RIETI Discussion Paper Series 11-E-055

FDI in Emerging Economies: An analysis in a firm heterogeneity model

ITO Koji
RIETI

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 11-E-055
June 2011

FDI in Emerging Economies: An analysis in a firm heterogeneity model

ITO Koji *
Research Institute of Economy, Trade and Industry

Abstract

In recent years, Japanese manufacturers in both competitive and less competitive sectors have penetrated emerging economies, and sales in 2008 by Japanese affiliates established via foreign domestic investment (FDI) exceeded Japan's revenues from exports. To consider this phenomenon and the significance of FDI for emerging economies, this study constructs a two-country model featuring two factors of production, two industries (with different factor intensities), and firm heterogeneity. Thereafter, the study numerically analyzes trends in FDI by industry and examines how the economies of both countries are affected.

Results of the analysis show that highly productive firms favor FDI. That is true whether their industries make intensive use of a scarce factor of production or use a more abundant factor intensively.

Compared to the situation in which only export is possible, FDI increases competition among firms in both industries. Real wages and welfare increase as a result. On the other hand, low-productivity firms are forced to exit, and the number of firms decreases. This analysis also shows that FDI could work to help prevent a decline in real revenues of industries that make intensive use of a scarce factor of production.

Keywords: firm heterogeneity, FDI, export, industry, and factor intensity.
JEL classification: F1

* The author would like to thank Masahisa Fujita, Ryuhei Wakasugi, Masayuki Morikawa and other seminar participants at RIETI for their constructive comments and suggestions.
The author also acknowledges the support of RIETI and Grants-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (Scientific Research(c), No.22530258). All remaining errors are my own. Email: ito-koji@rieti.go.jp

1 Introduction

In the present era, emerging economies, including Asian economies, are growing rapidly, and Japanese firms aggressively seek new markets among them. Between 2001 and 2007, the growth rate of Japanese foreign direct investment (FDI) exceeded export growth, and sales by Japanese foreign subsidiaries substantially exceeded Japanese exports in 2008 (Figure 1). [1] [2] Second, this trend is evident among competitive sectors, such as electronics and transportation, and among less competitive sectors, such as clothing, food, and agriculture. [3]

Does the increase of FDI in emerging economies improve Japan's economic welfare? What significance does it have for Japan's economy? This study addresses these questions.

Current theoretical models for FDI are inadequate to analyze the fact that FDI and export are occurring simultaneously across multiple sectors of Japanese manufacturing. The standard vertical FDI model since Helpman (1984) consists of two countries, two factors of production (skilled and unskilled labor), and two goods (one more skill-intensive than the other). Helpman considered monopolistic competition in the market for differentiated goods. In the Heckscher-Ohlin model, if distribution of factor endowments is remarkably biased between countries factor prices equalization is

[1] This trend is obvious not merely for Japanese manufacturing but for the Japanese industry as a whole. According to the Bank of Japan "Balance of Payments," cumulative Japanese FDI, which was 39.6 trillion yen at the end of 2001, increased by 56.1 % to 61.7 trillion yen at the end of 2008. Sales by foreign subsidiaries increased rapidly. Data from the Ministry of Economy, Trade, and Industry "Basic Survey on Overseas Business Activities" shows that sales of foreign subsidiaries in 2007 were 236.2 trillion yen, 2.8 times greater than exports of 83.9 trillion yen. The growth rate in sales of foreign subsidiaries between 2001 and 2007 was 9.8 % yearly compared with 9.4 % yearly growth in exports.

[2] Japan's FDI in emerging economies is increasing remarkably. According to the Ministry of Economy, Trade, and Industry "Basic Survey on Overseas Business Activities," sales by Japanese firms' foreign subsidiaries in Asia grew from 20.3 trillion yen in 2001 to 49.2 trillion yen in 2007. The increase is remarkable compared to sales by Japanese firms' foreign subsidiaries in the U.S. and Europe.

[3] Even in non-manufacturing, generally considered less competitive than Japanese manufacturing, firms are starting business in emerging markets. FDI of Japanese non-manufacturing industries increased 46.4 % from 3,049 billion yen in 2005 to 4,462 billion yen in 2008. The growth rate exceeds that of FDI of Japanese manufacturers (36.0 % , from 7,311 billion yen in 2005 to 9,944 billion yen in 2008). Among the composition of the Japanese FDI forward Asia in 2008, wholesale and retail (1,543 billion yen) is third, behind electric machines and appliances (2,345 billion yen) and vehicles and appliance (2,076 billion yen).

not obtained. However, Helpman divides the operations of the skill-intensive industry in the skill-abundant country into headquarters and production and shows that factor prices are equalized by shifting production toward the foreign country which has an abundant unskilled labor.

In these "vertical FDI models," the sharp difference in factor endowments between two countries generates FDI, and the model works well to explain conventional cases - for example, firms in developed economies close a domestic factory and open a factory in a developing economy where wages are low. [4]

Today, however, FDI by Japanese manufacturers transcends this model's usefulness. As we see, firms in the comparatively disadvantaged sector also invest in emerging economies. In addition, many Japanese manufacturing firms recognize Asian economies not only as a base of production and exporting but also as a market. [5] That mode of FDI requires a different theoretical model.

Markusen and Venables (1998) established the theoretical model for such cases of "horizontal FDI." [6] Their model also features two countries, two production factors, and two goods. But their horizontal model differs from the vertical model in two respects: it recognizes that trade entails costs, and it accommodates demand. They analyze multinational firms and domestic firms (the former grow foreign business via FDI and pay attendant fixed costs; the latter grow foreign business by export and pay transport variable costs. They show that when (a) consumer demand in both countries is large, (b) both countries' factor endowments and technology (factor prices narrow) tend to be similar, and (c) the variable cost of exporting is higher, multinational firms becomes more dominant.

The horizontal FDI model is convenient for analyzing FDI between advanced countries at similar economic levels. [7] However, economic levels and

[4]It previously was thought that Japanese FDI in emerging economies has mainly been vertical FDI. Hayakawa and Matsuura (2009) calculated each sector's share of vertical FDI subsidiaries (subsidiaries with less than a 50 % of local sales share) in three areas (North America, Europe and Asia), using micro data from Ministry of Economy, Trade and Industry "Basic Survey on Overseas Business Activities." In 1999, the shares of vertical FDI in North America and Europe, where Japanese firms mainly invest, were around 20 %. On the other hand, the shares of FDI in Asian countries were 40 - 60 %.

[5]For example, Kokusai Kyouryoku Ginkou (2009) surveyed Japanese manufacturers' opinions concerning which foreign countries are most promising and why. The results showed China, India, Vietnam, and Thailand are promising. "Expectation for future growth of the local market" was the most popular answer.

[6]Markusen (2002) shows the details concerning vertical models. Feenstra (2004) explains the outline of theories of multinational firms such as vertical and horizontal FDI.

[7]Many researchers recognize that FDI by U.S. firms is mainly horizontal. For example,

factor endowments differ between advanced economies like Japan and the emerging economies in which Japanese firms invest.

Therefore, in this study, I focus on the "firm heterogeneity" approach that is now mainstream in trade research. In this approach, productivity of firms is the key factor that influences firms' decisions to access foreign markets. Following this approach, Helpman et al. (2004) expanded Melitz (2003), who treated only exports, and built a model in which firms can choose between export and FDI. They show theoretically that higher-productivity firms choose FDI over export. [8] [9] Several firm heterogeneity models, including Helpman et al. (2004), attempt to clarify conditions under which firms prefer export or FDI. However, these models usually consist of one product and one production factor; therefore, few consider traditional questions such as which goods should be exported or how factors should be allocated between industries. However, these issues gradually have come to be considered in models of firm heterogeneity. In one of the first papers investigating this issue, Bernard et al. (2007) expanded Melitz (2003) into a two-goods and two-factor model and analyzed theoretically the effect of trade liberalization given differences in factor endowments.

The results of Bernard et al. (2007) are as follows. [10] After the open-

by using data from the U.S. Bureau of Economic Analysis, Department of Commerce, Blonigen (2005) reveals that 67.4 % of foreign sales of U.S. multinational firms are from local markets and, therefore, horizontal FDI is dominant.

Many empirical tests also reveal that FDI by U.S. firms fits the conclusions of horizontal FDI models. For example, Carr et al. (2001) empirically examined what variables affect sales of U.S. multinationals. They found that the amount of GDP of both U.S. and invested countries has a positive effect, and the difference of GDP has a negative effects. Brainard (1997) also shows empirically that foreign sales of U.S. multinational firms are larger when GDPs of the U.S. and the invested countries are similar.

Opinions differ about the effects of varying factor endowments and technologies between countries on U.S. FDI. Carr et al. (2001) found that the skill difference (differences in the ratio of skilled labor to total labor) between the U.S. and invested countries has a positive effect on the sales of multinational firms (This result supports the knowledge capital model in which vertical and horizontal FDI coexist). Blonigen et al. (2003) conducted the same empirical research as Carr et al. (2001), but replaced the skill difference with the difference in average years of study and showed that its coefficient is negative (thereby supporting the horizontal FDI model).

[8]Recently, results of the firm heterogeneity model have been confirmed empirically. See Bernard et al. (2007) concerning U.S. firms and Wakasugi et al. (2008) and Todo (2009) concerning Japanese firms. These investigations clarify that only a few firms account for a large share of exports and FDI, and that firms which export or invest in foreign countries have greater productivity and are larger than other firms.

[9]Helpman (2006) surveyed firms' choices of exporting or FDI in the economy with firm heterogeneity of productivity.

[10]In Bernard et al. (2007), goods of comparatively advantaged means goods which are produced by using a scarce factor intensively, and trade entails fixed costs and iceberg-form variable costs.

ing of trade, high-productivity firms, even in comparatively disadvantaged industries, choose to export. Hence, there is intra-industry trade in both industries. By the start of trade, the expected increase in revenue of the comparatively advantaged industry is larger than that of the comparatively disadvantaged industry. Therefore, competition in the comparatively advantaged industry intensifies, and its zero-profit cutoff productivity increases. [11] [12] The industries' demand for factors of production also increases, and the increased use of the relatively abundant factor by the comparatively advantaged industry is larger than that of other factors. This also causes the level of zero-profit cutoff productivity to increase for the comparatively advantaged industry. In a steady state, it is larger than the increase of zero-profit cutoff productivity of the comparatively disadvantaged industry.

With regard to the expected profit in a foreign country, the comparatively advantaged industry expects to earn greater profits in a foreign country than does the comparatively disadvantaged industry.

Hence, more firms in the comparatively advantaged industry seek to export, and export cutoff productivity decreases further. As a result, the difference of zero-profit cutoff productivity and export cutoff productivity is smaller in the comparatively advantaged industry than in the comparatively disadvantaged industry, by trade. That is, the fewer firms enters, but the share of exporting firms in enterging firms increases more in the comparatively advantaged industry. However, as trade liberalizes, total real revenue of both advantaged and disadvantaged industries increases, but the real revenue of the comparatively disadvantaged industry decreases. That is, the real revenue of the comparatively advantaged industry increases and improves the wealth of a country.

Bernard et al. (2007) revealed these results by building a theoretical model and presenting a special numerical example in which wages of both countries are symmetric. [13] However, they consider only export, not FDI. Therefore, this study adds FDI to their model and analyzes the behavior of exporting and FDI, and analyzes the welfare effect of FDI if both countries allow FDI in addition to export. [14]

[11] We refer to the level of productivity at which a firm earns zero profit as "zero-profit cutoff productivity." All firms with productivity above this level can produce, and no firm with lower productivity can produce.

[12] This means a greater decrease in the number of entering firms.

[13] "Symmetric" indicates that the ratio of skilled/unskilled labor in the home country is the same as the ratio of unskilled/skilled labor in foreign country, and the factor price ratio of relatively abundant/scarce factor is the same in both countries.

[14] We can say this task is an enlargement of Helpman (2004) to a two-goods and two-factor model.

The structure of this paper is as follows. Section 2 builds the theoretical model. Section 3 considers the effect of FDI. Section 4 presents the numerical analysis. Section 5 concludes and considers the implications of Japanese firms increasing their FDI in emerging economies. [15]

2 Model

This study introduces FDI into the model of Bernard et al. (2007). [16] Consider a global economy consisting of two countries, two industries, and two factors of production. Both countries have two industries: the first employs skilled labor intensively, and the second employs unskilled labor intensively. The home country (a developed economy, indexed by H) has a relatively abundant supply of skilled labor, and the foreign country (an emerging economy, indexed by F) has a relative abundance of unskilled labor. In both industries, firms with heterogeneous productivity produce differentiated goods.

2.1 Consumption

Consumers gain utility by consuming products of industries that intensively employ skilled or unskilled labor. Suppose the utility function of the representative consumer is a Cobb-Douglas function:

$$U_H = (C_1^H)^{\alpha_1}(C_2^H)^{\alpha_2}, \quad 0 < \alpha_i < 1 \tag{1}$$

i ($i = 1, 2$) means an index of industry (product). That is, 1 represents a skilled-labor-intensive product and 2 represents an unskilled-labor-intensive product. $\alpha_1 + \alpha_2 = 1$. C_i^H is an index of consumed products produced by industry i, which consists of a differentiated product $q_i^H(\omega)$ produced by each firm in industry i. Assume its form is a CES function

$$C_i^H = \left[\int q_i^H(\omega)^\rho d\omega \right]^{\frac{1}{\rho}} \tag{2}$$

[15] There is no existing research which uses two-country firm heterogeneity model with two factors of production and two industries. Hence, in Section 2, I refer to the effect of market size of two countries on FDI (which is related to the reason why we reject the adoption of the horizontal FDI model) and industry or industries where FDI is seen (which is related to the reason why we reject the adoption of the vertical FDI model).

[16] FDI is investment behavior and entails an accumulation of capital stock. However, much existing research regards FDI as a sale of foreign subsidiaries that was previously established via FDI, dismissing the formation of capital stock. In this paper, I follow this idea.

where $\sigma \equiv 1/(1-\rho) > 1$ is the constant elasticity of substitution across differentiated goods. P_i^H, a price index of products produced by industry i is also shown as a CES function of prices of differentiated goods, $p_i^H(\omega)$. That is,

$$P_i^H = \left[\int p_i^H(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} \tag{3}$$

2.2 Production

Second, we consider production activities in each country. There are two inputs: skilled and unskilled labor. Suppose the total endowments of skilled and unskilled labor in country H are $\bar{S}^H$ and $\bar{L}^H$, respectively, and $\bar{S}^F$ and $\bar{L}^F$ in country F. Since country H has comparatively more skilled labor and country F comparatively more unskilled labor, that means $\bar{S}^H/\bar{L}^H > \bar{S}^F/\bar{L}^F$. [17]

In this model, each firm must pay fixed entry costs by employing skilled and unskilled labor when it enters an industry. The cost is shown as

$$f_{ei}^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}, \quad f_{ei}^H > 0 \tag{4}$$

where w_S^H and w_L^H are the wages of skilled and unskilled labor in country H. Each firm does not know its productivity before entering a foreign market. Only after entering does it discover its productivity, which is stochastically distributed.

After entering, each firm decides (a) whether it produces or not, and (b) whether it enter a foreign market or not, considering its productivity and following several costs.

When a firm produces a good, it has to pay production costs. In this model, production costs consist of a fixed and a variable cost. Fixed costs of each firm in an industry are identical. Variable cost is a function of each firm's productivity. Suppose the cost function of a firm with productivity φ_i^H is

$$\Gamma_i^H(\varphi_i^H) = \left[f_i^H + \frac{q_i^H}{\varphi_i^H} \right] (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}, \quad 1 > \beta_1 > \beta_2 \tag{5}$$

Suppose industrial factor intensities, β_1 and β_2, are common in both countries and $\beta_1 > \beta_2$ (that is, industry 1 is more intensive with respect to skilled labor). f_i^H (> 0) is a factor of fixed cost.

[17] In the following sections, as per Bernard et al. (2007), I refer to products produced using the comparatively abundant (scarce) factor intensively, "comparatively advantaged (disadvantaged) products."

A firm can enter a foreign market by export or via FDI, but it must pay additional costs. When exporting, a firm also must pay iceberg-style variable transport costs and fixed cost. The fixed cost of exporting is

$$f_{ix}^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}, \quad f_{ix}^H > f_i^H \tag{6}$$

The common fixed factor for each firm, f_{ix}^H, is larger than f_i^H. I assume the standard icedberg-style variable transport cost. That is, τ_i (> 1) units are needed to export one unit of product to a foreign market.

When a firm enters a foreign market via FDI, it must pay the fixed cost of FDI and the fixed cost for additional production in the foreign market.

$$(f_{ia}^H + f_i^F)(w_S^F)^{\beta_i} (w_L^F)^{1-\beta_i}, \quad f_{ia}^H > f_{ix}^H \tag{7}$$

The common fixed factor of FDI, f_{ia}^H, is larger than f_{ix}^H and a function of wages in the foreign country.

Taking account of its productivity, costs of production, export, and FDI, etc., each firm examines its production alternatives. Firms have four choices: (a) no production, (b) produce only for the domestic market, (c) produce for domestic and export markets, and (d) produce in both countries. Productivity differs for each firm. Therefore, not all firms enter the foreign market by exporting or FDI. Some firms choose not to enter the foreign market at all.

As in the usual firm heterogeneity models, suppose that firms in each industry compete in monopolistically competitive markets. As a result of profit maximization, each firm sets its price as follows. First, the price for country H by a firm in industry i, p_{id}^H, is shown as

$$p_{id}^H(\varphi_i^H) = \frac{(w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}}{\rho \varphi_i^H} \tag{8}$$

Considering fixed and variable costs of exporting, the price of exporting products into the foreign market, p_{ix}^H, is

$$p_{ix}^H(\varphi_i^H) = \frac{\tau_i (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}}{\rho \varphi_i^H} \tag{9}$$

The price set by a firm that chooses FDI instead of exporting is

$$p_{ia}^H(\varphi_i^H) = \frac{(w_S^F)^{\beta_i} (w_L^F)^{1-\beta_i}}{\rho \varphi_i^H} \tag{10}$$

Given the prices established above, a firm's revenue from its domestic market, export, and FDI is shown as follows. Revenue from its domestic market is

$$r_{id}^H(\varphi_i^H) = \alpha_i R^H \left(\frac{\rho P_i^H \varphi_i^H}{(w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}} \right)^{\sigma-1} \tag{11}$$

R^H is the total wages of domestic consumers.

Revenue from export and FDI are shown as follows, respectively.

$$r_{ix}^H(\varphi_i^H) = \tau_i^{1-\sigma}\left(\frac{P_i^F}{P_i^H}\right)^{\sigma-1}\left(\frac{R^F}{R^H}\right)r_{id}^H(\varphi_i^H) \tag{12}$$

$$r_{ia}^H(\varphi_i^H) = (WR_i^{HF})^{\sigma-1}\left(\frac{P_i^F}{P_i^H}\right)^{\sigma-1}\left(\frac{R^F}{R^H}\right)r_{id}^H(\varphi_i^H) \tag{13}$$

where

$$WR_i^{HF} \equiv \frac{(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i}}{(w_S^F)^{\beta_i}(w_L^F)^{1-\beta_i}}$$

Finally, profits from the domestic market, export, and FDI are calculated from the revenue and costs presented above:

$$\pi_{id}^H(\varphi_i^H) = \frac{r_{id}^H(\varphi)}{\sigma} - f_i^H(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i} \tag{14}$$

$$\pi_{ix}^H(\varphi_i^H) = \frac{r_{ix}^H(\varphi)}{\sigma} - f_{ix}^H(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i} \tag{15}$$

$$\pi_{ia}^H(\varphi_i^H) = \frac{r_{ia}^H(\varphi)}{\sigma} - (f_{ia}^H + f_i^F)(w_S^F)^{\beta_i}(w_L^F)^{1-\beta_i} \tag{16}$$

2.3 Conditions for Production, Export and FDI

Here, we consider the condition of domestic production, export, and FDI. Suppose the zero-profit cutoff productivity of industry i in country H is φ_i^{*H}. By definition, the following equation holds:

$$r_{id}^H(\varphi_i^{*H}) = \sigma f_i^H(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i} \tag{17}$$

I refer to the productivity level at which a firm's profit from exporting is zero as "export cutoff productivity," and the productivity level at which profit from FDI is zero as "FDI cutoff productivity." Suppose the export and FDI cutoff productivities of industry i in country H are φ_{ix}^{*H} and φ_{ia}^{*H}, respectively. By definition,

$$r_{ix}^H(\varphi_{ix}^{*H}) = \sigma f_{ix}^H(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i} \tag{18}$$

$$\pi_{ia}^H(\varphi_{ia}^{*H}) = \pi_{ix}^H(\varphi_{ia}^{*H}) \tag{19}$$

hold. From (14), with regard to arbitrary two productivities φ' and φ", $r_{id}(\varphi") = (\varphi"/\varphi')^{\sigma-1} r_{id}(\varphi')$ holds. From this relationship and (18), we have

$$\varphi_{ix}^{*H} = \Lambda_i^H \varphi_i^{*H} \quad where \quad \Lambda_i^H \equiv \tau_i \left(\frac{P_i^H}{P_i^F}\right)\left(\frac{R^H}{R^F}\frac{f_{ix}^H}{f_i^H}\right)^{\frac{1}{\sigma-1}} \tag{20}$$

That is, as the variable cost of exporting rises and the ratio of fixed export costs to fixed production costs increases, export cutoff productivity increases compared to zero-profit cutoff productivity. Examining the relationship between domestic and foreign markets, the larger ratio of the domestic price level P_i^H to the foreign price level P_i^F, and the larger ratio of the domestic total wage R^H to the foreign total wage R^F raise the export cutoff productivity to zero-profit productivity.

From (19), the following relationship can be shown:

$$\varphi_{ia}^{*H} = \theta_i^H \varphi_i^{*H} \tag{21}$$

where

$$\theta_i^H \equiv \left(\frac{P_i^H}{P_i^F}\right)\left\{\frac{R^H}{R^F}\frac{1}{(WR_i^{FH})^{1-\sigma} - \tau_i^{1-\sigma}}\left(\frac{f_i^F + f_{ai}^H}{f_i^H} WR_i^{FH} - \frac{f_{ix}^H}{f_i^H}\right)\right\}^{\frac{1}{\sigma-1}}$$

$$WR_i^{FH} \equiv \frac{(w_S^F)^{\beta_i}(w_L^F)^{1-\beta_i}}{(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i}}$$

This equation shows the same relationship between relative price and market size as equation (20). Additionally, when the cost of FDI increases relative to the cost of exporting, the FDI cutoff productivity increases relative to zero-profit cutoff productivity. [18]

[18]From equation (21), we can indicate the following points.

With regard to the effect of market size of two countries on FDI, even in case that the differential of two countries' market size (the total wages, R^H and R^F) is quite large, there are FDI firms in both countries unless θ_i^H is infinite. In this regard, our model is closer to the actual tendency of FDI between developed and developing countries than the horizontal FDI model in which FDI might not be seen when economic sizes of two countries are quite different.

With regard to the industry (or industries) where FDI can be seen, it is clear that some firms in the comparatively advantage and disadvantaged industry in both countries also enter the foreign market via FDI unless θ_i^H is infinite because equation (21) holds in both industries. To this extent, our model is closer to the actual tendency of FDI between developed and developing countries than the vertical FDI model in which FDI cannot be seen only in comparative advantage industry in one country.

2.4 Free Entry Condition

A firm decides to enter an industry by comparing the expected profits and costs of entering the market. I assume that firms exit the industry at a constant rate δ after entry.

$$\chi_i^H = \frac{1 - G(\varphi_{ix}^{*H})}{1 - G(\varphi_i^{*H})} \tag{22}$$

$$\phi_i^H = \frac{1 - G(\varphi_{ia}^{*H})}{1 - G(\varphi_i^{*H})} \tag{23}$$

The expected profit is described as follows:

$$\frac{1 - G(\varphi_i^{*H})}{\delta}(\bar{\pi}_{id}^H + \chi_i^H \bar{\pi}_{ix}^H + \phi_i^H \bar{\pi}_{ia}^H) \tag{24}$$

where

$$\chi_i^H = \frac{1 - G(\varphi_{ix}^{*H})}{1 - G(\varphi_i^{*H})} \tag{25}$$

$$\phi_i^H = \frac{1 - G(\varphi_{ia}^{*H})}{1 - G(\varphi_i^{*H})} \tag{26}$$

are the conditional probability of export and FDI after entry, respectively, and

$$\bar{\pi}_{id}^H = \frac{1}{1 - G(\varphi_i^{*H})} \int_{\varphi_i^{*H}}^{\infty} \left\{ \left(\frac{\varphi_i^H}{\varphi_i^{*H}} \right)^{\sigma-1} - 1 \right\} g(\varphi_i^H) d\varphi_i^H \cdot f_i^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i} \tag{27}$$

$$\bar{\pi}_{ix}^H = \frac{1}{G(\varphi_{ia}^{*H}) - G(\varphi_{ix}^{*H})} \int_{\varphi_{ix}^{*H}}^{\varphi_{ia}^{*H}} \left\{ \left(\frac{\varphi_i^H}{\varphi_{ix}^{*H}} \right)^{\sigma-1} - 1 \right\} g(\varphi_i^H) d\varphi_i^H \cdot f_{ix}^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i} \tag{28}$$

$$\begin{aligned} \bar{\pi}_{ia}^H = \frac{1}{1 - G(\varphi_{ia}^{*H})} & \int_{\varphi_{ia}^{*H}}^{\infty} \left\{ \left(\frac{\varphi_i^H}{\varphi_i^{*H}} \right)^{\sigma-1} - \left(\frac{\varphi_{ia}^H}{\varphi_i^{*H}} \right)^{\sigma-1} \right\} g(\varphi_i^H) d\varphi_i^H \\ & \cdot f_i^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i} (W R_i^{HF})^{\sigma-1} \left(\frac{R^H}{R^F} \right) \left(\frac{P_i^F}{P_i^H} \right)^{\sigma-1} \\ & + \left\{ \left(\frac{\varphi_{ia}^{*H}}{\varphi_{ix}^{*H}} \right)^{\sigma-1} - 1 \right\} f_{ix}^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i} \end{aligned} \tag{29}$$

are the average profit from domestic sales, export and FDI, respectively.

If the expected profit continues to exceed entry cost, firms continue to enter the industry. Finally, in equilibrium, the expected profit equals the cost of entry.

$$\frac{1-G(\varphi_i^{*H})}{\delta}(\bar{\pi}_{id}^H+\chi_i^H\bar{\pi}_{ix}^H+\phi_i^H\bar{\pi}_{ia}^H)=f_{ei}^H(w_S^H)^{\beta_i}(w_L^H)^{1-\beta_i} \tag{30}$$

This is the free entry condition.

2.5 Equilibrium Condition

In equilibrium, the sales revenue of goods is equal to consumners' expense to the goods in each industry of both countries. In country H, the following equation holds:

$$\begin{aligned}R_i^H=\alpha_i R^H M_i^H\left(\frac{p_{id}^H(\tilde{\varphi_i^H})}{P_i^H}\right)^{1-\sigma}+\alpha_i R^F\chi_i^H M_i^H\left(\frac{p_{ix}^H(\tilde{\varphi_{ix}^H})}{P_i^F}\right)^{1-\sigma}\\ +\alpha_i R^F M_i^H\phi_i^H M_i^H\left(\frac{p_{ia}^H(\tilde{\varphi_{ia}^H})}{P_i^H}\right)^{1-\sigma}\end{aligned} \tag{31}$$

where M_i^H is the number of firms that entered industry i.

The price index in equilibrium is

$$P_i^H=\left[M_i^H(p_{id}^H(\tilde{\varphi_i^H}))^{1-\sigma}+\chi_i^F M_i^F(\tau_i p_{id}^F(\tilde{\varphi_{ix}^F}))^{1-\sigma}+\phi_i^F M_i^F p_{ia}^F(\tilde{\varphi_{ia}^F})^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{32}$$

After FDI is allowed, foreign firms also employ workers in the foreign country. Therefore, in labor market equilibrium the following equations hold:

$$S_1^H+S_2^H+S_{1a}^H+S_{2a}^H=\bar{S}^H \tag{33}$$

$$L_1^H+L_2^H+L_{1a}^H+L_{2a}^H=\bar{L}^H \tag{34}$$

where S_i^H and L_i^H are skilled and unskilled labor employed by domestic firms, and S_{ia}^H and L_{ia}^H are skilled and unskilled labor employed by foreign firms.

Regarding S_i^H, L_i^H, S_{ia}^H and L_{ia}^H,

$$\frac{w_S^H}{w_L^H}=\frac{\beta_1}{1-\beta_1}\frac{L_1^H}{S_1^H}=\frac{\beta_2}{1-\beta_2}\frac{L_2^H}{S_2^H}=\frac{\beta_1}{1-\beta_1}\frac{L_{1a}^H}{S_{1a}^H}=\frac{\beta_2}{1-\beta_2}\frac{L_{2a}^H}{S_{2a}^H} \tag{35}$$

holds by cost minimization.

Taking entry and FDI into account, the following relationship holds between S_i^H and S_{ia}^H.

$$\frac{S_{ia}^H}{S_i^H} = \frac{L_{ia}^H}{L_i^H} = \frac{\phi_i^F M_i^F}{f_i M_i^H + f_{ix}\chi_i^H M_i^H}\left[\left\{\left(\frac{\theta_i^F}{\Lambda_i^F}\right)^{\sigma-1} - 1\right\} f_{ix} W R_i^{FH} + (f_i + f_{ai})\right] \tag{36}$$

In addition, the revenue of each industry is equal to the expense to the production factors. Hence

$$R_i^H = w_S^H S_i^H + w_L^H L_i^H + w_S^F S_{ia}^F + w_L^F L_{ia}^F \tag{37}$$

holds. This is the whole model. [19]

3 Characteristics of the Equilibrium

We cannot have a closed-form in this model. Therefore, I demonstrate a numerical example in the next section. However before doing so, I reveal a few characteristics of the equilibrium of the model.

We assume that the FDI cutoff productivity φ_{ia}^{*H} exceeds zero-profit cutoff productivity φ_i^{*H}. [20] Then firms with productivity exceeding φ_{ia}^{*H} enter the foreign market via FDI. Regarding the relationship between φ_{ia}^{*H} and φ_{ix}^{*H}, we can put forth the following proposition:

Proposition 1 *Other things being equal, the relationship between φ_{ix}^{*H} and φ_{ia}^{*H} is decided by (a) export variable cost τ_i, (b) the difference between fixed cost of FDI and export $f_i^F + f_{ai}^H - f_{ix}^H$, and (c) the wage differential of both countries. The larger τ_i, the smaller $f_i^F + f_{ai}^H - f_{ix}^H$ is and the larger wage difference, the smaller is φ_{ia}^{*H} compared to φ_{ix}^{*H}.*

[19] The number of firms which enter an industry is decided to keep the total number of firms constant. Let M_{ei}^H be the number of firms to enter into industry i. As firms exit the industry at a constant rate δ in each period, then

$$M_{ei}^H = \frac{\delta M_i^H}{1 - G(\varphi_i^{*H})}$$

holds. The total industrial cost of entry $M_{ei}^H f_{ei}^H (w_S^H)^{\beta_i} (w_L^H)^{1-\beta_i}$ is equal to the industrial total profit because of (30), and the amount of the total industrial revenue R_i^H deducted by profit is equal to the payment to labor in the production sector.

[20] When φ_{ia}^{*H} is below φ_i^{*H}, all firms that enter an industry enter foreign markets by FDI. However we do not consider such a case because it is quite different from the results of empirical research.

Proposition 1 is clear from the comparison of Λ_i^H and θ_i^H. That is, if the cost of FDI is less than the cost of exporting, more firms prefer FDI over exporting. $\varphi_{ix}^{*H} > \varphi_{ia}^{*H}$ might hold. [21]

Next, regarding industrial zero-profit cutoff productivity and average productivity, the following proposition holds:

Proposition 2 *If FDI is allowed under the condition in which costly export is possible, the zero-profit cutoff productivity and average productivity rise in each industry.* [22]

In both industries, FDI raises the expected revenue from entering the foreign market. Therefore, more firms enter the foreign market, and competition intensifies. More intense competition forces low-productivity firms to exit the market, and both zero-profit cutoff productivity and average productivity rise.

Let us compare industrial shares of FDI firms. We can see which industry has the larger share by looking at the value of θ_1^H/θ_2^H. Under free trade, it becomes 1. If there is no trade (τ is infinite),

$$\frac{\theta_1^H}{\theta_2^H} = \left\{ (SL^{FH})^{\sigma(\beta_1-\beta_2)} \frac{(f_1^H + f_{a1}^H)(SL^{FH})^{1-\beta_1} - f_{1x}^H (SL^{FH})^{(1-\beta_2)(1-\sigma)}}{(f_2^H + f_{a2}^H)(SL^{FH})^{1-\beta_2} - f_{2x}^H (SL^{FH})^{(1-\beta_1)(1-\sigma)}} \right\}^{\frac{1}{\sigma-1}} \tag{38}$$

where

$$SL^{FH} \equiv \frac{\bar{S}^F/\bar{L}^F}{\bar{S}^H/\bar{L}^H}$$

holds. If the coefficients of production, consumption, FDI fixed cost, and export variable cost are the same in both countries, the right-hand side of (38) is decided by σ. Under a normal situation in which σ is from 3 to 4, the value exceeds 1 (Figure 2). Under costly trade, θ_1^H/θ_2^H is affected by the ratio of prices of each good between the two countries. But if the price difference is small, it converges between the free trade economy and autarky, greater than 1. That is, the share of FDI firms in the comparatively disadvantaged industry is larger than that of the comparatively advantaged industry.

In addition, we can point out the following proposition from this equation:

Proposition 3 *When prices are given, θ_1^H/θ_2^H converges to 1 if*
(a) The export variable cost τ_i is smaller.
(b) The difference of skilled labor intensity ($\beta_1 - \beta_2$) is smaller.

[21] In this case, by definition of φ_{ia}^{*H}, all firms with higher productivity than φ_{ia}^{*H} enter into the foreign market by FDI and no firm chooses export. But this is also quite a departure from the result of empirical research.

[22] The proof of this property is the same as for Proposition 4. of Bernard et al. (2007).

(c) The difference of ratio of factor endowments is smaller (SL^{FH} converges to 1).

This proposition means that (a) even in a comparatively advantaged industry, firms have an incentive to invest in the foreign country when the variable cost of exporting is high, and (b) if the factor endowments and technology of both countries become similar, firms in both industries will make similar choices regarding FDI and exporting.

In the costly trade model of Bernard et al. (2007), the increment of the zero-profit cutoff productivity of a comparatively advantaged industry is larger than that of the comparatively disadvantaged industry ($\Delta\varphi_1^{*H} > \Delta\varphi_2^{*H}$, $\Delta\varphi_2^{*F} > \Delta\varphi_1^{*F}$) , and the average productivity of a comparatively advantaged industry increases than that of comparatively disadvantaged industry. Such results are proved under the condition that there is no FDI. In this paper, the same results do not necessarily hold, as we see in the next section.

4 Numerical Solutions

As Bernard et al. (2007) show, we cannot have a closed-form solution in a two-good and two-factor model of firm heterogeneity with costly trade. Therefore, they show numerical solutions by simulation. [23] As they did, I show the results of numerical solutions because the model in this paper is more complex than them.

4.1 Parameters

In my simulation, the benchmark is Bernard et al. (2007). Therefore, I set the parameters as they did.

The distribution of firms' productivity φ_i follows a Pareto distribution, which is standard in the firm heterogeneity models. That is, the distribution function $G(\varphi_i)$ and density function $dG(\varphi_i)$ are defined as follows:

$$G(\varphi_i) = 1 - k^b \varphi_i^{-b} \tag{39}$$

$$dG(\varphi_i) = bk^b \varphi_i^{-(b+1)} \tag{40}$$

[23] In horizontal FDI models, numerical solutions are often used as in Markusen and Venables (1998) and Markusen(2002).

$b(>0)$ and $k(>0)$ are parameters. k indicates the lowest productivity among entering firms. Here, I set $b = 3.4$, $k = 0.2$. Regarding consumption, suppose σ is 3.8 (standard) and the parameters of consumption function are $\alpha_1 = \alpha_2 = 0.5$. Cost parameters of export and FDI are set as $f_{ei} = 2$, $f_i = 0.1$, and $f_{ix} = 0.1$. The new parameter included in this study, f_{ia}, is set as 0.5. The exit probability of firm, δ, is 0.025. These parameters are the same in both countries.

As for factor endowments, suppose that $\bar{S}^H = 1200$, $\bar{L}^H = 1000$, $\bar{S}^F = 1000$ and $\bar{L}^F = 1200$. I assume that the endowment of each factor differs between two countries but the ratio of the relatively abundant factor to the scarce factor is the same. Factor intensity for each industry is set as $\beta_1 = 0.6$ and $\beta_2 = 0.4$.

I also change the value of variable trade cost τ_i from 1.2 to 2.0 and we can see the effect when trade cost decreases.

I set wages symmetrically, as per Bernard et al. (2007). This indicates that wages of skilled labor in the home country w_S^H are the same as wages of unskilled labor in the foreign country w_L^F, and $w_L^H = w_S^F$.

I performed simulations under these parameters and found solutions by using Dynare. [24]

4.2 Entry and Access to foreign market

First, I look at the entry to industry by firms and access to foreign market.

The FDI cutoff productivity of the comparatively disadvantaged industry exceeds that of the comparatively advantaged industry because price levels do not differ significantly between the two countries, as seen in the preceding section (Figure 3). [25]

Export cutoff productivity of the comparatively advantaged industry is higher than that of the comparatively disadvantaged industry when the degree of trade liberalization τ_i is high (for example, in the case of low tariff rates) (Figure 4). This phenomenon, not compatible with the Hecksher-Ohlin model, arises as follows.

[24] Dynare is a program for analyzing dynamic stochastic general equilibrium models. Our model is not dynamic, but we can have steady state values of our nonlinear equation system by using Dynare.

[25] The variables of the comparatively advantaged (disadvantaged) industry in country H are almost the same as those of the comparatively advantaged (disadvantaged) industry in country F. Hence, I explain the result of country H only. BK refers to the result of my benchmark, Bernard et al. (2007).

As we have seen, the comparatively disadvantaged industry prefers FDI and the comparatively advantaged industry prefers to export. As trade is liberalized, firms in the comparatively advantaged industry attempt to shift from FDI to exporting. Firms in the comparatively disadvantaged industry attempt the same maneuver, but less earnestly. The increase of export firms in the comparatively advantaged industry has numerous lowering effects on the price of comparatively disadvantaged industry in the importing country. [26] Hence, in the importing country, the relative price ratio of the comparatively advantaged industry increases and that of the comparatively disadvantaged industry decreases. As a result, the export cutoff productivity of the comparatively advantaged industry exceeds that of the comparatively disadvantaged industry.

Zero-profit cutoff productivity of the comparatively disadvantaged industry also exceeds that of the comparatively advantaged industry when trade is liberal because the increase in imports intensifies competition. There is no wonder that the expected revenue of each industry increases, compared to the Bernard-Redding-Schott Benchmark, because of FDI.

4.3 Price index and real factor price

Compared to the Bernard-Redding-Schott Benchmark case, price indexes of each industry P_1^H and P_2^H decrease because FDI intensifies competition. The noteworthy points are (a) P_2^H is lower than P_1^H when trade is highly liberalized, and (b) P_1^H declines as τ_i rises. The reason for (a) is the increased imports by the comparatively disadvantaged industry (the comparatively advantaged industry in the foreign country). The reason for (b) is the behavior of FDI firms. The explanation is as follows.

When trade is less liberal, both industries prefer FDI over exporting, but the comparatively disadvantaged industry is more profitable because it can employ the abundant factor it uses intensively in production. Therefore, FDI increases among firms in the comparatively disadvantaged industry and drives down the price index of the comparatively advantaged industry in the foreign country.

Real factor prices (real wages)

$$W_S^H \equiv \frac{w_s^H}{(P_1^H)^{\alpha_1}(P_2^H)^{\alpha_2}}, \quad W_L^H \equiv \frac{w_L^H}{(P_1^H)^{\alpha_1}(P_2^H)^{\alpha_2}}$$

[26] Price index is decided by (a) the number of domestic, export, and FDI firms and (b) each average price of the these three categories of firms.

increase more than in the benchmark case because FDI increases demand for factors of production (Figure 7). It is different from the benchmark that the wage of unskilled labor increases as the degree of trade freedom diminishes. This is because less liberal trade prompts more firms in the comparatively advantaged industry (comparative disadvantaged industry in foreign country) to prefer FDI.

4.4 Number of Firms

Greater competition by FDI lowers the number of firms compared to the benchmark case (Figure 8). The decrease of firms in the comparatively disadvantaged industry is obvious. Therefore, the number of exporting firms and FDI firms in the comparatively advantaged industry exceeds that of the comparatively disadvantaged industry regardless of the degree of liberal trade. Note that (a) the number of entry firms decreases in both industries, and (b) the number of firms in the comparatively advantaged industry is larger than that in the comparatively disadvantaged industry. These situations are the same as the Bernard-Redding-Schott Bbenchmark.

On the one hand, as trade is liberalized, the number of exporting firms increases because export cutoff productivity decreases. On the other hand, the number of FDI firms decreases because of the increase in FDI cutoff productivity.

4.5 Employment

The trend of employment is the same as the benchmark case. We see an increase in employment for the comparatively advantaged industry and a decrease for the comparatively disadvantaged industry (Figure 9).

Looking at the composition of employment by domestic firms and FDI foreign firms, FDI firms in both industries reduce employment but FDI firms in the comparatively advantaged industry reduces less. The difference is explained by the different tendencies toward FDI in both industries.

Domestic firms in the comparatively advantaged industry increase employment as trade is liberalized. Domestic firms in the comparatively disadvantaged industry can also increase employment because FDI firms reduce their workforces, mainly less abundant unskilled workers in the country.

4.6 Industrial real revenue and Welfare

Real revenue of the comparatively advantaged industry

$$RR_i^H \equiv \frac{R_i^H}{(P_1^H)^{\alpha_1}(P_2^H)^{\alpha_2}}$$

increases because it expands exports after trade is liberalized (Figure 10). Real revenue is higher than the benchmark case because revenue per firm increases as the number of firms decreases.

By contrast, we cannot posit a simple relationship between the real revenue of the comparatively disadvantaged industry and trade liberalization. Intensified competition from FDI prompts more firms to exit the industry, depressing real revenue. But the decrease in export cut-off productivity greater than the comparatively advantaged industry makes the number of export firms increase. In our numerical example, the latter effect, coupled with the effect of a decreased price level, exceeds the former effect.

Economic welfare U^H is equal to the sum of each industry's real revenue, $(R_1^H + R_2^H)/(P_1^H)_1^{\alpha}(P_2^H)_1^{\alpha}$. [27] We can confirm that FDI increases welfare in our case (Figure 11).

5 Conclusion

In this study, I have expanded a recently-developed firm heterogeneity model into a two-goods two-factor model and introduced FDI in the model. Then I analyzed the tendencies of industries to choose exporting or FDI and analyzed the effect of FDI on the economy through numerical examples.

The model demonstrates that highly productive firms tend to prefer FDI whether they are in an industry that employs an abundant factor of production intensively or in an industry that employs a scarcer factor intensively. This is the outcome that earlier vertical and horizontal FDI models cannot explain well. In addition, the model demonstrates that firms in the former industrial category are more likely to choose FDI, and this result reflects the actual preference of Japanese firms when building businesses in emerging economies.

According to results demonstrated by the model, FDI increases competition among firms and raises the real wage and welfare of both countries.

[27] This relationship is introduced from the utility maximization condition. The sum of both industries' revenue, $R_1^H + R_2^H$, is distributed to $P_1^H C_1^H$ and $P_2^H C_2^H$ at $\alpha : 1-\alpha$, and we can have the equation by substituting the relationship.

On the whole, it is desirable to facilitate FDI, but doing so also has negative consequences; increased competition forces low-productivity firms to exit the market, and the number of firms decreases.

The industry that employs the relatively abundant factor of production intensively has greater flexibility in choosing exporting or FDI. As expected, firms in such an industry export when trade conditions are liberal, and they access foreign markets via FDI when conditions are restrictive. In contrast, firms in the industry employing the scarcer factor intensively are locked into FDI because conditions do not favor export. However, these firms can make use of the more abundant factor of production available in the foreign economy.

The difference in tendencies of industries to choose exporting or FDI affects the industries' revenue. If trade is liberal, the industry employing the more abundant factor intensively prefers export over FDI, and the industry's real revenue increases. The other industry also shifts from FDI to exporting, but less intently. However, the increase in number of exporting firms raises the industry's real revenue. The increase of real revenue in the industry employing the scarcer factor intensively differs markedly from results suggested by the models of Heckscher-Ohlin and Bernard et al. (2007).

FDI by Japanese manufacturers in emerging economies has been active across sectors. According to results of this study, it is rational for high-productivity firms to invest in emerging economies with lower wages, even if those firms employ unskilled labor intensively. In addition, the level of trade restrictions in emerging economies is greater than that in advanced countries, making it more effective for Japanese firms to use FDI that to export.

Numerous policy implications emerge from this research. In particular, it is important for policymakers to liberalize not only trade but also FDI. In Japan's case, trade liberalization benefits industries employing skilled labor and hinders industries employing unskilled labor. Improving opportunities for FDI could reduce the impact on the latter even though the exit of low-productivity firms is inevitable. Many emerging economies restrict foreign investment to protect their domestic industries. Japan should appeal to their governments to ease FDI restrictions, especially for industries that employ more unskilled workers.

From the viewpoint of promoting Japanese FDI, it is import to facilitate FDI by firms in industries reliant on unskilled labor. Sales by Japanese foreign affiliates are nearly three times larger than exports by Japanese firms. But as recent empirical research reveals, FDI is common only among a few

large, highly productive firms. Since the cost of entering foreign markets affects the choice of FDI, policies to reduce this cost are essential for promoting FDI by firms lacking information about foreign markets. Such policies include assisting with information about foreign markets and foreign countries' policies toward FDI and business risk.

References

[1] Japan Bank for International Corporation. (2009). *Report on Japanese Manufacturers' Overseas Business Operations -FY2009 (the 21st) Survey on Foreign Direct Investment-* (in Japanese).

[2] Ryuhei Wakasugi, Yasuyuki Todo, Hitoshi Sato, Shuichiro Nishioka, Toshiyuki Matsuura, Banri Ito and Asyumu Tanaka. (2008). "The Internationalization of Japanese Firms: New Findings Based on Firm-Level Data." *RIETI Discussion Paper Series*, 08-E-036.

[3] Bernard, Andrew B., Stephen J. Redding and Peter K. Schott. (2007). "Comparative Advantage and Heterogeneous Firms." *Review of Economic Studies*, 74: 31-66.

[4] Bernard, Andrew B., Bradford J. Jensen, Stephen J. Redding and Peter K. Schott. (2007). "Firms in International Trade." *Journal of Economic Perspectives*, 21(3): 105-130.

[5] Blonigen, Bruce A., Ronald B. Davies and Keith Head. (2003). "Estimating the Knowledge-Capital Model of the Multinational Enterprise: Comment." *American Economic Review*, 93(3): 980-994.

[6] Blonigen, Bruce A. (2005). "A Review of the Empirical Literature on FDI Determinants." *NBER Working Paper*, No.11299.

[7] Brainard, Lael S. (1997). "An Empirical Assessment of the Proximity-Concentration Trade-Off Between Multinational Sales and Trade." *American Economic Review*, 87(4): 520-544.

[8] Carr, David L., James R. Markusen, and Keith Maskus. (2001). "Estimating the Knowledge-Capital Model of the Multinational Enterprise." *American Economic Review*, 91(3): 693-708.

[9] Feenstra, Robert E.(2004). *Advanced International Trade*: Princeton University Press.

[10] Hayakawa, Kazunobu and Toshiyuki Matsuura. (2009). "Complex Vertical FDI and Firm Heterogeneity: Evidence from East Asia." *IDE Discussion Paper*, No.211.

[11] Helpman, Elhanan. (1984). "A Simple Theory of International Trade with Multinational Corporations." *Journal of Political Economy*, 92(3): 451-471.

[12] Helpman, Elhanan. (2006). "Trade, FDI and the Organization of Firms." *Journal of Economic Literature*, 44(3): 589-630.

[13] Helpman, Elhanan, Marc J. Melitz, and Stephan R. Yeaple. (2004). "Export versus FDI with Heterogeneous Firms." *American Economic Review*, 94(1): 300-316.

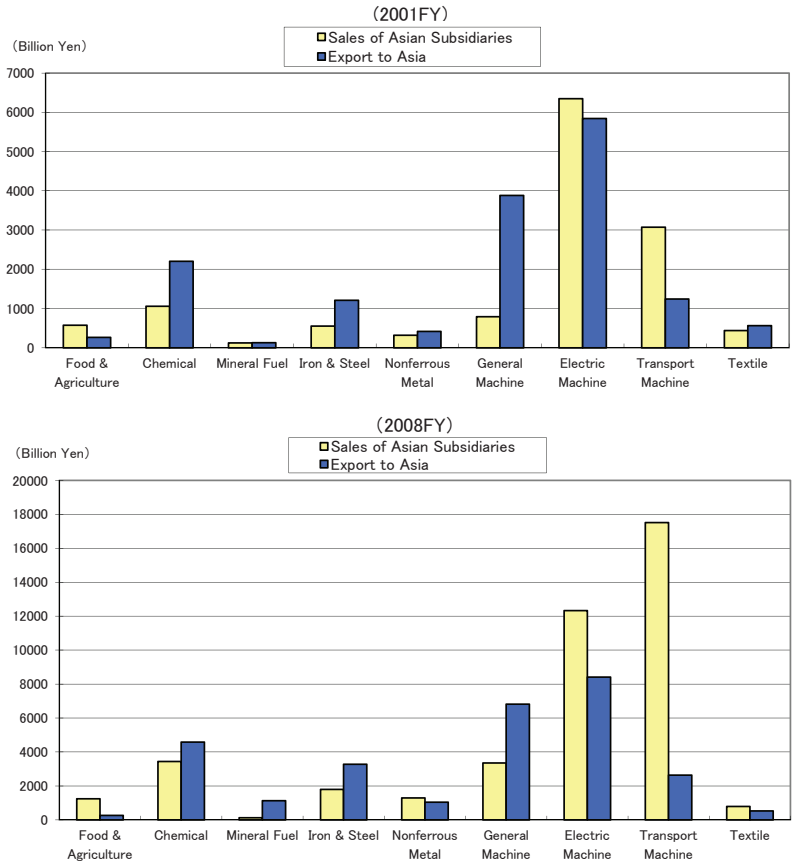
[14] Markusen, James R. and Anthony j. Venables. (1998). "Multinational Firms and the New Trade Theory." *Journal of International Economics*, 46: 183-203.

[15] Markusen, James R. (2002) *Multinational Firms and the Theory of International Trade*: MIT Press.

[16] Melitz, Marc. J. (2003). "The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695-1725.

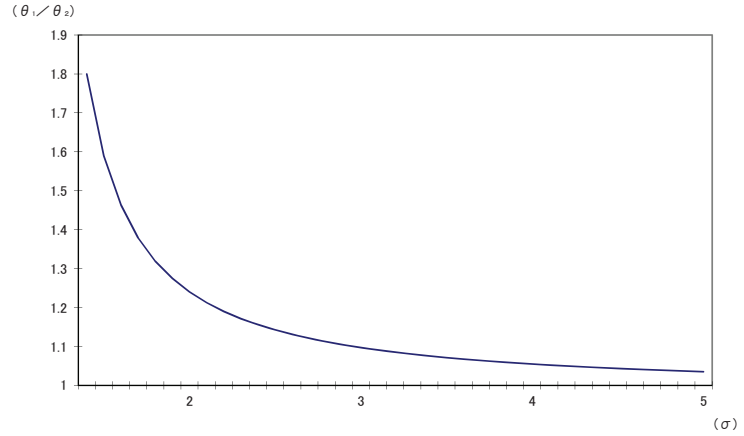
[17] Todo Yasuyuki. (2009). "Quantitative Evaluation of Determinants of Export and FDI: Firm-level evidence from Japan." *RIETI Discussion Paper Series*, 09-E-019.

Figure 1　Sales of Asian Subsidiaries and Export to Asia
by Japanese Manufacturing Industry



Source：Ministry of Finance "Trade Statistics of Japan", Ministry of Economy, Trade and Industry "Basic Survey on Overseas Business Activities"

Figure 2　σ and θ1／θ2 (in Autarky)



Note: Variables are as follows.
Factor endowment: Skilled Labor in country H = 1200 Unskilled labor in country H = 1000
Skilled Labor in country F = 1000 Unskilled labor in country F = 1200
fi=0.1、fix =0.1、fia=0.5、τi=1.2(common in both countries and both industries)
β1=0.6、β2=0.6 (common in both countries)

Figure 3 FDI Productivity Cut-Off by Industry

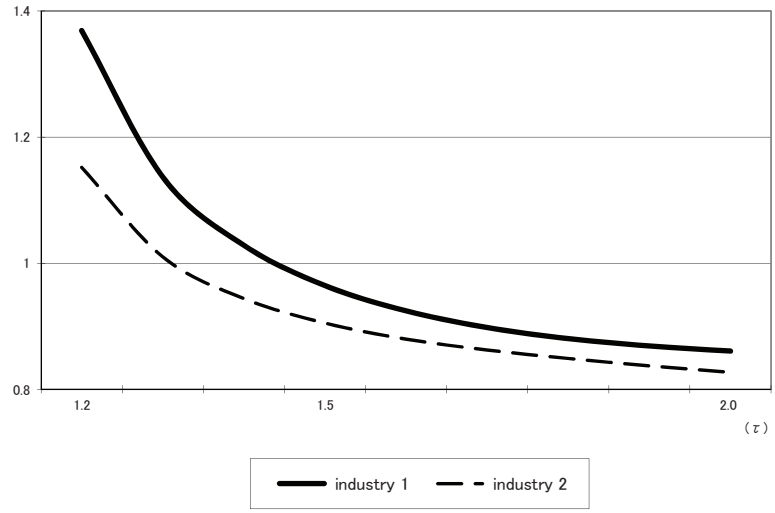
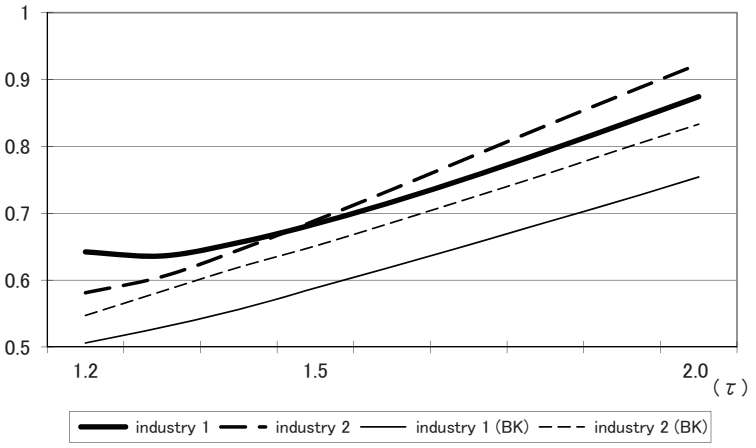


Figure 4 Exporting Productivity Cut-Off by Industry



(Reference) Relative Price by Goods

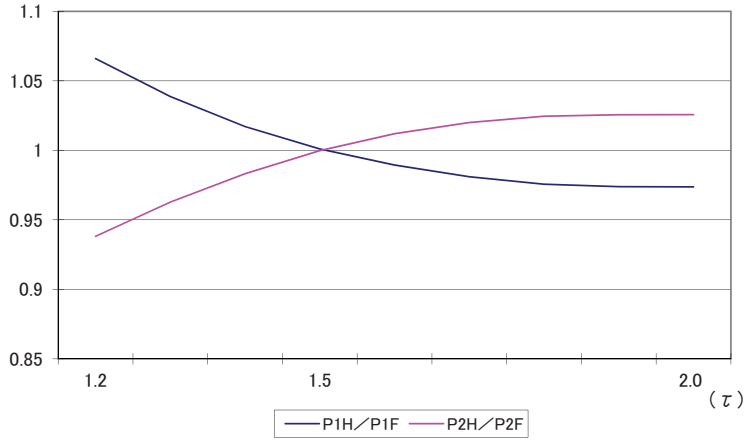


Figure 5 Zero-Profit Productivity Cut-off by Industry

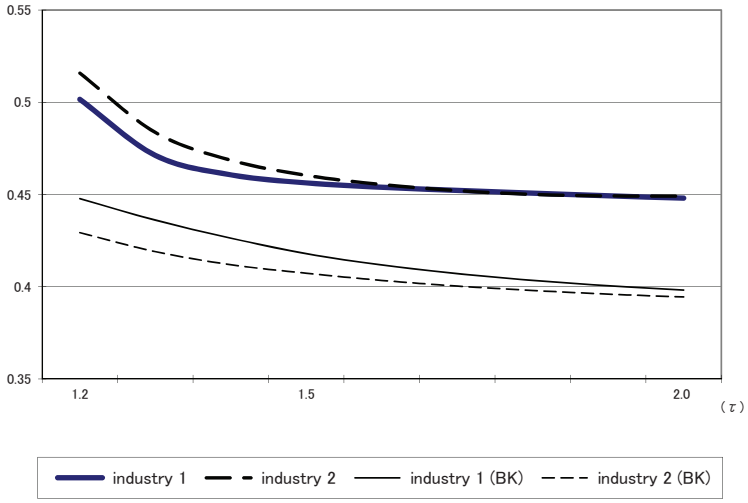


Figure 6 Price

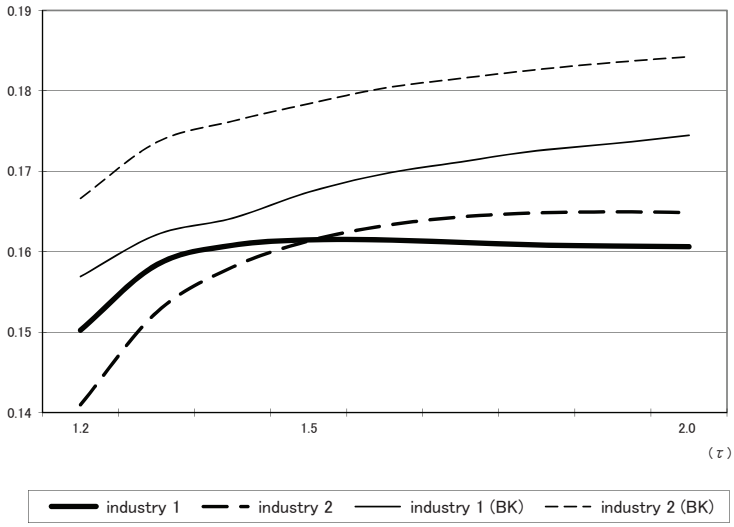


Figure 7 Real Factor Price

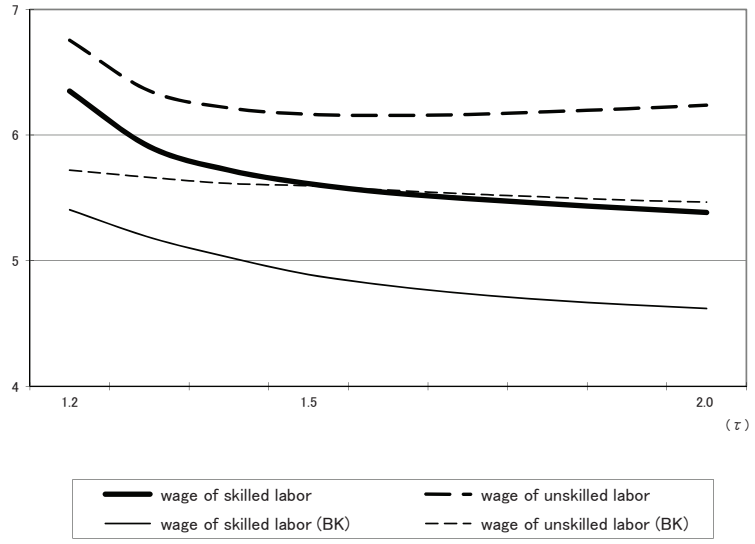
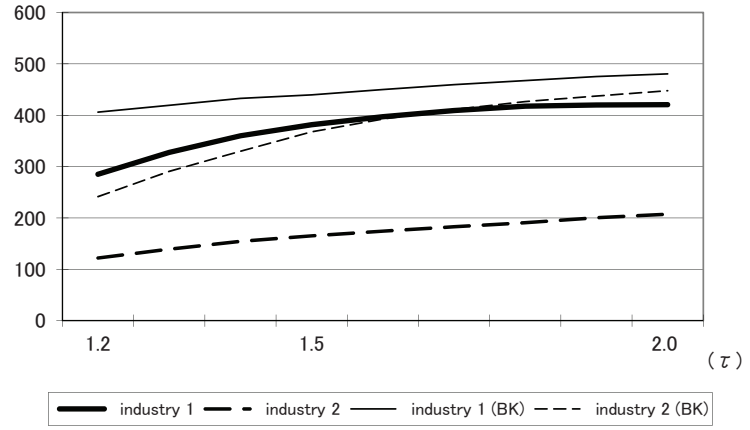


Figure 8　Entry of Firms by Industry



(Composition)

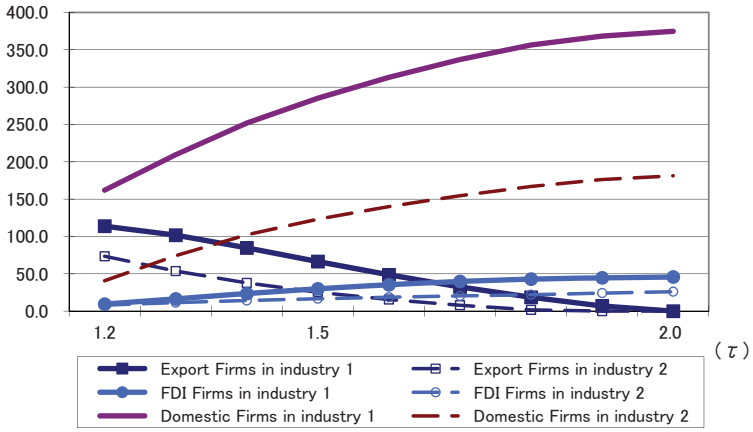


Figure 9　Employment by Industry

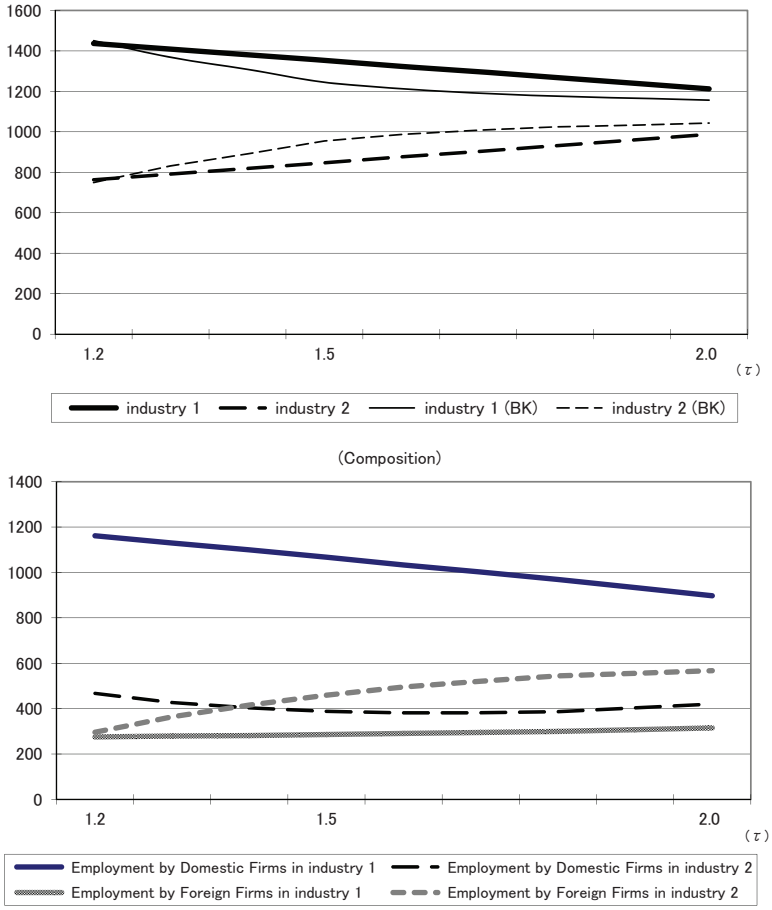


Figure 10 Real Income by Industry

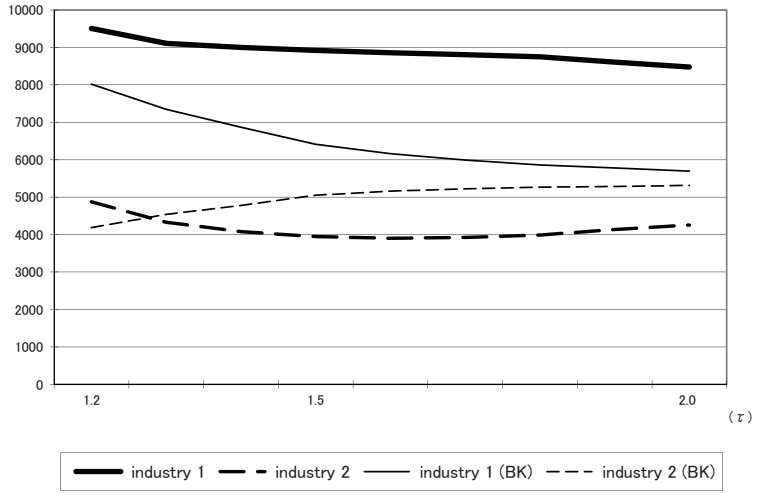


Figure 11 Welfare