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Supply Chains and FTAs†

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Abstract

This study theoretically and empirically examines the effects of free trade agreements (FTAs) on the supply chains of multinational enterprises (MNEs). Data on Japanese overseas manufacturing affiliates indicate that Japanese MNEs develop their supply chain networks in the local and other countries' markets instead of trading with parent firms in Japan. We develop a simple firm heterogeneity model and examine its implications to explain this finding and confirm whether FTAs encourage MNEs to construct those networks. Our theoretical model reveals that FTAs affect the sales of domestic and export firms through changes in status. However, our theoretical model cannot confirm if FTAs increase the firms' sales in the local or other countries' markets because the signs of exogenous variables such as fixed labor inputs for the activities to follow the rules of the FTAs, tariffs, and the number of FTA member states are ambiguous. Thus, we empirically analyze whether FTAs increase local sales or sales in other countries' markets. Our results reveal that regional FTAs have positive effects on sales in other countries' markets, whereas bilateral FTAs do not increase local sales. In addition, we find that FTAs between local governments and large markets have varying effects depending on the conditions of the large markets. Our results indicate that Japanese MNEs develop supply chain networks by effectively utilizing various FTAs.

Keywords: Supply Chain Networks, Free Trade Agreements, Firm Heterogeneity

JEL classification: F12 F13 F14

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1. Introduction

The effect of free trade agreements (FTAs) on supply chain networks constructed by multinational enterprises (MNEs) is a key topic in international economics. Over the last three decades, many governments have used FTAs to increase trade with their partners while the Doha Round negotiations under the World Trade Organization (WTO) have remained stuck. This is because policymakers believe that FTAs help integrate foreign economies into their own country's economy and improve its efficiency constructing cross-border supply chain networks of MNEs. As such, 373 FTAs have been implemented as of January 22nd, 2025 according to the WTO[1].

Over the last several decades, the offshore activities of MNEs have increased because of technological progress, including information and communication technologies (ICTs), construction of large-scale transport infrastructure in developing countries, and increase in global competition. MNEs have formed cross-border supply chain networks to enhance their efficiency and competitiveness by splitting production processes and moving these processes to other locations to give them competitive advantages. FTAs encourage MNEs to develop these networks by reducing tariffs, enhancing institutional transparency, and protecting foreign direct investment (FDI).

Many studies examine the effects of FTAs on MNE activities. While some theoretical studies use Melitz's (2003) firm heterogeneity model that features FTAs (Demidova and Krishna, 2008; Jafari and Britz, 2018), they do not analyze the effect of FTAs on the activities of overseas affiliates. Thus, to identify the characteristics of FTAs that may affect a firm's sales, we follow Merlitz (2003) and construct a simple theoretical model.[2] Other empirical studies examine the relationship between FTAs and supply chain networks using both aggregate and firm-level data. Murakami (2023) examines whether regional FTAs increase intra-regional exchanges of goods to illustrate the effects of FTAs on the development of the networks. Moreover, Urata and Kato (2016), Hayakawa (2020), and Neri-Laine et al. (2023) investigate whether FTAs affect export and import behaviors at the firm level.

Although existing studies find the positive effects of FTA on trade and FDI by MNEs, they usually examine the effects of FTAs on the hub-and-spoke systems of MNEs, focusing on whether FTAs encourage local firms to increase their exports or imports. The MNEs also use regional FTAs to efficiently reallocate their production processes across the regions based on the different factor endowment between countries. They further develop supply chain networks using FTAs between local governments and large countries. For example, in the EU, procurement, production, and sales are not always settled in a single country but are linked between EU member

[1] This is the number of regional trade agreements (RTAs) which include FTAs.

[2] Helpman, et al. (2004) develop a firm-hetero model that incorporates FDI, but we do not adopt their model as the basis for our model because we focus on the activity of foreign affiliates only in the investment and export destinations.

states for many Japanese overseas affiliates. Japanese manufacturing firms also have overseas affiliates in Mexico to increase their sales in the US through the North American Free Trade Agreement (NAFTA). This implies that MNEs flexibly form supply chain networks through various types of FTAs. To deepen our understanding of this issue, this study examines the effects of FTAs on local sales and exports to other markets using firm-level data from the Japanese manufacturing sector.

The remainder of this paper is organized as follows. Section 2 reviews activities of Japanese companies' overseas affiliates. Section 3 develops a model to illustrate the theoretical implications of various types of FTAs. Section 4 explains the empirical models and data. Section 5 presents and analyzes the empirical results. Lastly, Section 6 concludes the study.

2. Brief review of the activities of Japanese overseas affiliates

Over the past several decades, Japanese firms have explored foreign markets to increase profits through economies of scale. Recently, the activities of overseas affiliates through FDI have played a greater role in business expansion than direct exports and imports. In 2019, before the COVID-19 pandemic, total sales and procurement of Japanese overseas affiliates in the manufacturing sector was approximately 1.78 trillion USD (195 trillion JPY), which was larger than total exports and imports (1.39 trillion USD: and 153 trillion JPY, respectively) in the same year[3]. The FDI of Japanese firms is regionally biased toward large economies. As Figure 1 shows, from 2009 to 2017, approximately 40% of the overseas affiliates of Japanese manufacturing firms are in neighboring northeast Asian countries. Approximately 25% are in ASEAN countries, while 16% and 12% of the affiliates are located in NAFTA member countries and the EU (including the UK), respectively. Only 4% of the Japanese overseas affiliates are located in countries that have bilateral FTAs with Japan (e.g. Australia and India)[4]. Evidently, Japanese MNEs have constructed supply chain networks in Asia, Europe, and North America through overseas affiliates.

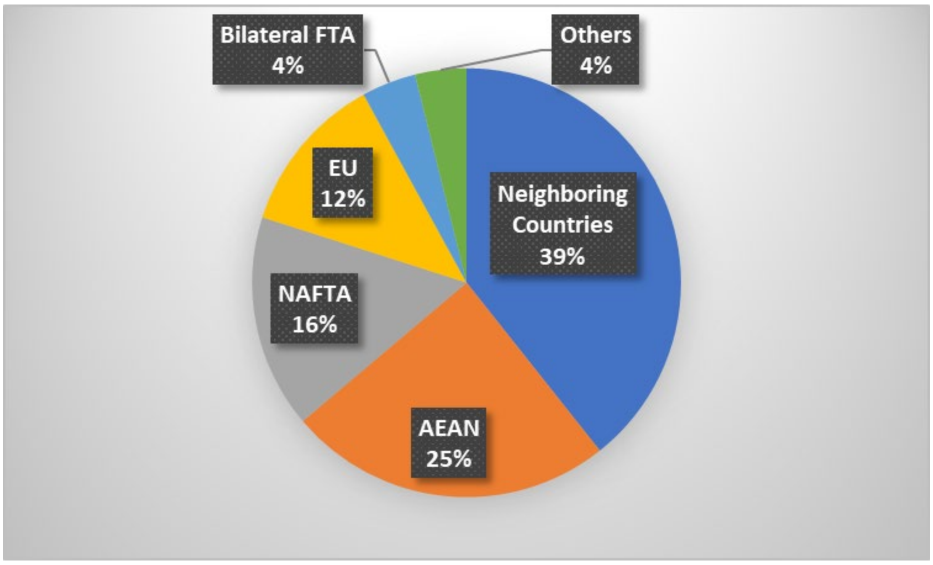
Many researchers discuss the hub-and-spoke systems between parent firms and their overseas affiliates in such networks, specifically focusing on the relations between the parent firms and their overseas affiliates (e.g. Urata and Kato, 2017). However, in practice, networks have become considerably more sophisticated. Figure 2 presents the activities of overseas Japanese manufacturing affiliates from 2015 to 2017 by region[5]. It shows that the share of the Japanese market in overseas affiliates is smaller than those of local markets and other countries

[3] Data are obtained from the Ministry of Finance and the Ministry of Economy, Trade, and Industry (METI) of Japan.
[4] Share of the countries where Japan only has bilateral FTAs.
[5] The other countries are excluded in Figure 2 because those countries account for less than 4% of all overseas affiliates, and no consistent characteristics.

in both the sales and procurement. This remains true for overseas affiliates located in countries where Japan has bilateral FTAs. Local markets account for the largest share in all regions, while exports to other countries are higher in regions where FTAs exist. This implies that Japanese manufacturing firms' supply chain networks do not rely on the simple hub and spoke system. Rather, networks are developed via overseas affiliates in the local and other countries' markets.

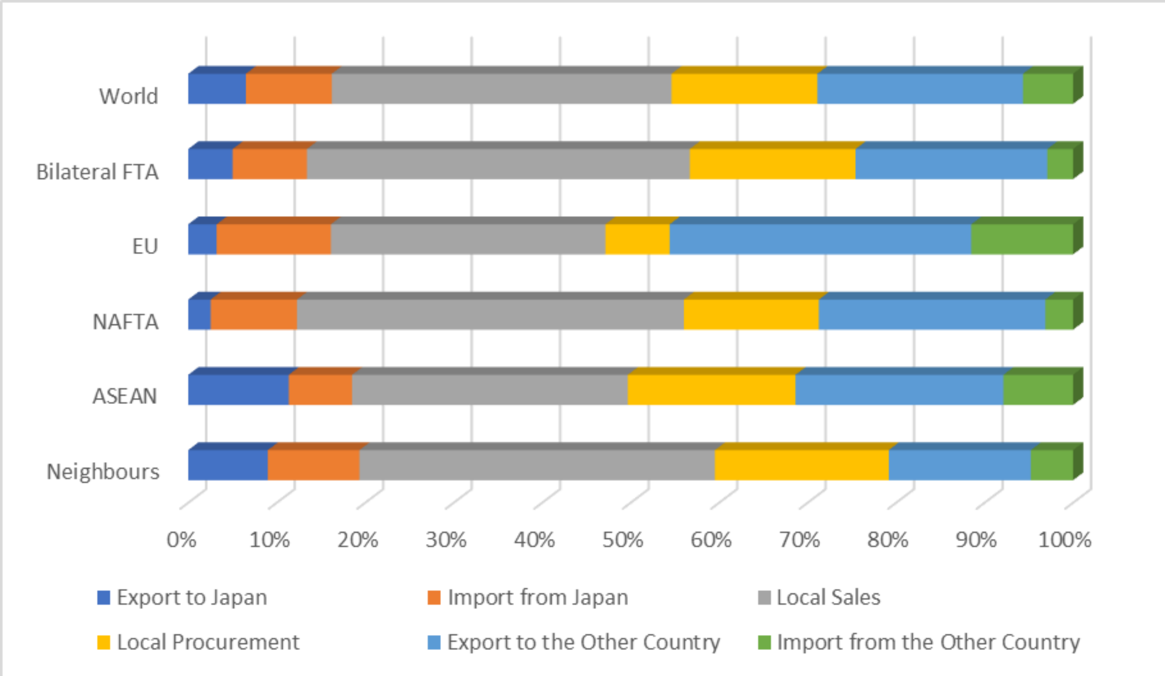
Additionally, Figure 2 illustrates how FTAs affect supply chain networks. As mentioned above, the percentage of overseas Japanese affiliates in countries that have bilateral FTAs with Japan is small; although the percentage is higher in ASEAN countries. Meanwhile, the percentage of exports to countries in ASEAN, the EU, and NAFTA member states are larger than to neighboring countries. This implies that the effects of FTAs are not always unique. In addition, FTAs between local governments and their trade partners may affect the structure of the supply chains of MNEs, as well as the FTAs between Japan and the local governments.

Figure 1 Manufacturing overseas affiliates



Data Source: METI, the Basic Survey on Overseas Business Activities

Figure 2 Activities of oversea affiliates by region



Data Source: METI, the Basic Survey on Overseas Business Activities

3. Theory

Although theoretical studies on the impact of FTA are fewer than empirical works, some theoretical studies consider firm heterogeneity. Demidova and Krishna (2008) discuss the role of firm heterogeneity in analyzing the level of rules of origin in FTAs. Jafari and Britz (2018) incorporate Melitz's (2003) model into the Global Trade Analysis Project (GTAP) model to analyze the extensive and intensive margins of trade and productivity effects. These studies focus on the impact of FTA on global production networks or the extensive and intensive margin of trade. By contrast, our study reveals how FTA affect the decision making of foreign affiliates of MNEs.

3.1 The model

We theoretically examine how FTA affect a firm's behavior, especially on firm sales. We focus on the effect of a change in the parameter related to FTA breadth/depth: g, which corresponds to the fixed labor input for the activities to comply with the rules of FTA ($F_i(\varphi)$ described below); the level of tariff τ; and the number of export destinations n.[6] We regard g and τ as proxy variables for expansion of FTA (FTA breadth) and promotion of

[6] Even if tariffs are eliminated, i.e., $\tau = 1$, the results of comparative statics (the sign of partial derivative coefficient) are unchanged.

FTA (FTA depth), respectively.[7] In addition, because our model assumes that all countries are FTA members consisting of $n+1$ symmetric countries, n can be regarded as a proxy for FTA depth.

Although our model is similar to Melitz's (2003) firm heterogeneity model in that we focus on the impact through fluctuations in productivity, it differs from the standard Melitz model in several ways. First, in our model, FTA, unemployment, and fixed costs depend on firm-specific productivity. Second, unlike in Melitz's (2003) model, we treat market entry and exit as exogenous firm behaviors to simplify our model's structure. In the theoretical analysis, we exclude headquarters' behavior from the model to focus on the impact of FTA on the production and sales activities of foreign affiliates only in investment and export destinations. We refer to foreign affiliate *firms* to simplify the expressions.

The household maximizes the utility $U = X = \left(\int_{\omega\in\Omega} x(\omega)^{\rho} d\omega\right)^{1/\rho}$, $0<\rho<1$, subject to the budget constraint $PX = \int_{\omega\in\Omega} p(\omega)x(\omega)d\omega$, where the measure of the set Ω suggests the mass of available goods, $x(\omega)$ is the demand for each variety ω, $p(\omega)$ is its price, $P = \left(\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right)^{1/(1-\sigma)}$ is the price index, and $\sigma = (1-\rho)^{-1} > 1$ is the elasticity of substitution between varieties. Thus, the demand for each variety is as follows:

$$x(\omega) = \left(\frac{p(\omega)}{P}\right)^{-\sigma} X. \tag{1}$$

There is a continuum of monopolistically competitive firms, each producing a variety of differentiated goods. Firms are classified into domestic and export firms. The domestic firm consists of a domestic plant, which produces goods only for the domestic market. The export firm is comprised of a domestic plant and n export plants serving the foreign markets. The production function of each type of plant is respectively assumed to be $x_D(\varphi) = \varphi l_D(\varphi)$ and $\tau x_{EX}(\varphi) = \varphi l_{EX}(\varphi)$, where $l_i(\varphi)$ is the labor input, φ is the firm-specific productivity, τ is a per-unit iceberg-type tariffs, and the subscript i $(i = D, EX)$ shows the related variables of domestic and export. We choose labor as the numéraire and wage w is normalized to one. In our model, exogenous wage rigidity leads to unemployment. The profit of a plant is shown as $\pi_i(\varphi) = p_i(\varphi)x_i(\varphi) - l_i(\varphi) - F_i(\varphi)$, where $F_i(\varphi)$ denotes the fixed cost. We regard the fixed cost of a domestic plant as a product planning cost based on market research. An export plant entails the fixed labor input for the activities to follow the rules of FTA in addition

[7] An increase in FTA breadth indicates an increase in areas including the corresponding FTA, such as trade, investment, and technology. An increase in areas is thought to increase in administrative tasks in taking advantages of that FTA. Therefore, we, consider an increase in the fixed labor input engaged in administrative tasks in an FTA as a proxy for FTA breadth.

to the product planning cost, thus $F_D(\varphi) < F_{EX}(\varphi)$. Additionally, we assume that all plants assign their employees to these activities and goods production; thus, as in Nishiyama (2017), the fixed costs in these plants depend on their productivity level and are defined as $F_D(\varphi) = f/\varphi$ and $F_{EX}(\varphi) = g/\varphi$. Note that $0 < f < g$ because $0 < F_D(\varphi) < F_{EX}(\varphi)$. Profit maximization yields the following optimal prices:

$$p_D(\varphi) = \frac{1}{\rho\varphi}, \qquad p_{EX}(\varphi) = \frac{\tau}{\rho\varphi}. \tag{2}$$

From Eqs. (1) and (2), we find that $r_D(\varphi) = \tau^{\sigma-1} r_{EX}(\varphi)$, where $r_i(= p_i x_i)$ denotes the revenue. The profit function can then be rewritten as:

$$\pi_i(\varphi) = \frac{r_i(\varphi)}{\sigma} - F_i(\varphi), \qquad \frac{r_i(\varphi_1)}{r_i(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma-1}. \tag{3, 4}$$

Each firm draws its productivity φ from a fixed distribution $g(\varphi)$ that has a continuous cumulative distribution $G(\varphi)$. To better understand our results, we assume the Pareto distribution for productivity $G(\varphi) = 1 - \varphi^{-k}$, $g(\varphi) = k\varphi^{-k-1}$, where the lower bound of productivity is normalized to one and $k > \sigma - 1$ is the shape parameter. The average productivity of each type of operating plant is

$$\tilde{\varphi}_i = \left(\int_{\varphi_{imin}}^{\infty} \varphi^{\sigma-1} \frac{g(\varphi)}{1 - G(\varphi_{imin})} d\varphi\right)^{\frac{1}{\sigma-1}} = \left(\frac{k}{1+k-\sigma}\right)^{\frac{1}{\sigma-1}} \varphi_{imin}, \tag{5}$$

where $1 - G(\varphi_{imin})$ is the ex-ante probability of a successful draw and φ_{imin} shows the cutoff level, which suggests the lowest productivity level of operating firm. We call φ_{Dmin} and φ_{EXmin} the domestic- and export-cutoff productivity, respectively. Each cutoff productivity ensures $\pi_i(\varphi_{imin}) = 0$; hence

$$r_D(\varphi_{Dmin}) = \frac{\sigma f}{\varphi_{Dmin}}, \; r_{EX}(\varphi_{EXmin}) = \frac{\sigma g}{\varphi_{EXmin}}. \; (\because (3)) \tag{6}$$

Using Eqs. (4)-(6) and $r_D(\varphi) = \tau^{\sigma-1} r_{EX}(\varphi)$, we derive

$$r_D(\tilde{\varphi}_D) = \frac{k}{1+k-\sigma}\frac{\sigma f}{\varphi_{Dmin}}, \; r_{EX}(\tilde{\varphi}_{EX}) = \frac{k}{1+k-\sigma}\frac{\sigma g}{\varphi_{EXmin}}, \tag{7}$$

$$\chi = \frac{1 - G(\varphi_{EXmin})}{1 - G(\varphi_{Dmin})} = \left(\frac{\varphi_{Dmin}}{\varphi_{EXmin}}\right)^k = \tau^{k\frac{1-\sigma}{\sigma}} \left(\frac{g}{f}\right)^{\frac{-k}{\sigma}} = \chi\left(\underset{-}{\underbrace{g}}, \underset{-}{\underbrace{\tau}}\right), \tag{8}$$

where $0 < \chi < 1$ is the ratio of the export firms ($\because g > f,\ \tau > 1,\ \sigma > 1$). The sign in the parenthesis in Eq. (8) suggests partial derivative coefficient; thus, an increase in g decreases χ whereas a decrease in τ increases χ.

As noted above, we exclude firms entry and exit behaviors. Assuming that the total mass of potential entrants (NOT the number of producing firms) M is equal to one, the number of each type of producing plant is determined by

$$M_i = \left(1 - G(\varphi_{imin})\right)M = \varphi_{imin}{}^{-k}. \tag{9}$$

Because the aggregate expenditure equals aggregate revenue, using Eqs. (4), (5), (7), and (9) yields

$$E = \int_{\varphi_{Dmin}}^{\infty} r_D(\varphi) M_D \frac{g(\varphi)}{1 - G(\varphi_{Dmin})} d\varphi + n \int_{\varphi_{EXmin}}^{\infty} r_{EX}(\varphi) M_{EX} \frac{g(\varphi)}{1 - G(\varphi_{EXmin})} d\varphi$$

$$= {\varphi_{Dmin}}^{-k-1} \frac{k\sigma}{1 + k - \sigma} \left(f + ng\chi^{\frac{1+k}{k}} \right),$$

where E is the aggregate expenditure that is assumed to be exogenously fixed. Thus, by rearranging this equation and considering Eq. (8), we obtain the following[8]:

$$\varphi_{Dmin} = \left(\frac{k\sigma}{1 + k - \sigma} \frac{1}{E} \right)^{\frac{1}{1+k}} \left(f + ng\chi^{\frac{1+k}{k}} \right)^{\frac{1}{1+k}} = \varphi_{Dmin}\left(\underbrace{g}_{-}, \underbrace{\tau}_{-}, \underbrace{n}_{+}, \underbrace{E}_{-} \right), \tag{10}$$

$$\varphi_{EXmin} = \chi^{-\frac{1}{k}} \varphi_{Dmin} = \varphi_{EXmin}\left(\underbrace{g}_{+}, \underbrace{\tau}_{+}, \underbrace{n}_{+}, \underbrace{E}_{-} \right). \tag{11}$$

The impacts of exogenous shocks g, τ, n, and E on the variables related to intra-industry reallocation (φ_{imin} and χ) are shown in Eqs. (8), (10), and (11). These results can be interpreted as follows. First, when the fixed labor input for the activities to follow the rules of FTA g increases, only higher productivity firms, which can pay high fixed costs, survive; thus, φ_{EXmin} increases. Then, the operating condition of domestic firms improves relative to exporters; hence, φ_{Dmin} decreases, leading to a decrease in the ratio of the number of exporters χ. Second, a reduction in tariff τ improves the operating condition of export firms due to an increase in the demand for the export goods because of a decrease in price. Then, the operating condition of domestic firms relatively worsens; thus, φ_{Dmin} increases, φ_{EXmin} decreases, and χ increases. Third, an increase in the number of export destinations (FTA members) n increases the aggregate revenue of all firms. Then, under the assumption that aggregate expenditure E is exogenously fixed, the number of operating firms M_D must decrease to maintain the equilibrium between aggregate expenditure and aggregate revenue. Therefore, φ_{Dmin} increases (Eq. (9)). This increase in φ_{Dmin} also raises the level of φ_{EXmin} (see Eq. (11)). Finally, an increase in aggregate expenditure E, which can be regarded as national income or market size, decreases both φ_{Dmin} and φ_{EXmin}. This result comes directly from an increase in the revenue of all operating firms owing to the loosening of budget constraints. The results above are summarized in Proposition 1.

Proposition 1. The effect of the expansion and promotion of FTA on productivity varies depending on its triggers, i.e., an increase in g*,* n*,* E*, and a decrease in* τ *(see Figure 3). In particular, an increase in* g *biases intra-industry resource toward the firms with lower productivity, i.e., domestic firms (recall that* φ_{Dmin} *decreases and*

[8] For the derivation of the solutions, see Appendix.

φ_{EXmin} *increases), whereas a decrease in* τ *biases it toward the higher productivity firms, i.e., export firms. An increase in* n *raises productivity within an industry, whereas an increase in E decreases it.*

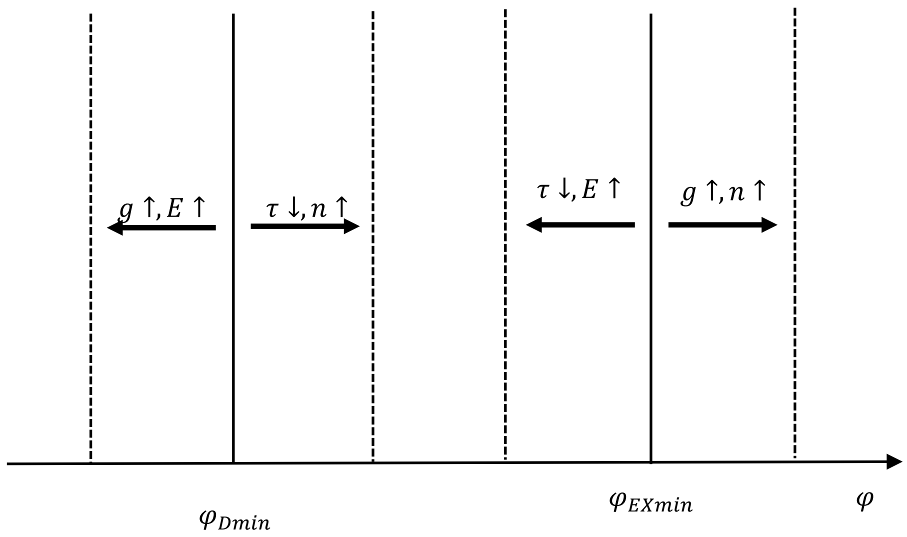


Figure 3 The effect of FTA on domestic- and export-cutoff productivity

3.2 The impact of FTA on sales of firms

Let us consider the average sales of domestic and export firms. Using Eqs. (4), (5), (7), and $r_D(\varphi) = \tau^{\sigma-1} r_{EX}(\varphi)$, we derive

$$\begin{aligned} s_D &= \frac{1}{M_D - M_{EX}} \int_{\varphi_{Dmin}}^{\varphi_{EXmin}} r_D(\varphi) M_D \frac{g(\varphi)}{1 - G(\varphi_{Dmin})} d\varphi \\ &= \frac{k\sigma}{1+k-\sigma} \left(f - \tau^{\sigma-1} g \chi^{\frac{1+k}{k}} \right) \frac{1}{\varphi_{Dmin}} \frac{1}{1-\chi}. \end{aligned} \tag{12a}$$

$$\begin{aligned} s_{EX} &= \frac{1}{M_{EX}} \left(\int_{\varphi_{EXmin}}^{\infty} r_D(\varphi) M_{EX} \frac{g(\varphi)}{1 - G(\varphi_{EXmin})} d\varphi + n \int_{\varphi_{EXmin}}^{\infty} r_{EX}(\varphi) M_{EX} \frac{g(\varphi)}{1 - G(\varphi_{EXmin})} d\varphi \right) \\ &= \frac{k\sigma}{1+k-\sigma} (\tau^{\sigma-1} + n) g \frac{1}{\varphi_{EXmin}}. \end{aligned} \tag{12b}$$

The number of domestic firms (NOT plants) is $M_D - M_{EX}$. These equations imply that exogenous shocks directly and indirectly affect average sales via a change in cutoff productivity. To confirm the impact of FTA on average sales, we derive the partial derivatives of s_D and s_{EX}.

Differentiating Eq. (12a) with respect to g, τ, n, and E, we obtain

$$\frac{1}{s_D}\frac{\partial s_D}{\partial g} = \underbrace{\underbrace{-\frac{\tau^{\sigma-1} g \chi^{\frac{1+k}{k}}}{f - \tau^{\sigma-1} g \chi^{\frac{1+k}{k}}}}_{-} \left(\underbrace{\frac{1}{g}}_{+} + \underbrace{\frac{1+k}{k\chi}\frac{\partial \chi}{\partial g}}_{-} \right) + \underbrace{\frac{-1}{\varphi_{Dmin}} \frac{\partial \varphi_{Dmin}}{\partial g}}_{+}}_{+} + \underbrace{\frac{1}{1-\chi}\frac{\partial \chi}{\partial g}}_{-} \gtreqless 0, \tag{12c}$$

$$\frac{1}{s_D}\frac{\partial s_D}{\partial \tau} = \underbrace{\underbrace{-\frac{\tau^{\sigma-1} g \chi^{\frac{1+k}{k}}}{f - \tau^{\sigma-1} g \chi^{\frac{1+k}{k}}}}_{-}\left(\underbrace{\frac{\sigma-1}{\tau}}_{+} + \underbrace{\frac{1+k}{k\chi}\frac{\partial \chi}{\partial \tau}}_{-}\right) + \underbrace{\frac{-1}{\varphi_{Dmin}}\frac{\partial \varphi_{Dmin}}{\partial \tau}}_{+}}_{+} + \underbrace{\frac{1}{1-\chi}\frac{\partial \chi}{\partial \tau}}_{-} \gtreqless 0, \tag{12d}$$

$$\frac{1}{s_D}\frac{\partial s_D}{\partial n} = -\frac{1}{\varphi_{Dmin}}\frac{\partial \varphi_{Dmin}}{\partial n} < 0,\ \ \frac{1}{s_D}\frac{\partial s_D}{\partial E} = -\frac{1}{\varphi_{Dmin}}\frac{\partial \varphi_{Dmin}}{\partial E} > 0. \tag{12e,f}$$

Then, differentiating Eqs. (12b), we derive

$$\frac{1}{s_{EX}}\frac{\partial s_{EX}}{\partial g} = \underbrace{\frac{1}{g}}_{+} + \underbrace{\frac{-1}{\varphi_{EXmin}}\frac{\partial \varphi_{EXmin}}{\partial g}}_{-} = \frac{1}{\sigma g}\left\{(\sigma-1) + \frac{1+k-\sigma}{1+k}\frac{n g \chi^{\frac{1+k}{k}}}{f + n g \chi^{\frac{1+k}{k}}}\right\} > 0, \tag{12g}$$

$$\frac{1}{s_{EX}}\frac{\partial s_{EX}}{\partial \tau} = \underbrace{\frac{\tau^{\sigma-1}}{\tau^{\sigma-1}+n}\frac{\sigma-1}{\tau}}_{+} + \underbrace{\frac{-1}{\varphi_{EXmin}}\frac{\partial \varphi_{EXmin}}{\partial \tau}}_{-} \gtreqless 0, \tag{12h}$$

$$\frac{1}{s_{EX}}\frac{\partial s_{EX}}{\partial n} = \underbrace{\frac{1}{\tau^{\sigma-1}+n}}_{+} + \underbrace{\frac{-1}{\varphi_{EXmin}}\frac{\partial \varphi_{EXmin}}{\partial n}}_{-} \gtreqless 0,\ \ \frac{1}{s_{EX}}\frac{\partial s_{EX}}{\partial E} = -\frac{1}{\varphi_{EXmin}}\frac{\partial \varphi_{EXmin}}{\partial E} > 0. \tag{12i,j}$$

Considering the equations above, the relationship between exogenous variables (g, τ, n, and E) and average sales can be expressed as follows:

$$s_D = s_D\left(\underbrace{g}_{?},\ \underbrace{\tau}_{?},\ \underbrace{n}_{-},\ \underbrace{E}_{+}\right),\ \ s_{EX} = s_{EX}\left(\underbrace{g}_{+},\ \underbrace{\tau}_{?},\ \underbrace{n}_{?},\ \underbrace{E}_{+}\right). \tag{13a,b}$$

We find that an increase in the fixed labor input for FTA g can either increase or decrease the average sales of domestic firms s_D but certainly increase that of export firms s_{EX}. This indicates that an increase in g decreases the revenue of export firms. The revenue of domestic firms then increases relative to that of exporters, and s_D receives increasing pressure. This effect is expressed as the sum of the first and second terms on the right-hand side of Eq. (12c). Simultaneously, the number of domestic firms increases owing to improvements in domestic firms' operating conditions. This decreases pressure on the *average* sales of domestic firms, s_D ($= S_D/(M_D - M_{EX})$, where S_D is the total sales of domestic firms). This effect corresponds to the third term in Eq. (12c). The magnitude of the relationship between these opposite pressures is not definitely determined; therefore, the effect of an increase in g on s_D becomes uncertain. In contrast, an increase in g definitely increases s_{EX}. As shown in Eq. (7), the larger the fixed labor input of export firms g, the larger their average revenue, and hence; s_{EX} becomes larger. This is because only firms with higher productivity (larger profits), which can pay larger fixed costs, can survive. Simultaneously, an increase in g also decreases pressure on s_{EX} through a rise in φ_{EXmin} (see Eq. (11)). Notwithstanding these opposing pressures, the increasing pressure on s_{EX} dominates the decreasing pressure; therefore, s_{EX} increases, as shown in Eq. (12g).

In addition, we find that a decrease in tariffs τ leads to variations in s_D through the channels similar to the case of a change in g. A decrease in τ worsens the operating conditions of domestic firms relative to export firms, and it puts a decreasing pressure on s_D (the sum of the first and second terms of Eq. (12d)). However, the number of domestic firms decreases; thus, s_D experiences increasing pressure (the third term in Eq. (12d)) because of the decrease in the denominator of $S_D/(M_D - M_{EX})$. Similar to the above, since the magnitude of the relationship between these pressures is uncertain, the effect of a decrease in τ on s_D becomes ambiguous. As for the impact on s_{EX}, a decrease in τ improves the operating condition of export plants and relatively worsens it of domestic plants. Therefore, the revenue of domestic plants owned by export firms decreases; hence, s_{EX} experiences decreasing pressure (the first term in Eq. (12h)). Simultaneously, a decrease in τ also increases pressure on s_{EX} through an increase in the revenue of export plants due to a decrease in φ_{EXmin} (the second term of Eq. (12h)). However, the magnitude of the relationship between them is ambiguous; hence, the impact of a decrease in τ on s_{EX} is also uncertain.

Moreover, we find that an increase in the number of export destinations n decreases s_D due to an increase in φ_{Dmin}. This implies that the larger the number of countries that commit to an FTA, the lower the average sales of domestic firms. By contrast, the effect of an increase in n on s_{EX} is ambiguous; that is, an FTA promotion can either increase or decrease the average sales of export firms. An increase in n directly increases s_{EX} (the first term of Eq. (12i)); however, it decreases s_{EX} because of an increase in φ_{EXmin} (the second term of Eq. (12i)).

Finally, we find that an increase in the aggregate expenditure E increases sales; hence, revenue of all firms increases due toy loosening household budget constraints. Thus, cutoff productivity (φ_{Dmin} and φ_{EXmin}) decreases, as shown in Eqs. (10) and (11). Subsequently, their average sales, s_D and s_{EX} increase. In other words, an increase in E corresponding to the size of the economy or market increases firms' sales as a result of the reinforcement of intra-industry resource bias towards lower productivity.

Proposition 2. A change in exogenous variables related to FTA breadth (fixed labor input for FTA g*)/depth (tariffs* τ *and the number of export destinations* n*) directly and indirectly changes the average sales of operating firms through a change in intra-industry reallocation. However, as shown in Eqs. (13a) and (13b), a change in the status of the FTA may or may not increase the sales of domestic and export firm (*s_D *and* s_{EX}*), and the effect primarily depends on magnitude of the relationship among some conflicting forces as described above.*

Although our theoretical analysis reveals that the breadth/depth of an FTA affects the sales of local affiliates, most of the signs of the partial derivatives in our comparative statics are indeterminate. Thus, we empirically examine the effects of FTAs on the sales of local affiliates by FTA-type and discuss whether MNEs efficiently utilize different FTAs in their supply chain networks.

4. Empirical analysis

4.1 Empirical Models

In constructing supply chain networks, the overseas affiliates of Japanese manufacturing firms may consider three different FTAs: FTAs between Japan and the overseas affiliate's country, regional FTAs including the overseas affiliate's country, and FTAs between the overseas affiliate's country and large markets such as China, the EU, and the US. Our theoretical model presents the effects of variables related to FTA depth/breadth and firm productivity on sales. It reveals that the effects of FTAs on sales are not unique. Rather, the effects of FTAs on domestic and export sales differ by exogenous factors that trigger changes such as tariffs, the number of export destinations, fixed labor input for activities to follow the rules of FTAs, and market sizes. Based on these theoretical implications, we carefully examine whether FTAs affect the sales of overseas affiliates, considering the differences between the above FTA patterns and proxies for the factors that trigger changes. Many existing studies on the effects of FTAs discussed the effect of bilateral FTAs on trade with the home country. By contrast this study examines the effects of bilateral FTAs on local sales, since trade with Japan accounts for a small share of overseas affiliates' sales. Meanwhile, most of Japan's bilateral FTAs are not simple FTAs but Economic Partnership Agreements that widely support the local activities of overseas Japanese affiliates, and bilateral FTAs have positive effects on the local procurement of overseas affiliates in ASEAN countries (Hayakawa, 2020). Therefore, we examine whether bilateral FTAs help the local sales and local procurement of overseas affiliates. We also analyze whether regional FTAs or FTAs with large markets encourage overseas affiliates to export to other countries. We estimate the effects of FTAs measured by depths and breadths as proxies to trigger changes such as tariffs and unit factor inputs, respectively. In these regressions, we add the control variables for firm characteristics and market environment. We assume that firms determine their use of FTAs efficiently based on these conditions. We separately estimate the effects of bilateral FTAs on local sales and of regional FTAs on exports to identify the effects of FTAs on local sales and exports discussed in the theoretical model. The estimation models are as follows:

$$Local\ Sales_{it} = \beta_0 + \beta_1\ FTA_{jt} + \beta_2 lnMarkupu_{hit} + \beta_3 lnGDP_{lt} + \sum_{\sigma} \gamma_{\sigma} control_{it} + u_{it}, \qquad (14)$$

$$Export\ to\ the\ 3rd\ Country_{it} = \theta_0 + \theta_1\ FTA_{lt} + \theta_2 lnMarkup_{hit} + \theta_3 lnGDP_{lt} + \sum_{\rho} \delta_{\rho} conntrol_{it} + \nu_{it}\ , (15)$$

where FTA in Eq. (14) represents a bilateral FTA between Japan and local governments, whereas the FTA in Eq. (15) shows the regional FTA/FTA between local governments and large economies such as the ASEAN, China, the EU, and the US. Subscripts h, i, l, and t denote the parent firm, individual overseas affiliates, local market, and year, respectively. Markup is the estimated markup level of parent firms and level of product differentiation. GDP is a proxy for local market size. The set of control variables consists of productivity, age, a subsidiary dummy, firm size, a dummy for finished goods of overseas affiliates, and the human capital levels of the local markets. Eqs. (14) and (15) are estimated using Santos and Teneryo's (2006) Poisson pseudo-maximum likelihood method due to the heteroscedastic error terms and the existence of zeros in the dependent variable in our estimation models.

Regarding the coefficients for the explanatory variables, our theoretical model assumes that the effects of FTAs on local sales are ambiguous in terms of tariffs (depth) or fixed labor inputs (breadth). Regional FTAs are expected to positively affect exports to other countries through an increase in the number of countries (depth) or fixed labor inputs (breadth). The FTAs with large markets are not expected to have any effect in terms of tariffs but are expected to have a positive effect in terms of fixed labor inputs. The parent firm's markup is positive for local sales but might be negative for exports to other countries because the conditions of market competition might differ between the local and export markets. Overseas affiliates can have profit margins by relying on the differentiated products of parent firms, while they may encounter greater price competition in export markets. The size of the local market is positive for sales but negative for exports to other countries because firms cannot justify exploring markets in other countries if the local markets are sufficiently large. Labor productivity and firm size of overseas affiliates are expected to be positive for both local sales and exports to other countries. The quality of local human capital and technology level of local economies are also expected to be positive.

4.2 Data

FTA data are available from the WTO. We construct the depth and breadth data of both bilateral and regional FTAs following Jinji et al. (2022) and Murakami (2023). We estimate parent firms' markup data using firm-level data from the Basic Survey of Japanese Business Structure and Activities[9]. We integrate these data into the panel data of Japanese overseas affiliates obtained from the Basic Survey on Overseas Business Activities. Both surveys are compiled by METI. We cover the 2009-2017 period. We deflate the sales of overseas affiliates using Japan's export deflators because they are recorded in terms of JPY, and the parent firm possibly plans its business, covering

[9] We estimate firm-level markups following Loecker (2013).

all supply chain processes. The deflators are available from the Bank of Japan[10]. Real GDP data, as a proxy for the size of local markets, are taken from the United Nations Conference on Trade and Development (UNCTAD)[11]. The levels of human capital in the local markets can be obtained from the Penn World Tables[12].

4.3 Empirical Results

Descriptive Statistics

Table 1 presents the performance of firms by sector and region. The regions in which the parent firms have the highest markups vary across sectors. Parent firms in the light and machinery manufacturing sectors have higher markups in countries that have bilateral FTAs with Japan. Parent firms under the heavy manufacturing sector shows a higher markup in neighboring countries. Parent firms under the transportation and miscellaneous manufacturing sectors have a higher markup in EU member states. The results indicate that parent firms' roles in supply chain networks differ by region and sector. The results also show that Japanese manufacturing firms face greater competition in the US market.

In terms of sales and profits, NAFTA (the US) is the most important market for overseas affiliates of Japanese manufacturing firms; although, Asia has the largest number of overseas affiliates. The share of the Japanese market in total sales is relatively higher for overseas affiliates in neighboring countries and ASEAN countries, whereas the share of the local market is higher in NAFTA countries. In the EU, the share of other countries is higher. These results indicate that Japanese manufacturing MNEs form supply chain networks based on regional advantages. In Asian networks, Japan continues to play an important role in supply chains because of its geographical proximity. Regional cross-border networks are developed in the EU because transportation costs between member states are low. Meanwhile, many overseas affiliates of the Japanese firms in NAFTA seem to directly explore the US market instead of shipping from Canada and Mexico. Lastly, the Japanese market is relatively important for overseas affiliates in countries that have bilateral FTA with Japan and are operating in the light, heavy, and machinery industries; although, not for those operating in the transportation industry.

[10] http://www.boj.or.jp/en/statistics/index.htm/
[11] Statistics | UNCTAD
[12] PWT 10.01 | Penn World Table | Groningen Growth and Development Centre | University of Groningen (rug.nl)

Table 1 Performance of firms by the sector and region

Location	Industry	markup	Sales	Profit	Japan	Local	Third
Neibours	**Light**	2.799	3922.55	283.26	0.407	0.652	0.135
AEAN	**Light**	2.772	4600.06	296.97	**0.412**	0.540	0.254
NAFTA	**Light**	2.559	15461.38	**398.80**	0.155	**0.796**	0.133
EU	**Light**	2.678	**16101.25**	295.26	0.119	0.560	**0.450**
Bilateral FTA	**Light**	**2.857**	6707.53	125.23	0.342	0.684	0.177
Neibours	**Heavy**	**1.575**	5415.76	256.06	0.240	0.753	0.160
AEAN	**Heavy**	1.570	6840.37	262.84	0.208	0.700	0.287
NAFTA	**Heavy**	1.456	**11910.56**	**1061.33**	0.172	**0.767**	0.157
EU	**Heavy**	1.316	10944.14	635.22	0.104	0.549	**0.470**
Bilateral FTA	**Heavy**	1.548	7151.51	637.89	**0.293**	0.697	0.228
Neibours	**Machinery**	2.271	9111.60	390.77	0.331	0.621	0.212
AEAN	**Machinery**	2.227	7958.15	360.81	**0.336**	0.581	0.282
NAFTA	**Machinery**	2.500	**16924.51**	**425.58**	0.123	0.807	0.175
EU	**Machinery**	2.516	14749.07	345.95	0.095	0.657	**0.344**
Bilateral FTA	**Machinery**	**2.630**	8911.18	381.73	0.089	**0.871**	0.124
Neibours	**Transport**	2.535	23408.52	1840.08	**0.218**	0.773	0.141
AEAN	**Transport**	2.474	30605.13	1756.98	0.156	0.748	0.236
NAFTA	**Transport**	2.578	**83013.41**	**1996.65**	0.077	0.843	0.189
EU	**Transport**	**2.611**	43215.42	407.20	0.086	0.542	**0.459**
Bilateral FTA	**Transport**	2.569	43879.86	1399.01	0.050	**0.877**	0.183
Neibours	**Miscellaneous**	1.978	2367.78	168.52	0.318	0.671	0.201
AEAN	**Miscellaneous**	1.978	2310.74	147.60	**0.379**	0.623	0.222
NAFTA	**Miscellaneous**	2.227	**6205.51**	**334.79**	0.069	0.853	0.192
EU	**Miscellaneous**	**2.257**	4015.51	153.11	0.055	0.677	**0.376**
Bilateral FTA	**Miscellaneous**	2.238	1751.66	117.98	0.193	**0.903**	0.151

Estimation Results and Discussion

Table 2 presents the estimation results for the effects of the FTAs on the activities of overseas affiliates of Japanese manufacturing firms. The results show that the coefficients for bilateral FTAs on local sales are statistically insignificant for both WTO depth and breadth. These results are consistent with our theoretical implication that the effects of both the WTO depth and breadth are ambiguous. However, regional FTAs have statistically significant positive coefficients on exports to other countries. The positive coefficients for FTA breadth indicate that an increase in the fixed labor input by regional FTAs increases the sales of export firms. As expected, a decrease in tariff rates and an increase in the number of FTA partners encourage exports; although, our model does not clarify whether these triggers have positive effects on export firms' sales. This implies that regional FTAs encourage overseas affiliates to expand their supply chains across the national borders of FTA member countries. The effects of FTAs with large markets also provide insights into the effects of different triggers. Bilateral FTAs with ASEAN, China, and the EU have statistically significant positive coefficients for FTA depth. These positive estimates may capture the positive effects of tariff reductions, increase in the number of trade partners, and access to large markets. Unlike in ASEAN and the EU, access to China does not directly imply an increase in the number of FTA partners. However, we might consider this an expansion of export destinations because China is linked to many other countries as the center of supply chains for Japanese overseas affiliates.

Table 2 Main Estimation Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Local Sales		Export to Other Countries			
VARIABLES	Depth	Width	Depth	Width	Depth	Width
Bilateral FTA	0.153	0.213				
	(0.137)	(0.189)				
Regional FTA			0.294**	0.408**	0.513***	0.623***
			(0.125)	(0.159)	(0.148)	(0.172)
FTA with ASEAN					1.870**	-3.451**
					(0.729)	(1.437)
FTA with China					1.289***	3.541***
					(0.488)	(0.647)
FTA with EU					0.883***	0.742**
					(0.315)	(0.375)
FTA with the US					-0.144	0.210
					(0.492)	(0.491)
Markup	0.0349***	0.0349***	-0.0996***	-0.0997***	-0.0995***	-0.0969***
	(0.00920)	(0.00920)	(0.0263)	(0.0263)	(0.0263)	(0.0258)
GDP	0.122***	0.121***	-0.193***	-0.195***	-0.188***	-0.164***
	(0.0150)	(0.0141)	(0.0217)	(0.0219)	(0.0283)	(0.0241)
Firm Age	0.163***	0.163***	0.0487	0.0495	0.0621	0.0624
	(0.0258)	(0.0259)	(0.0541)	(0.0542)	(0.0545)	(0.0547)
Productivity	0.804***	0.803***	0.840***	0.840***	0.834***	0.830***
	(0.0190)	(0.0191)	(0.0481)	(0.0481)	(0.0477)	(0.0470)
!st Subsidiary	0.00736	0.00715	-0.459***	-0.458***	-0.473***	-0.458***
	(0.0351)	(0.0351)	(0.0776)	(0.0777)	(0.0752)	(0.0765)
Firm Size	0.843***	0.843***	0.981***	0.981***	0.983***	0.990***
	(0.0125)	(0.0125)	(0.0247)	(0.0247)	(0.0249)	(0.0251)
Finished Goods	0.313***	0.313***	0.543***	0.542***	0.549***	0.555***
	(0.0332)	(0.0332)	(0.0864)	(0.0865)	(0.0857)	(0.0849)
Human Capital	-0.000881	-0.000842	0.322***	0.310***	0.385***	0.180*
	(0.0319)	(0.0320)	(0.102)	(0.102)	(0.110)	(0.109)
Constant	-11.03***	-11.00***	-8.898***	-8.835***	-9.307***	-8.897***
	(0.376)	(0.361)	(0.690)	(0.694)	(0.701)	(0.683)
Observations	44,063	44,063	33,912	33,912	33,912	33,912
R-squared	0.560	0.559	0.452	0.451	0.452	0.459
Robust standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

The estimates of FTA breadth is statistically significantly positive for bilateral FTAs with China and the EU but statistically significantly negative for that with ASEAN countries. This might reflect differences in the components of FTAs and their roles in supply chain networks. China and the EU are considered the regional centers of the supply chain networks of Japanese overseas manufacturing affiliates. Therefore, a greater cooperation with them have positive effects on exports to those large markets. Although the ASEAN region seemingly plays an important role in supply chain networks, it is not at the center of the network during the data period. Thus, an increase in fixed labor input may negatively impact exports to ASEAN countries.

Unlike for the FTAs with ASEAN, China, and the EU, estimates for the bilateral FTAs with the US are not statistically significant. This indicates that unlike the NAFTA, bilateral FTAs with the US do not encourage overseas affiliates to explore the US market from an outside location. This is consistent with the fact that the US government has pressed Japanese manufacturers, such as automobile makers, to increase FDI rather than exports into the US.

Moreover, the estimation results for the other variables provide various insights. The coefficients for the parent firm's markup are statistically significant in both local sales and exports to other countries, but the signs are contradictory. This implies that while overseas affiliates face severe price competition in other countries' markets, they have an advantage in local sales if parent firms are more differentiated. The levels of human capital in the local market are statistically insignificant for local sales and statistically significantly positive for exports to other countries. This also indicates that overseas affiliates face greater competition in other countries' markets, while the higher markup of parent firms provides advantages to their local sales. As expected, local sales increase and exports to other countries decrease if the local market is large. For example, overseas affiliates in the US usually focus on the US market. Firm age has a statistically significant positive coefficient for local sales, while it is statistically insignificant for exports to other countries. Thus, the experience of overseas affiliates helps them further explore local markets but does not always increase sales in other markets. Their experience in the local market does not always help them increase sales in other markets because the markets differ. The first subsidiary dummy is statistically insignificant in the local sales model, whereas it is significantly negative for that of exports to other countries. This might explain why the first subsidiaries explore the local market or export finished products to Japan and explore another market at different stages of supply chain construction. As expected, the labor productivity of overseas affiliates and firm size are both statistically significantly positive. The dummy for finished goods is also statistically significantly positive in all the regressions. This indicates that intra-firm supply chains are not always long, and overseas affiliates mainly provide finished goods for each intra-firm supply chain.

This is consistent with the results of our recent interview surveys of overseas affiliates of Japanese manufacturing firms in Vietnam and Thailand.

We also estimate the same models with a one-year lag for the explanatory variables to confirm the robustness of our results. As Table 3 illustrates, the estimation results are similar. The result for FTA with the EU, measured as the FTA-breadth, is statistically insignificant, unlike in the previous estimation. The results for all other FTA variables are the same. Our empirical analysis reveals that different types of FTAs have different effects on the sales of overseas Japanese manufacturing affiliates. This implies that Japanese MNEs effectively utilize various FTAs to develop their supply chains, depending on local conditions. This also seemingly supports the implications of our theoretical model.

Our findings have several policy implications. Our results show that Japanese manufacturing MNEs reconstruct their supply chain networks following changes in local or regional conditions such as Brexit, decoupling between China and the US, and signings of large regional FTAs such as the CP-TPP and RCEP. Since the early 2010s, many researchers have discussed the multi-polarization of supply chain networks in Asia. This discussion has intensified as the decoupling between China and the US States escalated. However, in practice, decoupling is hard because China has already become the center of the regional supply chains for Japanese manufacturing MNEs. Although the ASEAN region is important in the networks, our empirical results imply that the roles of the ASEAN region and China in supply chains differ.

Table 3 Estimation Results using the 1st Difference (Robustness Checks)

	(7)	(8)	(9)	(10)	(11)	(12)
	Local Sales		Export to Other Countries			
VARIABLES	Depth	Width	Depth	Width	Depth	Width
Bilateral FTA	0.141	0.152				
	(0.153)	(0.211)				
Regional FTA			0.449***	0.582***	0.831***	0.732***
			(0.129)	(0.165)	(0.143)	(0.170)
FTA with ASEAN					2.102**	-3.857**
					(0.880)	(1.565)
FTA with China					2.182***	4.782***
					(0.543)	(0.781)
FTA with EU					0.863**	0.442
					(0.348)	(0.392)
FTA with the US					0.299	0.217
					(0.493)	(0.493)
Markup	0.0337***	0.0336***	-0.101***	-0.101***	-0.0991***	-0.0963***
	(0.00945)	(0.00945)	(0.0295)	(0.0295)	(0.0292)	(0.0286)
GDP	0.137***	0.134***	-0.165***	-0.169***	-0.134***	-0.133***
	(0.0169)	(0.0160)	(0.0225)	(0.0228)	(0.0271)	(0.0241)
Firm Age	0.225***	0.225***	0.0134	0.0137	0.0154	0.0195
	(0.0335)	(0.0336)	(0.0554)	(0.0554)	(0.0553)	(0.0553)
Productivity	0.706***	0.705***	0.719***	0.719***	0.712***	0.701***
	(0.0227)	(0.0227)	(0.0442)	(0.0442)	(0.0448)	(0.0436)
!st Subsidiary	-0.00140	-0.00165	-0.495***	-0.494***	-0.509***	-0.492***
	(0.0392)	(0.0391)	(0.0857)	(0.0856)	(0.0830)	(0.0842)
Firm Size	0.821***	0.821***	0.949***	0.949***	0.954***	0.964***
	(0.0133)	(0.0133)	(0.0281)	(0.0281)	(0.0281)	(0.0285)
Finished Goods	0.388***	0.388***	0.572***	0.571***	0.581***	0.583***
	(0.0399)	(0.0400)	(0.0981)	(0.0981)	(0.0973)	(0.0965)
Human Capital	0.0223	0.0223	0.169***	0.167***	0.193***	0.0878
	(0.0271)	(0.0271)	(0.0634)	(0.0634)	(0.0654)	(0.0628)
Constant	-9.946***	-9.894***	-6.713***	-6.646***	-7.451***	-6.854***
	(0.458)	(0.442)	(0.786)	(0.794)	(0.787)	(0.792)
Observations	33,984	33,984	25,741	25,741	25,741	25,741
R-squared	0.531	0.530	0.408	0.408	0.414	0.420

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This study examines the effects of FTAs on the supply chain networks of MNEs using data of overseas Japanese manufacturing affiliates. Our theoretical model shows that the effects of FTAs on sales are not always unilaterally determined because most of the signs of the partial derivatives of the FTA status variables are ambiguous. Therefore, we examine the effects of FTAs by type. Our estimation results imply that Japanese MNEs effectively utilize different FTAs in their supply chain networks. Different from existing studies, this study does not focus on the effects of the FTA on exports to Japan because the share of Japan is smaller than that of local and other countries' markets. Instead, we investigate whether overseas affiliates effectively utilize FTAs spearheaded by local governments for the development of their supply chain networks. In other words, our study explicitly discusses the effects of FTAs on supply chain networks beyond the hub-spoke system between parent firms and overseas affiliates.

Our findings highlight the need to examine the supply chain networks of MNEs based on multi-tiered systems. With major changes in geopolitical circumstances, such as decoupling between China and the US, MNEs must use various FTA schemes effectively to reconstruct their supply chain networks and reshore their production processes. This study offers important implications for industrial policies designed by governments to attract foreign firms and encourage domestic firms to explore the global market amid the anti-globalization.

Appendix: Derivations

Using Eqs. (4), (5), (7), (9), and $\chi = (\varphi_{Dmin}/\varphi_{EXmin})^k$, we derive the aggregate revenue R:

$$R = \int_{\varphi_{Dmin}}^{\infty} r_D(\varphi) M_D \frac{g(\varphi)}{1 - G(\varphi_{Dmin})} d\varphi + n \int_{\varphi_{EXmin}}^{\infty} r_{EX}(\varphi) M_{EX} \frac{g(\varphi)}{1 - G(\varphi_{EXmin})} d\varphi$$

$$= M_D \left\{ \int_{\varphi_{Dmin}}^{\infty} \left(\frac{\varphi}{\tilde{\varphi}_D}\right)^{\sigma-1} r_D(\tilde{\varphi}_D) k {\varphi_{Dmin}}^k \varphi^{-1-k} d\varphi \right.$$

$$\left. + n \int_{\varphi_{EXmin}}^{\infty} \left(\frac{\varphi}{\tilde{\varphi}_{EX}}\right)^{\sigma-1} r_{EX}(\tilde{\varphi}_{EX}) \chi k {\varphi_{EXmin}}^k \varphi^{-1-k} d\varphi \right\} = M_D\big(r_D(\tilde{\varphi}_D) + n\chi r_{EX}(\tilde{\varphi}_{EX})\big)$$

$$= {\varphi_{Dmin}}^{-k} \frac{k\sigma}{1 + k - \sigma} \left(\frac{f}{\varphi_{Dmin}} + n\chi \frac{g}{\varphi_{EXmin}}\right) = {\varphi_{Dmin}}^{-k-1} \frac{k\sigma}{1 + k - \sigma} \left(f + ng\chi^{\frac{1+k}{k}}\right).$$

Since aggregate expenditure is equal to aggregate revenue, we have

$$E = R = {\varphi_{Dmin}}^{-k-1} \frac{k\sigma}{1 + k - \sigma} \left(f + ng\chi^{\frac{1+k}{k}}\right).$$

Solving this equation for φ_{Dmin}, we obtain the solution of domestic-cutoff productivity:

$$\varphi_{Dmin} = \left(\frac{k\sigma}{1+k-\sigma}\frac{1}{E}\right)^{\frac{1}{1+k}}\left(f + ng\chi^{\frac{1+k}{k}}\right)^{\frac{1}{1+k}}. \tag{10}$$

Differentiating Eq. (10) with respect to g, τ, n, and E, we derive

$$\frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial g} = \underbrace{\frac{ng\chi^{\frac{1+k}{k}}}{f + ng\chi^{\frac{1+k}{k}}}\frac{1}{1+k}}_{+}\underbrace{\left(\underbrace{\frac{1}{g}}_{+} + \underbrace{\frac{1+k}{k\chi}\frac{\partial\chi}{\partial g}}_{-}\right)}_{-} < 0, \quad \frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial\tau} = \frac{ng\chi^{\frac{1+k}{k}}}{f + ng\chi^{\frac{1+k}{k}}}\frac{1}{k\chi}\frac{\partial\chi}{\partial\tau} < 0,$$

$$\frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial n} = \frac{ng\chi^{\frac{1+k}{k}}}{f + ng\chi^{\frac{1+k}{k}}}\frac{1}{1+k}\frac{1}{n} > 0, \quad \frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial E} = -\frac{1+k-\sigma}{k\sigma}\frac{1}{1+k}\frac{1}{E} < 0.$$

Similarly, from Eq. (11), we have

$$\frac{1}{\varphi_{EXmin}}\frac{\partial\varphi_{EXmin}}{\partial g} = \underbrace{-\underbrace{\frac{1}{k\chi}\frac{\partial\chi}{\partial g}}_{+} + \underbrace{\frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial g}}_{-}}_{+} > 0, \quad \frac{1}{\varphi_{EXmin}}\frac{\partial\varphi_{EXmin}}{\partial\tau} = \underbrace{-\underbrace{\frac{1}{k\chi}\frac{\partial\chi}{\partial\tau}}_{+} + \underbrace{\frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial\tau}}_{-}}_{+} > 0,$$

$$\frac{1}{\varphi_{EXmin}}\frac{\partial\varphi_{EXmin}}{\partial n} = \frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial n} > 0, \quad \frac{1}{\varphi_{EXmin}}\frac{\partial\varphi_{EXmin}}{\partial E} = \frac{1}{\varphi_{Dmin}}\frac{\partial\varphi_{Dmin}}{\partial E} < 0.$$

Next, using Eqs. (4), (5), (7), and $r_D(\varphi) = \tau^{\sigma-1}r_{EX}(\varphi)$, we derive the average sales:

$$\begin{aligned} s_D &= \frac{1}{M_D - M_{EX}}\int_{\varphi_{Dmin}}^{\varphi_{EXmin}} r_D(\varphi)M_D\frac{g(\varphi)}{1 - G(\varphi_{Dmin})}d\varphi \\ &= \frac{1}{1-\chi}\left(\int_{\varphi_{Dmin}}^{\infty} r_D(\varphi)\frac{g(\varphi)}{1 - G(\varphi_{Dmin})}d\varphi - \int_{\varphi_{EXmin}}^{\infty}\tau^{\sigma-1}r_{EX}(\varphi)\chi\frac{g(\varphi)}{1 - G(\varphi_{EXmin})}d\varphi\right) \\ &= \frac{1}{1-\chi}\left(r_D(\tilde{\varphi}_D) - \tau^{\sigma-1}\chi r_{EX}(\tilde{\varphi}_{EX})\right) \\ &= \frac{k\sigma}{1+k-\sigma}\left(f - \tau^{\sigma-1}g\chi^{\frac{1+k}{k}}\right)\frac{1}{\varphi_{Dmin}}\frac{1}{1-\chi}. \end{aligned} \tag{12a}$$

$$\begin{aligned} s_{EX} &= \frac{1}{M_{EX}}\left(\int_{\varphi_{EXmin}}^{\infty} r_D(\varphi)M_{EX}\frac{g(\varphi)}{1 - G(\varphi_{EXmin})}d\varphi + n\int_{\varphi_{EXmin}}^{\infty} r_{EX}(\varphi)M_{EX}\frac{g(\varphi)}{1 - G(\varphi_{EXmin})}d\varphi\right) \\ &= (\tau^{\sigma-1} + n)r_{EX}(\tilde{\varphi}_{EX}) \\ &= \frac{k\sigma}{1+k-\sigma}(\tau^{\sigma-1} + n)g\frac{1}{\varphi_{EXmin}}. \end{aligned} \tag{12b}$$

References

Berman, N., Martin, P., and Mayer, T. (2012). How do Different Exporters React to Exchange Rate Changes? The Quarterly Journal of Economics. 127(1), 437–492.

Demidova, S. and Krishna, K. (2008). Firm Heterogeneity and Firm Behavior with Conditional Policies. Economics Letters, 98(2), 122-128.

Hart, O. D. (1982). A Model of Imperfect Competition with Keynesian Features. The Quarterly Journal of Economics, 97(1), 109–138.

Hayakawa, K. (2020). Production Networks and Utilization of Free Trade Agreements by Japanese Subsidiaries in ASEAN. Public Policy Review, Research Institute, Ministry of Finance Japan, 16(1), 121-134.

Helpman, E., Melitz, M. J., and Yeaple, S. R. (2004). Export Versus FDI with Heterogeneous Firms. American Economic Review, 94(1), 300-316.

Jafari,. Y. and Britz, W. (2018). Modelling Heterogeneous Firms and Non-Tariff Measures in Free Trade Agreements using Computable General Equilibrium. Economic Modelling, 73, 279-294.

Jinji, N., Zhang, X., and Haruna, S. (2022). Deep Integration, Global Firms, and Technology Spillovers. Springer. Open Access.

Melitz, M. J. (2003). The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity. Econometrica, 71(6), 1695–1725.

Murakami, Y. (2025). Do Deep Regional Trade Agreements Facilitate Regional Production Networks in Latin American and Caribbean Countries. Review of World Economics. Online Publication.

Neri-Laine, M., Orefice, G., and Ruta, M. (2023). Deep Trade Agreements and Heterogeneous Firm Exports. World Bank Policy Research Paper, 10277.

Nishiyama, H. (2017). The Effect of Exchange Rate Fluctuation on Intra-industry Reallocation in a Firm Heterogeneity Model with Trade and Foreign Direct Investment. The Quarterly Review of Economics and Finance, 64, 32–43.

Urata, S. and Kato, A. (2017). The Impact of FTAs on Procurement Behavior of Japanese Firms' overseas Affiliates. RIETI Discussion Paper, 17-E-113.