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The Plant-Moving Threat as a Motivation for Offshoring*

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This study develops a simple theoretical model by combining a collective wage-bargaining model and an orthodox offshoring model with firm heterogeneity to examine the threat motivation for offshoring. The theoretical analysis shows that firms may have an incentive to offshore and explore their ability to use plant moving as a threat and suggests that highly productive and offshorable firms pay lower wages based on such threats.

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1. INTRODUCTION

For the past several decades, the rapid growth of offshoring by firms has become a prominent phenomenon in the global economy, and globalization of firms' production activities has become a prime concern in international economics. Several studies have contributed to understanding the determinants and economic impact of firms' offshoring, and the relevant policies. The relationship between offshoring and factor markets — particularly the labor market — has been one of the more controversial issues examined in international economics in the past few decades. Most previous related studies have mainly focused on the economic impact of offshoring on the labor market. The majority of this literature has focused on analyzing the effects of offshoring on factor prices in the labor market, or wages, and the extent of employment.

Wage level and wage inequality are two major academic concerns when investigating the influence of offshoring on wages. Many researchers argue that the globalization of firms' production activities might be a potential source of the growing wage inequality in developing and developed countries. The explanations of the factors of offshoring that induce wage inequality differ across theoretical models and studies (e.g., skill-biased technical changes, changes in relative labor demand, team production structure, and production facility mobility). However, it seems that there is consistent evidence of the wage-inequality effects of offshoring; that is, offshoring is likely to increase wage inequality (e.g., Feenstra and Hanson, 1996a, 1996b, 1997, 1999; Slaughter, 2000; Antràs *et al*., 2006; Sayek and Senser, 2006; Crino, 2009; Kwon, 2011).

By contrast, the effect of offshoring on wage level is unclear and rather controversial. Some studies argue that offshoring may increase the wage rate in a host country and that offshoring firms may pay higher wages. The rationales usually given for the positive wage effect of offshoring are higher productivity of offshoring firms and technology spillover effects from foreign direct investment (FDI)/offshoring. For example, since highly productive firms are more likely to offshore (Helpman *et al*., 2004; Helpman, 2006), the liberalization of foreign production may increase the industry's productivity and wage level. Furthermore, offshoring firms are the most productive firms in a country and therefore might be more willing to pay higher wages than others. Offshoring or FDI may entail technology spillover effects in the host country, and this may increase the productivity and wage rates in that country. If offshoring occurs as a result of the international fragmentation of production processes, countries that are relatively labor abundant might experience increases in wage rates (Helpman, 1984). A large number of empirical studies seem to support the positive impact of offshoring on wage levels (Aitken *et al*., 1996; Glewwe, 2000; Lipsey and Sjoholm, 2003, 2004; Brown *et al*., 2004).

On the other hand, some economists, social activists, and international institutions insist that offshoring may reduce wage levels in the host and home countries. Typically, this argument is theoretically based on the market power of multinationals in the local labor market or the mobility of production processes across countries. For example, as Brown *et al*. (2004) argue, offshoring firms may have monopsonistic power in the host country's labor market and may try to reduce the wage rates in that country. Further, firms' motivation to set up "sweatshops" might induce lower wages, unfair labor contracts, hiring of undesirable workers such as children, and undesirable working conditions in host countries — particularly in developing countries. Note that offshoring firms choose a production location from among potential host countries to minimize their costs and relocate their production facilities in response to wage rates, labor regulations, and working conditions. This type of international capital mobility provides stronger bargaining power to offshoring firms or multinationals, and offshoring may therefore deteriorate the working conditions and wage levels in host countries. However, the importance of the sweatshop motivation behind offshoring is controversial, and some researchers insist that its effect might be small or negligible (For a literature review, see Brown *et al*., 2004; McMillian, 2010).

The mobility of firms' production facilities may provide employers an advantage over their employees in the labor markets in both the home and host countries. For example, the liberalization of foreign production or offshoring can provide employer firms better outside options — that is, foreign production — in wage bargaining with their domestic workers and help them reduce their negotiated domestic wages. The effect of the plant-moving threat, called the threat effect in this study, has been perceived widely in the literature (e.g., Freeman, 1995; Rodrik, 1997; Uchitelle, 2000; Burke and Epstein, 2001, 2007), and many researchers have studied the economic influences of this threat. For example, studies analyze the role of the threat effect in the strategic choice of foreign production location (e.g., Zhao, 1995; Naylor and Santoni, 1999), wage rate and employment level (e.g., Mezzetti and Dinopoulos, 1991; Zhao, 1998, 2001; Rodrik, 1999; Choi, 2001; Jeon and Kwon, 2016), union activity (e.g., Bronfenbrenner, 2000, 2001), firms' labor productivity (Seguino, 2007), and wage inequality (Kwon, 2011).

As discussed, the possibility of foreign production and the threat effect may induce lower domestic wages and higher profits for firms without actual foreign production. Further, the threat effect implies that firms could be motivated to invest abroad to pursue better options and gain stronger bargaining power in wage negotiations with their domestic workers. Hence, the mobility of production facilities itself might be a potential motivation for foreign production; however, to my knowledge, the threat motivation for offshoring has not been discussed in previous studies. Since, as previous studies argue (Helpman *et al*, 2004; Antràs and Helpman, 2004; Helpman, 2006), highly productive firms are more likely to offshore their production processes, the threat motivation for offshoring also implies that relatively more productive and offshorable firms may pay lower domestic wages.

Thus, this study theoretically examines (1) firms' motivation to offshore in order to explore the potential of the plant-moving threat and (2) whether highly productive and offshorable firms pay lower wages based on such threats. Following the theoretical models formalizing the threat effect

(Rodrik, 1999; Kwon, 2011; Jeon and Kwon, 2016), this study constructs a simple version of the traditional collective wage-bargaining model (McDonald and Solow, 1981) to consider the plant-moving threat. Furthermore, it incorporates the constructed wage-bargaining model into the orthodox FDI model with firm heterogeneity (Helpman *et al*., 2004) and studies the threat motivation for offshoring by more productive firms.[1)]

The rest of the paper is organized as follows. Section 2 presents a theoretical model to examine firms' locational choices for production processes, allowing for the threat effect and its theoretical implications. Section 3 presents the results, and section 4 summarizes.

2. THEORETICAL MODEL OF NEGOTIATED WAGES UNDER MATERIAL OFFSHORING

2.1. The Simple Model

Assume that manufacturing firm *i*, located in home country *H*, produces a differentiated final good $\theta_i \in \Theta$ and serves the global market. Assume also that the firm produces one unit of the final good by combining one unit each of two intermediate inputs, x_l, $l = 1, 2,$ and that there is no assembly cost. The two intermediate inputs differ in terms of their characteristics, but use the same production technology. In particular, assume further that the production of the intermediate inputs requires only labor input, and that firm *i* produces one unit of the intermediate input by using $1/\phi_i$ units of labor, where $\phi_i > 0$ is firm *i*'s productivity required to produce each intermediate input.

The intermediate inputs can be produced in the home country *H* or foreign country *F*, depending on firm *i*'s locational choice for production.[2)] If firm *i*

[1)] Recently, Felbermayr *et al*. (2011) constructed a similar theoretical model by combining the collective bargaining and trade model with firm heterogeneity and analyzed the influence of trade liberalization on unemployment and the wage level.

[2)] The final assembly can also be done in either the home or the foreign country, depending on decides to produce any one intermediate input in a foreign country, it will incur a positive fixed cost to establish a production facility $fe_i > 0$ in the foreign country. Furthermore, if the firm decides to produce additional intermediate inputs in the foreign country, it will have to expand its existing foreign production facility with an additional fixed cost of $fx_i > 0$. Assume that the fixed cost to establish a new production facility in the foreign country is higher than that required to expand an existing facility; that is, $fe_i > fx_i$. Domestic production may require some fixed start-up costs fe_i^H and fixed costs for expansion fx_i^H. Assume that the fixed costs for domestic production are relatively low or that the firm can simply convert its existing production facility to produce θ_i; we assume $fe_i^H = fx_i^H = 0$ for analytic tractability. Now, suppose that the wage rate in the home and foreign countries, w_H and w_F, respectively, are different. Assume that offshoring firms transfer their technologies to foreign affiliates, and, hence, foreign affiliates have the same productivities to parent firms. Given the technology, the marginal cost for firm *i* to produce one unit of the final good is simply $mc_i^{jk} = \left(w_j + w_k\right)/\phi_i \equiv \overline{w}_{jk}/\phi_i$, where $j,k \in \{H, F\}$ are the locations of the production facilities for inputs 1 and 2, respectively.

Turning to the demand for the final good θ_i, assume that the global market is integrated into a single market and that a representative consumer in the integrated global market has a constant elasticity of substitution (CES) utility function for $\theta_i \in \Theta$, where Θ is the set of differentiated final goods. Suppose also that the global demand for the final good θ_i is given by the following standard CES function:[3)]

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the firm’s decision. However, since we assume no additional cost for assembly of intermediate inputs, if no transportation cost is involved in the firm’s trade, the location of the final assembly process does not have any effect. Hence, for analytical simplicity, we assume that no transportation cost is involved in the firm’s trade and that the intermediate inputs are assembled into the final good in the home country.

3) Given demand function can be easily derived from the Dixit-Stiglitz type CES utility function. However, since the purpose of the paper is not the derivation of the full-scale equilibrium, the simplified CES demand function is used for the analytic tractability. The derivation of the simplified CES demand function from the Dixit-Stiglitz type CES utility function is in Appendix.

$$q(\theta) = Ap(\theta)^{-\varepsilon}, \quad \varepsilon > 1,$$

where $A > 0$. Before considering market competition, consider a simple monopoly situation to analyze firm i's optimal production choice. Assuming firm i has monopolistic power over its differentiated product market, we show that the profit and output of firm i become respectively

$$\begin{aligned} \pi_i^{jk}\left(w_j,\ w_k,\ \phi_i\right) &= \frac{A}{\varepsilon}\left(\frac{\varepsilon-1}{\varepsilon}\frac{\phi_i}{\overline{w}_{jk}}\right)^{\varepsilon-1} - \Gamma_i^{jk} \equiv \Phi_i\left(A,\ \phi_i\right)\left(\frac{1}{\overline{w}_{jk}}\right)^{\varepsilon-1} - \Gamma_i^{jk}, \\ q_i^{jk}\left(w_j,\ w_k,\ \phi_i\right) &= A\left(\frac{\varepsilon-1}{\varepsilon}\frac{\phi_i}{\overline{w}_{jk}}\right)^{\varepsilon}. \end{aligned} \tag{1}$$

Where $\Phi_i\left(\phi_i,\ A\right) \equiv \left(A/\varepsilon\right)\left(\phi_i\left(\varepsilon-1\right)/\varepsilon\right)^{\varepsilon-1}$, and Γ_i^{jk} denotes the fixed cost of firm i, which depends on the firm's location choice for producing inputs $j,k \in \{H,\ F\}$. Note that $\partial\Phi_i / \partial\phi_i \geq 0$ and $\partial\Phi_i / \partial A \geq 0$. Note that, since $\Phi_i\left(\phi_i,\ A\right)$ is increasing in ϕ_i, productivity ϕ_i can be obtained from the inverse function of $\Phi_i\left(\phi_i,\ A\right)$.

Given the technology and demand structure, suppose that monopoly firm i plays the following three-stage offshoring and wage-bargaining game:

1) Firm i chooses the location for producing intermediate inputs x_l, $l \in \{1,\ 2\}$; the firm can produce any of the intermediate inputs in either the home or the foreign country. Once firm i decides to offshore one of the intermediate inputs to a foreign country, it auctions an affiliate's location to the potential host countries, considering the offered wage rates of those countries. Thus, the wage rate w_F for foreign production is assumed to be nonnegotiable and given.[4)]
2) Depending on the location chosen for producing its intermediate inputs, firm i undertakes a wage-bargaining game with the representative of its workers. In particular, if firm i decides to produce input x_l,

[4)] Even if the wage negotiation in foreign country is allowed, the result in the paper is not changed if the competitive wage level in foreign country is lower than that in host country. It is because that, if the competitive wage level in foreign country is lower than in home country, the negotiated wage in foreign country is lower than in home country.

$l \in \{1, 2\}$ in the home country, it undertakes a wage-bargaining game with the representative of the workers who produce input x_l. However, if the firm decides to produce x_l, $l \in \{1, 2\}$ in a foreign country, it will have to pay the given foreign wage rate w_F to produce the inputs in the foreign country without any wage negotiation.

3) Given the results in the above two stages, if firm *i* operates in the market, it will choose a monopolistic output level to maximize its profits.

As described above, if firm *i* decides to produce any one of the intermediate inputs in its home country in the first stage, the wage rate of the home country workers is determined by a Nash bargaining game. If the wage negotiation succeeds, the firm earns profits and the workers earn the negotiated wage income. However, if the wage negotiation in the home country fails, firm *i* and the workers may exercise other options. Specifically, the domestic workers will work for other industries and earn competitive wages w_H^c. Unlike for domestic workers, the firm's outside options depend on the feasibility of foreign production. That is, if the firm's wage bargaining with domestic workers fails and it has an established foreign production facility, one option for the firm would be to expand that facility with an additional fixed cost fx_i and offshore the domestic intermediate input to the foreign country. The other option for the firm is not to produce the final good, earn nothing, and even lose the fixed cost already incurred.[5)]

Assume that firm *i* cares about its monopoly profits, and the representative of the workers cares about the aggregate wage income of the employed workers. Thus, the utility function of the workers' representative is given

5) When a wage negotiation fails, firms that do not have foreign production facilities may continue their production by establishing foreign facilities or outsourcing their production to foreign producers, similar to those that have foreign production facilities. However, for such firms, moving their production process to a foreign country is relatively costly and is a less likely choice. Hence, for analytical simplicity, we assume that only producers having foreign facilities switch their production location to a foreign country by incurring additional costs.

by $u\left(w_H, L_i\right) = w_H L_i$, where w_H stands for the negotiated wage and L_i the employment level offered by firm *i* in the home country. If the firm auctions the location of the input production to the possible host countries, the wage rate of the workers in the foreign production unit will be the lowest (competitive) foreign wage rate w_F, and there will be no negotiation regarding this wage. Finally, assume that the wage rate in the foreign country *F* is not higher than the competitive wage rate in the host country *H*; that is, $w_F \le w_H^c$.

Now, consider the Nash wage-bargaining game in the home country. If the bargaining powers of firm *i* and the representative of the domestic workers are α and $1-\alpha$, respectively, and the firm produces one of the intermediate inputs in the home country, the Nash product between firm *i* and the domestic workers is given by

$$NP_i^{jk} = \left[\pi_i^{jk}\left(w_H, \phi_i\right) - \bar{\pi}_i\right]^{\alpha} \left[\left(w_H - w_H^c\right) L_i^{jk}\left(w_H, \phi_i\right)\right]^{1-\alpha} \quad \text{for} \quad j,k \in \left\{H, F\right\},$$

where $\bar{\pi}_i$ is the outside option of firm *i*, and $L_i^{jk}\left(w_H, \phi_i\right)$ is the employment level offered by firm *i* in the home country when an input is produced in each of countries *j* and *k*.

2.2. Firms' Locational Choice and Wage Negotiation

Given the structure of the three-stage game, firm *i* has four available choices for the production location: $jk \in \left\{HH, HF, FH, FF\right\}$, where *j* and *k* are firm *i*'s location choices for the production of inputs 1 and 2, respectively. Since the two differentiated inputs are technically identical, HF and FH are mathematically and technically identical. Therefore, firm *i* has three possible strategies: domestic production $(\eta_i = 0)$, partial offshoring $(\eta_i = 1)$, and full offshoring $(\eta_i = 2)$, where η_i denotes the number of offshored intermediate inputs.

2.2.1. Full offshoring (*FF*, $\eta_i = 2$)

First, consider the situation in which firm *i* offshores both the intermediate inputs to a foreign country. The firm produces all its intermediate inputs in the foreign country using foreign labor with fixed costs fe_i and fx_i. Assuming no wage bargaining in the foreign country, as discussed earlier, firm *i*'s profit with the production mode of full offshoring is simply

$$\pi_i^{FF}\left(w_F,\ \phi_i\right) = \Phi_i\left(A,\ \phi_i\right)\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - fe_i - fx_i \equiv o\pi_i^{FF}\left(w_F,\ \phi_i\right) - fe_i - fx_i,$$

where $\overline{w}_{FF} = 2w_F$, and $o\pi_i^{FF}\left(w_F,\ \phi_i\right)$ is firm *i*'s operating profit with full offshoring.

2.2.2. Partial offshoring (*HF*, $\eta_i = 1$)[6)]

Now, consider the situation in which firm *i* offshores one of the two intermediate inputs to a foreign country. The firm produces one of the intermediate inputs in its home country using domestic workers by paying them the negotiated wage w_H, and produces the other input in the foreign country with wage rate w_F and fixed cost fe_i. Therefore, the profit and output of the firm are respectively given as

$$\pi_i^{HF}\left(w_H,\ w_F,\ \phi_i\right) = \Phi_i\left(A,\ \phi_i\right)\left(\frac{1}{\overline{w}_{HF}}\right)^{\varepsilon-1} - fe_i, \text{ and}$$

$$q_i^{HF}\left(w_H,\ w_F,\ \phi_i\right) = A\left(\frac{\varepsilon-1}{\varepsilon}\frac{\phi_i}{\overline{w}_{HF}}\right)^{\varepsilon}, \text{ where } \overline{w}_{HF} = \overline{w}_{FH} = w_H + w_F .$$

Note that the firm's domestic employment is $L_i^{HF}\left(w_H,\ w_F,\ \phi_i\right) = q_i^{HF}$, and it negotiates for a wage settlement with the representative of the domestic

6) Because partial offshoring in this paper is a production mode that one intermediate input is produced in home and another intermediate input is produced in foreign country. Hence, partial offshoring in this paper is intrinsically the same to the vertical offshoring in offshoring literatures such as Helpman (1984), Antràs and Helpman (2005) and Grossman and Rossi-Hansberg (2008). Vertical offshoring with production facilities in two countries is engaged in intra-firm and intra-industry trade (e.g., Han and Lee, 2012).

workers. Clearly, the firm's negotiated wage depends on the credibility of its plant-moving threat. That is, if the threat of further offshoring of the domestic input in the wage negotiation is credible, the outside option of the firm in the wage bargaining is $\pi_i^{FF}\left(w_F,\ \phi_i\right)$. Otherwise, its outside option is simply the loss of its fixed cost $-fe_i$. We call the former partial offshoring with threat, and the latter partial offshoring without threat.

1) Partial offshoring without threat (*HF*(*NT*))

First, consider the situation of partial offshoring without threat. Assume that the threat of offshoring the intermediate inputs to a foreign country is not credible. Now, the outside options of the firm and the workers in wage negotiation are $-fe_i$ and a competitive wage rate, respectively. Thus, the Nash product between the two parties in the home country is

$$\begin{aligned} NP_i^{HF(NT)} &= \left[\pi_i^{HF}\left(w_H,\ w_F,\ \phi_i\right)+fe_i\right]^{\alpha}\left[\left(w_H-w_H^c\right)q_i^{HF}\left(w_H,\ w_F,\ \phi_i\right)\right]^{1-\alpha} \\ &\equiv \left[\Pi_i^{HF}\right]^{\alpha}\left[U_i^{HF}\right]^{1-\alpha}, \end{aligned} \tag{2}$$

where $\Pi_i^{HF}\equiv\pi_i^{HF}\left(w_H,w_F,\phi_i\right)+fe_i$ and $U_i^{HF}\equiv\left(w_H-w_H^c\right)q_i^{HF}\left(w_H,w_F,\phi_i\right)$. By solving the first-order condition of the Nash bargaining game, the negotiated domestic wage rate can be obtained. The negotiated domestic wage rate with partial offshoring without threat is

$$\hat{w}_H^{NT}=w_H^c+\frac{1-\alpha}{\varepsilon-1}\left(w_H^c+w_F\right)>w_F\,. \tag{3}$$

Therefore, $\bar{w}_{HF(NT)}=\hat{w}_H^{NT}+w_F=\left[\left(\varepsilon-\alpha\right)/\left(\varepsilon-1\right)\right]\left(w_H^c+w_F\right)>\bar{w}_{FF}$.

2) Partial offshoring with threat (*HF*(*T*))

Now, consider the situation of partial offshoring with threat. Assume that firm *i*'s threat to offshore a domestic intermediate input to a foreign country is credible. Since, as assumed earlier, the firm can easily expand its foreign production facility and produce its intermediate input if its domestic wage negotiation fails, the outside option of the firm in its wage bargaining is

$\bar{\pi}_i = \pi_i^{FF}\left(w_F, \phi_i\right)$. Therefore, the Nash product between firm i and the representative of the domestic workers in partial offshoring with threat is

$$\begin{aligned} NP_i^{HF(T)} &= \left[\pi_i^{HF}\left(w_H, w_F, \phi_i\right) - \pi_i^{FF}\left(w_F, \phi_i\right)\right]^{\alpha} \\ &\quad \times \left[\left(w_H - w_H^c\right) q_i^{HF}\left(w_H, w_F, \phi_i\right)\right]^{1-\alpha} \\ &= \left[\Pi_i^{HF} - \left(o\pi_i^{FF} - fx_i\right)\right]^{\alpha} \left[U_i^{HF}\right]^{1-\alpha}. \end{aligned}$$

As the Nash product is not linear, it is difficult to derive an explicit solution to the negotiated domestic wage settlement. However, the range of negotiated wages can be obtained from the first-order condition. Using simple algebra, we can rewrite the first-order condition of the Nash bargaining game between the firm and workers as follows:

$$\begin{aligned} &\left[\alpha\left(\frac{U_i^{HF}}{\Pi_i^{HF}}\right)^{1-\alpha} \frac{\partial \Pi_i^{HF}}{\partial w_H} + (1-\alpha)\left(\frac{\Pi_i^{HF}}{U_i^{HF}}\right)^{\alpha} \frac{\partial U_i^{HF}}{\partial w_H}\right] \\ &-(1-\alpha)\frac{o\pi_i^{FF} - fx_i}{\Pi_i^{HF}}\left(\frac{\Pi_i^{HF}}{U_i^{HF}}\right)^{\alpha} \frac{\partial U_i^{HF}}{\partial w_H} = 0. \end{aligned} \tag{4}$$

Note that the expression within the squared bracket in equation (4) is identical to the first-order condition of Nash product (2).

Proposition 1: *If the offshoring of a domestic intermediate input is a credible threat, there exists negotiated domestic wage* $\hat{w}_H^T$ *such that* $\hat{w}_H^T \in \left[w_H^c,\ \hat{w}_H^{NT}\right]$.

Proof: Since the expression within the squared bracket in equation (4) is essentially identical to the first-order condition in offshoring without threat, $\hat{w}_H^{NT}$ converts the expression within the squared bracket to zero. Further, note that $\partial U_i^{HF} / \partial w_H \mid_{w_H = \hat{w}_H^{NT}} \geq 0$ because

$$\left.\frac{\partial U_i^{HF}}{\partial w_H}\right|_{w_H=\hat{w}_H^{NT}} = q_i^{HF}\left(\hat{w}_H^{NT}\right)\left(1-\varepsilon\frac{\left(\hat{w}_H^{NT}-w_H^c\right)}{\hat{w}_H^{NT}+w_F}\right) = q_i^{HF}\left(\hat{w}_H^{NT}\right)\frac{\left(\varepsilon-1\right)\alpha}{\varepsilon-\alpha} \geq 0 .$$

Therefore, the LHS of equation (4) is non-positive, implying that $\hat{w}_H^T \leq \hat{w}_H^{NT}$. Combining this result with $\hat{w}_H^{NT} > w_H^c$, we have $\hat{w}_H^T \in \left[w_H^c, \hat{w}_H^{NT}\right]$. Q.E.D.

Proposition 1 implies that if a firm offshores a domestic intermediate input to a foreign country, the firm can reduce its negotiated domestic wages by threatening its employees that it will move its production process in case of need.

Corollary 1.1: *If the offshoring of a domestic intermediate input is a credible threat, firm i can reduce its marginal cost to produce its final good by threatening its domestic employees that it will offshore its production process in case of need. That is,* $\overline{w}_{FF} \leq \overline{w}_{HF(T)} \leq \overline{w}_{HF(NT)}$.

Proof: Since $w_F \leq w_H^c$ and $\hat{w}_H^T \in \left[w_H^c,\ \hat{w}_H^{NT}\right]$ from proposition 1, $\overline{w}_{FF} = 2w_F \leq \overline{w}_{HF(T)} = \hat{w}_H^T + w_F \leq \hat{w}_H^{NT} + w_F = \overline{w}_{HF(NT)}$. Q.E.D.

3) Credibility of the threat

Note that the plant-moving threat is credible only if $\pi_i^{FF} \geq \pi_i^{HF(NT)}$ and the firm can threaten its domestic workers in the wage-bargaining game. Therefore, the profit of firm *i* with partial offshoring can be expressed as follows:

$$\pi_i^{HF} = \begin{cases} \pi_i^{HF(NT)} & \text{if } \Phi_i \leq fx_i\left[\left(1/\overline{w}_{FF}\right)^{\varepsilon-1} - \left(1/\overline{w}_{HF(NT)}\right)^{\varepsilon-1}\right]^{-1} \equiv \Phi_1 \\ \pi_i^{HF(T)} & \text{if } \Phi_i \geq \Phi_1 \end{cases}, \qquad (5)$$

where the cutoff Φ_1 of a credible plant-moving threat can be obtained from the credibility condition.[7)]

2.2.3. Domestic production (*HH*, $\eta_i = 0$)

Now, consider the case in which firm *i* produces all its intermediate inputs in the home country with a negotiated domestic wage w_H. Since no fixed cost is involved in foreign production, the profit and output of the firm are respectively given as follows:

$$\pi_i^{HH}\left(w_H,\ \varphi_i\right) = \Phi_i\left(A,\ \varphi_i\right)\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}, \text{ and } q_i^{HH}\left(w_H,\ \varphi_i\right) = A\left(\frac{\varepsilon-1}{\varepsilon}\frac{\varphi_i}{\overline{w}_{HH}}\right)^{\varepsilon},$$

where $\overline{w}_{HH} = 2w_H^{HH}$ and the domestic employment level of firm *i* is $L_i^{HF}\left(w_H, \varphi_i\right) = 2q_i^{HH}$.

Unlike in the partial offshoring case, the firm does not have any production facility outside the home country. Therefore, once the wage negotiation fails, the firm cannot produce anything and earns nothing. The outside options of the firm and workers in wage negotiation are zero and a competitive wage rate, respectively. Thus, the Nash product between the two parties in a negotiated domestic wage settlement with domestic production is

$$NP_i^{HH} = \left[\pi_i^{HH}\left(w_H, \varphi_i\right)\right]^{\alpha}\left[\left(w_H - w_H^c\right)2q_i^{HH}\left(w_H, \varphi_i\right)\right]^{1-\alpha};$$

$$w_H^{HH} = \frac{\varepsilon-\alpha}{\varepsilon-1} w_H^c > w_H^c .$$

From $\varepsilon \geq 1 \geq \alpha$, $w_H^{HH} \in \left[w_H^c,\ \hat{w}_H^{NT}\right]$.[8)] Corollary 1.1 implies

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7) $\pi_i^{FF} \geq \pi_i^{HF(NT)} \Leftrightarrow \Phi_i \geq fx_i\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(NT)}}\right)\right]^{-1} \equiv \Phi_1 \geq 0.$

8) $\hat{w}_H^{NT} = \frac{\varepsilon-\alpha}{\varepsilon-1} w_H^c + \frac{1-\alpha}{\varepsilon-1} w_F \geq \frac{\varepsilon-\alpha}{\varepsilon-1} w_H^c = w_H^{HH}$, since $\varepsilon \geq 1 \geq \alpha$.

$\overline{w}_{FF} \le \overline{w}_{HF(T)} \le \overline{w}_{HF(NT)} \le \overline{w}_{HH}$. [9)]

3. RESULTS

3.1. Firms' Location Decisions

Profit-maximizing firm *i* chooses a location for input production such that it obtains maximum profit. In the first stage of the game, the firm's profit is $\pi_i = \max\left[\pi_i^{HH},\ \pi_i^{HF(NT)},\ \pi_i^{HF(T)},\ \pi_i^{FF}\right]$. Note that, given a productivity of ϕ_i, the profit of the firm, as shown in equation (1), is a linear function of $\Phi_i\left(A\right)$; that is, the profit slope is steeper if $\overline{w}_{jk}$ is higher, and the fixed cost structure determines the intercept of profit at the *y*-axis. Since $\overline{w}_{FF} \le \overline{w}_{HF(T)} \le \overline{w}_{HF(NT)} \le \overline{w}_{HH}$ and $\Gamma_i^{FF} \ge \Gamma_i^{HF} \ge \Gamma_i^{HH}$, where Γ_i^{jk} denotes the fixed costs of firm *i*, which produces the two inputs in countries *j* and *k* for $j,k \in \{H,\ F\}$, we can analyze the optimal location choice for the firm. Note that the cutoff between *HF*(*NT*) and *FF* is Φ_1. Now, let Φ_2 and Φ_3 be the respective cutoffs between *HH* and *FF* and between *HH* and *HF*(*NT*). Similarly, let $\hat{\Phi}_1$ and $\hat{\Phi}_3$ be the respective cutoffs between $HF(T)$ and FF and between HH and $HF(T)$:[10)]

$$\Phi_2 \equiv \left(fe_i + fx_i \right) \left[\left(\frac{1}{\overline{w}_{FF}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right]^{-1}; \tag{6}$$

---

9) $\overline{w}_{HF(T)} = \frac{\varepsilon-\alpha}{\varepsilon-1}\left(w_H^c + w_F\right) \le 2\frac{\varepsilon-\alpha}{\varepsilon-1} w_H^c = \overline{w}_{HH}$ and $\overline{w}_{FF} \le \overline{w}_{HF(T)} \le \overline{w}_{HF(NT)}$ from corollary 1.1.

10) We obtain cutoffs Φ_2 and Φ_3 from $\pi_{HH} = \pi_{FF}$ and $\pi_{HH} = \pi_{HF(NT)}$, respectively. Similarly, cutoffs $\hat{\Phi}_1$ and $\hat{\Phi}_3$ are obtained from $\pi_{FF} = \pi_{HF(T)}$ and $\pi_{HH} = \pi_{HF(T)}$, respectively.

$$\Phi_3 \equiv fe_i \left[\left(\frac{1}{\overline{w}_{HF(NT)}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right]^{-1}; \tag{7}$$

$$\hat{\Phi}_1 \equiv fx_i \left[\left(\frac{1}{\overline{w}_{FF}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(T)}} \right)^{\varepsilon-1} \right]^{-1} \geq \Phi_1; \tag{8}$$

$$\hat{\Phi}_3 \equiv fe_i \left[\left(\frac{1}{\overline{w}_{HF(T)}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right]^{-1} \leq \Phi_3. \tag{9}$$

For analytic convenience, we assume that a plant-moving threat is not allowed, and that the firm's available locational strategies are domestic production (HH), partial offshoring without threat ($HF(NT)$), and full offshoring (FF). First, consider the situation in which $\Phi_2 \leq \Phi_3$. A simple algebraic calculation gives us $\Phi_1 \leq \Phi_2 \leq \Phi_3$ from $\Phi_2 \leq \Phi_3$, indicating that the firm never chooses partial offshoring without threat (see the appendix and figure 1).

Note that condition $\Phi_2 \leq \Phi_3$ can be rewritten as

$$\Phi_2 \leq \Phi_3 \Leftrightarrow \frac{fx_i}{fe_i} \leq \frac{\left(1/\overline{w}_{FF}\right)^{\varepsilon-1} - \left(1/\overline{w}_{HF(NT)}\right)^{\varepsilon-1}}{\left(1/\overline{w}_{HF(NT)}\right)^{\varepsilon-1} - \left(1/\overline{w}_{HH}\right)^{\varepsilon-1}} \equiv \Omega_{NT}. \tag{10}$$

Condition (10) implies that, for a firm with established foreign production facility, the fixed cost to expand in an existing foreign production facility is low enough compared to the marginal cost advantage of full offshoring: $fx_i \leq \Omega_{NT}\, fe_i$. Therefore, the firm prefers full offshoring to partial offshoring without threat. For a firm without foreign production facility, the fixed cost to establish a production facility is high enough to establish a foreign affiliate: $fe_i \geq fx_i / \Omega_{NT}$. Hence, the firm without foreign affiliate does not establish one.

Now, suppose that the plant-moving threat is allowed. We can show that for a certain range of $\left(fe_i, fx_i\right)$, the firm is likely to engage in partial offshoring even if the additional fixed cost to expand the foreign production facility is relatively high and partial offshoring without threat does not have any advantage over other production modes. This case is shown in figure 1.

Proposition 2: *Even if* $fx_i / fe_i \le \Omega_{NT}$ *, firms may prefer partial offshoring for the advantage of domestic wage bargaining up to a certain range of* Φ *and* $\left(fe_i, fx_i\right)$.

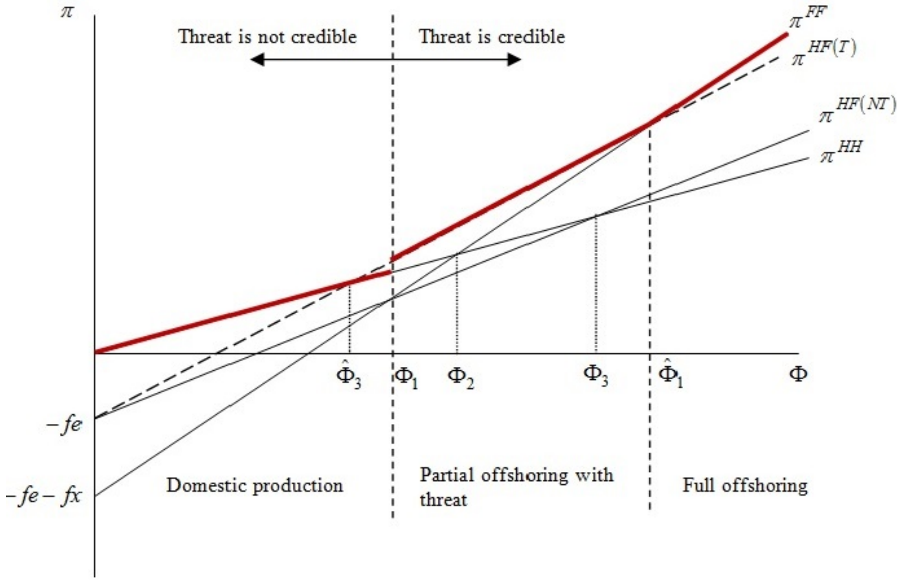
Proof: Note that condition $\Phi_2 \le \Phi_3$ implies that $fx_i / fe_i \le \Omega_{NT}$. From the definition of $\hat{\Phi}_1$, the firm chooses offshoring with threat over full offshoring, and the threat to offshore is credible only if $\Phi \in \left[\Phi_1, \hat{\Phi}_1\right]$; that is, $\pi_{HF,T} \ge \pi_{FF}$ only if $\Phi \le \hat{\Phi}_1$ and $\pi_{HF(NT)} \le \pi_{FF}$ only if $\Phi \ge \Phi_1$. Clearly, $\left[\Phi_1, \hat{\Phi}_1\right]$ is not empty because $\hat{\Phi}_1 \ge \Phi_1$. Further, partial offshoring with threat is a better choice for firms over domestic production only if $\pi_{HF(T)} \ge \pi_{HH}$ and $\Phi \ge \hat{\Phi}_3$. Thus, the condition for firms to choose partial offshoring with threat over other production modes is $\Phi \in \left[\max\left[\Phi_1, \hat{\Phi}_3\right], \hat{\Phi}_1\right]$. Since $\hat{\Phi}_1 \ge \Phi_1$, $\left[\max\left[\Phi_1, \hat{\Phi}_3\right], \hat{\Phi}_1\right]$ is not an empty set only if $\hat{\Phi}_1 \ge \hat{\Phi}_3$. Using simple algebra (see the appendix), we derive $\hat{\Phi}_3 \le \Phi_2$ from $\hat{\Phi}_1 \ge \hat{\Phi}_3$ and obtain the following condition:

$$\hat{\Phi}_3 \le \Phi_2 \Leftrightarrow \frac{fx_i}{fe_i} \ge \frac{\left(1/\bar{w}_{FF}\right)^{\varepsilon-1} - \left(1/\bar{w}_{HF(T)}\right)^{\varepsilon-1}}{\left(1/\bar{w}_{HF(T)}\right)^{\varepsilon-1} - \left(1/\bar{w}_{HH}\right)^{\varepsilon-1}} \equiv \Omega_T .$$

Combining this with $fx_i / fe_i \le \Omega_{NT}$, the proposition holds only if there exists any fx_i / fe_i such that $fx_i / fe_i \in \left[\Omega_T, \Omega_{NT}\right]$, because $\bar{w}_{HF(NT)} \le \bar{w}_{HF(T)}$, $\Omega_T \le \Omega_{NT}$, and therefore $\left[\Omega_T, \Omega_{NT}\right]$ is not empty. Thus, for some $fx_i / fe_i \in \left[\Omega_T, \Omega_{NT}\right]$ and $\Phi \in \left[\Phi_1, \hat{\Phi}_1\right]$, partial offshoring with threat is the firm's optimal choice. Q.E.D.

Figure 1 presents proposition 2 and the optimal production mode of firm *i*. From proposition 2 and figure 1, we have the following corollary, but

Figure 1 Proposition 2

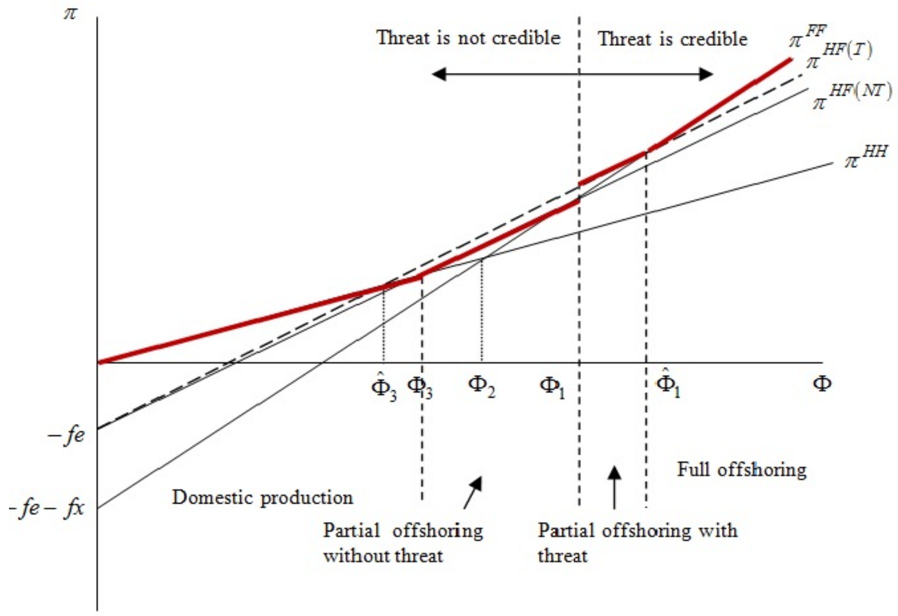


with no proof.

Corollary 2.1: *Assuming* $fx_i\ /\ fe_i \in [\Omega_T,\ \Omega_{NT}]$, *firm* i *produces both the inputs through (1) domestic production if* $\Phi \in (0,\ \Phi_1]$, *(2) partial offshoring with threat if* $\Phi \in \left[\Phi_1,\ \hat{\Phi}_1\right]$, *and (3) full offshoring if* $\Phi \in \left[\hat{\Phi}_1,\ \infty\right)$. *Further, assuming* $fx_i\ /\ fe_i \le \Omega_T$, *firm* i *produces both the inputs through (1) domestic production if* $\Phi \in (0,\ \Phi_2]$, *and (2) full offshoring if* $\Phi \in [\Phi_2,\ \infty)$.

Corollary 2.1 suggests that for a certain range of $(fe_i,\ fx_i)$ such that $fx_i\ /\ fe_i \in [\Omega_T,\ \Omega_{NT}]$, firm i determines its location for input production according to the following rules because $\Phi(A,\ \phi)$ is a increasing function of market size and productivity. If the firm has low productivity or a small market, it chooses to produce both the inputs in its home country. If the firm has moderate productivity or market size, it establishes a foreign production facility to produce one of the two inputs and exercises the outside

Figure 2 Proposition 3



option in domestic wage negotiations; otherwise, it prefers to produce both the inputs in the foreign country. For $fx_i / fe_i \leq \Omega_T$, since the firm's plant-moving threat is not credible and partial production is not desirable, the firm with low productivity or small market decides to produce both the inputs in the home country; otherwise, it prefers to offshore both inputs to the foreign country.

Now, consider the situation in which $\Phi_3 \leq \Phi_2$. A simple algebraic calculation gives us $\Phi_3 \leq \Phi_2 \leq \Phi_1$ from $\Phi_3 \leq \Phi_2$, and the firm can choose partial offshoring without threat as well as partial offshoring with threat (see the appendix and figure 2). Hence, we have proposition 3:

Proposition 3: *If* $\Phi_3 \leq \Phi_2$, *both partial offshoring without threat and partial offshoring with threat are available production modes for the firm, depending on the firm's productivity.*

Proof: Note that when $\Phi_3 \le \Phi_2$, it implies that $\hat{\Phi}_3 \le \Phi_3 \le \Phi_2 \le \Phi_1 \le \hat{\Phi}_1$ (see the appendix). Since any $\Phi \in \left[\Phi_1,\ \hat{\Phi}_1\right]$ satisfies $\Phi \ge \hat{\Phi}_3$, the firm that has $\Phi \in \left[\Phi_1,\ \hat{\Phi}_1\right]$ chooses partial offshoring with plant-moving threat. Further, a firm that has $\Phi \in \left[\Phi_3,\ \Phi_1\right]$ chooses partial offshoring without threat (see figure 2). Q.E.D.

As $\Phi_3 \le \Phi_2$ can be rewritten as $fx_i / fe_i \ge \Omega_{NT}$, it implies that the fixed cost for a firm to expand its existing foreign production facility is relatively low compared to the marginal cost advantage of partial offshoring. Therefore, the firm can consider partial offshoring without threat as a potential production mode just as it does full offshoring or domestic production. Further, if full offshoring results in more profit than partial offshoring without threat, the plant-moving threat will be credible and the firm will be able to reduce its negotiated domestic wage by threatening the workers (partial offshoring with threat). Figure 2 presents the optimal production mode of firm i, and we have corollary 9, but with no additional proof.

Corollary 3.1: *If $fx_i / fe_i \ge \Omega_{NT}$, firm i produces both the inputs through (1) domestic production if $\Phi \in \left(0,\ \Phi_3\right]$, (2) partial offshoring without threat if $\Phi \in \left[\Phi_3,\ \Phi_1\right]$, (3) partial offshoring with threat if $\Phi \in \left[\Phi_1,\ \hat{\Phi}_1\right]$, and (4) full offshoring if $\Phi \in \left[\hat{\Phi}_1,\ \infty\right)$.*

Corollary 3.1 shows that owing to the relatively low fixed cost to expand its foreign production facility, firm *i* decides its location for the input production based on the following rules. If the firm has very low productivity or a very small market, it chooses to produce both the inputs in its home country. If the firm has relatively low (but not too low) productivity or a relatively small (but not too small) market, it establishes a foreign production facility to produce one of the two inputs. In this case, using the plant-moving threat in domestic wage negotiations is not credible because offshoring all the intermediate inputs would not be profitable. If the firm has relatively high (but not too high) productivity and a relatively large (but not too large) market, offshoring all the inputs is profitable, the plant-moving threat becomes credible, and the firm chooses partial offshoring with threat; otherwise, the firm prefers to produce both the inputs in the foreign country.

Note that $\hat{w}_H^T \leq \hat{w}_H^{NT} \leq w_H^{HH}$. Corollary 3.1 and the fact that $\partial\Phi_i / \partial\phi_i \geq 0$ imply that if firm i has high productivity, it is more likely to pay lower negotiated domestic wages to its workers in the home country.

Corollary 3.2: *Highly productive firms may be motivated to engage in partial offshoring in order to pay lower domestic wages through the threat effect.*

3.2. Industry Equilibrium

As discussed above, firm i can reduce its negotiated domestic wages with the threat of additional offshoring. In this subsection, we discuss the industry equilibrium based on the firm's decision rules in a monopolistic competitive market. First, assume that the market for final good Θ is monopolistic competitive and that many firms, including firm i, are considering entry into the final good Θ market. Consider the following Melitz-type entry/exit sequence for firms (Melitz, 2003).

1) Initially, firms considering market entry are identical, and they do not know their productivity prior to entry. They must pay a positive fixed entry cost ft_i, which is an irreversible sunk cost, to enter the market and draw their productivity.
2) Once firms enter the market, they draw their productivity ϕ from a common distribution $\mu(\phi)$ with positive support $[0, \infty)$ and realize their productivity. A firm that draws low productivity may decide to exit from the market immediately without producing any final good. A firm that decides to produce the final good plays the offshoring/wage-bargaining game described in the previous section: that

is, it chooses the optimal production modes from HH, $HF(NT)$, $HF(T)$, and FF.

3) Given the firms' entry decisions and optimal production modes, they compete with one another in the monopolistic competitive market. Once a firm produces the final good, it earns monopolistic profit $\pi_{i\in I}^{jk}$, where I is a set of firms and $jk \in \{HH, HF(NT), HF(T), FF\}$ denote the production modes.

Because the realized productivity ϕ differs across all firms, those in the Θ market are heterogeneous in terms of productivity and form a monopolistic competitive market consisting of heterogeneous firms. The above entry/exit sequence is the standard setup of the Melitz model, and we can directly apply this model to derive the industry equilibrium. However, unlike the original Melitz model, which considers an infinite time horizon and simple entry/exit dynamics, we consider a one-shot wage-bargaining game for analytic simplicity.[11)]

First of all, note that there is a fixed entry cost ft_i. Since the firms that draw low productivity exit before producing any final good, the firms that enter the market should draw the productivity that provides them non-negative profits. Hence, in equilibrium, a free-entry condition for monopolistic competition should be satisfied, $\pi^{HH}(\phi_Z;\, A^*) - ft_i = 0,$ where $\phi_Z(A^*)$ is the cutoff productivity. The free-entry condition can be rewritten as

$$\begin{aligned}\pi^{HH}(\phi_Z;\, A) - ft_i = 0 &\Leftrightarrow \Phi(\phi_Z, A)\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1} - ft_i = 0 \\ &\Rightarrow \Phi_Z \equiv \Phi(\phi_Z,\, A) = ft_i\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right]^{-1}.\end{aligned} \tag{11}$$

To avoid trivial situation, assume that the cutoff productivity $\phi_Z(A^*)$ is

11) Because the Melitz model focuses on a steady-state equilibrium with a constant exit rate δ in each period, an infinite-horizon analysis is basically identical to a single-period analysis.

lower than other productivity cutoffs in previous section. It implies that the fixed entry cost ft_i to draw productivity is low enough.[12)]

$$\text{Assumption: } \frac{ft_i}{fe_i} \le \frac{1}{\left(\bar{w}_{HH} / \bar{w}_{HF(T)}\right)^{\varepsilon-1} - 1}.$$

As discussed in the previous section, the firms' available production modes depend on the relative sizes of $\left(fe, fx\right)$. Consider the case of $fx_i / fe_i \le \Omega_T$ in corollary 2.1. Partial offshoring with/without threat is not an available choice for firms, and they have two production modes (*HH*, *FF*). The cutoff productivity $\phi_2\left(A\right)$ for a firm to choose its production mode between *HH* and *FF* is obtained from the condition $\Phi\left(\phi_2\left(A\right)\right) = \Phi_2$: that is, $\phi_2\left(A\right) = \Phi^{-1}\left(\Phi_2\right)$ where $\Phi^{-1}\left(\cdot\right)$ is a inverse function of $\Phi\left(\phi\right)$. Since firms continue to enter the market until their expected profit equals zero, the zero cutoff profit condition is

$$E\pi\left(A^*\right) = \int_{\phi_Z}^{\phi_2} \pi^{HH}\left(\phi, A^*\right)\mu\left(\phi\right)d\phi + \int_{\phi_2}^{\infty} \pi^{FF}\left(\phi, A^*\right)\mu\left(\phi\right)d\phi = 0, \qquad (12)$$

where A^* is the equilibrium market size satisfying (12) and $\phi_i = \Phi^{-1}\left(\Phi_i\right)$.[13)] Combining zero cutoff profit condition (12) and corollary 2.1, the following proposition can be obtained:

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12) Since the lowest cutoff in the previous section is $\hat{\Phi}_3$, this assumption means $\Phi_Z \le \hat{\Phi}_3$ and $\Phi_Z \le \hat{\Phi}_3$ can be modified as:

$$\Phi_z < \hat{\Phi}_3 \Leftrightarrow ft_i\left[\left(\frac{1}{\bar{w}_{HF(T)}}\right)^{\varepsilon-1} - \left(\frac{1}{\bar{w}_{HH}}\right)^{\varepsilon-1}\right] \le fe_i\left[\left(\frac{1}{\bar{w}_{HH}}\right)^{\varepsilon-1}\right]$$
$$\Leftrightarrow \frac{ft_i}{fe_i} \le \frac{1}{\left(\bar{w}_{HH} / \bar{w}_{HF(T)}\right)^{\varepsilon-1} - 1}.$$

13) In Melitz model, cutoff productivity ϕ_Z is determined from the zero cutoff profit condition and free-entry condition. In the model of the paper, A^* is determined from the zero cutoff profit condition and free-entry condition. Since ϕ_Z is a function of A^*, cutoff productivity ϕ_Z is also determined from the two conditions.

Proposition 4: *If* $fx_i\ /\ fe_i \le \Omega_T$ *in a monopolistic competitive market, there exists an equilibrium* A^* *such that the firms drawing the productivity of* $\phi \in \left[\phi_Z\left(A^*\right),\ \phi_2\left(A^*\right)\right]$ *produce both the inputs in their home country, and those drawing the productivity of* $\phi \in \left[\phi_2\left(A^*\right),\ \infty\right)$ *produce both their inputs in a foreign country.*

Proof: Appendix.

Consider the case of $fx_i\ /\ fe_i \in \left[\Omega_N,\ \Omega_{NT}\right]$. As discussed in corollary 2.1, firms can choose their production mode from domestic production (*HH*), partial offshoring with threat (*HF*(*T*)), and full offshoring (*FF*). Note that the free-entry condition $\pi^{HH}\left(\phi_Z;\ A\right) - ft_i = 0$ holds, and there are two cutoff productivity conditions for firms to decide on: $\Phi\left(\phi_1\left(A\right)\right) = \Phi_1$ and $\Phi\left(\hat{\phi}_1\left(A\right)\right) = \hat{\Phi}_1$, where $\phi_1\left(A\right)$ and $\hat{\phi}_1\left(A\right)$ are the respective cutoff productivities between *HF*(*NT*) and *HH* and between *HF*(*T*) and *FF*.[14] The zero cutoff profit condition is

$$E\pi\left(A^\dagger\right) = \int_{\phi_Z}^{\phi_1} \pi^{HH}\left(\phi, A^\dagger\right)\mu\left(\phi\right)d\phi + \int_{\phi_1}^{\hat{\phi}_1} \pi^{HF(T)}\left(\phi, A^\dagger\right)\mu\left(\phi\right)d\phi + \int_{\hat{\phi}_1}^{\infty} \pi^{FF}\left(\phi, A^\dagger\right)\mu\left(\phi\right)d\phi = 0, \tag{13}$$

where $A^\dagger$ is the equilibrium market size satisfying (13). Combining zero cutoff profit condition (13) and corollary 2.1, the following proposition can be obtained:

Proposition 5: *If* $fx_i\ /\ fe_i \in \left[\Omega_N,\ \Omega_{NT}\right]$ *in a monopolistic competitive market, there exists an equilibrium* $A^\dagger$ *such that the firms drawing the productivity of* $\phi \in \left[\phi_Z\left(A^\dagger\right),\ \phi_1\left(A^\dagger\right)\right]$ *produce both the inputs in their home country, those drawing the productivity of* $\phi \in \left[\phi_1\left(A^\dagger\right),\ \hat{\phi}_1\left(A^\dagger\right)\right]$ *engage in partial offshoring with the threat, and those drawing the productivity of* $\phi \in \left[\hat{\phi}_1\left(A^\dagger\right),\ \infty\right)$ *produce both the inputs in a foreign country.*

[14] See figure 1.

Proof: Appendix.

Finally, consider the case of $fx_i / fe_i \geq \Omega_{NT}$. As discussed in corollary 2.2, the production modes available to firms are domestic production (*HH*), partial offshoring without threat, partial offshoring with threat (*HF*(*T*)), and full offshoring (*FF*). Because firms have four available choices, there are three cutoff productivity conditions with regard to their decision rule: $\Phi\left(\phi_3\left(A\right)\right)=\Phi_3$, $\Phi\left(\phi_1\left(A\right)\right)=\Phi_1$, and $\Phi\left(\hat{\phi}_1\left(A\right)\right)=\hat{\Phi}_1$, where ϕ_3 is cutoff productivity between *HH* and *HF*(*NT*).[15] Further, the zero-profit condition $\pi^{HH}\left(\phi_Z;A\right)-ft_i=0$ still holds in equilibrium, and the following zero cutoff profit condition should be satisfied:

$$
\begin{aligned}
E\pi\left(\tilde{A}\right) &= \int_{\phi_Z}^{\phi_3}\pi^{HH}\left(\phi,\tilde{A}\right)\mu\left(\phi\right)d\phi+\int_{\phi_3}^{\phi_1}\pi^{HF(NT)}\left(\phi,\tilde{A}\right)\mu\left(\phi\right)d\phi \\
&\quad +\int_{\phi_1}^{\hat{\phi}_1}\pi^{HF(T)}\left(\phi,\tilde{A}\right)\mu\left(\phi\right)d\phi+\int_{\hat{\phi}_1}^{\infty}\pi^{FF}\left(\phi,\tilde{A}\right)\mu\left(\phi\right)d\phi \qquad (14) \\
&= 0,
\end{aligned}
$$

where $\tilde{A}$ is the equilibrium market size satisfying (14). Combining zero cutoff profit condition (14) and proposition 3, the following proposition can be obtained:

Proposition 6: *If* $fx_i / fe_i \geq \Omega_{NT}$ *in a monopolistic competitive market, there exists an equilibrium* $\tilde{A}$ *such that the firms drawing the productivity of* $\phi\in\left[\phi_Z\left(\tilde{A}\right),\ \phi_3\left(\tilde{A}\right)\right]$ *produce both the inputs in their home country, those drawing the productivity of* $\phi\in\left[\phi_3\left(\tilde{A}\right),\ \phi_1\left(\tilde{A}\right)\right]$ *engage in partial offshoring without threat, those drawing the productivity of* $\phi\in\left[\phi_1\left(\tilde{A}\right),\ \hat{\phi}_1\left(\tilde{A}\right)\right]$ *engage in partial offshoring with threat, and those drawing the productivity of* $\phi\in\left[\hat{\phi}_1\left(\tilde{A}\right),\ \infty\right)$ *produce both their inputs in a foreign country.*

Proof: Appendix.

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[15] See figure 2.

Propositions 5 and 6 show that, in monopolistic competitive equilibrium, some of relatively highly productive firms may be motivated engage in partial offshoring in order to pay lower domestic wages through the threat effect.

4. SUMMARY

It is widely believed that the mobility of firms' production facilities may provide employer firms an advantage over labor market employees in the home country because of the firms' ability to make plant-moving threats. This advantage of the plant-moving threat implies that firms could also be motivated to invest abroad to gain an advantage in wage negotiations with their domestic workers. Hence, the mobility of production facilities itself might be a potential motivation for foreign production.

This study developed a simple theoretical model to analyze this threat motivation for offshoring under wage negotiations between firms and labor unions. In particular, the traditional collective wage-bargaining model and the orthodox FDI model with firm heterogeneity are combined. The theoretical analysis suggests that firms may be motivated to offshore and explore the potential of a plant-moving threat and that highly productive and offshorable firms pay lower wages through such threats.

APPENDIX

A1. The Derivation of the Given CES Utility Function

Assume that a representative consumer in country H consumes the continuously differentiated goods $\theta \in \Theta$ and has the following CES utility function:

$$U = \left[\int_{\theta \in \Theta} q(\theta)^{(\varepsilon-1)/\varepsilon} \, d\theta \right]^{\varepsilon/(\varepsilon-1)},$$

where Θ is the set of differentiated goods. $\varepsilon > 1$ is the elasticity of substitution across varieties and is assumed to be constant across varieties. The budget constraint with the income R is $\int_{\theta \in \Theta} p(\theta) q(\theta) d\theta = R$. The demand function for a variety θ can be obtained from the utility maximization of the representative consumer:

$$q(\theta) = \frac{R}{P^{1-\varepsilon}} \left(p(\theta) \right)^{-\varepsilon} \equiv A p(\theta)^{-\varepsilon}, \text{ where } P = \left[\int_{\theta \in \Theta} p(\theta)^{1-\varepsilon} \, d\theta \right]^{1/(1-\varepsilon)}. \quad \text{(A1)}$$

P is the CES price index. For the consistency with previous sections, let $A = R / P^{1-\varepsilon}$ and, then, demand function (12) is equivalent to given CES demand function.

A2. Proof of $\Phi_2 \le \Phi_3 \rightarrow \Phi_1 \le \Phi_2 \le \Phi_3$

Proof:

$\Phi_2 \le \Phi_3$

$$\Leftrightarrow \left(fe_i + fx_i \right) \left[\left(\frac{1}{\overline{w}_{HF(NT)}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right] \le fe_i \left[\left(\frac{1}{\overline{w}_{FF}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right]$$

$$\Leftrightarrow fx_i \left[\left(\frac{1}{\overline{w}_{HF(NT)}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right] \le fe_i \left[\left(\frac{1}{\overline{w}_{FF}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(NT)}} \right)^{\varepsilon-1} \right]$$

$$\Leftrightarrow fx_i \left[\left(\frac{1}{\overline{w}_{FF}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}} \right)^{\varepsilon-1} \right] \le \left(fe_i + fx_i \right) \left[\left(\frac{1}{\overline{w}_{FF}} \right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(NT)}} \right)^{\varepsilon-1} \right]$$

$\Leftrightarrow \Phi_1 \le \Phi_2$.

Therefore, $\Phi_1 \le \Phi_2 \le \Phi_3$. Q.E.D.

A3. Proof of $\hat{\boldsymbol{\Phi}}_1 \le \hat{\boldsymbol{\Phi}}_3 \to \boldsymbol{\Phi}_2 \le \hat{\boldsymbol{\Phi}}_3$ and $\hat{\boldsymbol{\Phi}}_1 \ge \hat{\boldsymbol{\Phi}}_3 \to \hat{\boldsymbol{\Phi}}_3 \le \boldsymbol{\Phi}_2$

Proof:

$$\hat{\Phi}_1 \le \hat{\Phi}_3$$

$$\Leftrightarrow fx_i\left[\left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right] \le fe_i\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1}\right]$$

$$\Leftrightarrow (fe_i + fx_i)\left[\left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right] \le fe_i\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right]$$

$$\Leftrightarrow \Phi_2 \le \hat{\Phi}_3.$$

Q.E.D.

A4. Proof of $\boldsymbol{\Phi}_3 \le \boldsymbol{\Phi}_2 \to \hat{\boldsymbol{\Phi}}_3 \le \boldsymbol{\Phi}_3 \le \boldsymbol{\Phi}_2 \le \boldsymbol{\Phi}_1 \le \hat{\boldsymbol{\Phi}}_1$

Proof:

$$\Phi_3 \le \Phi_2$$

$$\Leftrightarrow fe_i\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right] \le (fe_i + fx_i)\left[\left(\frac{1}{\overline{w}_{HF(NT)}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right]$$

$$\Leftrightarrow fe_i\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(NT)}}\right)^{\varepsilon-1}\right] \le fx_i\left[\left(\frac{1}{\overline{w}_{HF(NT)}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right]$$

$$\Leftrightarrow (fe_i + fx_i)\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HF(NT)}}\right)^{\varepsilon-1}\right] \le fx_i\left[\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1} - \left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\right]$$

$$\Leftrightarrow \Phi_2 \le \Phi_3$$

Since $\hat{\Phi}_3 \le \Phi_3$ and $\Phi_1 \le \hat{\Phi}_1$, $\hat{\Phi}_3 \le \Phi_3 \le \Phi_2 \le \Phi_1 \le \hat{\Phi}_1$. Q.E.D.

A5. Proof of Proposition Propositions 4, 5 and 6

Proof: To prove existence of industry equilibrium, we need to show that there are non-negative equilibrium market sizes A^*, $A^\dagger$ and $\tilde{A}$ satisfying zero cutoff profit conditions (12), (13) and (14), respectively. Equilibrium market size can be obtained in following ways:

$$E\pi\left(A^*\right)=\int_{\phi_Z}^{\phi_2}\pi^{HH}\left(\phi,A^*\right)\mu(\phi)d\phi+\int_{\phi_2}^{\infty}\pi^{FF}\left(\phi,A^*\right)\mu(\phi)d\phi=0$$

$$\Leftrightarrow\int_{\phi_Z}^{\phi_2}\Phi\left(\phi,A^*\right)\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\mu(\phi)d\phi$$

$$+\int_{\phi_2}^{\infty}\left[\Phi\left(\phi,A^*\right)\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}-fe-fx\right]\mu(\phi)d\phi-ft=0$$

$$\Leftrightarrow\frac{A^*}{\varepsilon}\left(\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon-1}\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\int_{\phi_Z}^{\phi_2}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}\int_{\phi_2}^{\infty}\phi^{\varepsilon-1}\mu(\phi)d\phi\right]$$

$$=\int_{\phi_2}^{\infty}(fe+fx)\mu(\phi)d\phi+fx$$

$$\Leftrightarrow A^*=\frac{\varepsilon\left(\frac{\varepsilon}{\varepsilon-1}\right)^{\varepsilon-1}\int_{\phi_2}^{\infty}(fe+fx)\mu(\phi)d\phi+fx}{\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\int_{\phi_Z}^{\phi_2}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}\int_{\phi_2}^{\infty}\phi^{\varepsilon-1}\mu(\phi)d\phi\right]}$$

$$E\pi\left(A^\dagger\right)=\int_{\phi_Z}^{\phi_1}\pi^{HH}\left(\phi,A^\dagger\right)\mu(\phi)d\phi+\int_{\phi_1}^{\hat{\phi}_1}\pi^{HF(T)}\left(\phi,A^\dagger\right)\mu(\phi)d\phi$$

$$+\int_{\hat{\phi}_1}^{\infty}\pi^{FF}\left(\phi,A^\dagger\right)\mu(\phi)d\phi=0$$

$$\Leftrightarrow\frac{A^\dagger}{\varepsilon}\left(\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon-1}\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\int_{\phi_Z}^{\phi_1}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1}\int_{\phi_1}^{\hat{\phi}_1}\phi^{\varepsilon-1}\mu(\phi)d\phi\right.$$

$$\left.+\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}\int_{\hat{\phi}_1}^{\infty}\phi^{\varepsilon-1}\mu(\phi)d\phi\right]=\int_{\phi_1}^{\infty}(fe+fx)\mu(\phi)d\phi+fx$$

$$\Leftrightarrow A^{\dagger}=\varepsilon\left(\frac{\varepsilon}{\varepsilon-1}\right)^{\varepsilon-1}\left[\int_{\phi_1}^{\infty}(fe+fx)\mu(\phi)d\phi+fx\right]/$$

$$\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\int_{\phi_Z}^{\phi_1}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1}\int_{\phi_1}^{\hat{\phi}_1}\phi^{\varepsilon-1}\mu(\phi)d\phi\right.$$

$$\left.+\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}\int_{\hat{\phi}_1}^{\infty}\phi^{\varepsilon-1}\mu(\phi)d\phi\right]$$

$$E\pi(\tilde{A})=\int_{\phi_Z}^{\phi_3}\pi^{HH}(\phi,\tilde{A})\mu(\phi)d\phi+\int_{\phi_3}^{\phi_1}\pi^{HF(NT)}(\phi,\tilde{A})\mu(\phi)d\phi$$

$$+\int_{\phi_1}^{\hat{\phi}_1}\pi^{HF(T)}(\phi,\tilde{A})\mu(\phi)d\phi+\int_{\hat{\phi}_1}^{\infty}\pi^{FF}(\phi,\tilde{A})\mu(\phi)d\phi=0$$

$$\Leftrightarrow\frac{\tilde{A}}{\varepsilon}\left(\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon-1}\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\int_{\phi_Z}^{\phi_3}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{HF(NT)}}\right)^{\varepsilon-1}\right.$$

$$\times\int_{\phi_3}^{\phi_1}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1}\int_{\phi_1}^{\hat{\phi}_1}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}$$

$$\left.\times\int_{\hat{\phi}_1}^{\infty}\phi^{\varepsilon-1}\mu(\phi)d\phi\right]=\int_{\phi_3}^{\infty}(fe+fx)\mu(\phi)d\phi+ft$$

$$\Leftrightarrow\tilde{A}=\varepsilon\left(\frac{\varepsilon}{\varepsilon-1}\right)^{\varepsilon-1}\left[\int_{\phi_3}^{\infty}(fe+fx)\mu(\phi)d\phi+ft\right]/$$

$$\left[\left(\frac{1}{\overline{w}_{HH}}\right)^{\varepsilon-1}\int_{\phi_Z}^{\phi_3}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{HF(NT)}}\right)^{\varepsilon-1}\int_{\phi_3}^{\phi_1}\phi^{\varepsilon-1}\mu(\phi)d\phi\right.$$

$$\left.+\left(\frac{1}{\overline{w}_{HF(T)}}\right)^{\varepsilon-1}\int_{\phi_1}^{\hat{\phi}_1}\phi^{\varepsilon-1}\mu(\phi)d\phi+\left(\frac{1}{\overline{w}_{FF}}\right)^{\varepsilon-1}\int_{\hat{\phi}_1}^{\infty}\phi^{\varepsilon-1}\mu(\phi)d\phi\right]$$

Thus, A^*, $A^{\dagger}$ and $\tilde{A}$ satisfying zero cutoff profit conditions (12), (13) and (14), respectively, exist and non-negative. By plugging A^*, $A^{\dagger}$ and $\tilde{A}$t corollary 2.1 and proposition 3, proposition 4, 5, and 6 can be derived.

O.E.D.

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