

Multinational M&A in Upstream Industry and Organizational Change*

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Abstract

This study explores the boundary response of domestic firms faced with increased openness to new foreign multinational M&A in an intermediate-input market in a host country. We develop a theoretical framework to study the impact of new foreign multinational M&A on the wholesale price of intermediate inputs as a key market condition in the host country and explore how the intermediate-input prices affect the organizational choice of domestic firms between domestic vertical integration and outsourcing. We find that new foreign multinational M&A raises the intermediate-input prices and facilitates the firms' choice of domestic vertical integration.

1 Introduction

The expansion of multinational production and intra-firm transactions over recent decades has shed light on the organizational choices that emphasize methods to obtain intermediate inputs as a subject of economics research.¹ This study, hence, captures this rising trend of intra-firm trade and its corresponding impact on organizational choice.

One recent paper, Antràs and Helpman (2004), captures the current observed pattern of organizational forms, including outward FDI and cross-border transaction of intermediate inputs through intrafirm imports. The locations and methods of obtaining intermediate inputs have become central decisions concerning a firm's boundary in recent trade literature in this field. In the literature, a firm (final-good producer) must make two choices with respect to intermediate inputs: (i) whether to trade intermediate inputs through arm's-length transactions or integrate with suppliers (intermediate-input suppliers) and produce on their own, and (ii) whether to rely on a domestic or foreign country supplier for intermediate inputs. These two decisions offer four organizational choices for firms based on heterogeneous productivity across firms: domestic outsourcing, domestic vertical integration, foreign outsourcing, and foreign vertical integration (outward FDI; multinational entry into a foreign intermediate-input market). Antràs and Helpman (2004) find that foreign vertical integration is preferable to other organizational forms when foreign vertical integration with suppliers in a host country provides an efficient production chain from a cheaper wage rate in the host country and higher firm productivity, which covers the higher fixed costs associated with establishing a subsidiary in the foreign country.

Based on these organizational form concepts, this study captures the recent trend of increasing multinational

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production and intra-firm imports. We analyze the boundary response of domestic firms in a host country when the domestic upstream industry faces increased openness to new foreign multinational entry. Particularly, we focus on local firms' organizational choice between domestic outsourcing and domestic vertical integration when more foreign multinational firms choose foreign vertical integration with local suppliers in the host country.

Based on the concept of four organizational forms and within-sectoral heterogeneous firms, this study introduces an intermediate-input market from which outsourcing firms purchase their intermediate inputs. We focus on a two-country setup where both firms and suppliers exist in both countries and show that intermediate-input prices rise in a host country when more foreign firms choose foreign vertical integration with the suppliers in a host country.

If a firm chooses vertical integration, this withdraws an integrated intermediate-input supplier from the local intermediate-input market. This decreases the competition in an intermediate-input market, and increases the market power of the remaining suppliers in the market and the intermediate-input price for outsourcing firms that purchase intermediate inputs from the market. In this setup, when more foreign firms choose to vertically integrate with an intermediate-input supplier in a host country, the withdrawal of integrated suppliers from the intermediate-input market increases intermediate-input prices in the host country, and the marginal cost of final-good production increases under outsourcing. Drawing on this logic for rising intermediate-input prices in a host country, we show that increased openness to new foreign multinational entry in an intermediate-input market increases intermediate-input prices and facilitates domestic vertical integration in the host country. Although there are two more channels that affect domestic organizational choices—competition through the change in aggregate production (consumption) and profit compensation to integrated suppliers paid by vertically integrated firms—the price effect is predominant.

Our motivation for this research is related to a recent study that emphasizes the impact of output price on the decision to vertically integrate. Conconi, Legros, and Newman (2012) find that free trade and suppliers' mobility between two countries changes vertical organizational structure. Their key determinants of vertical organizational structure are the price of output and terms of trade. Focusing on the output price as a key determinant, Alfaro, Conconi, Fadinger, and Newman (2016) show that the more integrated the firm, the lower the unit cost of production. Vertical integration is facilitated more when the price is sufficiently high to cover the higher fixed cost of integration with more subsidiaries. The main difference of this study is to focus on the impact of price change in intermediate-input market in the host country by new foreign multinational M&A.

The remainder of this study is organized as follows. Section 2 introduces the model and Section 3 characterizes the equilibrium. Section 4 provides comparative statics using simulation analysis. Section 5 provides some concluding remarks. Finally, Appendix A shows the derivation of equilibrium outcomes.

2 Model

This section sets up the model. Subsection 2.1 first characterizes consumers. Subsection 2.2 then characterizes producers, and subsection 2.3 introduces the timing of the game.

2.1 Consumers

Assume a world with two countries: country H and country F . Each country has $J \in \mathbb{N}_+$ sectors and is populated by a unit measure of consumers. Following Antràs and Helpman (2004), consumers in country $l \in \{H, F\}$ have identical preferences represented by

$$U_l = y_{l0} + \frac{1}{\mu} \sum_{j=1}^J Y_{lj}^\mu, 0 < \mu < 1, \quad (1)$$

where y_{l0} is the consumption of a homogeneous good in country l , Y_{lj} is an index of aggregate consumption in country l 's sector $j \in \{1, 2, \dots, J\}$, and $\mu \in (0, 1)$ is the share of spending that a consumer devotes to products from sector j . Aggregate consumption in country l 's sector j is a CES function

$$Y_{lj} = \left[\int y_{lj}(i)^\alpha di \right]^{\frac{1}{\alpha}}, 0 < \alpha < 1, \quad (2)$$

of the consumption of different varieties $y_{lj}(i)$. Parameter α measures the degree of product differentiation within the sector; that is, as $\alpha \in (0, 1)$ becomes larger, the product is less differentiated. We assume that $\alpha > \mu$, so that varieties within a sector are more substitutable for each other than they are for y_{l0} or for varieties from a different sector. The elasticity of substitution between any two varieties in a given country l 's sector is given by $1/(1 - \alpha)$. We assume that the parameters μ and α are the same in every sector and country, which facilitates a focus on cross-sectoral differences in wage rates. Given these preferences, the inverse demand function of good i in country l 's sector j is given by

$$p_{lj}(i) = Y_{lj}^{\mu-\alpha} y_{lj}(i)^{\alpha-1}. \quad (3)$$

2.2 Producers

In each country and each sector, there are two markets associated with intermediate inputs and final goods. To focus on cross-sectoral differences in wage rates, we assume that the number of suppliers (intermediate-input suppliers) N_l and the number of firms (final-good producers) n_l are the same in every industry and every country; that is, $N_l = N$ and $n_l = n$ for each $l \in \{H, F\}$. All firms face a perfectly elastic supply of labor in each country. The wage rate in country l is denoted by c_l .² We assume that country F has a higher wage rate:

$$c_F > c_H. \quad (4)$$

Suppliers in country l are identical in terms of their productivity. The suppliers produce one unit of intermediate inputs by using one unit of labor in country l ; that is, the per unit production cost is c_l . We assume that suppliers produce homogeneous inputs and compete in quantity.³ This modeling strategy clarifies how a change in the number of suppliers affects the decision of organizational forms through changes in intermediate-input prices.⁴

In contrast to suppliers, firms are heterogeneous in terms of their productivity to produce final goods $\theta > 0$ in each country and each sector. For every sector and country, the productivity level of firms is drawn from a common distribution $G(\theta)$. In Section 4, we introduce the case where $G(\theta)$ is defined by a Pareto distribution. The firm with productivity θ produces θ units of final goods using one unit of intermediate inputs; specifically, the production technology given productivity θ is

$$y_{lj}(\theta) = \theta x_{lj}(\theta), \quad (5)$$

where $x_{lj}(\theta)$ is the quantity of intermediate inputs produced by the firm with productivity θ . As productivity θ increases, the firm demands a smaller amount of intermediate inputs to produce the same amount of final goods. The per unit production cost for firms is decreasing in θ .

2.3 Timing of game

The timing of the game is as follows (see also Figure 1). The game consists of four stages. In Stage 1, all firms observe their productivity level θ and decide whether to be active. If they decide to be inactive, they earn zero profits.⁵

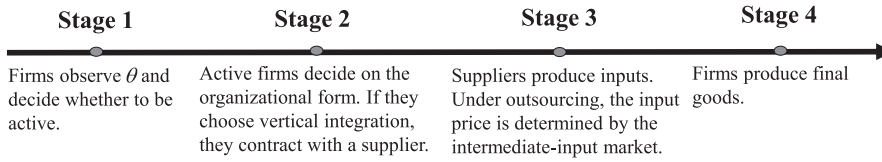


Figure 1: Timing of game

In Stage 2, active firms decide on their organizational form. The organizational form here takes one of four forms (see also Table 1). The first form is *domestic outsourcing*, DO , for which a firm purchases its intermediate inputs from the domestic intermediate-input market. The second form is *foreign outsourcing*, FO , for which a firm purchases its intermediate inputs from the foreign intermediate-input market. The third form is *domestic vertical integration*, DV , for which a firm vertically integrates with a domestic supplier. Finally, the fourth form is *foreign vertical integration*, FV , for which a firm vertically integrates with a foreign supplier.

Table 1: Characteristics of four organizational forms

Organizational form	Integration or outsourcing	Firms' location	Suppliers' location
DO	Outsourcing	l	l
FO	Outsourcing	l	m
DV	Integration	l	l
FV	Integration	l	m

Following Antràs and Helpman (2004), after the choice of organizational form, firms incur fixed organizational costs, which are denominated in terms of labor in a domestic country. That is, when the firm in country $l \in \{H, F\}$ chooses organizational form $k \in \{DO, DV, FO, FV\}$, it incurs $c_l f_{l|k} j$. To simplify the discussion, we call $f_{l|k} j$ organizational costs. We assume that organizational costs procuring intermediate inputs from the foreign country are higher than organizational costs procuring intermediate inputs from the domestic country. This assumption can be justified because the fixed costs of searching, monitoring, and communicating are significantly higher in a foreign country.⁶ We also assume that the organizational costs to vertically integrate with a domestic (foreign) supplier are higher than the costs associated with domestic (foreign) outsourcing because firms must invest in subsidiaries. Therefore, the organizational costs are ranked as follows: for each $l \in \{H, F\}$,

$$f_{l|DO} < f_{l|DV} < f_{l|FO} < f_{l|FV}. \quad (6)$$

In Stage 3, suppliers produce intermediate inputs. The determination of production levels depends on the organizational form. When the firm chooses vertical integration in Stage 2, the firm can induce the supplier to choose the production level of intermediate inputs to maximize their joint profits. In contrast, when the firm chooses outsourcing, it procures intermediate inputs in the intermediate-input market. In the intermediate-input market, suppliers engaging in outsourcing compete in quantity. The price of intermediate inputs in country l 's sector j is

denoted by w_{llj} .

In Stage 4, all firms start production of final goods. When the firm chooses domestic (foreign) vertical integration, it can directly procure the intermediate inputs from a supplier in country l (m). In contrast, when the firm in country l chooses domestic (foreign) outsourcing, it procures intermediate inputs from the intermediate-input market in country l (m). The number of suppliers (firms) engaging in outsourcing in country l 's sector j is denoted by N_{lO} (n_{lO}), and the number of vertically integrated suppliers (firms) in country l 's sector j is denoted by N_{lV} (n_{lV}). By definition, $N_l = N_{lO} + N_{lV}$ holds for each $l \in \{H, F\}$.⁷⁸ The profit of a firm engaging in $k \in \{DO, FO, DV, FV\}$ in country l is denoted by π_{lk} . The profit of an unintegrated (integrated) supplier in country l is denoted by Π_{lO} (Π_{lV}).

3 Equilibrium

In this section, we explore the organizational form decision given the number of vertically unintegrated suppliers N_{lO} and aggregate production (consumption) Y_{lj} . Because we now focus on a particular sector, we drop index j from all of the variables. Let θ_{lk} be the country l 's cutoff productivity, which is the lowest value of θ inducing the firm with productivity θ to choose organizational form $k \in \{DO, FO, DV, FV\}$. Although a number of equilibrium patterns may exist, we focus on the following equilibrium, which is most reasonable under condition (6):

$$\theta_{lDO} < \theta_{lDV} < \theta_{lFO} < \theta_{lFV}. \quad (7)$$

In the analysis below, we explore the existence of an equilibrium that satisfies conditions (6) and (7), simultaneously. Subsection 3.1 first introduces the characteristics of each organizational form. Subsection 3.2 then considers the existence of an equilibrium.

3.1 Four organizational forms

In this subsection, we introduce four organizational forms; domestic outsourcing, DO , foreign outsourcing, FO , domestic vertical integration, DV , and foreign vertical integration, FV . Appendix A provides the precise characterization of equilibria.

Domestic and foreign outsourcing

When a firm in country l chooses domestic (foreign) outsourcing, it procures intermediate inputs from the intermediate-input market in country l (m). Given intermediate-input prices w_l and w_m and the firm's productivity level, the firm engaging in domestic (foreign) outsourcing optimally chooses the amount of intermediate inputs to maximize $Y_l^{\mu-\alpha} \theta x^\alpha - w_l x - c_l f_{lDO}$ ($Y_l^{\mu-\alpha} \theta x^\alpha - w_m x - c_l f_{lFO}$) in Stage 4. By anticipating the behavior of firms, each supplier in country l (m)'s intermediate-input market optimally chooses its production level to maximize $w_l x - c_l x$ ($w_m x - c_m x$) in Stage 3.

By solving the above problems, equilibrium prices are characterized as follows. In the equilibrium, intermediate-input prices in country l (m) are

$$w_l(N_{lO}, c_l) = c_l \frac{N_{lO}}{N_{lO} - (1 - \alpha)} > c_l, \quad (8)$$

$$w_m(N_{mO}, c_m) = c_m \frac{N_{mO}}{N_{mO} - (1 - \alpha)} > c_m, \quad (9)$$

where $l, m \in \{H, F\}$ $l \neq m$ and where $w_{lDO} \rightarrow c_l$ and $w_{lFO} \rightarrow c_m$ as $N \rightarrow \infty$. Equations (8) and (9) imply that intermediate-input prices do not depend on μ, α , and Y_l , which are parameters of inverse demand. More importantly, the intermediate-input prices depend on the wage rate and the number of unintegrated suppliers in the country from which firms purchase intermediate inputs. Equations (8) and (9) imply an increasing wage rate and the intermediate-input price is strictly decreasing in the number of unintegrated suppliers and approaches a single margin case where suppliers sell intermediate inputs at their marginal costs. Therefore, like the standard Cournot model with linear demand and cost functions, as the number of suppliers increases, the intermediate-input market becomes competitive and approaches to the perfectly competitive market.

By contrast, the equilibrium prices of final goods produced by outsourcing firms in country l are given by

$$p_{lDO}(\theta, N_{lO}) = \frac{c_l}{\alpha\theta} \frac{N_{lO}}{N_{lO} - (1 - \alpha)}, \quad (10)$$

$$p_{lFO}(\theta, N_{mO}) = \frac{c_m}{\alpha\theta} \frac{N_{mO}}{N_{mO} - (1 - \alpha)}, \quad (11)$$

where $p_{lDO}(\theta, N) \rightarrow c_l/\alpha\theta$ and $(\theta, N) \rightarrow c_m/\alpha\theta$ as $N \rightarrow \infty$. Similar to intermediate-input prices, final-good prices also depend on the wage rate and the number of unintegrated suppliers in the country from which firms purchase intermediate inputs. In contrast to input prices, final goods produced by outsourcing firms depend on the firms' productivity, and they are decreasing in θ .

Firms' equilibrium profits are derived as follows. The profits of firms engaging in outsourcing are

$$\pi_{lDO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha\theta N_{lO} - (1-\alpha)}{c_l} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - c_l f_{lDO}, \quad (12)$$

$$\pi_{lFO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha\theta N_{mO} - (1-\alpha)}{c_m} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - c_l f_{lFO}. \quad (13)$$

Equations (12) and (13) imply that the profits of firms engaging in outsourcing are increasing in θ while the final-good price is decreasing in θ , which can be explained by the per unit production cost. From equation (5), the firm with productivity θ produces one unit of final goods by using $1/\theta$ unit of intermediate inputs; that is, per unit production cost under domestic (foreign) outsourcing is w_l/θ (w_m/θ). Thus, as the firm becomes efficient, the per unit production cost decreases, and the firm with higher productivity earns higher profits. By contrast, each unintegrated supplier in country l earns;

$$\Pi_{lO} = \varphi_l \left(\frac{\alpha}{N_{lO}} \right)^{\frac{1}{1-\alpha}} \left(\frac{N_{lO} - (1-\alpha)}{c_l} \right)^{\frac{\alpha}{1-\alpha}} \left[1 - \frac{N_{lO} - (1-\alpha)}{N_{lO}} \right], \quad (14)$$

where

$$\varphi_l = n_l Y_l^{\frac{\mu-\alpha}{1-\alpha}} \int_{\theta_{lDO}}^{\theta_{lDV}} \theta^{\frac{\alpha}{1-\alpha}} dG(\theta) + n_m Y_m^{\frac{\mu-\alpha}{1-\alpha}} \int_{\theta_{mFO}}^{\theta_{mFV}} \theta^{\frac{\alpha}{1-\alpha}} dG(\theta). \quad (15)$$

Equation (15) can be interpreted as the scale parameter of intermediate-input demand. The intermediate-input demand is positively related to the number of firms in both countries and the cutoff productivities for vertical integration in both countries while it is negatively related to the cutoff productivities for outsourcing in both countries. Moreover, equation (14) shows that $\Pi_{lO} \rightarrow 0$ as $N_{lO} \rightarrow \infty$. Hence, like the standard Cournot model, the intermediate-input market approaches to the perfectly competitive market for the infinite number of suppliers in country l .

By comparing equations (12) and (13), the following lemma is derived.

Lemma 1. For $f_{lDO} = f_{lFO}$, $\pi_{lDO}(\theta) \lessgtr \pi_{lFO}(\theta)$ if and only if

$$\frac{c_l N_{lO}}{N_{lO} - (1 - \alpha)} \geq \frac{c_m N_{mO}}{N_{mO} - (1 - \alpha)}. \quad (16)$$

Proof. Assume that $f_{lDO} = f_{lFO}$. From equations (12) and (13), we have

$$\pi_{lDO}(\theta) - \pi_{lFO}(\theta) = (1 - \alpha)(\alpha\theta)^{\frac{\alpha}{1-\alpha}} Y_l^{\frac{\mu-\rho}{1-\rho}} \left[\left(\frac{N_{lO} - (1 - \alpha)}{c_l N_{lO}} \right)^{\frac{\alpha}{1-\alpha}} - \left(\frac{N_{mO} - (1 - \alpha)}{c_m N_{mO}} \right)^{\frac{\alpha}{1-\alpha}} \right]. \quad (17)$$

Therefore, we have the relationship in the statement of Lemma 1. $\square$

Lemma 1 implies that all firms in country H prefer domestic outsourcing to foreign outsourcing if the number of unintegrated suppliers in country F is smaller than the number of unintegrated suppliers in country H . Moreover, Lemma 1 implies that the firm with a sufficiently large productivity level is more likely to choose outsourcing from the country with a lower wage rate; specifically, the firms with higher productivity are more likely to choose domestic (foreign) outsourcing in country H (F) under $c_F > c_H$.

Domestic and foreign vertical integration

When a firm in country l decides to engage in domestic (foreign) vertical integration, it can maximize the joint profit with a supplier in country l (m), which is denoted by $Y_l^{\mu-\alpha} \theta x^\alpha - c_l x - c_l f_{lk}$ ($Y_l^{\mu-\alpha} \theta x^\alpha - c_m x - c_l f_{lk}$). The equilibrium prices of final goods produced by vertically integrated firms in country l are given by

$$p_{lDV}(\theta) = \frac{c_l}{\theta\alpha} < p_{lDO}(\theta), \quad (18)$$

$$p_{lFV}(\theta) = \frac{c_m}{\theta\alpha} < p_{lFO}(\theta). \quad (19)$$

From equations (8), (9), (10), (11), (18), and (19) the properties of final-good prices are summarized as follows. First, for each country l , the price of final goods under domestic (foreign) vertical integration is lower than that of final goods under domestic (foreign) outsourcing. Second, these prices coincide if the intermediate input under outsourcing is supplied with zero margin $w_l = c_l$ ($w_m = c_m$) or, equivalently, there is an infinite number of suppliers. The difference in final-good prices arises because of the double marginalization problem; under outsourcing negative external effects exist. Raising the intermediate-input price decreases the firm profits, and increasing the final-good price decreases supplier profits.

In a vertical integration contract, the firm compensates the supplier for the profits that the supplier would gain if it operated in an outsourcing market. Therefore, in the equilibrium, the vertically integrated supplier earns

$$\Pi_{lV} = \Pi_{lO}. \quad (20)$$

The profits of vertically integrated firms are

$$\pi_{lDV}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\theta\alpha}{c_l} \right)^{\frac{\alpha}{1-\alpha}} (1 - \alpha) - \Pi_{lO} - c_l f_{lDV}, \quad (21)$$

$$\pi_{lFV}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\theta\alpha}{c_m} \right)^{\frac{\alpha}{1-\alpha}} (1 - \alpha) - \Pi_{mO} - c_l f_{lFV}. \quad (22)$$

By comparing equations (12), (13), (21), and (22), we have the following relationships.

Lemma 2. *For sufficiently large θ , the following condition holds:*

1. In country H ,

$$\pi_{H|DV}(\theta) > \max \{ \pi_{H|DO}(\theta), \pi_{H|FO}(\theta), \pi_{H|FV}(\theta) \}. \quad (23)$$

2. In country F ,

$$\pi_{F|FV}(\theta) > \max \{ \pi_{F|DO}(\theta), \pi_{F|FO}(\theta), \pi_{F|DV}(\theta) \}. \quad (24)$$

Proof. By differentiating equations (12), (13), (21), and (22) with respect to $\theta^{\frac{\alpha}{1-\alpha}}$, we have

$$\frac{\partial \pi_{H|DO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_l} \frac{N_{l|O} - (1-\alpha)}{N_{l|O}} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha), \quad (25)$$

$$\frac{\partial \pi_{H|FO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_m} \frac{N_{m|O} - (1-\alpha)}{N_{m|O}} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha), \quad (26)$$

$$\frac{\partial \pi_{H|DV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_l} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha), \quad (27)$$

$$\frac{\partial \pi_{H|FV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_m} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha). \quad (28)$$

In country H ,

$$\frac{\partial \pi_{H|DV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} > \max \left\{ \frac{\partial \pi_{H|DO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}}, \frac{\partial \pi_{H|FO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}}, \frac{\partial \pi_{H|FV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} \right\}, \quad (29)$$

holds for all $\theta > 0$. Therefore, for sufficiently large θ , $\pi_{H|DV}(\theta)$ becomes the largest value. By contrast, in country F ,

$$\frac{\partial \pi_{F|FV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} > \max \left\{ \frac{\partial \pi_{F|DO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}}, \frac{\partial \pi_{F|FO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}}, \frac{\partial \pi_{F|DV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} \right\}, \quad (30)$$

holds for all $\theta > 0$. Therefore, for sufficiently large θ , $\pi_{F|FV}(\theta)$ becomes the largest value. $\square$

Lemma 2 implies that in country H (F), a firm with a sufficiently high productivity level chooses domestic (foreign) vertical integration. The intuitive logic behind this result is as follows. For sufficiently higher productivity, the order of firm's profit does not depend on the difference in organizational cost $f_{l|k}$. In such an environment, the firm with higher productivity prefers domestic vertical integration to domestic outsourcing and prefers foreign vertical integration to foreign outsourcing because vertical integration solves a double marginalization problem. For a comparison of the two types of vertical integration, the firm's profit level depends only on the value of the wage difference. Because the wage rate in country F is higher, the firm in country H (F) prefers domestic (foreign) vertical integration for sufficiently higher productivity level.

3.2 Decision of organizational form

This subsection considers the decision by firms of organizational form by comparing profits derived in the previous subsection. From Lemma 2, the firm with sufficiently high productivity level in country H (F) chooses domestic (foreign) vertical integration regardless of the organizational cost. However, for firms with a low or intermediate level of productivity, the organizational choice depends on the level of organizational cost, wage rate, and intermediate-input price in each country. Assuming the order of cutoff productivity level (7), we can derive the following cutoff productivities if they exist.

Definition 1. By using equations (12), (13), (21), and (22), the four types of cutoff productivity are defined as follows:

1. Cutoff productivity for DO (or equivalently cutoff productivity to be active); $\pi_{l|DO}(\theta) = 0$.

$$\theta_{lDO}^{\frac{\alpha}{1-\alpha}} = \frac{c_l f_{lDO}}{Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_l}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{N_{lO} - (1-\alpha)}{N_{lO}}\right)^{\frac{\alpha}{1-\alpha}} (1-\alpha)}. \quad (31)$$

2. *Cutoff productivity for DV*; $\pi_{lDV}(\theta) = \pi_{lDO}(\theta)$.

$$\theta_{lDV}^{\frac{\alpha}{1-\alpha}} = \frac{c_l (f_{lDV} - f_{lDO}) + \Pi_{lO}}{Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_l}\right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) \left\{ 1 - \left(\frac{N_{lO} - (1-\alpha)}{N_{lO}}\right)^{\frac{\alpha}{1-\alpha}} \right\}}. \quad (32)$$

3. *Cutoff productivity for FO*; $\pi_{lFO}(\theta) = \pi_{lDV}(\theta)$.

$$\theta_{lFO}^{\frac{\alpha}{1-\alpha}} = \frac{c_l (f_{lFO} - f_{lDV}) - \Pi_{lO}}{Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_m}\right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) \left\{ \left(\frac{N_{mO} - (1-\alpha)}{N_{mO}}\right)^{\frac{\alpha}{1-\alpha}} - \left(\frac{c_m}{c_l}\right)^{\frac{\alpha}{1-\alpha}} \right\}}. \quad (33)$$

4. *Cutoff productivity for FV*; $\pi_{lFV}(\theta) = \pi_{lFO}(\theta)$.

$$\theta_{lFV}^{\frac{\alpha}{1-\alpha}} = \frac{c_l (f_{lFV} - f_{lFO}) + \Pi_{mO}}{Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_m}\right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) \left\{ 1 - \left(\frac{N_{mO} - (1-\alpha)}{N_{mO}}\right)^{\frac{\alpha}{1-\alpha}} \right\}}. \quad (34)$$

We derive the conditions to determine the cutoff productivity of domestic (foreign) vertical integration θ_{lDV} (θ_{lFV}). When comparing domestic (foreign) outsourcing with vertical integration, firms choose domestic (foreign) vertical integration if and only if $\pi_{lDV}(\theta) \geq \pi_{lDO}(\theta)$ ($\pi_{lFV}(\theta) \geq \pi_{lFO}(\theta)$). Because $\Pi_{lV} = \Pi_{lO}$, this condition can be rewritten as follows:

$$\pi_{lDV}(\theta) + \Pi_{lV} \geq \pi_{lDO}(\theta) + \Pi_{lO} \quad (\pi_{lFV}(\theta) + \Pi_{lV} \geq \pi_{lFO}(\theta) + \Pi_{lO}). \quad (35)$$

Condition (35) implies that firms choose domestic (foreign) vertical integration in the case where the joint operating profits under domestic (foreign) vertical integration are higher than that under domestic (foreign) outsourcing. Hence, we focus on the joint profits between vertical relations for the analysis below.

From now on, we consider the decision of organizational form. Given the existence of compensation for the case of vertical integration, we consider the following order of organizational costs:

$$f_{lDO} < f_{lDV} + \frac{\Pi_{lO}}{c_l} < f_{lFO} < f_{lFV} + \frac{\Pi_{mO}}{c_l}. \quad (36)$$

Note that if compensation for the case of vertical integration is zero, condition (36) coincides with condition (6) and that if condition (36) holds for each $l \in \{H, F\}$, the numerators of each cutoff productivity is always positive. Because $\pi_{lk}(\theta)$ is a linear function of $\theta^{\frac{\alpha}{1-\alpha}}$, the following condition must be satisfied.

$$0 < \frac{\partial \pi_{lDO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} < \frac{\partial \pi_{lDV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} < \frac{\partial \pi_{lFO}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}} < \frac{\partial \pi_{lFV}(\theta)}{\partial \theta^{\frac{\alpha}{1-\alpha}}}. \quad (37)$$

By using the above conditions, we first consider the organizational forms in country H . The following proposition summarizes the organizational choice in country H .

Proposition 1. *Suppose that condition (36) holds. In country H , all firms choose domestic sourcing; they choose domestic outsourcing or domestic vertical integration.*

Proof. To satisfy condition (7) in country H , condition (37) for $l = H$ must be satisfied. From equations (25), (26), (27), and (28) in the proof of Lemma 2, condition (37) is equivalent to

$$0 < c_F < w_F(N_{F|O}, c_F) < c_H < w_H(N_{H|O}, c_H). \quad (38)$$

We first consider domestic sourcing. $w_H(N_{H|O}, c_H) > c_H > 0$ holds. Hence, $\theta_{H|DO}$ and $\theta_{H|DV}$ exists such that $\theta_{H|DO} < \theta_{H|DV}$. We next consider foreign sourcing. Because $c_H < c_F$ and $c_F < w_F(N_{F|O}, c_F)$, condition $c_H > w_F(N_{F|O}, c_F) > c_F$ does not hold. Under condition (36), $\pi_{H|DV}(\theta) > \max\{\pi_{H|FO}(\theta), \pi_{H|FV}(\theta)\}$ holds for all $\theta > 0$. Therefore, no firms choose foreign sourcing in country H . $\square$

By interpreting Proposition 1 differently, no firms in country H choose foreign sourcing.⁹ This is because foreign sourcing requires higher organizational costs or intermediate-input prices.

We next consider the organizational form in country F . The following proposition identifies the conditions under which the four organizational forms exist in country F .

Proposition 2. A set of $\{f_{F|DO}, f_{F|DV}, f_{F|FO}, f_{F|FV}\} \in \mathbb{R}_+^4$ exists that satisfies the order of organizational costs (36) and the order of cutoff productivity levels (7) characterized by conditions (31), (32), (33), and (34) if the wage rate in country F is sufficiently high; specifically,

$$c_F > c_H \frac{N_{H|O}}{N_{H|O} - (1 - \alpha)}. \quad (39)$$

Proof. To satisfy condition (7) in country F , condition (37) for $l = F$ must be satisfied. From equations (25), (26), (27), and (28) in the proof of Lemma 2, condition (37) is equivalent to

$$c_H < c_H \frac{N_{H|O}}{N_{H|O} - (1 - \alpha)} < c_F < c_F \frac{N_{F|O}}{N_{F|O} - (1 - \alpha)}. \quad (40)$$

Because $c_H < c_F$ and $N_{H|O}/(N_{H|O} - (1 - \alpha)) > 1$, this condition holds if and only if condition (39) holds. Hence, condition (7) holds for appropriate values of organizational costs which satisfy condition (36). $\square$

The results in Propositions 1 and 2 are summarized in Figure 2 and 3. The role of condition (39) is explained as follows. If condition (39) holds, intermediate-input prices satisfy $w_F > c_F > w_H > c_H$ under which condition (37)

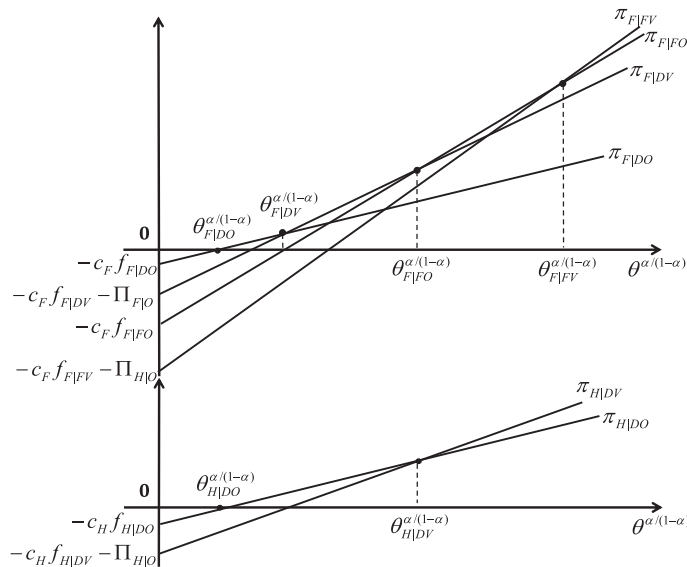


Figure 2: Equilibrium

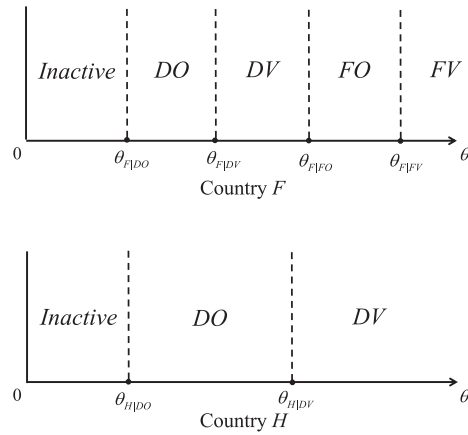


Figure 3: Relationship between cutoff productivities and organizational forms in each country

for $l = F$ holds. Figure 2 shows that these conditions guarantee the existence of four organizational forms in country F when organizational costs satisfy condition (36). Regarding this subsection's analysis, this section assumes that $\Pi_{l|O}$ and $N_{l|O}$ are exogenously given. However, $\Pi_{l|O}$ and $N_{l|O}$ are endogenously determined in the equilibrium and depend on the set of organizational costs. Because of a number of equations, we cannot analytically check whether conditions (36) and (39) simultaneously hold in the equilibrium. By using the quantitative analysis, the following section shows that an equilibrium exists under which these conditions hold simultaneously.¹⁰

4 Quantitative Analysis

Using the simulation analysis, this section focuses on the equilibrium where no firm chooses foreign sourcing in country H , and four organizational forms exist in country F . For the simulation analysis, we choose $G(\theta)$ to be a Pareto distribution with shape δ and scale b ; that is, the probability density function is $g(\theta) = \delta b^\delta \theta^{-\delta-1}$ and

$$G(\theta) = 1 - \left[\frac{b}{\theta} \right]^\delta \text{ for } \theta \geq b > 0. \quad (41)$$

where $\delta > \alpha / (1 - \alpha)$.

Before starting the simulation analysis, we derive $N_{l|O}$, Y_l and φ_l under Pareto distribution to endogenize these parameters for each $l \in \{H, F\}$ assuming that no firms choose foreign sourcing in country H , and four organizational forms exist in country F . First, we derive the number of unintegrated suppliers in country l .¹¹

$$N_{H|O} = N_H - b^\delta \left[\frac{n_F}{\theta_{F|FV}^\delta} + \frac{n_H}{\theta_{H|DV}^\delta} \right]. \quad (42)$$

$$N_{F|O} = N_F - n_F b^\delta \left[\frac{1}{\theta_{F|DV}^\delta} - \frac{1}{\theta_{F|FO}^\delta} \right]. \quad (43)$$

Second, aggregate production in country l is given by

$$Y_H^{\frac{\alpha(1-\rho)}{1-\alpha}} = \frac{(1-\alpha)n\delta b^\delta}{(1-\alpha)\delta - \alpha} \left(\frac{\alpha}{c_H} \right)^{\frac{\alpha}{1-\alpha}} \left[\theta_{H|DV}^{\frac{\alpha}{1-\alpha}-\delta} + \left(\frac{N_{H|O} - (1-\alpha)}{N_{H|O}} \right)^{\frac{\alpha}{1-\alpha}} \left[\theta_{H|DO}^{\frac{\alpha}{1-\alpha}-\delta} - \theta_{H|DV}^{\frac{\alpha}{1-\alpha}-\delta} \right] \right]. \quad (44)$$

$$Y_F^{\frac{\alpha(1-\rho)}{1-\alpha}} = \frac{(1-\alpha)n\delta b^\delta}{(1-\alpha)\delta - \alpha} \left(\frac{\alpha}{c_F} \right)^{\frac{\alpha}{1-\alpha}} \left[\left(\theta_{F|DV}^{\frac{\alpha}{1-\alpha}-\delta} - \theta_{F|FO}^{\frac{\alpha}{1-\alpha}-\delta} \right) \right]$$

$$\begin{aligned}
& + \left(\frac{N_{F|O} - (1 - \alpha)}{N_{F|O}} \right)^{\frac{\alpha}{1-\alpha}} \left(\theta_{F|DO}^{\frac{\alpha}{1-\alpha} - \delta} - \theta_{F|DV}^{\frac{\alpha}{1-\alpha} - \delta} \right) \\
& + \left(\frac{\alpha}{c_H} \right)^{\frac{\alpha}{1-\alpha}} \left[\left(\frac{N_{H|O} - (1 - \alpha)}{N_{H|O}} \right)^{\frac{\alpha}{1-\alpha}} \left(\theta_{F|FO}^{\frac{\alpha}{1-\alpha} - \delta} - \theta_{F|FV}^{\frac{\alpha}{1-\alpha} - \delta} \right) + \theta_{F|FV}^{\frac{\alpha}{1-\alpha} - \delta} \right].
\end{aligned} \tag{45}$$

Finally, φ_l becomes

$$\varphi_H = \frac{(1 - \alpha) \delta b^\delta}{(1 - \alpha) \delta - \alpha} \sum_{l \in \{H, F\}} n_l Y_l^{\frac{\mu - \alpha}{1 - \alpha}} \left(\theta_{l|DO}^{\frac{\alpha}{1 - \alpha} - \delta} - \theta_{l|DV}^{\frac{\alpha}{1 - \alpha} - \delta} \right), \tag{46}$$

$$\varphi_F = \frac{(1 - \alpha) n \delta b^\delta}{(1 - \alpha) \delta - \alpha} n_F Y_F^{\frac{\mu - \alpha}{1 - \alpha}} \left(\theta_{F|DO}^{\frac{\alpha}{1 - \alpha} - \delta} - \theta_{F|DV}^{\frac{\alpha}{1 - \alpha} - \delta} \right). \tag{47}$$

The remainder of this section is organized as follows. Subsection 4.1 explores the existence of an equilibrium. Subsection 4.2 introduces the comparative static analysis.

4.1 Equilibrium in quantitative analysis

This subsection explores the existence of an equilibrium by endogenously determining $N_{l|O}$, Y_l , and φ_l , which are exogenous parameters in the previous section. We assume that organizational costs satisfy condition (36). To begin the simulation analysis, we define the equilibrium conditions for the simulation analysis as follows.

Definition 2. *In the equilibrium, the following conditions hold simultaneously:*

1. Six cutoff productivities $\theta_{H|DO}$, $\theta_{H|DV}$, $\theta_{F|DO}$, $\theta_{F|DV}$, $\theta_{F|FO}$, $\theta_{F|FV}$ are solutions of equations (31) and (32) for $l = H$ and equations (31), (32), (33), and (34) for $l = F$.
2. $N_{H|O}$, $N_{F|O}$, Y_H , Y_F , φ_H , φ_F , $\Pi_{H|O}$ and $\Pi_{F|O}$ are solutions of equations (42), (43), (44), (45), (46), (47), and (14) for $l = H$, and F .
3. Six cutoff productivities satisfy condition (7).
4. $N_{H|O}$ satisfies condition (39).
5. $\Pi_{H|O}$ and $\Pi_{F|O}$ satisfy condition (36).

We now introduce the exogenous parameters (see also Table 2). Exogenous parameters α , δ , b , c_H are determined following Melitz and Redding (2013). We set the elasticity of substitution between any two varieties $\alpha = 0.75$ so that $1/(1 - \alpha) = 4$ holds.¹² The Pareto shape parameter for firm productivity is $\delta = 4.25$, under which we have $\delta > \alpha/(1 - \alpha)$.¹³ For the Pareto scale parameter for firm productivity and the wage rate in country H , we normalize $b = 1$ and $c_H = 1$, respectively.

Exogenous parameters that do not exist in Melitz and Redding (2013) are determined through the actual simulation analyses and set for a wide range of equilibrium existence.¹⁴ The preference parameter μ has to satisfy $\mu < \alpha$. We examine the case of $\mu = 0.1$. For the wage rate in country F , we set $c_F = 1.5$. For the number of suppliers N_l and the total number of firms n_l , we set $N_l = n_l = 5$.

In these parameters, we explore the existence of six organizational costs that satisfy the above equilibrium conditions and find the existence of an equilibrium.¹⁵ To find the existence of an equilibrium, we conduct a simulation for a wide range of parameters. To have four cutoff productivities and a sufficient range of simulations, a certain difference between each organizational cost is required. Specifically, we solve six organizational costs by exogenously setting six cutoff productivities that satisfy conditions in Definition 2.

Result 1. *An equilibrium exists that satisfies all conditions in Definition 2.*

Table 2: Basic Parameter Values

Parameter	value
α	0.75
δ	4.25
b	1
μ	0.1
c_H	1
c_F	1.5
N_H	5
N_F	5
n_H	5
n_F	5
$f_{H DO}$	0.1
$f_{H DV}$	0.2
$f_{F DO}$	0.1
$f_{F DV}$	0.2
$f_{F FO}$	2.5
$f_{F FV}$	5

The set of six organizational costs in basic parameter values are summarized in Table 2. Because the analysis here focuses on cross-sectoral differences in wage rates, we choose the same organizational costs for the same organizational forms between two countries; $f_{H|k} = f_{F|k}$.

4.2 Comparative statics

In this subsection, we explore how foreign multinational entry in country H and the change in wage rates in country H affect the organizational choice in country H . To conduct the analysis, we derive the number of domestic outsourcing firms and that of vertically integrated firms in country H ;

$$n_{H|O} = \int_{\theta_{H|DO}}^{\theta_{H|DV}} n_H g(\theta) d\theta = n_H b^\delta \left[\frac{1}{\theta_{H|DO}^\delta} - \frac{1}{\theta_{H|DV}^\delta} \right], \quad (48)$$

$$n_{H|V} = \int_{\theta_{H|DV}}^{\infty} n_H g(\theta) d\theta = n_H \left[\frac{b}{\theta_{H|DV}} \right]^\delta. \quad (49)$$

Equations (48) and (49) show that the relationship between the number of firms and cutoff productivities has the following properties. First, the number of vertically integrated firms in country H $n_{H|V}$ is strictly decreasing in the cutoff productivity of domestic vertical integration $\theta_{H|DV}$. Second, the number of outsourcing firms in country H $n_{H|O}$ is strictly decreasing in cutoff productivity of domestic outsourcing $\theta_{H|DO}$, but increasing in the cutoff productivity of domestic vertical integration $\theta_{H|DV}$; domestic outsourcing increases if $\theta_{H|DO}$ increases and $\theta_{H|DV}$ decreases.

Foreign multinational entry and organizational forms

We first consider the effect of foreign multinational entry in country H , which is captured by the decrease in the organizational cost for foreign vertical integration in country F . A decrease in the organizational cost for foreign vertical integration $f_{F|FV}$ induces the firms in country F to be more likely to vertically integrate with the supplier in country H . In the simulation analysis, we change the value of $f_{F|FV}$ from 4.0 to 6.0 by every 0.2. The effect of foreign multinational entry in country H is summarized as follows.

Result 2. *Foreign multinational entry in country H facilitates domestic vertical integration in country H but also discourages domestic outsourcing. The amount of domestic vertical integration $n_{H|V}$ increases but the number of domestic outsourcing $n_{H|O}$ decreases. Specifically, when the organizational cost for foreign vertical integration in*

country F $f_{F|FV}$ decreases, the following changes occur in country H :

1. Cutoff productivity of domestic vertical integration $\theta_{H|DV}$ decreases. That is, firms with higher productivity are more likely to choose domestic vertical integration.
2. Cutoff productivity of domestic outsourcing $\theta_{H|DO}$ increases. That is, firms with lower productivity become inactive.
3. Aggregate production Y_H increases.
4. Input price w_H increases.
5. Suppliers' profit $\Pi_{H|O}$ decreases.

Table 3 and Figure 4 summarize Result 2. By focusing on the joint profits between vertical relations, captured by condition (35), the intuitive logic behind these results is as follows. Foreign multinational entry reduces the number of unintegrated suppliers in country H ($N_{H|O}$ decreases). Equations (8) and (9) imply that this reduction always raises the intermediate-input price in country H 's intermediate-input market (w_H increases), which induces domestic outsourcing firms to earn smaller profits ($\pi_{H|DO}$ decreases). Hence, foreign multinational entry is not beneficial for

Table 3: Changes in country H when foreign multinational entry occurs

$f_{F FV}$	$\theta_{H DV}$	$\theta_{H DO}$	Y_H	w_H	$\Pi_{H O}$
4.0	2.9126	1.57982	1.629508	1.053254	0.00554
4.2	2.9143	1.57980	1.629492	1.053248	0.00571
4.4	2.9157	1.57978	1.629477	1.053244	0.00586
4.6	2.9169	1.57976	1.629465	1.053240	0.00599
4.8	2.9180	1.57975	1.629453	1.053237	0.00610
5.0	2.9189	1.57974	1.629443	1.053235	0.00620
5.2	2.9197	1.57973	1.629434	1.053233	0.00629
5.4	2.9205	1.57972	1.629426	1.053231	0.00637
5.6	2.9212	1.57971	1.629418	1.053230	0.00645
5.8	2.9218	1.57970	1.629411	1.053228	0.00651
6.0	2.9224	1.57969	1.629405	1.053227	0.00657

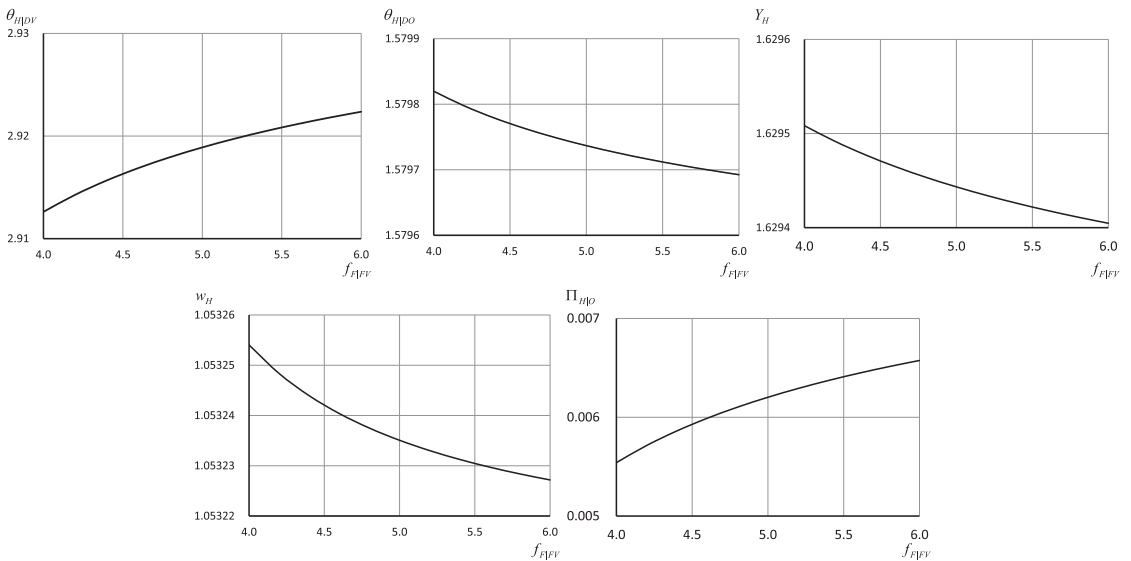


Figure 4: Relationships between $\theta_{H|DV}$ and $f_{F|FV}$ (upper left) between $\theta_{H|DO}$ and $f_{F|FV}$ (upper center), between Y_H and $f_{F|FV}$ (upper right), between w_H and $f_{F|FV}$ (lower left), and between $\Pi_{H|O}$ and $f_{F|FV}$ (lower right)

domestic outsourcing firms. In contrast, foreign multinational entry seems to be beneficial for unintegrated suppliers because competition among suppliers is mitigated. However, such a view is incorrect because foreign multinational entry leads to a shift in the input demand curve to the left through two channels. First, the higher intermediate-input price induces low productivity firms engaging in domestic outsourcing to be inactive in country H ($\theta_{H|DO}$ increases). Second, a decrease in the organizational cost for foreign vertical integration $f_{F|FV}$ in country F reduces the number of firms engaging in foreign outsourcing in country F ($\theta_{F|FO}$ increases). Because of shrinking intermediate-input demand, unintegrated suppliers earn smaller profits in country H ($\Pi_{H|O}$ decreases). Hence, foreign multinational entry decreases the joint profit between vertical relations under outsourcing. In other words, the profitability of vertical integration increases, comparatively. Therefore, the condition (35) holds for a lower productivity level. Hence, domestic vertical integration is facilitated in country H ($\theta_{H|DV}$ decreases).

Note that the decrease in $\theta_{H|DV}$ generates an indirect effect; from equation (44), domestic vertical integration enhances aggregate production in country H (Y_H increases) because vertical integration allows firms to operate more efficiently. Although equation (32) implies that the increase in aggregate production does not facilitate domestic vertical integration, the increase in intermediate-input prices and the decrease in suppliers' profits are dominant effects. Therefore, foreign multinational entry facilitates domestic vertical integration in country H .

Suppliers' marginal costs and organizational forms

Next, we explore the relationship between suppliers' marginal cost of production and organizational forms in country H . Suppliers' marginal cost is captured by wage rate c_H . Note that wage rate c_H affects the marginal cost of production and organizational costs. Because our focus here is the change in suppliers' marginal cost of production, we assume that organizational costs are not denominated in terms of labor in the domestic country. Specifically, the coefficient of fixed organizational cost f_{lk} is dropped for all $l \in \{H, F\}$ and $k \in \{DO, DV, FO, FV\}$. Then, firms' profits (12), (13), (21), and (22) can be rewritten as follows.

$$\pi_{H|DO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha\theta N_{H|O} - (1-\alpha)}{c_l} \frac{1}{N_{H|O}} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - f_{H|DO}, \quad (50)$$

$$\pi_{H|FO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha\theta N_{H|O} - (1-\alpha)}{c_m} \frac{1}{N_{H|O}} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - f_{H|FO}, \quad (51)$$

$$\pi_{H|DV}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\theta\alpha}{c_l} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - \Pi_{H|O} - f_{H|DV}, \quad (52)$$

$$\pi_{H|FV}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\theta\alpha}{c_m} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - \Pi_{H|O} - f_{H|FV}. \quad (53)$$

In the simulation analysis, we change the value of c_H from 0.9 to 1.1 by 0.02. The effect of a wage rates decrease in country H is summarized as follows.

Result 3. *The reduction in suppliers' marginal cost in country H increases the number of active firms in country H and suppliers' profits. When c_H decreases, the following changes occur in country H .*

1. *The cutoff productivity of domestic vertical integration $\theta_{H|DV}$ increases if firms' organizational costs in country H are sufficiently small, but the cutoff productivity decreases if those costs are not too small.*
2. *The cutoff productivity of domestic outsourcing $\theta_{H|DO}$ decreases. The number of active firms in country H increases.*
3. *Aggregate production Y_H increases.*

4. Intermediate-input prices w_H decrease.

5. Suppliers' profits $\Pi_{H|O}$ increase.

Table 4 and 5 and Figure 5 summarize the above results.¹⁶ Table 4 introduces the case of a basic parameter set. In contrast, Table 5 introduces the case of low organizational costs; $f_{IDO} = 0.04$ and $f_{IDV} = 0.08$. The intuitive logic behind these results is provided as follows. When suppliers' marginal cost in country H decreases, firms can procure intermediate inputs from country H inexpensively (w_H decreases), which increases the profitability of firms in country H and induces them more likely to be active ($\theta_{H|DO}$ decreases). Therefore, aggregate production increases (Y_H increases). Because the input demand increases and the marginal cost of production decreases, suppliers earn higher

Table 4: Changes in country H when suppliers' marginal costs increase (basic parameters)

c_H	$\theta_{H DV}$	$\theta_{H DO}$	Y_H	w_H	$\Pi_{H O}$
0.90	2.9166	1.5753	1.83	0.95	0.0069
0.92	2.9172	1.5762	1.79	0.97	0.0068
0.94	2.9177	1.5771	1.75	0.99	0.0066
0.96	2.9182	1.5780	1.71	1.01	0.0065
0.98	2.9186	1.5789	1.67	1.03	0.0064
1.00	2.9189	1.5797	1.63	1.05	0.0062
1.02	2.9192	1.5806	1.59	1.07	0.0061
1.04	2.9194	1.5814	1.56	1.10	0.0059
1.06	2.9196	1.5822	1.53	1.12	0.0058
1.08	2.9198	1.5830	1.49	1.14	0.0057
1.10	2.9200	1.5838	1.46	1.16	0.0055

Table 5: Changes in country H when suppliers' marginal costs increase ($f_{IDO} = 0.04$ and $f_{IDV} = 0.08$)

c_H	$\theta_{H DV}$	$\theta_{H DO}$	Y_H	w_H	$\Pi_{H O}$
0.90	2.403	1.2665	2.03	0.95	0.0067
0.92	2.402	1.2672	1.98	0.97	0.0066
0.94	2.401	1.2680	1.93	0.99	0.0064
0.96	2.400	1.2687	1.88	1.01	0.0063
0.98	2.398	1.2694	1.84	1.03	0.0061
1.00	2.397	1.2701	1.80	1.05	0.0060
1.02	2.396	1.2708	1.76	1.08	0.0059
1.04	2.395	1.2715	1.72	1.10	0.0057
1.06	2.394	1.2722	1.69	1.12	0.0056
1.08	2.393	1.2728	1.65	1.14	0.0055
1.10	2.392	1.2735	1.62	1.16	0.0053

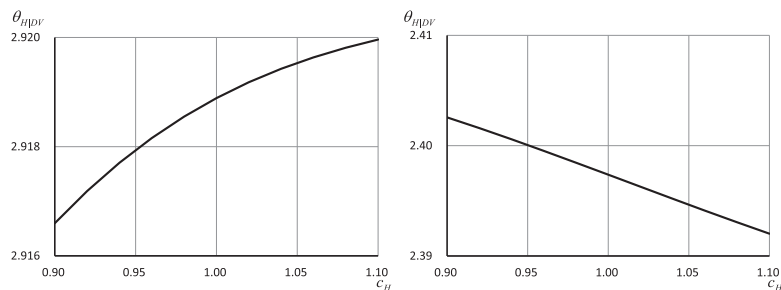


Figure 5: Relationships between $\theta_{H|DV}$ and c_H under basic parameters (left) and under $f_{IDO} = 0.04$ and $f_{IDV} = 0.08$ (right)

profits under outsourcing ($\Pi_{H|O}$ increases). Although the reduction of suppliers' marginal cost also has the effect of increasing vertically integrated profits, the higher suppliers' profits increase the amount of compensation under vertical integration. The compensation is more likely to be higher for the case of large Y_H , which is observed for smaller organizational costs in country H . Hence, for smaller organizational costs, the amount of vertical integration decreases.

5 Conclusion

This paper studies the boundary response of domestic firms to new foreign multinational M&A in an upstream market, from which outsourcing firms purchase intermediate inputs of a host country. The effect of new foreign multinational M&A on the host country may operate through many different channels and affect several different aspects of a host economy. This study focuses on an analysis of price change in an intermediate-input market and the organizational choices of domestic firms. We show that foreign firms' vertical integration with domestic suppliers in a host country elevates intermediate-input price in the host country and causes higher marginal cost of final-good production under outsourcing. Although there are two more channels of the effects of new foreign multinational M&A: the competition channel and profit compensation channel, the intermediate-input price channel still causes the predominant effect on the organizational choices of domestic firms.

The result in this study is caused by the price change in an imperfect competitive, N -supplier intermediate-input market. If an intermediate-input industry becomes free entry or a monopolistically competitive market under the current setup, there may be limited or zero additional incentive for more firms to choose vertical integration even after new foreign multinational entry. This is because an intermediate-input market under free entry causes additional entry if suppliers have positive profits. In the case of monopolistic competition it gives a fixed price regardless of the number of suppliers. An N -supplier intermediate-input market in our model might be justified by a market with scale economies, scarcity of inputs or suppliers, a high level of technology, or licensing requirements, for example.

In this study, tracking the intermediate-input price guides us to explore the incentive for firms to choose one organization form over another. Foreign vertical integration by new foreign multinationals withdraws suppliers from a local intermediate-input market. Although foreign multinational entry has two types: cross-border M&A and greenfield FDI, this setup captures the situation where foreign vertical integration reduces the number of suppliers who serves domestic firms.

If we consider the case of greenfield FDI or foreign subsidiaries who can sell their intermediate inputs to domestic firms, it implies an increase or no change in the number of suppliers in an intermediate-input market. Under our setup, these cases may decrease the intermediate-input price. Although our model does not investigate this possibility, the analysis by taking a partial derivative of the intermediate-input price with respect to the number of unintegrated suppliers $N_{H|O}$ can capture this effect. This case derives a very different result, implies the possibility of disintegration, and domestic outsourcing becomes more common than it was before new foreign multinational entry.

Notes

1 See, for example, Antràs and Helpman (2004, 2008), Grossman and Helpman (2003, 2004), and Legros and Newman (2013).

2 This wage rate is justified in a general equilibrium by assuming that C_l is the productivity of labor producing $Y_{H|O}$ in country l and that

labor supply is sufficiently large in every country so that each country produces Y_H^0 .

- 3 The industrial organization literature often assumes that suppliers compete in quantity. See, for example, Greenhut and Ohta (1979) and Salinger (1988).
- 4 If we assume monopolistic competition in an intermediate-input market, the input price does not depend on the number of suppliers. Additionally, if we assume price competition, the input price does not change and the distortion of outsourcing disappears, which implies that there is no benefit to vertical integration.
- 5 Unlike Antràs and Helpman (2004) and for simplicity, we do not consider the decision of entry into each sector because we consider the partial-equilibrium model.
- 6 See, for example, Antràs and Helpman (2004).
- 7 Similar to the industrial organization literature on excess entry theorem, we ignore the integer constraint on N_{HO} .
- 8 There are many works that ignore the integer constraint on firms in a Cournot competition framework. See, for example, the excess entry theorem literature such as Mankiw and Whinston (1986), Suzumura and Kiyono (1987), and Ghosh and Morita (2007).
- 9 Note that condition (36) is a sufficient condition; there are cases where no firms choose foreign vertical integration in country H even when this condition is violated.
- 10 More precisely, because Π_{HO} is determined by N_{HO} and φ_l , we mainly focus on N_{HO} and φ_l in the quantitative analysis from the next section.
- 11 The number of unintegrated suppliers is derived using $N_{HO} = N_I - N_{HV}$ and

$$\begin{aligned} N_{HV} &= n_F \int_{\theta_{FIV}}^{\infty} g(\theta) d\theta + n_H \int_{\theta_{HIV}}^{\infty} g(\theta) d\theta, \\ N_{FV} &= n_F \int_{\theta_{FIV}}^{\theta_{FO}} g(\theta) d\theta. \end{aligned}$$

- 12 Melitz and Redding (2013)'s setting on $1/(1-\alpha)$ is consistent with the estimates using plant-level US manufacturing data in Bernard, Eaton, Jensen, and Kortum (2003).
- 13 The value of δ is justified as follows. Because firm revenue, r , is a power function of firm productivity, it is also Pareto distributed and $G(r) = 1 - (b^*/r)^{\delta(1-\alpha)/\alpha}$ where b^* is the firm revenue of the lowest productive firm. Melitz and Redding (2013) and existing empirical analyses suggest that the firm size distribution defined by firm revenue is approximated by a Pareto distribution with a shape parameter $\delta(1-\alpha)/\alpha$ close to one. Additionally, firm revenue requires a finite mean; that is, we require $\delta(1-\alpha)/\alpha > 1$. These two conditions are satisfied for $\delta = 4.25$. For $\delta = 4.25$, $\delta(1-\alpha)/\alpha = 1.42$ holds.
- 14 The basic results do not change even in other parameter values.
- 15 GAMS is used for the simulation analysis.
- 16 We also explore the case where organizational costs are denominated in terms of labor in the domestic country and find that similar results hold even in such a case.

References

- Alfaro, L., Conconi, P., Fadinger, H., and Newman, A., 2016. Do Prices Determine Vertical Integration? *Review of Economic Studies* 83 (3), pp. 855–888.
- Antràs, P., and Helpman E., 2004. Global Sourcing. *Journal of Political Economy* 112 (3), pp. 552–580.
- Antràs, P., and Helpman E., 2008. Contractual Frictions and Global Sourcing. in Helpman, Elhanan, Dalia Marin, and Thierry Verdier, eds. *The Organization of Firms in a Global Economy* 9–54. Cambridge, MA: Harvard University Press.
- Bernard, A.B., Eaton, J., Jensen, B., and Kortum, S., 2003. Plants and Productivity in International Trade. *American Economic Review* 93 (4),

pp. 1268–1290.

Conconi, P., Legros, P., and Newman A. F., 2012. Trade liberalization and organizational change. *Journal of International Economics* 86 (2), pp. 197–208.

Ghosh, A., and Morita H., 2007. Free entry and social efficiency under vertical oligopoly. *RAND Journal of Economics* 38 (2), pp. 541–554.

Greenhut, J. M. and Ohta, H., 1979. Vertical Integration of Successive Oligopolists. *American Economic Review* 69 (1), pp. 137–141.

Grossman, G. M., and Helpman, E., 2003. Outsourcing versus FDI in Industry Equilibrium. *Journal of the European Economic Association* 1 (2–3), pp. 317–327.

Grossman, G. M., and Helpman, E., 2004. Managerial Incentives and the International Organization of Production. *Journal of International Economics* 63 (2), pp. 237–262.

Legros, P., and Newman A. F., 2013. A Price Theory of Vertical and Lateral Integration. *Quarterly Journal of Economics* 128 (2), pp. 725–770.

Mankiw, G. N., and Whinston M.D., 1986. Free Entry and Social Inefficiency. *RAND Journal of Economics* 17 (1), pp. 48–58.

Melitz, M., and Redding, S., 2013. Firm Heterogeneity and Aggregate Welfare. Working Papers hal-03473900, HAL.

Salinger, M. A., 1988. Vertical Mergers and Market Foreclosure. *Quarterly Journal of Economics* 103 (2), pp. 345–56.

Suzumura, K., and Kiyono K., 1987. Entry Barriers and Economic Welfare. *Review of Economic Studies* 54 (1), pp. 157–167.

Appendix A Equilibria in each organizational form

This appendix provides equilibrium outcomes in each organizational form. Appendix A.1 considers the case of outsourcing. Appendix A.2 introduces the case of vertical integration.

A.1 Outsourcing

We derive equilibrium outcomes in each organizational form by backward induction. We first consider firms' profit maximization problem given intermediate-input prices in Stage 4. We then consider the suppliers' profit maximization problem in Stage 3.

Firms' problem

The profit maximization problem for domestic outsourcing firms given an intermediate-input price w_l is given by

$$x_{lDO}(\theta) = \arg \max_x Y_l^{\mu-\alpha} \theta x^\alpha - w_l x - c_l f_{lDO} \quad (54)$$

The input demand for each firm given w_l becomes

$$x_{lDO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{w_l} \right)^{\frac{1}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}}. \quad (55)$$

The price of the final-good product given w_l becomes $p_{lDO}(\theta) = w_l/\alpha\theta$. The profits of firms engaging in domestic outsourcing given w_l becomes

$$\pi_{lDO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha\theta}{w_l} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - c_l f_{lDO} \quad (56)$$

On the other hand, the profit maximization problem for foreign outsourcing firms given an intermediate-input price w_m is given by

$$x_{lFO}(\theta) = \arg \max_x Y_l^{\mu-\alpha} \theta x^\alpha - w_m x - c_l f_{lFO} \quad (57)$$

The input demand for each firm given w_m becomes

$$x_{\ell FO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{w_m} \right)^{\frac{1}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}}. \quad (58)$$

The price of the final-good product given w_m becomes $p_{\ell FO}(\theta) = w_m/\alpha\theta$. The profits of firms engaging in foreign outsourcing given w_m becomes

$$\pi_{\ell FO}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{w_m}{\theta\alpha} \right)^{\frac{\alpha}{1-\alpha}} (1-\alpha) - c_l f_{\ell FO}. \quad (59)$$

We now derive the demand for the intermediate-input market in each country. We first derive the demand for intermediate-input market in country H . There are two types of demands for intermediate inputs produced by country H . The first demand is from country H , and the second demand is from country F . The demand for intermediate inputs produced in country H is

$$X_H = n_H \int_{\theta_{H|DO}}^{\theta_{H|DV}} x_{H|DO}(\theta) g(\theta) d\theta + n_F \int_{\theta_{F|FO}}^{\theta_{F|FV}} x_{F|FO}(\theta) g(\theta) d\theta = \left(\frac{\alpha}{w_H} \right)^{\frac{1}{1-\alpha}} \varphi_H. \quad (60)$$

As a result, we have the following inverse demand for the intermediate-input market in country H .

$$w_H(X_H) = \alpha \left(\frac{\varphi_H}{X_H} \right)^{1-\alpha}. \quad (61)$$

We next derive the demand for the intermediate-input market in country F . In contrast to country F , there is only one type of demand for intermediate inputs produced by country F ; specifically, only the demand from country F exists. The demand for intermediate inputs produced in country F is

$$X_F = n_F \int_{\theta_{F|DO}}^{\theta_{F|DV}} x_{F|DO}(\theta) g(\theta) d\theta = \left(\frac{\alpha}{w_F} \right)^{\frac{1}{1-\alpha}} \varphi_F. \quad (62)$$

By solving this equation with respect to w_F , we have the following inverse demand for the intermediate-input market in country F .

$$w_F(X_F) = \alpha \left(\frac{\varphi_F}{X_F} \right)^{1-\alpha}. \quad (63)$$

Supplier's problem

Assume that $N_{\ell O} < N_l$ suppliers compete in quantity. Let $x_{\ell\eta}$ be the quantity of supplier η 's production where $\eta \in \{1, 2, \dots, N_{\ell O}\}$. The profit maximization problem for supplier η is

$$\max_{x_{\ell\eta}} \alpha \left(\frac{\varphi_l}{\sum_{\eta}^{N_{\ell O}} x_{\ell\eta}} \right)^{1-\alpha} x_{\ell\eta} - c_l x_{\ell\eta}. \quad (64)$$

By assuming symmetric equilibrium, the production of each supplier becomes

$$x_{\ell\eta} = \left(\frac{\alpha (N_{\ell O} - (1-\alpha))}{c_l} \right)^{1-\alpha} \varphi_l N_{\ell O}^{-\frac{2-\alpha}{1-\alpha}} \quad (65)$$

Firms and suppliers engaging in outsourcing earn (12), (13), and (14).

A.2 Integration

The profit maximization problem under domestic vertical integration is given by

$$x_{\ell DV}(\theta) = \arg \max_x Y_l^{\mu-\alpha} \theta x^\alpha - c_l x - c_l f_{\ell DV}. \quad (66)$$

The input demand for each firm becomes

$$x_{\ell DV}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_l} \right)^{\frac{1}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}}. \quad (67)$$

The price of the final-good product becomes $p_{\parallel DO}(\theta) = c_l/\alpha\theta$. The profit level of firms engaging in domestic vertical integration becomes equation (21).

On the other hand, the profit maximization problem for foreign outsourcing firms given an intermediate-input price w_m is given by

$$x_{\parallel FO}(\theta) = \arg \max_x Y_l^{\mu-\alpha} \theta x^\alpha - w_m x - c_l f_{\parallel FO}. \quad (68)$$

The input demand for each firm becomes

$$x_{\parallel FV}(\theta) = Y_l^{\frac{\mu-\alpha}{1-\alpha}} \left(\frac{\alpha}{c_m} \right)^{\frac{1}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}}. \quad (69)$$

The price of the final-good product becomes $p_{\parallel FV}(\theta) = c_m/\alpha\theta$. The profit level of firms engaging in foreign vertical integration becomes equation (22).