



# Relationship between FDI, foreign ownership restrictions, and technology transfer in the resources sector: A derivation approach



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## ABSTRACT

In various industries, multinational companies are the dominant players while local firms play a less prominent role. We consider such an industry and develop a model in which foreign multinationals strategically interact in technology transfer and compete in the product market stage. Furthermore, we analyze the welfare implications of often observed FDI policy measures. We find that the cost of technology transfer provides a possible rationale for why in practice FDI crowding out effects are often smaller in less developed countries. We also find that foreign ownership restrictions may reduce FDI crowding-out effects. However, the net effect of these restrictions on host country welfare will be negative. Finally, we find that, in industries with low levels of product market competition (e.g. the natural resources sector), the government may improve welfare by taking away the joint venture equity share of the domestic firm.

## 1. Introduction

Due to a lack of financial and technological resources many (developing) countries depend on Foreign Direct Investment (FDI) to extract and export their natural resources. An often imposed restriction on FDI in the natural resources sector is mandatory joint ownership with local firms. Joint Ventures (JVs) between foreign multinationals and local (state-owned) firms are widely used by governments in order to capture economic rents from their natural resources. Abu Dhabi's state-owned firm ADNOC, for example, has a 60% share in the Emirate's oil and gas operations, while, 40% is owned by international oil companies. Recently, Iran also decided to move more towards a JV structure in order to attract foreign investment into the energy sector. In Botswana and Namibia local state-owned firms have formed 50-50 JVs with De Beers in the diamond extraction industry. In contrast, governments may also restrict foreign ownership directly instead of imposing mandatory joint ventures. The government may, for example, manage equity stakes in foreign operated projects through a ministry or through a separate agency. A similar measure was taken in Norway's oil and gas sector in the 1980s when the government took away significant

ownership shares of the national oil company Statoil and put them under direct control of the government through the so called States Direct Financial Interest (SDFI) portfolio. In Nigeria the Oil and Gas Reform Implementation Committee (OGIC) proposed a similar framework for Nigeria's oil & gas sector. The committee recommended that the National Petroleum Asset Management Agency (NPAMA) should oversee investments by the state, while The National Petroleum Corporation (NNPC) would be active as a commercial company (see (Thurber and Istad, 2010)).<sup>1</sup> We develop a simple model where a host country government either directly restricts the equity share of foreign firms or it imposes mandatory joint ventures with a domestic firm. Furthermore, the foreign firms transfer technology to their subsidiaries in the host country. The goal of this model is to shed light on the relationships between foreign ownership restrictions, technology transfer, and market structure.

We find that in sectors with high cost of technology transfer and low levels of product market competition (e.g. in the natural resources sector), the government may improve host country welfare by taking away the local firm's equity shares in joint ventures. As a result of this policy measure the domestic firm will become active in the market. This

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<sup>1</sup> The policy recommendations of the OGIC have, however, not been implemented.

increases the level of product market competition and improves host country welfare. Furthermore, we find that crowding-out effects of FDI will be stronger in case of lower cost of technology transfer. The rationale behind this result is that due to higher cost of technology transfer, multinational corporations will transfer less technology to their affiliates. This weakens the competitive position of multinational affiliates and improves the competitive position of the local firm.

The literature on technology transfer and foreign ownership restrictions is closely related to the current study. Lee and Shy (1992) show that foreign ownership restrictions reduce the quality of technology transfer by multinational firms. Asiedu and Esfahani (2001) show that in resource-based industries foreign firms prefer shared ownership in order to gain access to raw material sources. Javorcik and Saggi (2010) show that a foreign investor with higher quality technology is less likely to form a joint venture and more likely to enter directly. In contrast, Karabay (2010) shows that by imposing mandatory joint ventures a host country government may alleviate its informational constraints. Furthermore, Karabay (2010) shows that ownership restrictions should only decrease as the size of the multinational's firm-specific advantage increases. This stream of research, however, does not study an endogenously determined level of technology transfer which is an important focus of the current paper. The existing theoretical literature on technology transfer by multinational firms, mainly considers the entry mode of a foreign firm in a market dominated by domestic companies (see e.g. Ethier and Markusen (1996); Markusen (2001); Mattoo et al. (2004); Saggi, (1996, 1999)). However, numerous industries such as automobile, electronics, extractive and chemical industries, are dominated by foreign multinational companies and national firms play a less prominent role. Similar point is made by Markusen and Venables (1998). Multinational companies in these industries not only compete in the product market but they also strategically interact in technology transfer. We take this strategic interaction between multinational firms into account. Furthermore, the aforementioned papers do not consider crowding out effects of FDI. The crowding out effect of FDI has been analyzed separately from technology transfer in a small number of theoretical studies. Driffield and Hughes (2003) study the possibility of FDI crowding out local firms in the domestic capital market. Barry et al. (2005) analyze crowding out effects in the labor market. Similar to our analyzes Markusen and Venables (1999) consider crowding out effects in the product market. However, Markusen and Venables (1999) do not consider an endogenously determined level of technology transfer.

The next section outlines the model. Section 3 solves the model in case of direct foreign ownership restrictions and analyses the crowding-out effects of FDI. Section 4 solves the model in case of mandatory joint ventures and analyses the optimal type of foreign ownership restrictions. The final section concludes.

## 2. Model

We analyze a local firm ( $I$ ) that competes with  $n - 1$  multinational affiliates ( $m$ ).<sup>2</sup> The firms interact over two periods, where first technology investment is chosen and afterwards firms compete in the product market. In the first stage the multinational firms transfer technology,  $x_m$ , to their affiliates in the host country which reduces marginal cost of production from  $c$  to  $c_m = c - x_m$ .<sup>3</sup> Technology transfer is costly and the cost function of technology transfer has the standard quadratic form  $C(x_m) = \tau x_m^2/2$ . This form implies diminishing returns to technology transfer. Total and marginal cost of technology transfer both increase with  $\tau$ . Thus, the cost function for technology transfer shifts up as  $\tau$  increases and  $\tau$  can be related to the level of the cost of

technology transfer (see (Mattoo et al., 2004)). The second stage quantity competition is between  $n - 1$  multinational affiliates and one local company.

The linear inverse demand function for the product is given by  $p = a - (\sum_{m=1}^{n-1} q_m + q_l)$ . Where,  $p$  is the market price,  $a > 0$ ,  $Q_m = \sum_{m=1}^{n-1} q_m$  is total output of all the foreign firms operating in the host country and  $q_l$  is the output of the local firm. Hence,  $Q = Q_m + q_l$  denotes total output.

The foreign firms do not have full ownership. The government can either directly restrict foreign ownership or it may require foreign firms to establish a joint venture with the local firm. The share of foreign ownership is  $\theta$  with  $0 < \theta < 1$ . We proceed by deriving equilibrium levels of output and technology transfer as well as welfare implications under these two regimes.

## 3. Direct foreign ownership restrictions

Under the first regime the profit of a representative foreign firm, net of technology transfer cost, and that of the local firm are given by (1) and (2), respectively:

$$\pi_m^R(q_m, q_{-m}, q_l) = \theta(a - q_m - q_{-m} - q_l - c_m)q_m, \quad m \in \{1, \dots, n - 1\} \tag{1}$$

$$\pi_l^R(q_l, q_m, q_{-m}) = \left( a - q_l - \sum_{m=1}^{n-1} q_m - c \right) q_l. \tag{2}$$

where,  $R$  stands for foreign ownership restrictions regime and  $q_{-m}$  is the sum of outputs of all multinational affiliates other than firm  $m$ . Using the standard two-stage approach adopted in the literature on the economics of R & D<sup>4</sup> we can derive equilibrium outputs of the foreign firms and the local firm equilibrium output. They are given by:

$$q_m^R = \frac{a - c + 2(n-1)x_m - 2 \sum_{j=1, j \neq m}^{n-1} x_j}{n + 1}, \quad m \in \{1, \dots, n-1\}$$

$$\text{and } q_l^R = \frac{a - c - \sum_{m=1}^{n-1} x_m}{n + 1}. \tag{3}$$

Output of a foreign firm increases with its own technology transfer and decreases with technology transfer of competing firms. Output of the local firm goes down when technology transfer by foreign multinationals increases as it enhances the competitiveness of the subsidiaries.

The equilibrium level of technology transfer by a representative multinational is given by

$$x_m^R(\theta) = \frac{4\theta(n - 1)(a - c)}{\tau(n + 1)^2 - 8\theta(n - 1)} \tag{4}$$

Consequently, total transfer of technology is given by  $(n - 1)x_m^R(\theta)$ . In line with previous research (see e.g. Mattoo et al. (2004)) we impose certain restrictions on parameter  $\tau$ , i.e.  $\tau > 2$ .<sup>5</sup> As expected, technology transfer decreases with the cost of technology transfer ( $\tau$ ) and increases with the share of foreign ownership ( $\theta$ ).

### 3.1. Welfare

Producer surplus is equal to the profit of the local firm. By substituting the equilibrium level of technology transfer (i.e.  $x_m^R(\theta)$ ) into the function for local firm output in (3) we obtain the local firm's equilibrium level of output:<sup>6</sup>

<sup>4</sup> See e.g. Brander and Spencer (1983), d'Aspremont and Jacquemin (1988), Kamien et al. (1992), Kamien and Zang (2000), and Leahy and Neary (1997).

<sup>5</sup> This restriction ensures non-negative solutions for equilibrium levels of technology transfer under all relevant regimes.

<sup>6</sup> See Appendix A for the derivations under direct foreign ownership restrictions.

<sup>2</sup> Similar to Wang and Blomström (1992) we abstain from looking at the mode of entry choice of foreign firms. We assume all foreign firms have entered the country directly.

<sup>3</sup> Note  $0 \leq c \leq a$ .

$$q_i^R(\theta) = \frac{(a - c)((n + 1)\tau - 4\theta(n - 1))}{(n + 1)^2\tau - 8\theta(n - 1)} \tag{5}$$

As shown in Appendix A the output of the local firm decreases with the level of foreign ownership ( $\theta$ ) and with the number of foreign firms in the market ( $n$ ) and increases with the cost of technology transfer ( $\tau$ ). Given that the local firm will be active in the market if  $q_i^R(\theta) > 0$  we can state the following result:<sup>7</sup>

**Proposition 1.** *FDI fully displaces the local firm if  $\tau \leq \tau_i(n)$ , where*

$$\tau_i(n, \theta) = \frac{4\theta(n - 1)}{n + 1} \tag{6}$$

Furthermore,  $\tau_i(n, \theta)$  increases with  $n$  and with  $\theta$  and approaches 40 as  $n$  approaches infinity.

Proposition 1 implies that, if  $\tau > 4$  the local firm is active in the market irrespective of the number of foreign firms and the level of foreign ownership. Hence, for sufficiently high  $\tau$ , FDI does not completely displace the local firm. To understand the intuition of this result recall from (4) that an increase in  $\tau$  lowers the incentives for transferring technology. Also, from (3) it follows that lower technology transfer improves the competitive position of the local firm. As a result complete displacement of the local firm becomes less likely, when technology transfer becomes more costly i.e. when  $\tau$  increases. Given that cost of technology transfer are higher in less advanced countries (see e.g. Ramachandran (1993) or Teece (1977)) full local firm displacement due to foreign firm product market competition will be less likely in these countries. This may explain why crowding-out effects of FDI are more often observed in more advanced countries. This may also explain why most outward greenfield investment by emerging market firms is done in other developing countries instead of in more advanced countries where cost of technology transfer are low.

It also follows from Proposition 1 that foreign ownership restrictions will make displacement of the local firm less likely. Higher foreign ownership restrictions will create an improvement in the competitive position of the local firm. This in turn makes it less likely that the local firm will exit the market due to foreign firm product market competition. Often suggested reasons for foreign ownership restrictions are that host country governments use them to increase economic rents and to maintain local control of resources. In addition, Mattoo et al. (2004) show that a host country government may impose foreign ownership restrictions in order to influence the entry mode choice of a foreign firm.<sup>8</sup> Hence, besides these often mentioned reasons, the government may impose restrictions on foreign ownership in order to prevent FDI from displacing the local firm.

However, these restrictions on foreign ownership also reduce technology transfer by the foreign multinationals (as  $x_m^R(\theta)$  is increasing in  $\theta$ ). This in turn will reduce total output which implies a lower level of consumer surplus. To find the net effect of equity restrictions on welfare, we analyze host country welfare as a function of foreign ownership ( $\theta$ ). In Appendix C it is shown that host country welfare increases with  $\theta$ . This proves the following result.<sup>9</sup>

**Proposition 2.** *The negative effect of foreign ownership restrictions on consumer surplus outweighs the positive effect on producer surplus which implies an overall decrease in host country welfare due to equity restrictions.*

#### 4. Joint ventures

So far we have assumed that the government imposes foreign

<sup>7</sup> For detailed proof see Appendix B.

<sup>8</sup> Mattoo et al. (2004) show that in case of high cost of technology transfer the government imposes restrictions in order to induce acquisition instead of direct entry. In case of low cost of technology transfer the government imposes restrictions in order to induce direct entry instead of acquisition.

<sup>9</sup> For detailed proof see Appendix C.

ownership restrictions directly without imposing mandatory joint ventures with the local firm. In practice foreign firms often have to form joint ventures with domestic companies. Now, we consider a host country government that imposes on  $n - 1$  multinational affiliates that they form a joint venture with the local firm. If the domestic firm is not active in the market, there will be  $n - 1$  joint ventures operating in the market. The domestic firm may also choose to be active in the market through its own operations in which case there will be  $n$  companies active in the market:  $n - 1$  joint ventures and one domestic firm. In the following sub-sections we consider these two possible market structures. Furthermore, we analyze the optimal choice of the local firm by comparing its profit under these two market structures.

##### 4.1. Inactive local firm

In case the domestic firm is not active in the market but only has an equity share in foreign operated projects, the profit function of a representative foreign firm will be given by:

$$\pi_m^{JV}(q_m, q_{-m}) = \theta(a - q_m - q_{-m} - c_m)q_m, \tag{7}$$

$m \in \{1, \dots, n - 1\}$

where,  $JV$  stands for joint venture regime. Maximizing:  $\theta\pi_m^{JV}(x_m) - \frac{\tau x_m^2}{2}$ ,  $m \in \{1, \dots, n - 1\}$ , gives the equilibrium level of technology transfer.<sup>10</sup>

$$x_m^{JV}(\theta) = \frac{2\theta(n - 1)(a - c)}{n^2\tau - 2\theta(n - 1)} \tag{8}$$

Technology transfer will be higher under the  $JV$  regime than under direct foreign ownership restrictions if the following inequality holds:  $\Delta X \equiv x_m^{JV} - x_m^R > 0$ . By solving this inequality we can derive the following proposition:

**Proposition 3.** *Technology transfer by foreign multinationals is higher under mandatory joint ventures than under direct equity restrictions if  $\tau < \tau_i(n, \theta)$ , where*

$$\tau_i(n, \theta) = \frac{4\theta(n - 1)}{2n + 1 - n^2} \tag{9}$$

Furthermore, if  $n=2$  then  $\tau_i(n, \theta)$  increases with  $\theta$  and approaches 4 as  $\theta$  approaches 1 and if  $n > 2$  then  $\tau_i(n, \theta) < 0$ .

Threshold  $\tau_i(n, \theta)$  is depicted in Fig. 1 by the  $TT$  locus (for  $n=2$ ), where  $TT$  stands for technology transfer. For all values of  $\theta$  and  $\tau$  on the  $TT$  line technology transfers is the same under both types of foreign ownership restrictions. For all values under the locus technology transfer is higher under direct foreign ownership restrictions, while for all values above the locus technology transfer is higher under mandatory joint ventures.

In order to find which type of equity restriction the local firm prefers, we compare the profit of the local firm under the two regimes. The local firm prefers the joint venture regime over the regime with direct equity restrictions if:  $\Delta L \equiv \pi_i^{JV} - \pi_i^R > 0$ . Dividing  $\Delta L$  by  $(a - c)^2$  and fixing  $n$  allows for convenient graphical analysis in  $(\theta, \tau)$  space. The  $LF$  locus in Fig. 1 shows the contour of the function  $\Delta L/(a - c)^2 = 0$  where  $LF$  stands for local firm. Along this line the local firm is indifferent between direct foreign ownership restrictions and mandatory joint ventures. The government prefers the joint venture regime over the regime with direct equity restrictions if it ensures higher host country welfare, i.e. if  $\Delta W \equiv W^{JV} - W^R > 0$ . Similarly to above the  $WW$  locus in Fig. 1 is the contour of the function  $\Delta W/(a - c)^2 = 0$  where  $WW$  stands for welfare. Along this line host country welfare is the same under mandatory joint ventures as under direct foreign ownership restrictions.

<sup>10</sup> Derivations under the  $JV$  regime are provided in Appendix D.

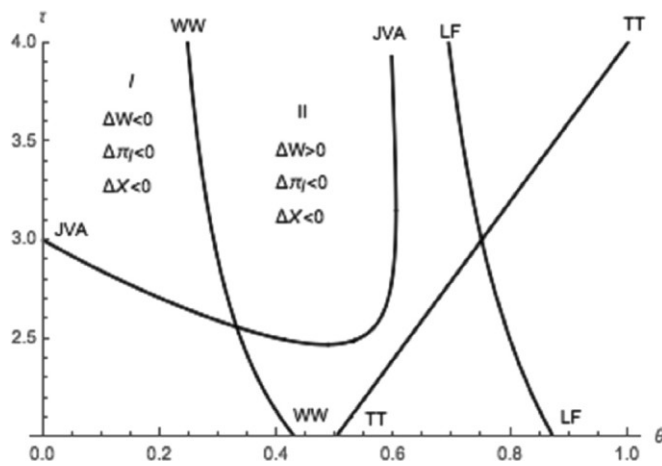


Fig. 1. Foreign ownership restrictions, technology transfer and policy intervention.

4.2. Active local firm

If the local firm is active in the market, the profit of a representative foreign firm is the same as that under direct foreign ownership restrictions. The local firm's profit is different now and is given by:

$$(n - 1)(1 - \theta)\pi_m^{JVA}(q_l, q_m) + \pi_l^{JVA}(q_l, q_m)$$

$$(n - 1)(1 - \theta) \left( a - q_l - \sum_{m=1}^{n-1} q_m - c_m \right) q_m + \left( a - q_l - \sum_{m=1}^{n-1} q_m - c \right) q_l$$

(10)

where, JVA stands for the joint venture regime when the local is active in the market. Derivations under the JVA regime are provided in Appendix E.

The local firm will be active in the market if:

$$\Delta\pi_l \equiv (n - 1)(1 - \theta)\pi_m^{JVA}(\theta) + \pi_l^{JVA}(\theta) - (n - 1)(1 - \theta)\pi_m^{JV}(\theta) > 0.$$

(11)

where the first term is the joint venture profit of the local firm when it is active in the market, the second term is the local firm's profit from its own operations, and the third term is the local firm's joint venture profit when it is not active in the market. The expression for  $\Delta\pi_l$  is quite cumbersome and non-linear in  $\tau$ ,  $\theta$ , and  $n$ . However, dividing  $\Delta\pi_l$  by  $(a - c)^2$  and fixing  $n$  allows for convenient graphical analysis in  $(\theta, \tau)$  space. The contour of the function  $\Delta\pi_l/(a - c)^2 = 0$  is illustrated in Fig. 1 by the JVA locus (for  $n=2$ ). Typically in the natural resources sector there is a low level of product market competition, so, we have set  $n=2$ . For all values of  $n$  and  $\tau$  on the JVA curve the local firm is indifferent between being active and not being active in the market. In the  $(\theta, \tau)$  parameter space under the JVA locus, the local firm prefers to be active and above the locus the local firm prefers not to be active (regions I and II). Hence, in case of higher levels of foreign ownership (i.e. a lower JV share for the local firm) the local firm will more likely choose to establish its own operations. If the local firm is active in the market, the joint venture profit will be lower due to an increase in product market competition. Hence, a higher joint venture share for the local firm will make it less attractive for the local firm to be active in the market.

The parameter space above the JVA locus in Fig. 1 is divided into two regions. In region I the local firm and the host country government prefer the joint venture regime and technology transfer by the foreign firm is also higher under the joint venture regime. In region II welfare is higher under direct foreign ownership restrictions, while the profit of the local firm and foreign firm technology transfer are both higher under the joint venture regime. Hence, in region I the local firm and the host country government prefer the same type of foreign ownership restriction (i.e. mandatory joint ventures). However, in practice the

level of foreign ownership will most likely be within the parameter space denoted by region II. If in region II the government has imposed mandatory joint ventures, it can improve welfare by instead restricting foreign ownership directly. The local firm will oppose this policy measure as it will lower its profits. However, the increase in consumer surplus due to this policy measure will outweigh the reduction in producer surplus.

5. Concluding remarks

In this paper we have analyzed FDI crowding out effects, technology transfer by foreign multinationals under different market structures, and optimal FDI policies. One way the host country government may reduce crowding out effects is by imposing foreign ownership restrictions. However, foreign ownership restrictions will also reduce the amount of technology transfer by the foreign multinational firms and the net effect of equity restrictions on host country welfare will be negative. Often governments require foreign companies to form joint ventures with local firms. We find that in sectors with high cost of technology transfer and low levels of product market competition (e.g. the natural resources sector), the government may improve host country welfare by taking away the local firm's equity shares in joint ventures. A similar measure was taken in 1984 by the Norwegian government. The government took away significant ownership shares from Statoil and started to manage these equity shares (i.e. the State's Direct Financial Interest portfolio) through the Ministry of Oil and Energy.<sup>11</sup> In Nigeria the Oil and Gas Reform Implementation Committee (OGIC) proposed a similar framework for Nigeria's oil and gas industry but these policy recommendations have not been implemented.<sup>12</sup> One reason may be that the Nigerian state-owned oil company has effectively prevented the implementation of this policy which would reduce its profits. In line with our findings international experience shows that the most successful national resources companies are those that have limited noncommercial objectives and are subject to competition from other companies (see (Heller et al., 2014)). Norway's national oil company, Statoil, and Chile's national mining company, Codelco, are two such examples. These companies have long been exposed to international competition, encouraged by governments expecting the efficiency of their state-owned companies to benefit from such competition (see (McPherson, 2010)).

We also provide a possible rationale for why FDI crowding out effects are more often observed in more advanced countries than in less advanced countries.<sup>13</sup> In more advanced countries transferring technology will be less costly.<sup>14</sup> As a result in such countries foreign multinational firms will transfer more technology to their subsidiaries which weakens the competitive position of local firms. The higher cost of technology transfer in less developed countries may also explain why these countries are often the preferred destination for outward FDI by emerging market firms.<sup>15</sup> In case of higher cost of technology transfer an emerging market firm may more easily compete with firms from advanced countries due to lower technology transfer by the latter.

One of the limitations of our analysis is that we use a static framework which prevents us from analyzing long-run effects of FDI on local investment. De Backer and Sleuwaegen (2003) analyzing Belgium manufacturing companies show that FDI displaces local investment in the short-run, but in the long-run this effect is

<sup>11</sup> Since 2001 Petoro a state holding company manages the government's interest. Statoil is responsible for selling Petoro's share of oil and gas but the revenue goes to the state.

<sup>12</sup> See Thurber and Istad (2010).

<sup>13</sup> See e.g. Blonigen and Wang (2004) and Borensztein et al. (1998). Agosin and Machado (2005) show FDI crowding out effects in Latin America but not in Africa (except in sub-period: 1990s) and also not in East Asia.

<sup>14</sup> See e.g. Teece (1977) and Ramachandran (1993).

<sup>15</sup> More than one-third of FDI in developing countries originates in other developing economies (Timmer et al., 2011).

moderated or even reversed. Hence, also in more advanced countries crowding out effects may be prevented in the long-run. Considering

long-run effects of FDI on domestic investment is beyond the scope of our model and should be addressed in further research.

**Appendix A. Equilibrium outputs and profits**

By substituting (4) into functions for output in (3), we obtain the equilibrium output of, respectively, a foreign multinational and the local firm:

$$q_m^R(\theta) = \frac{(a - c)(n + 1)\tau}{(n + 1)^2\tau - 8\theta(n - 1)}$$

$$\text{and } q_l^R(\theta) = \frac{(a - c)((n + 1)\tau - 4\theta(n - 1))}{(n + 1)^2\tau - 8\theta(n - 1)} \tag{12}$$

The derivative of local firm output w.r.t.  $n$  and  $\tau$  is, respectively, given by:

$$\frac{\partial q_l^R}{\partial n} = \frac{-\tau(a - c)(\tau - 4\theta + 8n\theta + 2n\tau - 4n^2\theta + n^2\tau)}{(8\theta + \tau - 8n\theta + 2n\tau + n^2\tau)^2}$$

$$\text{and } \frac{\partial q_l^R}{\partial \tau} = \frac{4\theta(a - c)(n - 1)^2(n + 1)}{(8\theta + \tau - 8n\theta + 2n\tau + n^2\tau)^2} > 0 \tag{13}$$

It follows that local firm output decreases with  $n$  if  $\tau > \frac{4\theta(n - 1)^2}{(n + 1)^2}$ . From the proof of Proposition 1 it follows that  $q_l > 0$  if  $\tau > \frac{4\theta(n - 1)}{n + 1}$ . Given that

$\frac{4(n - 1)^2}{(n + 1)^2} < \frac{4(n - 1)}{n + 1}$  local firm output decreases with  $n$  for  $q_l > 0$ .

This implies:

$$\pi_l^R(\theta) = \frac{(a - c)^2((n + 1)\tau - 4\theta(n - 1))^2}{((n + 1)^2\tau - 8\theta(n - 1))^2}$$

$$\text{and } \Pi_m^R(\theta) = \frac{\theta\tau(a - c)^2((n + 1)^2\tau - 8\theta(n - 1)^2)}{((n + 1)^2\tau - 8\theta(n - 1))^2}$$

**Appendix B. Proof of proposition 1**

The local firm will be active in the market if  $q_l^R > 0$ . Restriction on  $\tau > 2$  ensures that denominator of the expression is positive. Hence, we need to ensure only  $(n + 1)\tau - 4\theta(n - 1) > 0$ . This implies that FDI will not fully displace the local firm if parameter  $\tau$  is sufficiently high, i.e.  $\tau > \tau_c(n, \theta) = \frac{4\theta(n - 1)}{n + 1}$ . This proves the first part of Proposition 1. Furthermore,  $\lim_{n \rightarrow \infty} \frac{4\theta(n - 1)}{n + 1} = 4\theta$ . Finally,  $\frac{\partial \tau_c(n, \theta)}{\partial n} = \frac{8\theta}{(n + 1)^2} > 0$ . This proves the second part of Proposition 1.

**Appendix C. Proof of proposition 2**

Host country welfare is given by

$$W^R(\theta) = \frac{(a - c)^2(((n + 1)n\tau - 4\theta(n - 1))^2 + 2((n + 1)\tau - 4\theta(n - 1))^2)}{2((n + 1)^2\tau - 8\theta(n - 1))^2}$$

The derivative of host country welfare w.r.t. foreign ownership is:

$$\frac{\partial W^R(\theta)}{\partial \theta} = \frac{-4\tau(a - c)^2(n - 1)^2(n + 1)(4\theta + 2\tau - 4n\theta + n\tau - n^2\tau)}{(8\theta + \tau - 8n\theta + 2n\tau + n^2\tau)^3}$$

Host country welfare decreases with foreign ownership if:  $4\theta + 2\tau - 4n\theta + n\tau - n^2\tau > 0 \Leftrightarrow \frac{\tau(n + 2 - n^2)}{4\theta(n - 1)} > 0$  which is impossible given that  $n \geq 2$ . Hence, total welfare increases with  $\theta$ .

**Appendix D. Derivations under joint venture**

Optimizing the profit function in (7) with respect to output and rewriting gives:

$$a - q_m - Q - c + x_m = 0, \quad m \in \{1, \dots, n - 1\}. \tag{14}$$

Next, assuming symmetric equilibrium, taking summations, and solving for total output implies:

$$Q^{JV} = \frac{(n - 1)(a - c) + \sum_{m=1}^{n-1} x_m}{n} \tag{15}$$

Plugging (15) in (14) gives:

$$q_m^{JV} = \frac{a - c + (n - 1)x_m - \sum_{j=1, j \neq m}^{n-1} x_j}{n}, \quad m \in \{1, \dots, n - 1\}. \tag{16}$$

In the first stage, when a representative multinational sets the level of technology transfer, it maximizes  $\theta\pi_m^{JV}(x_m) - \frac{\tau x_m^2}{2}$ . Optimizing with respect to  $x_m$  and assuming symmetry in equilibrium gives the optimal level of technology transfer by a representative foreign firm.<sup>16</sup>

$$x_m^{JV} = \frac{2\theta(n-1)(a-c)}{n^2\tau - 2\theta(n-1)}, \quad m \in \{1, \dots, n-1\}. \tag{17}$$

Subsequently, total technology transfer is  $(n-1)x_m^{JV}$ . By substituting (17) into (16) we obtain the equilibrium output of any given foreign firm in the host country:

$$q_m^{JV}(\theta) = \frac{(a-c)n\tau}{n^2\tau - 2\theta(n-1)} \tag{18}$$

It follows that foreign firm profit net of technology transfer cost and local firm profit are, respectively, given by:

$$\pi_m^{JV}(\theta) = \left[ \frac{(a-c)n\tau}{n^2\tau - 2\theta(n-1)} \right]^2$$

and  $\pi_l^{JV}(\theta) = \frac{(1-\theta)(n-1)(a-c)^2 n^2 \tau^2}{(n^2\tau - 2\theta(n-1))^2}$ . (19)

Welfare is now given by:

$$W^{JV}(\theta) = \frac{(a-c)^2 n^2 \tau^2 (n-1)(n+1-2\theta)}{2(n^2\tau - 2\theta(n-1))^2} \tag{20}$$

**Appendix E. Derivations under joint venture and active local firm**

Under joint venture regime with active local firm the equilibrium outputs of the foreign firms and the local firm equilibrium output are given by (21) and (22), respectively:

$$q_m^{JVA}(\theta) = \frac{a-c + 2(n-1)x_m - 2\sum_{j=1, j \neq m}^{n-1} x_j}{2 + \theta(n-1)}, \quad m \in \{1, \dots, n-1\}. \tag{21}$$

$$q_l^{JVA}(\theta) = \frac{(a-c)(2-n+\theta(n-1)) - (2-\theta)\sum_{m=1}^{n-1} x_m}{2 + \theta(n-1)}. \tag{22}$$

From (1) and (21) it follows that for a representative multinational from an advanced country, the profit net of cost of technology transfer can be expressed as  $\theta(q_m^{JVA}(\theta))^2$ . Hence, foreign firm technology transfer under entry is given by:

$$x_m^{JVA}(\theta) = \frac{4\theta(n-1)(a-c)}{\tau(2 + \theta(n-1))^2 - 8\theta(n-1)}. \tag{23}$$

Plugging value for technology transfer in (23) under entry into expressions for output in (21) and (22) gives equilibrium output of, respectively, a foreign firm and of the local firm:

$$q_m^{JVA}(\theta) = \frac{(a-c)(2 + \theta(n-1))\tau}{\tau(2 + \theta(n-1))^2 - 8\theta(n-1)} \text{ and} \tag{24}$$

$$q_l^{JVA}(\theta) = \frac{(a-c)((2-n+\theta(n-1))(2 + \theta(n-1))\tau - 4\theta(n-1))}{\tau(2 + \theta(n-1))^2 - 8\theta(n-1)} \tag{25}$$

This implies that:

$$\pi_m^{JVA}(\theta) = \left[ \frac{(a-c)(2 + \theta(n-1))\tau}{\tau(2 + \theta(n-1))^2 - 8\theta(n-1)} \right]^2 \text{ and} \tag{26}$$

$$\pi_l^{JVA}(\theta) = \left[ \frac{(a-c)((2-n+\theta(n-1))(2 + \theta(n-1))\tau - 4\theta(n-1))}{\tau(2 + \theta(n-1))^2 - 8\theta(n-1)} \right]^2 \tag{27}$$

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<sup>16</sup> Recall that restriction  $\tau > 2$  ensures non-negative solutions for all  $n \geq 2$ .

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