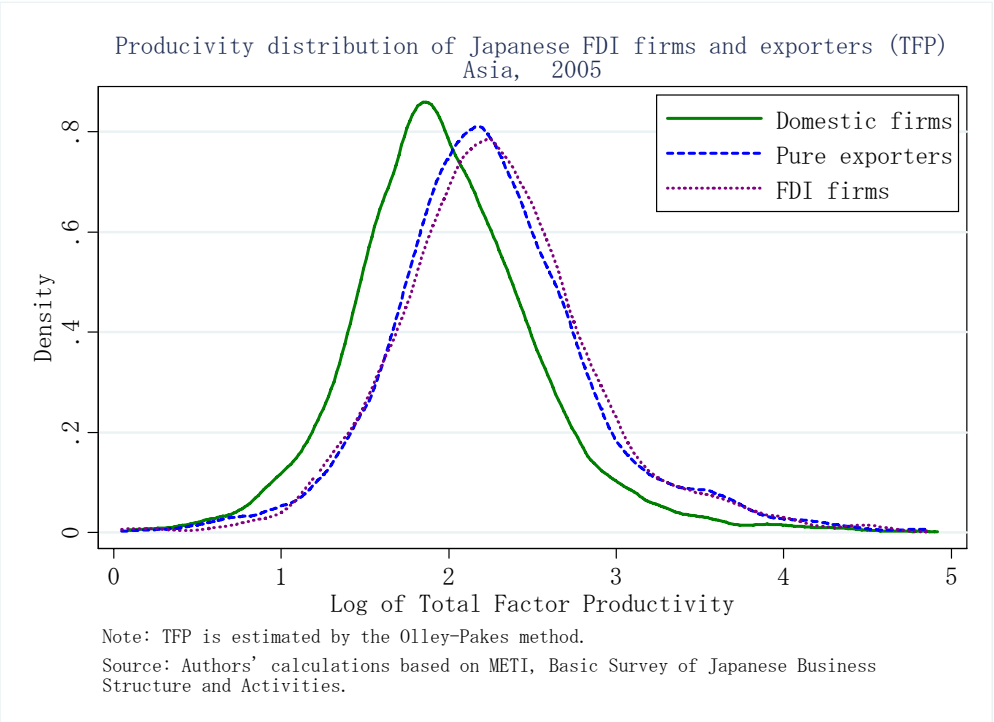


Figure 3. Productivity distribution of Japanese exporters and FDI firms: North America and Europe

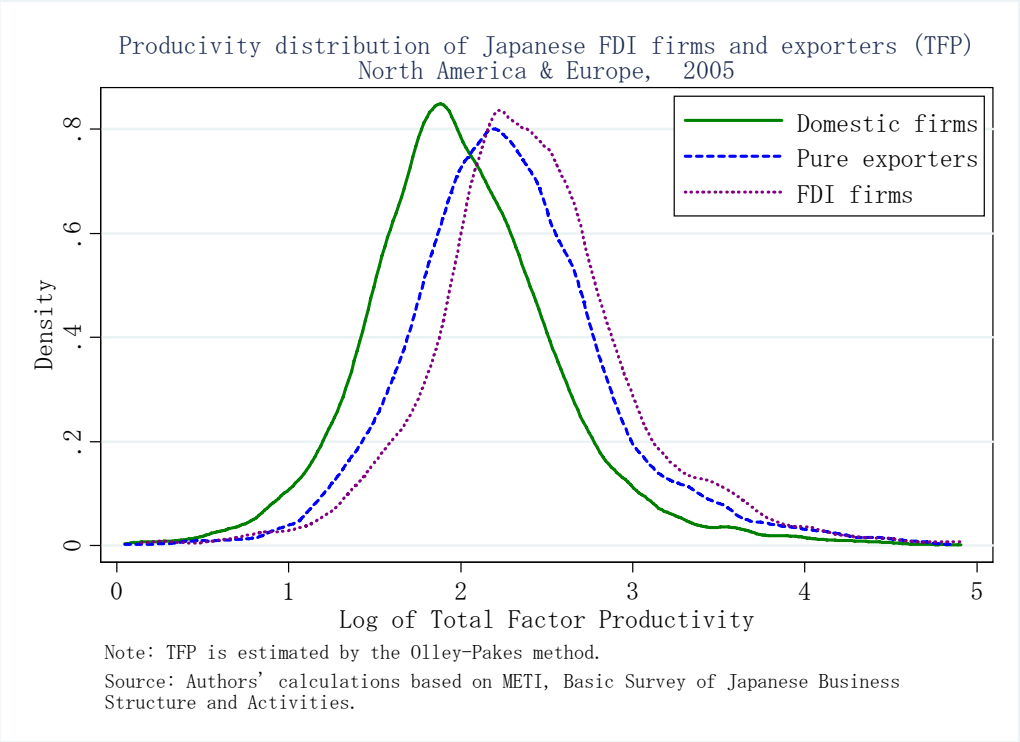


Figure 4. Internationalization mode and average productivity

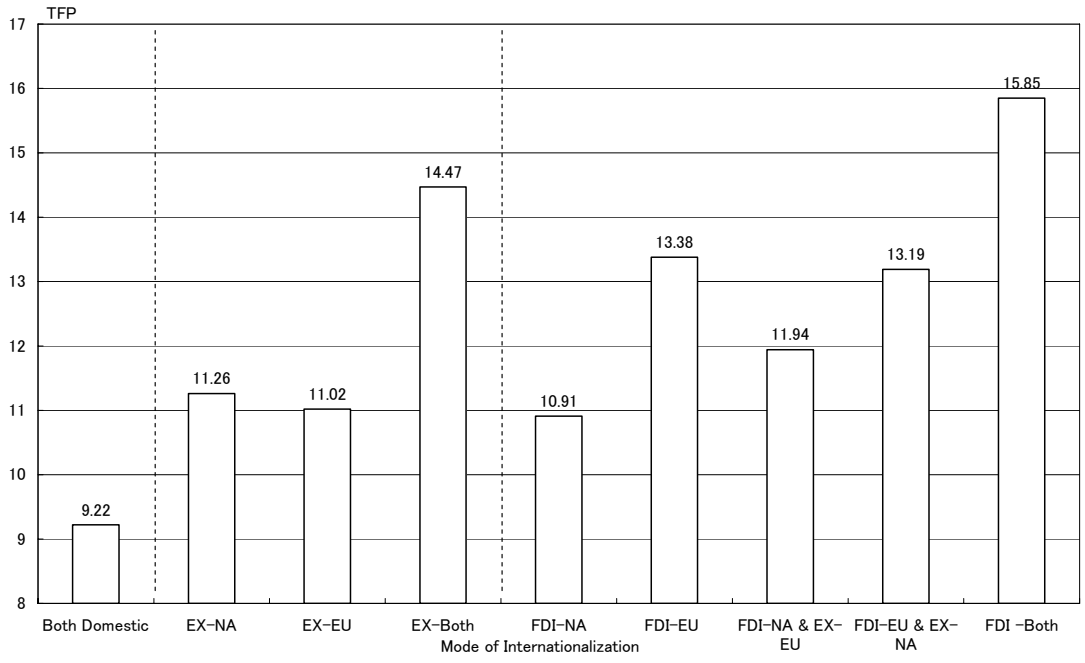


Table 1. Internationalization modes and distribution of Japanese firms

		North America			
		Domestic	Export	FDI	Total
EU	Domestic	9762	392	349	10503
		(78.07)	(3.13)	(2.79)	(84.00)
	Export	278	748	276	1302
		(2.22)	(5.98)	(2.21)	(10.41)
	FDI	44	64	591	699
		(0.35)	(0.51)	(4.73)	(5.59)
	Total	10084	1204	1216	12504
		(80.65)	(9.63)	(9.72)	(100.00)

Figures in parentheses present percent.

Table 2. Estimated results

	Dependent variable: log of TFP
Dummy variables for	
Export to only N.A.	0.156***
	[0.028]
Export to only EU	0.152***
	[0.033]
Export to both N.A. & EU	0.231***
	[0.021]
FDI in only N.A.	0.187***
	[0.030]
FDI in N.A. and Export to EU	0.227***
	[0.033]
FDI in only EU	0.205**
	[0.081]
Export to N.A. & FDI in EU	0.231***
	[0.067]
FDI in both N.A. & EU	0.422***
	[0.025]
log K/L	-0.0833***
	[0.0037]
(log K/L) squared	0.0245***
	[0.0012]
R&D/real sales	-0.00780***
	[0.0026]
Skilled L/L	0.723***
	[0.041]
log age	-0.110***
	[0.0074]
Constant	1.779***
	[0.054]
Observations	12370
R-squared	0.29

RobN.A.t standard errors in brackets. Industry dummies are suppressed.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Difference in estimated coefficients

Modes of Internationalization	Difference in TFP	S.E.
EX-NA vs. EX-EU	0.004	0.042
EX-Both vs. Ex-One		
NA	0.075 **	0.034
EU	0.079 **	0.038
FDI vs. EX		
NA	0.032	0.04
EU	0.053	0.087
FDI-NA vs. FDI-EU	0.017	0.085
FDI-Both vs. FDI-One		
NA	0.235 ***	0.037
EU	0.218 ***	0.084
FDI-EU･EX-NA vs. FDI-NA･EX-EU	0.004	0.074
FDI-Both vs. FDI-EU･EX-NA	0.191 ***	0.07
FDI-Both vs. FDI-NA･EX-EU	0.196 ***	0.039

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Estimated Results under the Multinomial Logit Model

Choice of internationalization modes	EX-NA	EX-EU	EX-Both	FDI-NA	FDI-EU	FDI-NA&EX-EU	FDI-EU&EX-NA	FDI-Both
Log TFP	0.582***	0.561***	0.756***	0.667***	0.955***	0.853***	1.020***	1.566***
	[0.110]	[0.127]	[0.082]	[0.118]	[0.336]	[0.125]	[0.259]	[0.098]
Log K / L	0.138***	0.110**	0.224***	0.299***	0.023	0.421***	0.348***	0.757***
	[0.039]	[0.045]	[0.031]	[0.045]	[0.101]	[0.053]	[0.106]	[0.046]
Skilled L / L	1.170***	0.887*	0.774**	0.944**	1.015	1.182**	1.500*	0.553
	[0.433]	[0.504]	[0.325]	[0.451]	[1.203]	[0.464]	[0.889]	[0.356]
R&D / Sales	0.189***	0.228***	0.304***	0.280***	0.341***	0.350***	0.429***	0.474***
	[0.032]	[0.032]	[0.020]	[0.030]	[0.059]	[0.027]	[0.038]	[0.021]
Constant	-28.871***	-4.540***	-4.942***	-28.126***	-30.094***	-28.846***	-30.945***	-29.189***
	[1.026]	[1.058]	[1.042]	[1.030]	[1.282]	[0.765]	[1.200]	[0.766]
Observations	11285							
Pseudo R-squared	0.156							

Standard errors in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: Industry dummies are suppressed.