

Multinational Firms and Technology Transfer*

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Abstract

We construct an oligopoly model in which a multinational firm has a superior technology compared to local firms. Workers employed by the multinational acquire knowledge of its superior technology. The multinational may pay a wage premium to prevent local firms from hiring its workers and thus gaining access to their knowledge. In this setting, the host government has an incentive to attract FDI due to technology transfer to local firms or the wage premium earned by employees of the multinational firm. However, when FDI is particularly attractive to the multinational firm, the host government has an incentive to discourage FDI.

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JEL classification: F13; F23; J41; L13; O14; O33; O38

I. Introduction

Foreign direct investment (FDI) is one of the most important channels through which technology can be transferred across countries. In a typical year, transactions between parent firms and their subsidiaries in royalties and license fees account for over 80 percent of international technology transactions; see UNCTAD (1992). By encouraging multinationals to establish local production facilities, developing countries hope to generate technology transfer to local firms: the presence of multinational firms may facilitate

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imitation, as in Glass and Saggi (1999a) or have more general contagion effects, as in Findlay (1978).¹

However, the role of labor mobility as a channel of technology transfer across firms has not received adequate attention. This channel differs from others because technology moves across firms through the physical movement of workers who have been exposed to the technology. The goal of this paper is to capture the role of labor mobility as a mechanism of technology transfer and examine the implications of this transfer for host country policy toward FDI.

In our model, a source firm decides whether to establish a production facility in a host country (by engaging in FDI). If the source firm undertakes FDI, the host firm it competes with may gain access to the source firm's superior technology by hiring away its workers. Recognizing the attractiveness of its workers to the host firm, the source firm weighs the cost of paying higher wages against the benefit of limiting technology transfer to the host firm.

The source firm may instead choose to produce in a more expensive location where physical separation protects against the spread of its technology to its rivals. Both methods of preventing technology transfer—production elsewhere or paying a wage premium—raise the source firm's costs. Our model identifies the circumstances under which a multinational chooses to pay a wage premium or produce elsewhere to preserve its technological superiority.

We find that the choices made by the source firm commonly clash with the interests of host welfare, providing a motive for an active host government FDI policy. FDI-inducing policies can indeed raise host welfare, and can do so even if technology transfer does *not* result, due to the wage premium paid to prevent technology transfer.² On the other hand, banning FDI can raise host welfare if source firms would reap a significant cost reduction through FDI.

Evidence on the mobility of workers from multinationals to host firms is consistent with our model. Labor mobility from multinationals to host firms occurs predominantly in more developed countries, where multinationals do not have as substantial an advantage over host firms. Gershenberg (1987) finds evidence of only minor labor mobility from multinationals to Kenyan firms. Bloom (1992) finds substantial technological transfer in South Korea when production managers left multinationals to join host firms. Pack (1997) reports that in the chemical industry in Taiwan during the mid-1980s, almost

¹See Pack and Saggi (1997) for further discussion of the role multinationals play in technology diffusion.

²Glass and Saggi (1999b) provide a related argument based on general equilibrium effects.

50 percent of all engineers and 63 percent of skilled workers that quit multinationals, left to join local firms.

Evidence documenting that multinationals pay higher wages than host firms is also consistent with our model. These wage differentials are usually larger in less developed countries, where multinationals are more advantaged relative to host firms. Using data from Mexico, Venezuela, and the United States, Aitken, Harrison, and Lipsey (1996) find that multinationals pay higher wages than host firms in the developing countries, but not in the United States.³ Haddad and Harrison (1993) collected data on wage premiums paid by multinationals relative to local firms by industry in Morocco. In some industries such as textiles and metal products, multinationals pay roughly the same wages as local firms, and local firms share roughly the same technology. In other industries such as food products and chemicals, multinationals pay more than local firms and maintain their productivity advantage.⁴ This is the pattern our model would predict. Of course, multinationals may pay wage premiums for many reasons. For example, multinationals may pay efficiency wages to control shirking. Multiple explanations could be behind the data—we isolate one previously neglected reason.

While the potential importance of technological transfer from multinationals is widely recognized, few rigorous models examine this process of technology transfer across firms. The main exception is Ethier and Markusen (1996).⁵ Our paper differs from theirs in key areas. We examine the transfer of process (rather than product) technology so that the source firm always faces competition: the issue is the strength of competition. We explore the implications of partial technology transfer, where the host firm may remain disadvantaged relative to the multinational, even with access to the superior technology. In our model, workers decide *individually* whether to leave to work for the local firm and we analyze the implications of our model for host country policy toward FDI.⁶

Taylor (1993) allows firms to disguise their technology to limit technology

³Similarly, Globerman, Ries, and Vertinsky (1994) find no wage premium for foreign affiliates in Canada, after adjusting for size and capital intensity.

⁴Xu (2000) finds evidence that technology transfer from U.S. multinationals generates productivity growth in developed countries but not developing countries; see also Borensztein, De Gregorio, and Lee (1998) and Kokko (1994).

⁵See also Ethier (1986) and Horstmann and Markusen (1992) for the choice of entry mode between exporting, FDI, and licensing. Choi (2001) considers the choice between FDI and licensing under moral hazard; see also Saggi (1999). We assume the source firm keeps its operations within the firm.

⁶In Fosfuri, Motta, and Ronde (2001) and Markusen (2001), the local partner of a multinational becomes the competition.

transfer through imitation.⁷ Taylor considers product technology, whereas we consider process technology, so the strategy used to control technology transfer differs. Our argument is related to the idea in Salop and Scheffman (1987) that firms may take actions to raise their rival's costs, but our analysis adds an active role for host firms in countering the cost increase.⁸ The costs of host firms in equilibrium are always less than or equal to the costs in the absence of the source firm since host firms can choose not to hire the multinational's workers.

Section II develops our basic model of technology transfer through labor mobility across firms. Section III extends the model to allow for the possibility of production elsewhere and considers the welfare implications of FDI in the host country. Section IV explores whether the host government has an incentive to encourage or discourage FDI. Section V concludes. Proofs are provided in the Appendix.

II. A Model of Technology Transfer

A source (*S*) firm and a host (*H*) firm produce a homogeneous good and compete as Cournot oligopolists in a market outside the host country. Each firm has constant returns to scale production technology. The source firm's technology is superior: it requires less labor per unit of output than the host firm.⁹

Workers employed by the source firm acquire knowledge about some of its technology, and some of this knowledge can be transferred to the host firm if they switch employers. The exposure of workers to the superior technology occurs immediately upon arrival at the source firm. The assumption of instantaneous exposure captures the trait that the time required to observe a new technology is extremely short relative to the length of time during which the source firm has to protect its technological advantage. Instantaneous exposure also implies that wage premiums cannot be recovered by initially depressing wages.

It is worth emphasizing that exposure to technology differs from general training: firms have a choice whether or not to train their workers, training involves costs, and replacing trained workers with untrained workers affects productivity. If workers were costly to train, then the source firm would have an additional incentive to pay wage premiums to keep its workers from

⁷Siotis (1999) has emphasized that diffusion makes FDI less attractive for source firms and Petit and Sanna-Randaccio (2000) also consider the effect of spillovers on a firm's entry mode; see also Dinopoulos and Syropoulos (1998).

⁸Roy and Viaene (1998) also model cost-raising strategies of multinationals.

⁹Ownership advantages such as unique product designs and superior process technologies are a mainstay of the theory of the multinational firm; see Markusen (1995) and Brainard (1997).

leaving, even if they left for non-competing firms. Wage premiums due to training costs are already well understood. Our model is designed to determine whether any wage premiums are paid *purely* to control technology diffusion.

Workers are considered *informed* if they have knowledge of the superior technology and *uninformed* otherwise. Due to instantaneous exposure, all workers employed by the source firm are informed. To produce one unit of output, the source firm needs one unit of labor (by normalization). To produce one unit of output, the host firm needs θ units of informed labor or Θ units of uninformed labor. Technology transfer enhances a host firm's productivity $\theta \leq \Theta$. Define the relative labor requirement for the host firm as $\Gamma \equiv \Theta/\theta \geq 1$.

Technology transfer may remain incomplete ($\theta \geq 1$) for numerous reasons. First, workers may only know about the portion of the technology they worked with at the source firm. Second, the source firm may be able to maintain an advantage because the host firm lacks the superior management and organization made available to the source firm by its headquarters. Third, the technology may not be as well suited for the host firm. Other economic fundamentals such as the level of a country's development, the education level of its workers, and perhaps its protection of intellectual property may also play a role.

Workers are identical except for whether they are initially employed by the source firm. If not employed by this industry, all workers can earn a wage equal to one (by normalization) elsewhere in the economy. Thus, firms face a perfectly elastic supply of uninformed labor at the given host wage.

Our model proceeds as follows. The firms compete for informed workers, and then they compete in the product market. Once the source firm chooses the wage it offers to its workers, the host firm chooses the wage it offers the source firm's workers (given the wage offered by the source firm). We analyze the subgame-perfect equilibrium of this model through backward induction, beginning with the output stage.

Output Stage

Let the output of firm i be given by q_i , where $i \in \{S, H\}$ represents source or host, and let total output be $Q = q_H + q_S$. The demand function is given by $p(Q)$, with $p' < 0$ and $p'' < 0$. Each firm i picks its quantity q_i to maximize its profits $\pi_i = [p(Q) - c_i]q_i$, given the quantity chosen by the other firm, where the marginal cost c_i of each firm i depends on whether technology transfer occurs. The equilibrium outputs of the firms solve the standard first-order conditions: $\partial\pi_i/\partial q_i = p(Q) + q_i p'(Q) - c_i = 0$. The second-order conditions are $\partial^2\pi_i/\partial q_i^2 = 2p'(Q) + q_i p''(Q) < 0$.

Wages and Technology Transfer

Consider the wage decision of the host firm. Denote the wage offered by the source firm by w_S . By offering a wage arbitrarily above w_S , the host firm can lure away workers from the source firm. The host firm's optimal response is to match the source firm's wage for informed workers unless uninformed workers are a better value.

Lemma 1. *The host firm matches the source firm's wage $w_H = w_S + \varepsilon$ for informed workers if the source firm's wage is sufficiently low $w_S < \Gamma$ or offers the market wage $w_H = 1$ to uninformed workers otherwise.*

For the host firm, producing a unit of output costs Θ using uninformed workers or θw_S using informed workers.¹⁰ For any wage the source firm offers, the host firm hires informed or uninformed workers, depending on which is the cheaper method of production. When $w_S = \Gamma \equiv \Theta/\theta$, the two methods of production are equally expensive, and the host firm hires only uninformed workers by convention. Our assumptions regarding the perfectly elastic supply of *uninformed* workers and instantaneous knowledge transfer to workers imply that if the host firm decides to match the wage of the source firm, the host firm faces a perfectly elastic supply of *informed* workers at the source firm's wage.

Next consider whether paying a wage premium to prevent technology transfer raises the source firm's profits, which depends on the extent that technology transfer to the host firm remains incomplete (magnitude of θ). In the *no technology transfer* (N) equilibrium, the source firm's marginal cost equals $c_S^N = \Gamma > 1$ and the host firm's marginal cost equals $c_H^N = \Theta > \theta$. In the *technology transfer* (T) equilibrium, the source firm's marginal cost equals $c_S^T = 1$ and the host firm's marginal cost equals $c_H^T = \theta$. The source firm can either produce at marginal cost 1 and have its rival's marginal cost be θ or produce at marginal cost Γ and have its rival's marginal cost be Θ . Thus, the no technology transfer equilibrium involves higher costs of production for both firms. We denote each profit function π_i^j by $\pi_i^j(c_S^j, c_H^j)$ to highlight the marginal cost of each firm under each equilibrium j , with $j \in \{N, T\}$ representing no technology transfer or technology transfer.

We first examine the behavior of $\pi_S^T(1, \theta)$ and $\pi_S^N(\Gamma \equiv \Theta/\theta, \Theta)$ to determine parameter conditions under which the two equilibria arise. Both profits are strictly increasing in θ . The more incomplete is technology transfer, the higher are source profits under the technology transfer equilibrium due to the larger marginal cost of the host firm:

¹⁰Since ε is arbitrarily close to zero, we drop it from further expressions.

$$\frac{\partial \pi_S^T(1, \theta)}{\partial \theta} = p' \left(\frac{\partial q_H^T}{\partial \theta} \right) q_S^T > 0. \tag{1}$$

Source profits under no technology transfer also increase in θ due to the lower marginal cost ($\Gamma \equiv \Theta/\theta$) of the source firm:

$$\frac{\partial \pi_S^N(\Theta/\theta, \Theta)}{\partial \theta} = \left[p' \frac{\partial q_H^T}{\partial \theta} + \frac{\Theta}{\theta^2} \right] q_S^N > 0. \tag{2}$$

When $\theta = 1$, source profits under technology transfer exceed source profits under no technology transfer: $\pi_S^T(1, 1) > \pi_S^N(\Theta, \Theta)$. In a Cournot equilibrium where firms have constant marginal costs, a uniform increase in the cost of all firms lowers profits of each firm. Furthermore, at the upper boundary where $\theta = \Theta$, both firms have the same marginal cost under technology transfer and no technology transfer, so source profits do not depend on whether technology transfer occurs: $\pi_S^T(1, \Theta) = \pi_S^N(1, \Theta)$. For both technology transfer and no technology transfer to arise under different parameter values, there needs to be an intersection of the two profit functions at some threshold θ_S where $1 < \theta_S < \Theta$.

Definition 1. *The source firm threshold θ_S is the level of θ such that source profits under technology transfer equal source profits under no technology transfer: $\pi_S^T(1, \theta_S) = \pi_S^N(\Theta/\theta_S, \Theta)$.*

We are assured of at least one intersection between the two profit functions if $\pi_S^T(1, \theta)$ (plotted against θ) meets $\pi_S^N(\Theta/\theta_S, \Theta)$ from below at the upper boundary $\theta = \Theta$:

$$\left. \frac{\partial \pi_S^T}{\partial \theta} \right|_{\theta=\Theta} > \left. \frac{\partial \pi_S^N}{\partial \theta} \right|_{\theta=\Theta}. \tag{3}$$

We assume the above condition is satisfied (as it is if Θ is sufficiently large) so that the source firm curtails technology transfer for sufficiently high values of θ .¹¹ The case where the profit functions do not intersect (due to Θ being very small) is uninteresting because then the source firm always

¹¹Using the first-order conditions and noting that $q_S^T = q_S^N$ when $\theta = \Theta$, condition (3) is equivalent to $p' \partial q_H^T / \partial \theta > p' \partial q_H^N / \partial \theta + 1/\Theta$. When Θ is large, the second term on the RHS is small and the above condition essentially implies that an increase in the host firm's own cost θ must have a larger negative impact on its output than a decrease in its rival's cost (recall that $p' < 0$). Condition (3) is satisfied for linear demand.

prefers technology transfer. Figure 1 illustrates the two equilibria for the case of linear demand: S^T depicts π_S^T and S^N depicts π_S^N .¹²

Proposition 1. *When $\theta \geq \theta_S$, the source firm offers the wage $w_S^N = \Gamma$ and the no technology transfer equilibrium occurs, whereas when $\theta < \theta_S$, the source firm offers the wage $w_S^T = 1$ and the technology transfer equilibrium occurs.*

It might be conjectured that a source firm’s desire to limit the diffusion of its technology should be largest when diffusion would be most complete, but such logic tells only half of the story. Diffusion is more costly to prevent—the wage premium required would be larger—when it would be more complete. In fact, the source firm curtails technology transfer when technology transfer to the host firm is highly incomplete (θ is large). In curtailing technology transfer, the source firm’s marginal cost increases by $(\Theta - \theta)/\theta$ whereas the host firm’s marginal cost increases by $\Theta - \theta$. Clearly, the bigger is θ , the bigger the increase in the marginal cost of the host firm relative to the source firm, making the no technology transfer equilibrium more attractive for the source firm. An increase in its own costs is more attractive to the source firm when accompanied by a larger relative increase in the costs of its rival (which happens when θ is large).

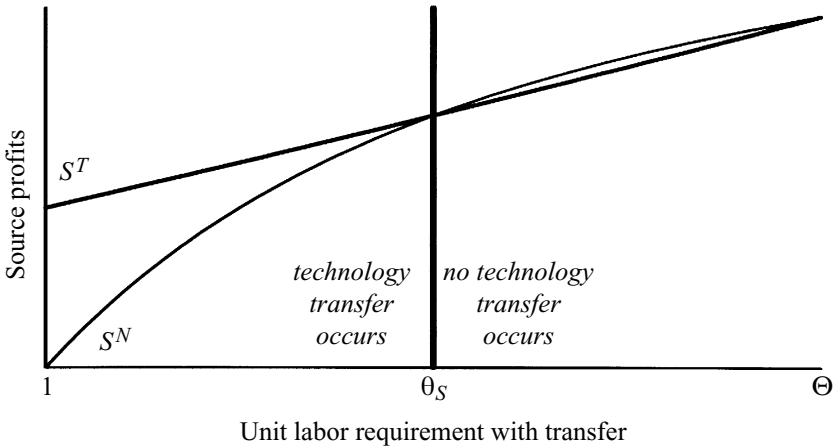


Fig. 1. Source profits and technology transfer

¹²For linear demand $\theta_S = 2$ so that there exists a range over which the source firm prevents technology transfer if $\Theta > 2$.

How does the host firm fare under the two equilibria? The host firm enjoys higher profits in the technology transfer equilibrium than in the no technology transfer equilibrium $\pi_H^T \geq \pi_H^N$. Total industry profits are lower in the no technology transfer equilibrium and the source firm's profits must be higher relative to technology transfer. As a result, the host firm must have lower profits under the no technology transfer equilibrium.

Thus, a clear conflict emerges between the interests of the source firm and the host firm: the source firm prefers no technology transfer when its advantage remains substantial (for $\theta \geq \theta_S$), while the *host firm prefers technology transfer*. More surprising is that the interests of the workers fall in line with those of the source firm, not the host firm, since they earn a wage premium only in the no technology transfer equilibrium.

Multiple Host or Source Firms

How do our results change if there are multiple host or source firms? Let n be the number of symmetric host firms and m the number of symmetric source firms. To ease exposition for this extension, let the demand function be given by $p = A - Q$. Our main interest is in determining the source firm threshold θ_S .

First, all source firms simultaneously choose the wages they offer to the informed workers. Next, all host firms simultaneously choose whether to hire informed or uninformed workers. Consider a host firm's decision of whether or not to hire informed workers. All host firms seek to hire workers away from the source firm that pays the lowest wage, denoted by \underline{w} . A host firm's choice is independent of the wage offered by other host firms because, given the marginal cost of production of its rivals, a host firm always seeks to minimize its own cost. Thus, Lemma 1 applies to any host firm (with w_S replaced by \underline{w}), regardless of the wage offered by all other host firms. Recall that due to our assumption of instantaneous technology transfer, host firms seeking to hire informed workers do not face a binding constraint regarding the supply of such workers. Consequently, cost minimization dictates the choices of host firms and given the wages offered by source firms, either all host firms offer the wage \underline{w} or none.

Suppose $m - 1$ source firms decide to retain their workers by paying the wage Γ . The m th source firm can prevent technology spillovers to all host firms by offering the wage Γ or allow technology spillovers by offering the wage 1.¹³ When is it advantageous to prevent technology spillovers?

¹³Clearly, no source firm seeking to retain informed workers would offer a wage other than Γ : a higher wage increases own cost without offering any benefit whereas a lower wage cannot prevent technology spillovers.

Proposition 2. *For linear demand, the source firm threshold is $\theta_S(m, n) = (m + n)/n$: if $\theta > \theta_S(m, n)$, then all source firms offer the wage Γ and no technology transfer occurs.*

The threshold θ_S is increasing in the number of source firms m and decreasing in the number of host firms n . If there is only one source firm ($m = 1$), then $\theta_S(1, n) = (1 + n)/n$ and as the number of host firms n becomes very large, the source firm *always* prevents technology transfer: $\lim_{n \rightarrow \infty} \theta_S = 1$. With many host competitors, the benefit of restricting technology transfer is large since the source firm can increase the costs of all host competitors by paying the wage premium.

If instead there is only one host firm ($n = 1$), then $\theta_S(m, 1) = m + 1$ and as the number of source firms m becomes very large, the source firm always allows technology transfer: $\lim_{m \rightarrow \infty} \theta_S = \infty$. The incentive to curtail technology transfer is dampened when there are several source firms: each is tempted *not* to offer a wage premium given that all of its source rivals are doing so.

In summary, the presence of multiple host firms decreases the likelihood of technology transfer whereas the presence of multiple source firms increases it relative to duopoly. An interesting property is that the threshold $\theta_S(m, n)$ equals 2 whenever $m = n$. Under linear demand, moving from the duopoly case where $m = n = 1$ to say $m = n = 2$ does not affect the range of parameters over which technology transfer occurs. The effect of an increase in the number of host firms n exactly offsets the effect of an increase in the number of source firms m .

III. Production Location

We now consider a preliminary stage in which the source firm chooses between locating its production facilities in the host country or some alternative location. If the source firm chooses the alternative location, its marginal cost is $\omega \geq 1$ and the possibility of technology transfer to the host firm is eliminated, as host firms cannot hire away the source firm's workers in other countries.

FDI Decision

The host country offers potential cost savings to the source firm, but with greater potential for technology transfer to rival firms. When making its decision regarding production location, the source firm realizes that its own cost of production, as well as the cost of its rivals, depends on whether or not it finds preventing technology transfer attractive. The implied costs are summarized in Table 1 (recall that $\Theta \geq \theta \geq 1$, $\Gamma \equiv \Theta/\theta \geq 1$, and $\omega \geq 1$).

Table 1. Marginal costs under different regimes

Regime	Source firm's cost	Host firm's cost
Production elsewhere	ω	Θ
FDI with no technology transfer	Γ	Θ
FDI with technology transfer	1	θ

Begin by defining the change in profits $\Delta\pi_i^{jk} \equiv \pi_i^j - \pi_i^k$, for firm $i \in \{H, S\}$ due to switching equilibrium regimes between $j, k \in \{E, N, T\}$. $\Delta\pi_S^{EN} = 0$ depicts the boundary between production elsewhere and FDI with no technology transfer; $\Delta\pi_S^{ET} = 0$ depicts the boundary between production elsewhere and FDI with technology transfer; $\Delta\pi_S^{TN} = 0$ depicts the boundary $\theta = \theta_S$ between FDI with and without technology transfer.

Lemma 2. *The locus of $\Delta\pi_S^{ET} = 0$ is downward sloping in θ and intersects the ω -axis below the locus of $\Delta\pi_S^{EN} = 0$. The locus of $\Delta\pi_S^{TN} = 0$ is a vertical line at $\theta = \theta_S$. These loci all intersect each other at (θ_S, ω_S) where $\omega_S \equiv \Theta/\theta_S$.*

These three source firm profit loci divide the (θ, ω) space into three regions: production elsewhere (when ω is low), FDI with technology transfer (when ω is high and θ is low), and FDI with no technology transfer (when ω is high and θ is high), as in Figure 2.

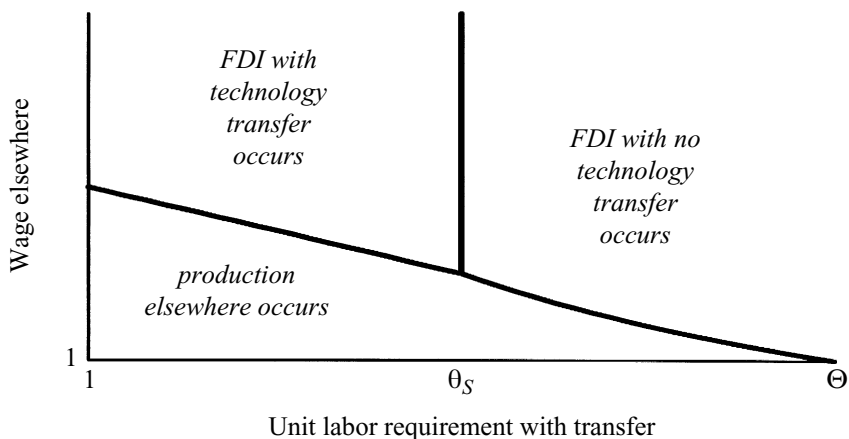


Fig. 2. Source firm chosen entry mode

Proposition 3. *When $\theta \geq \theta_S$, the source firm produces elsewhere iff the cost elsewhere is sufficiently low $\omega \leq \Gamma$ or else engages in FDI and prevents technology transfer. When $\theta < \theta_S$, the source firm produces elsewhere iff the cost elsewhere is sufficiently low $\omega \leq \Omega$ or else engages in FDI and allows technology transfer.*

Welfare Implications of FDI

How does welfare in the host country depend on the regime chosen by the source firm? Define host welfare in equilibrium j as the host firm’s profits and any wage premium $W^j \equiv \pi_H^j + B^j$, where the total wage premium is $B^j \equiv (w_S^j - 1)q_S^j$. No wage premium is paid in the technology transfer equilibrium $B^T = 0$, while the wage premium in the no technology transfer equilibrium is $B^N \equiv (\Gamma - 1)q_S^N > 0$. Consumption is assumed to occur outside the host country for simplicity, so no consumer surplus need be measured.

Begin by constructing the boundaries where host welfare is the same across regimes in the (θ, ω) plane. $\Delta W^{ET} \equiv W^E - W^T = \pi_H^E - \pi_H^T = 0$ forms the boundary between where production elsewhere or FDI with technology transfer are best for host welfare in Figure 3. Similarly, $\Delta W^{EN} \equiv W^E - W^N = 0$ forms the boundary between where production elsewhere or FDI with no technology transfer are best for host welfare. Host

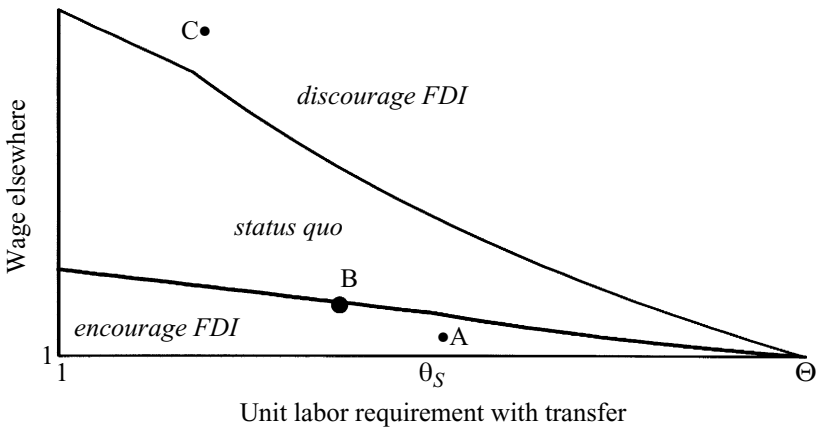


Fig. 3. Host policy toward foreign investment

welfare favors production elsewhere when costs are higher elsewhere, as high costs for the source firm shift profits toward the host firm.

Lemma 3. *The locus of $\Delta W^{ET} = 0$ is downward sloping in θ and intersects the ω -axis above the locus of $\Delta W^{EN} = 0$.*

IV. Policy Analysis

Technology transfer is one of the dominant reasons why developing countries are interested in attracting FDI. We examine whether host countries can benefit from attracting FDI through a lump-sum subsidy conditional on FDI.

Inducing FDI with No Technology Transfer

Figure 3 compares the source firm's choice of entry mode (FDI or production elsewhere) to the mode that maximizes host welfare. Suppose the parameter values are such that the source firm opts for production elsewhere. In addition, suppose $\theta > \theta_S$ so that, if the source firm engages in FDI, it will not allow technology transfer (such as at point **A** in Figure 3). Would the host country want to *induce* FDI by the source firm? Even absent technology transfer, the host country's welfare can be improved by inducing FDI.

When $\omega = \Gamma$, an arbitrarily small payment to the source firm conditional on producing in the host economy will improve host welfare. Since FDI with no technology transfer involves a wage premium, host welfare is strictly higher under FDI with no technology transfer than under production elsewhere. The interests of the host workers tip the balance in favor of FDI (with no technology transfer) over production elsewhere, even though technology transfer is absent. The first rationale for attracting FDI suggested by our model is *increased wages for host workers*.

In general, when $\omega < \Gamma$, the source firm must be offered a subsidy of at least $(\Gamma - \omega)q_S^N$ so that its profits are unaffected. The profits of the host firm are unaffected. Host workers, however, gain the amount $(\Gamma - 1)q_S^N$. Thus, such a policy of inducing FDI improves welfare because $\omega > 1$. Host welfare improves since some part of the source firm's cost savings from FDI are transferred to host workers as higher wages.

Inducing FDI with Technology Transfer

Again, suppose the parameter values are such that the source firm opts for production elsewhere. But now suppose $\theta < \theta_S$ so that, if the source firm engages in FDI, it will allow technology transfer (such as at point **B** in Figure 3). Would the host country then want to *induce* FDI by the source firm? Here, too, there exists a potential rationale for attracting FDI: the host

firm enjoys technology transfer from the source firm. To attract FDI, the host government can induce FDI by compensating the source firm for the loss in profits that FDI entails relative to production elsewhere. Are there circumstances under which such a policy improves welfare? Yes.

Suppose parameters lie on the boundary between production elsewhere and FDI with technology transfer with $\theta < \theta_S$. Then, the source firm is exactly indifferent between production elsewhere and FDI with technology transfer, but the host country *strictly prefers FDI* with technology transfer. A small incentive to FDI can yield an improvement in host welfare, net of the subsidy payment. Here, the improvement in host welfare results from *higher profits of the host firm*.

In general, the host government can benefit from attracting FDI that generates technology transfer if industry profits rise.¹⁴ Moving below the boundary where the source firm is indifferent, the subsidy required rises, but there remains a region where the gain in host profits still warrants the subsidy required. The host government must offer a subsidy of at least $\Delta\pi_S^{ET}$ to keep source profits unaffected. Host profits increase by $\Delta\pi_H^{TE}$, so provided $\Delta\pi_H^{TE} > \Delta\pi_S^{ET}$, the host profit gains are sufficient to offset source profits losses.

Preventing FDI

Does FDI with technology transfer always dominate production elsewhere in terms of host welfare? Not necessarily. In a region (including point **C** in Figure 3), the source firm chooses FDI with technology transfer but host welfare is highest under production elsewhere. Here, *FDI with technology transfer actually lowers host welfare relative to production elsewhere*. Since the wage elsewhere ω is high in this region, the source firm enjoys a substantial decline in its marginal cost if it switches from production elsewhere to FDI, thereby harming the host firm's profits, despite the host firm enjoying lower costs due to technology transfer.

Similar adverse consequences from FDI can result even when the source firm pays a wage premium to curtail technology transfer. The harm to host firms can dominate the benefit to workers, causing a net reduction in host welfare. Therefore, host welfare can be raised by restricting FDI when the source firm finds FDI highly attractive.

¹⁴Host consumption would add more benefits under technology transfer due to lower price and larger output.

Policy Contrast

If both ω and θ are high, as for countries at low levels of development, the host government *discourages* FDI; whereas if both ω and θ are low, as for countries at higher levels of development, the host government *encourages* FDI. A shift in policy toward encouraging FDI may occur as a country develops: the potential for technology transfer becomes less partial in nature due to enhanced absorptive capacity, and the cost reduction from FDI for source firms is reduced when host wages become closer to wages elsewhere.

Proposition 4. *The host government has an incentive to induce FDI (if FDI would not otherwise occur) when the cost elsewhere ω is sufficiently low and prevent FDI if the wage elsewhere ω is sufficiently high.*

V. Conclusion

We examine a market where a source firm possesses a superior technology relative to a host firm. If the source firm opts for FDI, technology may diffuse to the host firm if it hires workers who have been exposed to the superior technology by working for the source firm. We show that the source firm may be able to increase its profits by raising the wage it pays its workers by enough to prevent them from switching employers. Such a wage premium can raise the source firm's profits by preventing the cost reduction for the host firm that would otherwise occur.

Our model implies that there could be two possible rationale for attracting FDI: technology transfer which increases the host firm's profits or wage premiums that benefit workers. Yet the realization of one of these benefits is insufficient to make FDI always more attractive relative to production elsewhere for the host country. Nevertheless, there do exist circumstances under which the host country can improve its welfare by making the source firm switch to FDI through policy intervention.

Appendix

Proof of Lemma 1

The host firm matches the source firm's wage if $\pi_H^T(w_S, \theta w_S) > \pi_H^N(w_S, \Theta)$. $\pi_H^T(w_S, \Theta)$ is strictly increasing in w_S . When $w_S = \Gamma$, $\pi_H^T(w_S, \theta w_S) = \pi_H^N(w_S, \Theta)$. Furthermore, at $w_S = 1$, $\pi_H^T(w_S, \theta w_S) > \pi_H^N(w_S, \Theta)$. For all $w_S < \Gamma$, $\pi_H^T(w_S, \theta w_S) > \pi_H^N(w_S, \Theta)$, whereas for all $w_S > \Gamma$, $\pi_H^T(w_S, \theta w_S) < \pi_H^N(w_S, \Theta)$. Thus, the unique intersection $\pi_H^T(w_S, \theta w_S) = \pi_H^N(w_S, \Theta)$ occurs at $w_S = \Gamma$.

Proof of Proposition 2

Suppose $m - 1$ source firms offer the wage premium Γ and consider the decision of the m th source firm. The source firm m 's profits under technology transfer equal

$$\pi_m^T = \left[\frac{A - (m + n) + (m - 1)\Gamma + n\theta}{m + n + 1} \right]^2, \tag{A1}$$

whereas its profits under no technology transfer equal

$$\pi_m^N = \left[\frac{A - (n + m)\Gamma + (m - 1)\Gamma + n\Theta}{m + n + 1} \right]^2. \tag{A2}$$

Then, $\pi_m^N - \pi_m^T > 0$ and no technology transfer is the Nash equilibrium if

$$-(m + n) \left(\frac{\Theta - \theta}{\theta} \right) + n(\Theta - \theta) > 0 \rightarrow \theta > \theta_s(m, n) \equiv \frac{m + n}{n}. \tag{A3}$$

Proof of Lemma 2

Consider first the derivation of the locus $\Delta\pi_S^{EN} \equiv \pi_S^E - \pi_S^N = 0$, along which the source firm is indifferent between production elsewhere and FDI with no technology transfer. Since under both regimes the host firm's marginal cost equals Θ , the source firm prefers FDI with no technology transfer over production elsewhere iff the wage elsewhere exceeds the wage required to prevent technology transfer $\omega > \Gamma$. The equation $\omega = \Gamma \equiv \Theta/\theta$ traces a downward sloping curve: above the curve the source firm prefers FDI with no technology transfer and below the curve production elsewhere.

Next consider the derivation of the locus $\Delta\pi_S^{ET} \equiv \pi_S^E - \pi_S^T = 0$ along which the source firm is indifferent between production elsewhere and FDI with technology transfer. The *maximum cost elsewhere* Ω (such that production elsewhere dominates FDI with technology transfer) is defined as a function of θ by¹⁵

$$\pi_S^E(\Omega, \Theta) = \pi_S^T(1, \theta) \leftrightarrow \Delta\pi_S^{ET} = 0. \tag{A4}$$

The equation $\omega = \Omega$ also traces a downward sloping curve: above the curve, the source firm prefers FDI with technology transfer while below the curve production elsewhere.

Next, consider the derivation of the locus $\Delta\pi_S^{TN} \equiv \pi_S^T - \pi_S^N = 0$ along which the source firm is indifferent between FDI with technology transfer and FDI with no technology transfer. Proposition 1 indicates that $\Delta\pi_S^{TN} = 0$ is a vertical line at $\theta = \theta_s$. To the left of this line, the source firm prefers FDI with technology transfer, while to the right FDI with no technology transfer. Since neither equilibrium under

¹⁵Since the RHS is increasing in θ , the LHS must also be increasing in θ , so Ω is decreasing in θ .

comparison involves production elsewhere, the difference in profits is independent of the cost of production elsewhere.

First, we show that the $\Delta\pi_S^{ET} = 0$ locus is downward sloping in the (θ, ω) space. Along the $\Delta\pi_S^{ET} = 0$ locus, $\pi_S^E(\omega, \Theta) = \pi_S^T(1, \theta)$. The RHS is increasing in θ while the LHS is unaffected. Thus, for the two to stay equal, as θ increases, ω must decrease. Second, we show that the $\Delta\pi_S^{ET} = 0$ locus intersects the ω -axis below the $\Delta\pi_S^{EN} = 0$ locus. The $\Delta\pi_S^{EN} = 0$ locus intersects the ω -axis at Θ . Let the $\Delta\pi_S^{ET} = 0$ locus intersect the ω -axis at some $\bar{\omega}$. At $\theta = 1$, $\pi_S^N(\Theta, \Theta) < \pi_S^T(1, 1)$ and $\pi_S^E(1, \Theta) > \pi_S^T(1, 1)$, so $\pi_S^E(\bar{\omega}, \Theta) = \pi_S^T(1, 1)$ at $1 < \bar{\omega} < \Theta$, since $\pi_S^E(\omega, \Theta)$ is decreasing in ω . Third, we show that the $\Delta\pi_S^{EN} = 0$ locus and the $\Delta\pi_S^{ET} = 0$ locus intersect at (θ_S, ω_S) , where $\omega_S \equiv \Theta/\theta_S$. At $\theta = \theta_S$, $\pi_S^N(\Theta/\theta_S, \Theta) = \pi_S^E(\omega_S, \Theta)$ if $\omega_S \equiv \Theta/\theta_S$, so $\Delta\pi_S^{EN}(\Theta/\theta_S, \Theta) = 0$. Also, at $\theta = \theta_S$, by definition $\pi_S^N(\Theta/\theta_S, \Theta) = \pi_S^T(1, \theta_S)$. Subtracting $\pi_S^E(\omega_S, \Theta)$ from both sides implies that at $\theta = \theta_S$, we must have $\Delta\pi_S^{EN}(\Theta/\theta_S, \Theta) = \Delta\pi_S^{ET}(1, \theta_S)$. By transitivity, all three loci must intersect at (θ_S, ω_S) .

Proof of Lemma 3

First, we show that the $\Delta W^{ET} = 0$ locus is downward sloping in the (θ, ω) space. Along the $\Delta W^{ET} = 0$ locus, $W^E = W^T$, which requires $\pi_H^E(\omega, \Theta) = \pi_H^T(1, \theta)$, as no wage premiums are paid in either case. The RHS is decreasing in θ while the LHS is unaffected. Thus, for the two to stay equal, as θ increases, ω must decrease to lower host profits when the source firm produces elsewhere. Second, we show that the $\Delta W^{ET} = 0$ locus intersects the ω -axis above the $\Delta W^{EN} = 0$ locus. Let the $\Delta W^{ET} = 0$ locus intersect the ω -axis at some $\bar{\omega}$ such that $\pi_H^E(\bar{\omega}, \Theta) = W^T$ and the $\Delta W^{EN} = 0$ locus intersect the ω -axis at some $\hat{\omega}$ such that $\pi_H^E(\hat{\omega}, \Theta) = W^N$. At $\theta = 1$, $W^N > W^T$ as $1 = \theta < \theta_W$, which implies $\pi_H^E(\hat{\omega}, \Theta) > \pi_H^E(\bar{\omega}, \Theta)$, where θ_W is the host welfare threshold such that $\Delta W^{NT} = 0$. Since increasing ω raises $W^E = \pi_H^E(\omega, \Theta)$, $\bar{\omega}$ must exceed $\hat{\omega}$. Third, we show that the $\Delta W^{EN} = 0$ locus and the $\Delta W^{ET} = 0$ locus intersect at (θ_W, ω_W) . At θ_W , by definition $W^N = W^T$, neither of which depend on ω . Define ω_W such that $\pi_H^E(\omega_W, \Theta) = \pi_H^T(1, \theta_W)$, which implies $W^E = W^T$. Thus, by transitivity, all three loci intersect at (θ_W, ω_W) , and $\omega_W > \omega_S$ follows from $\theta_W < \theta_S$ (and $\hat{\omega} > \Theta\hat{\omega}$).

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