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**FOREIGN DIRECT INVESTMENT AND
SPILLOVERS THROUGH WORKERS'
MOBILITY**

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ABSTRACT

Foreign Direct Investment and Spillovers through Workers' Mobility*

We analyse a model where a multinational firm can use a superior technology in a foreign subsidiary only after training a worker. Technological spillovers from foreign direct investment arise when this worker is later hired by a local firm. Pecuniary spillovers arise when the foreign affiliate pays the trained worker a higher wage to prevent her from moving to a local competitor. We study conditions under which these spillovers occur. We also show that the multinational firm might find it optimal to export instead of investing abroad to avoid dissipation of its intangible assets or the payment of a higher wage to the trained worker.

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NON-TECHNICAL SUMMARY

In recent years, both developed and developing countries have often encouraged investment by foreign firms. This favourable attitude towards multinational enterprises (MNEs) is due to the beneficial effects that foreign investment might generate on the local economy, in the form of higher employment, creation of infrastructure, technological spillovers or other externalities. This Paper focuses on a specific and important mechanism for foreign direct investment (FDI) generating spillovers: the mobility of workers from the subsidiaries of foreign firms to local companies. Our analysis helps identify conditions under which such spillovers occur.

Consistent with the empirical evidence (see for instance, Blömstrom and Kokko, 1998), we argue that, in order to employ efficiently some superior technology in its subsidiary abroad, an MNE trains a local worker. Once the worker has been trained, she could bring the new technology to a local firm, if it managed to hire her. This originates a competition between the MNE, which would like to keep her to avoid the diffusion of its advantage to competitors and the local firm which would like to hire the worker to appropriate their knowledge. If the MNE offers a higher wage, it manages to keep the worker, but *pecuniary spillovers* arise, since the trained worker is paid more than the reservation wage. If the local firm makes a higher offer to the trained worker, she will move and *technological spillovers* take place.

Our analysis shows that one important condition in determining which type of spillovers arises is the so-called 'joint-profit effect', which occurs when the profits of a monopolist are larger than the sum of the profits of two duopolists. Technological spillovers do not occur if the joint-profit effect holds. Therefore, attracting FDI into a country does not necessarily imply that local firms will benefit from the diffusion of the superior technology introduced by the MNEs' affiliates.

Our Paper shows that the mobility of trained workers is higher when MNEs offer *general* rather than *specific* on-the-job training (in the former case, a worker is equally productive within the training firm and another one; in the latter, she is more productive in the firm which gives her training), which is consistent with the labour economics literature. Our addition to this literature is to show that it is not only the nature of training (general versus specific) but also the degree of product market competition which affects labour mobility. Indeed, we predict that, other things being equal, higher labour mobility and more spillovers (both technological and pecuniary) occur when the local firm is not a close competitor of the MNE. This might mean that the local firm operates in another sector, produces a good which is vertically related to the

MNE's production (either upstream or downstream), or sells its products in a different geographical area than the MNE.

Our Paper also predicts that the 'absorptive capability' of the local firm plays an important role in determining the possible occurrence of spillovers. A low level of absorptive capability (which might be due to technological backwardness) reduces the potential for FDI generating spillovers. This is because the local firm could not make efficient use of the MNE's technology and therefore would not be able to make a strong offer for the trained worker, who would then stay with the MNE. The prediction of our model is thus consistent with the empirical finding that low levels of absorptive capability of local firms are associated with reduced benefits from FDI (e.g. Borensztein et al., 1998; Kokko, 1994). In relation to this, one would also expect higher labour mobility and more technological spillovers in host countries that are technologically advanced and have a highly skilled labour force.

Finally, we also show that in some circumstances an MNE might prefer to export rather than to invest abroad, precisely to avoid diffusion of its superior technology to the local rival and/or the payment of rents to the trained worker. This is because, by exporting, the MNE can rely on its home country workers and it does not need to train a local worker, thereby avoiding the risk of technological diffusion.

1 Introduction

The last two decades have witnessed an important change in the attitude of host countries towards multinational enterprises (MNEs). Most countries have removed their barriers to foreign direct investment (FDI) and have actively encouraged investment by foreign firms. Advocates of these policies claim that MNEs generate spillovers which benefit the host economy. Such spillovers may take several forms.¹

First, there may exist backward and forward linkages between foreign affiliates and local firms (Lall, 1980; Rodriguez-Clare, 1996). Second, foreign affiliates may increase local firms' productivity through 'demonstration effects'. For example, domestic competitors might successfully imitate technological innovations introduced by MNEs (Blömstrom, 1986; Mansfield and Romeo, 1980). Third, spillovers arise when subsidiaries of foreign firms train local employees who later join local firms or set up their own companies, bringing with them all (or part of) the technological, marketing, and managerial knowledge that they have acquired.

In this paper, we focus on this last form of spillovers, and we present a model in which technological spillovers arise due to the mobility of workers who have been trained by MNEs. Our main purpose is to study the conditions under which such spillovers occur.

The fact that MNEs undertake substantial efforts in the education of local workers has been documented in many instances (e.g., ILO, 1981; Lindsey, 1986), and empirical research seems to indicate that MNEs offer more training to technical workers and managers than do local firms (Gerschenberg, 1987; Chen, 1983). In early stages affiliates rely more intensively on expatriates, but subsequently they

¹See Blömstrom and Kokko (1998) for an extensive review of FDI spillovers.

tend to replace them with (cheaper) local workers who have been properly trained in the meanwhile (UNLTC, 1993).

However, evidence on spillovers due to workers' mobility is scarce and far from conclusive.² An early study by Behrman and Wallender (1976) shows that while labor mobility is important in certain circumstances, it is minimal in others. Gerschenberg (1987) analyzes MNEs' activity in Kenya. He concludes that mobility is lower for managers employed by MNEs than for those employed by local firms. In a study on the Taiwanese economy, Pack (1993) finds that labor mobility from MNEs to local firms is important and that often trained managers leave MNEs to run their own businesses. Aitken et al. (1997) study the effect of inward FDI on the wages of the local workforce in three different host countries. In Mexico and Venezuela, inward FDI increases the wages of the workers in MNE affiliates but has no effect on the wages of local firms' workers. In the US, inward FDI results in higher wages both in MNE affiliates and in local firms. Indirectly, this might show the existence of technological spillovers through labor mobility in the US, whereas in Mexico and Venezuela such labor mobility might be inhibited by either the higher wages paid by the MNEs or a larger technology gap.

Our paper provides a formalization which is consistent with these findings. We build a model where a MNE trains a local worker to run its subsidiary. Later the MNE and a local firm compete for the services of the trained worker. As a result, the MNE manages to keep the worker only if it offers better conditions than the local firm does. Spillovers from foreign direct investment can take two forms. Technological spillovers arise when the trained worker is hired by the local firm. Pecuniary spillovers arise when the MNE pays the worker a higher wage to prevent her from moving to the local competitor.

We find that the so-called 'joint-profit effect' (or 'efficiency effect') plays an

²See also Blömstrom and Kokko (1998).

important role in determining which type of spillovers arises. We show that technological spillovers do not occur if the joint profit of the MNE and the local firm is highest when the MNE can use the technology as a monopolist. This result is similar to the one obtained in the literature on the persistence of monopolies (see Tirole, 1988). The empirical implication is that one should expect higher labor mobility and more spillovers (both technological and pecuniary) when the local firm can use the technology in activities that do not compete fiercely the MNE. This occurs for example when the local firm can operate in markets for products which are unrelated or complementary to the MNE's products. Unfortunately, we are aware of no empirical studies which try to link the existence of spillovers with the sectors of activity of multinational and local firms.

We also find that a low level of "absorptive capability" by the local firm, which might be due to technological backwardness, reduces the potential for FDI generating spillovers. The empirical evidence seems to confirm that spillovers increase with the degree of absorptive capability of host country firms (see for instance, Borensztein et al., 1998; Kokko, 1994).

Further, the mobility of the trained workers is higher the more general is the on-the-job training given by the MNE, which is consistent with the labor economics literature (e.g., Becker, 1964). Our addition to this literature is to show that it is not only the nature of training (general versus specific) but also the degree of product market competition which affects labor mobility.

Finally, the MNE might anticipate that investing abroad would lead either to technological spillovers or to higher wages and choose to export instead. Anecdotal evidence confirms that this may sometimes be the reason why MNEs export. An illustrative example is drawn from the history of the chemical sector (Kudo, 1993). After World War I, the leading German chemical company IG Farben decided to increase its activity in the growing Japanese market, whose chemical industry was

still at an infant stage. IG Farben resorted to exporting and avoided FDI (and licensing) as much as possible in order to minimize the diffusion of technology to competitors.

Other game theoretical models have analyzed spillovers to foreign markets, although from different perspectives. In Ethier and Markusen (1996) technological spillovers arise as a result of a double moral hazard problem. A foreign firm endowed with a superior technology might renege on an exclusive contract with a local licensee by transferring technology to other local firms, whereas the licensee might 'cheat' by introducing a marginal improvement in the technology. Fosfuri and Motta (1999) and Siotis (1997) analyze the decision between exporting and FDI but they simply assume that when two firms locate in the same region a proportion of their know-how spills over to each other. This 'black-box' type of spillovers is quite familiar in the R&D literature (e.g., d'Aspremont and Jacquemin, 1988).

The rest of this paper is organized as follows. Section 2 presents the model, analyzes the equilibrium outcomes and discusses the results obtained. Section 3 concludes the paper.

2 The model

A Multinational Enterprise (MNE) has some payoff relevant information which can be thought of as a new technology, a new production process, a new managerial technique, or a new organizational form. We will call this information 'technology'. The technology has been accumulated prior to the game and it is exogenously given in our model. It has not yet been introduced to the foreign market on which we focus.

The MNE can either serve the foreign market through exports or establish a local subsidiary (i.e., do FDI). We disregard uninteresting cases where selling in the

foreign market is not profitable. FDI requires the firm to transfer its technology to the subsidiary. We assume that such a transfer is successful only if a local worker is well acquainted with the technology. The relevant technology can only be transmitted through oral communication or on-the-job training.

Apart from the MNE, there also exists a local firm l which could sell the product if it knew how the technology worked. We exclude the possibility of licensing agreements by assuming that the costs of contracting upon this knowledge-based asset are large enough.

The basic features of the game are described in Figure 1.

At time $T = 0$, the MNE decides whether to export or to do FDI. When exporting, the firm will make use of production facilities and trained workers located in the home country. When investing in the host market, the MNE will have to incur a fixed cost G , which includes all the expenses associated with operating in an unfamiliar foreign environment. The local firm does not have to incur this cost since it is already familiar with the local market.

In addition, if FDI is chosen, the MNE sends a staff of supervisors to the affiliate to train a local worker. After completion of the training, they return to headquarters.³ The total cost of training the worker is F , which we set equal to zero for simplicity.⁴

The worker who receives training is hired from a pool of identical untrained workers. She is paid the subsistence wage \bar{w} which is normalized to zero. We assume that the MNE can only write a one-period contract with the worker. We also assume that the worker is wealth-constrained and that she cannot borrow on the financial market, so that her first period wage must be non-negative. We discuss these assumptions in more detail at the end of this section.

³Alternatively a local worker is given training at the parent company.

⁴Qualitative results do not change with $F > 0$, see Fosfuri et al. (1998).

After having received proper training, the local worker (henceforth we shall refer to her as the 'trained' worker) has acquired all the necessary expertise, technology and information to produce the good. At period $T = 1$ production takes place, the good is sold and first-period profits are realized. The MNE is a monopolist in the market in the first period, since the local firm has no access to its technology. N_1 is the size of the market in period 1, as measured by the number of consumers. The MNE's profit is $N_1 \Pi_M^E(t)$ if it exports, where t is an export cost (tariff, transportation cost or wage differential). If the MNE does FDI, its profit is $N_1 \Pi_M$ (gross of set up costs), with $\Pi_M > \Pi_M^E(t)$. We set $N_1 = 1$ without loss of generality.

After production takes place, firm l realizes that it could also gain access to the technology by hiring the trained worker. The MNE would like to retain her to avoid the dissipation of the rents associated with her technology.

We model competition for the worker in the following way. Each firm simultaneously and independently makes a take-it-or-leave-it offer to the trained worker. The firm who offers more hires the worker and pays the wage it has offered. Put differently, the hiring process works like a first-price auction. If both firms offer the same wage we assume that the firm whose valuation of the worker is highest hires her (this assumption is made to guarantee equilibrium in pure strategies). We assume that firms have symmetric information about the value of the trained worker.⁵ Also note that we are assuming away the possibility that the local firm might hire workers from the home country of the MNE. Therefore, no spillovers can occur when the MNE chooses to export.⁶ This amounts to saying that spillovers are localized (e.g., Audretsch and Feldman, 1996).

We shall focus on the equilibrium in which the firm whose valuation of the worker

⁵In Fosfuri et al. (1998) we deal with the case of asymmetric information about the value of the trained worker, and show that our results are not sensitive to this change.

⁶It seems reasonable to assume that it is more difficult for the local firm to identify trained workers if they are in another country, and/or to attract such workers from abroad if identified.

is highest hires her by offering exactly the rival's valuation.⁷ This implies that the trained worker will appropriate some of the rents created by the technology.

Each firm's valuation of the worker depends on its outside options. We assume that firm l can only acquire the technology by hiring the worker (imitation is ruled out in our model). Hence, the local firm will make zero profits in the second period if it does not succeed in attracting the worker. If the MNE loses the trained worker, it will redeploy the staff from the headquarters to train another local worker.

After the MNE has decided between exports and FDI, production takes place and the second-period payoffs are realized. For simplicity, we assume a discount factor of 1. We denote by N_2 the second-period market size. If the MNE keeps the trained worker, its second period payoff is given by $N_2\Pi_M$ (gross of the wage paid to the worker), while it is $N_2\Pi_M^E(t)$ if it exports.

For expositional reasons, we focus first on the case where the MNE does not export in the last period of the game. This is the case if the following holds:

Assumption A1.

$$N_2(\Pi_M - \Pi_M^E(t)) \geq G.$$

Below we shall discuss briefly the case where A1 is not satisfied.

If the local firm hires the trained worker and enters the market, both firms earn gross profit $N_2\Pi_D(\phi)$ (the label D standing for "duopoly"). The parameter $\phi \in [0, 1]$ is an inverse measure of the degree of competition in the industry. We assume that $\Pi_D(\phi)$ is differentiable and strictly increasing in ϕ with $\Pi_D(0) = 0$ and $\Pi_D(1) = \Pi_M$. The degree of competition is affected by such variables as product differentiation, the mode of competition (e.g., price versus quantity competition), and competition laws and their enforcement in the local country. For instance, with homogenous

⁷We disregard equilibria where both firms offer a wage between the lowest and the highest valuation of the worker (and where the firm with the highest valuation hires her), since in these equilibria the firm with the lowest valuation is playing a weakly dominated strategy.

products and price competition $\phi = 0$, while with independent markets $\phi = 1$.

We also assume that the local firm has to pay a fixed cost $k \geq 0$ to benefit from the technology brought in by the trained worker. The parameter k measures the absorptive capability of the local firm and the transferability of the technology received by the worker. If she receives general training, such as organizational, managerial or marketing skills that can be costlessly used in other firms (and possibly other industries), k will be very low. If instead the worker has received training in firm specific technology, the local firm will find it more costly to adapt this technology to its own production process, and k will be high.⁸

We take ϕ and k to be exogenous and do not specify any functional relationship between them.⁹

We look for the sub-game perfect equilibrium in pure strategies of the game just described. We solve the model by backward induction.

Equilibrium solutions As a first step, we determine the outcome of the bidding for the trained worker. The local firm's valuation of the worker is $v_l = N_2 \Pi_D(\phi) - k$. The MNE will earn monopoly profit if it keeps the worker, and duopoly profit if it

⁸The distinction between general and specific on-the-job training is due to Becker (1964). In Becker, there is specific (general) training when workers' productivity is lower (equal) in other firms than in the firm which provides the training. We model this by means of a fixed cost, but the effect is the same, as k reduces the net payoff from hiring a worker trained elsewhere.

⁹Parameters k and ϕ might be related, but their relationship is not a priori obvious, as it might depend on the nature of the technology being transferred. For instance, one might expect that the technology received by the worker can be passed on to a rival firm more easily when the products are similar. However, if the worker has received general training, this technology could just as easily be transferred to firms which sell independent or complementary products as to firms which sell close substitutes. Further, it might be more difficult to transfer knowledge to a firm which sells similar products but has a different organizational or production structure than to a firm which sells less related products but has a similar structure.

loses her to the local competitor. Therefore, the MNE's valuation of the worker is $v_{mne} = N_2 (\Pi_M - \Pi_D(\phi))$.

Two situations are possible: either $v_{mne} \geq v_l$, and the MNE keeps the worker by paying her $w = N_2 \Pi_D(\phi) - k$; or $v_{mne} < v_l$, and the local firm hires the trained worker by paying her $w = N_2 (\Pi_M - \Pi_D(\phi))$. In the first case, the MNE pays the local worker more than the wage in the pool, and the local economy enjoys a *pecuniary spillover*. In the second case a *technological spillover* occurs, since the local firm manages to appropriate the MNE's technology.¹⁰ The following Lemma summarizes the outcome of the hiring process.

Lemma 1 *Technological spillovers never arise if:*

$$N_2 (\Pi_M - 2\Pi_D(\phi)) + k \geq 0. \quad (1)$$

Proof.

Spillovers do not occur if $v_{mne} \geq v_l$. After substituting, this inequality can be written as $N_2 (\Pi_M - \Pi_D(\phi)) \geq N_2 \Pi_D(\phi) - k$. Rearranging, this gives condition (1). ■

To better interpret this result, let us introduce the following definition:

Definition: *The 'joint profit' effect holds (does not hold) if the sum of the gross profits of two duopolists is smaller (larger) than or equal to the gross profit of a monopolist.*

The 'joint profit' effect implies that $\Pi_M \geq 2\Pi_D(\phi)$. This is sufficient to ensure that condition (1) holds and that the local firm will not hire the trained worker. This

¹⁰Notice that in both cases the worker benefits from a pecuniary spillover which puts her two period income above that earned by the workers in the pool.

result is reminiscent of the industrial organization literature which studies persistence of leadership over time. Indeed, the 'joint profit' effect, also called 'efficiency' effect, has been identified as the main condition under which a monopolist manages to keep out potential entrants (e.g., Tirole, 1988; Budd et al., 1993).

The 'joint profit' effect holds when the duopolists are competing fiercely enough. Condition (1) can also be written in terms of the "competition" parameter, as $\phi \leq \phi_1 \equiv \Pi_D^{-1} \left(\frac{\Pi_M}{2} + \frac{k}{2N_2} \right)$. This curve is illustrated in Figure 2. It is positively sloped in (k, ϕ) as $\frac{d\phi}{dk} = \frac{1}{2N_2 \frac{d\Pi_D(\phi)}{d\phi}} > 0$.

We can now move on to the equilibrium solution of the whole game, which is given by the following:

Proposition 1

(i) - *FDI and technological spillovers. The MNE invests in the first period and there exist technological spillovers if condition (1) does not hold and:*

$$\Pi_M - \Pi_M^E(t) \geq N_2 (\Pi_M - \Pi_D(\phi)); \quad (2)$$

(ii) - *FDI and pecuniary spillovers. The MNE invests in the first period but technological spillovers do not occur if condition (1) holds and:*

$$\Pi_M - \Pi_M^E(t) \geq N_2 \Pi_D(\phi) - k; \quad (3)$$

(iii) - *Exports. The MNE exports in the first period, and no spillovers arise, otherwise.*

Proof.

(i) If condition (1) does not hold, technological spillovers would occur if the MNE invested in the first period, by Lemma 1. Therefore, the MNE's decision is between investing (and later losing the trained worker) and exporting in order

to avoid competition in the second period (when the MNE will invest). Investing is preferred to exporting if: $\Pi_M - G + N_2\Pi_D(\phi) \geq \Pi_M^E(t) + N_2\Pi_M - G$, which re-arranged gives condition (2).

(ii) If condition (1) holds, technological spillovers do not arise in case of FDI in the first period. Investing is preferred to exports if: $\Pi_M - G + N_2\Pi_M - (N_2\Pi_D(\phi) - k) \geq \Pi_M^E(t) + N_2\Pi_M - G$, where $N_2\Pi_D(\phi) - k$ is the wage paid to the trained worker to prevent her from moving to the local firm in the second period. Rewritten, this inequality gives condition (3).

(iii) If neither condition (1) nor condition (2) hold, the MNE prefers to export to prevent technological spillovers from occurring. If condition (1) holds but condition (3) does not, the MNE prefers to export to avoid pecuniary spillovers. ■

The equilibrium outcomes are illustrated by Figure 2. The three loci ϕ_1, ϕ_2, ϕ_3 correspond to conditions (1), (2), (3) in Proposition 1. Locus ϕ_1 has already been discussed above. Condition (2) can be written as $\phi \geq \phi_2 \equiv \Pi_D^{-1}\left(\frac{\Pi_M^E(t)}{N_2} + \Pi_M\left(1 - \frac{1}{N_2}\right)\right)$, which is independent of k . Condition (3) can be written as: $\phi \leq \phi_3 \equiv \Pi_D^{-1}\left(\frac{\Pi_M - \Pi_M^E(t)}{N_2} + \frac{k}{N_2}\right)$, which is positively sloped as $\frac{d\phi_3}{dk} = \frac{1}{N_2 \frac{d\Pi_D(\phi)}{d\phi}} > 0$. Note also that we do not need to make assumptions on the sign of $\frac{d^2\Pi_D(\phi)}{d\phi^2}$, which implies that curves ϕ_1 and ϕ_3 can be convex, concave or linear (in the graph we arbitrarily chose to draw them as being linear but this obviously does not affect the results we obtain). When the region with exports exists, i.e. $\frac{\Pi_M - \Pi_M^E(t)}{N_2} < \frac{\Pi_M}{2}$, the curves ϕ_1, ϕ_2, ϕ_3 intersect at the same point.

Let us discuss the results obtained. First, notice that technological spillovers occur when market competition is low (ϕ is high) and technology is easily transferable (k is low). The role played by each variable can be easily understood through the following thought experiments. Suppose that we are close to the origin, so that both k and ϕ are low. This region is characterized by easily transferable technology but strong market competition. Strong competition implies that the local firm gets

low profits from hiring the trained worker. The MNE would retain the worker by paying a small additional wage (pecuniary spillovers would arise) and there is no reason to export instead of investing. Now keep k fixed but increase ϕ . As ϕ rises, competition weakens and the bid made by the local firm increases. Accordingly, the second-period wage necessary to retain the worker increases with ϕ . In the region $\phi_1 > \phi > \phi_3$ it is cheaper for the MNE to export in the first period than to do FDI and later pay the additional wage to the trained worker. For still higher values of ϕ ($\phi_2 > \phi > \phi_1$), the local firm's profit in case it hires the worker would be so high that it would outbid the MNE at the equilibrium. In this region, however, competition is still strong enough for the MNE to be hurt from losing its technology to a rival. Hence, the MNE exports in the first period to avoid dissipation of its technology. Finally, if ϕ rises even further ($\phi > \phi_2$), product market competition becomes so weak that the MNE's profit would not decrease much if the local firm hired the trained worker. As a result, at equilibrium the MNE prefers to invest in the first period even though it anticipates that it will lose the worker in the following period.

A similar line of reasoning clarifies the role played by the parameter k which measures the transferability of the technology. For any given degree of product market competition, an increase in k will lower the payoff the local firm would obtain were it able to hire the trained worker. As a result, its bid will be lower and the MNE will find it cheaper to retain its worker. Hence, for any given ϕ the region where the MNE invests in the first period and pecuniary spillovers occur becomes larger.

Our results imply the following empirical predictions about the occurrence of technological spillovers. First, one should expect, other things being equal, such spillovers to occur when the multinational and the local firm are not direct competitors. This might mean that the local firm operates in another sector, produces

a good which is vertically related to the MNE's production (either upstream or downstream), or sells its products in a different geographical area than the MNE. Of course, testing such a prediction would require very disaggregated data, which might explain why this analysis has not yet been undertaken to our knowledge. Nevertheless, Pack (1993) reports some anecdotal evidence about trained workers who leave MNEs to start their own businesses in activities which do not compete with the MNE's business.

Of course, the extent to which technological spillovers occur depends on the nature of the technology and how easily it can be transferred. It is well known since the work of Becker (1964) that the more specific the on-the-job training (or the less easily transferable the technology) the lower the expected mobility of trained workers. This effect is captured by the aforementioned results: technological spillovers occur only if k is low enough. But k can also be interpreted as an inverse measure of the *absorptive capability* of the local firm (Cohen and Levinthal, 1989). Then, a high k - a low level of absorptive capability - reduces the region in which technological spillovers occur. The prediction of our model is thus consistent with the empirical finding that low levels of absorptive capability of local firms are associated with reduced benefits from FDI (e.g., Borensztein et al. 1998; Kokko, 1994). This might also have a cross-country implication, as one would expect higher labor mobility and more technological spillovers in host countries that are technologically advanced and have a highly skilled labor force.¹¹

Finally, a more speculative interpretation of k is as a measure of the protection of intellectual property in the host country. Under the laws of trade secrets, the worker is not allowed to disclose the MNE's valuable technology to the local firm.

¹¹The fact that Aitken et al. (1997) find some (indirect) evidence of labor turnover in the US but not in Mexico and Venezuela might be consistent with this implication of our analysis. See also Borensztein et al. (1998).

Thus, k could be thought of as the expected fine the local firm has to pay if the worker discloses the technology, or the expected cost if a non-compete covenant is enforced.¹² In this perspective, Lee and Mansfield (1996) show that better general protection of intellectual property increases the probability of multinational firms investing in the country.

The literature on training has emphasized that one of the effects of "poaching" workers who have been trained elsewhere is to reduce the benefit of training itself, which in turn leads to underinvestment in training. In our model, poaching might lead the firm to export in the first period. The effect is similar, as the export choice involves no training of local workers. Acemoglu and Pischke (1998) point out that in countries where the institutional structure makes poaching more difficult (Germany, where wages for similar workers are fixed across firms and across regions, is a case in point) training levels will be higher than in markets where poaching raids are not restricted. Here we have a result of the same flavor, as restrictions on labor mobility can be seen as an increase in the transferability cost k .

Comparative Statics Figures 3(i) and 3(ii) illustrate some simple comparative statics with respect to t and N_2 . In Figure 3(i), we show the effect of an increase in transportation costs or tariffs, t . Since the export strategy becomes more costly, the region where FDI occurs at equilibrium is larger (ϕ_2 shifts downwards, and ϕ_3 shifts to the left). This is due to the traditional 'tariff-jumping' motivation for FDI and it is a well-known outcome (see Motta, 1992). Moreover, the downward shift of ϕ_2 increases the size of the region with technological spillovers. This implies that tariffs and similar policy instruments might be used to attract new technology

¹²A non-compete covenant specifies the period of time (and the geographic area) for which the employee cannot work for a competitor after leaving the firm (see, e.g. Budden, 1996). If a non-compete covenant is enforced, the local firm incurs a loss since it cannot acquire the technology immediately after the worker leaves the MNE.

into the country. According to Siotis (1997), this is precisely the policy followed by the European Commission to appropriate leading Japanese technology in the parts and components consumer electronics industry. He reports that Japanese firms had used only exports and avoided licensing agreements and FDI in the EU as a way to preserve their technological edge. Since changes in quotas and tariffs were ruled out by the EU commitment in the Uruguay Round negotiations, the European Commission threatened to use other measures such as antidumping duties and safeguard clauses to discourage Japanese exports, promote investments, and create technological spillovers.

However, the result that an increase in export costs t might lead to FDI and technological spillovers (whereas no spillovers would have arisen in the absence of government intervention) is conditional on the change in the equilibrium outcome, and entails an important discontinuity.¹³ If the government were not able to predict the outcome of the game with sufficient precision, it might choose a tariff rate which is not high enough for the MNE to switch to FDI. The effect of the tariff might then be detrimental, due to lower consumer surplus. Therefore, strong informational requirements are needed to ensure that a government can intervene to improve welfare.

Figure 3(ii) illustrates how the equilibrium outcome changes when the second-period market size expands. At equilibrium, a higher value of N_2 enlarges the region where exports occur, but its overall effect on technological spillovers is ambiguous. To see why, note that an increase in N_2 produces the following effects. First, the fixed cost k becomes less important relative to profits (which increase in N_2), implying that the local firm offers a higher wage to the trained worker. Hence, technological spillovers occur for a larger subset of the parameter space given that the MNE invests

¹³See Horstmann and Markusen (1992) for similar discontinuities in equilibria in a model that analyzes the choice between FDI and exports.

in the first period (the slope of ϕ_1 decreases). Furthermore, in order to keep the worker the MNE has to pay a higher wage. This makes FDI less attractive and the MNE chooses to export even if technological spillovers would not have resulted (the curve ϕ_3 shifts downwards and becomes flatter). Finally, a larger N_2 implies that competition in the second period would dissipate a larger (absolute) value of duopoly profits, so that the MNE has a stronger incentive to choose costly exports in the first period (ϕ_2 moves up). This reduces the possibility of technological spillovers.

The analysis leads to the somewhat unexpected implication that exports might be initially chosen in fast growing markets to avoid technology diffusion. There exists some evidence that exports are chosen in the early periods of foreign activity. Admittedly, though, there are probably other stories which explain this evolution better, such as the desire to know a market well before committing important resources (Horstmann and Markusen, 1996). Nevertheless, our results suggest that the attempt to keep technological potential intact might also play a role in certain circumstances.

Relaxing assumption A1 A discussion of the effect of market size growth would be incomplete without reminding the reader that we have so far analyzed equilibrium outcomes under A1, which assumes that exports are never profitable in the second period. It would be easy to show that relaxing this assumption¹⁴ would not modify our conclusions much with respect to the roles played by the parameters k , ϕ and t .

However, the effect of an increase in N_2 is worth mentioning because some non-monotonicities¹⁵ in the export versus FDI decision might appear. This effect is illustrated by Figure 4.¹⁶ For simplicity, we draw the equilibrium outcome in the

¹⁴However, in order for the analysis to have some interest we do assume that the MNE would always do FDI in the absence of spillovers, i.e. $(1 + N_2) (\Pi_M - \Pi_M^E(t)) > 0$.

¹⁵We are grateful to a referee for pointing out this possibility.

¹⁶Note that the functions ϕ_1, ϕ_2, ϕ_3 change in the region where $N_2 [\Pi_M - \Pi_M^E(t)] < G$.

(N_2, ϕ) plane, for the case of $G - (\Pi_M - \Pi_M^E(t)) > k$. Along the dashed horizontal lines in the figure (that is, for given degrees of product competition), the decisions about involvement in the foreign market can have a reversal as the second-period market grows. When market size is small, the optimal strategy for the MNE is to export in both periods. At intermediate levels of N_2 , the MNE finds it optimal to invest already in the first period because of the usual market size effect (as size grows, the fixed cost of FDI decreases relative to profits). But for large second-period markets, the relative importance of second-period profits is very high, and the MNE exports to avoid (technological or pecuniary) spillovers.

Different contractual arrangements So far we have assumed that the worker is wealth and credit constrained and only one-period contracts can be written. The two assumptions are crucial for our results, and exports would never occur if either of them were relaxed.

If contracts are complete, there exist several contractual arrangements that allow the MNE to enjoy all the rents accruing to its superior technology. One such arrangement is a two-period employment contract with the worker. A two-period contract rules out the possible mobility of the trained worker in the second period, and the trained worker is hired at the subsistence wage ($w = 0$). This contract trivially eliminates all technological and pecuniary spillovers.

However, when the sum of the duopoly profits (net of k) is higher than the monopoly profits, the aggregate rents are maximized when the worker leaves for the local firm. It is therefore optimal to include a clause in the contract sketched above that specifies a penalty that has to be paid by the worker if the contract is broken. By setting the penalty equal to $Max\{(\Pi_D(\phi) - k), (\Pi_M - \Pi_D(\phi))\}$, technological spillovers happen precisely when they maximize the aggregate rents. Furthermore, the penalty allows the MNE to extract all rents in the industry. Under

the assumptions made, FDI is always the first period internationalization strategy and the existence of technological spillovers is driven by inequality (1).

If the trained worker is not wealth constrained (for instance, because she can ask for a bank loan), the MNE anticipates her second period extra wage and therefore asks for a negative first period wage (either $w = -(\Pi_D(\phi) - k)$ if she will stay at the subsidiary or $w = -(\Pi_M - \Pi_D(\phi))$ if she will move to a local firm). This ensures that the aggregate rents are maximized and that all rents are captured by the MNE.

3 Summary and conclusions

Spillovers have often been treated as a 'black box' mechanism, where their nature is left unspecified. This paper provides a specific mechanism through which technology might involuntarily move from a firm towards others located in the same country. Therefore, the paper offers a rationale to the empirical literature which has uncovered the importance of localized spillovers (e.g., Audretsch and Feldman, 1996).

We have presented a model where technological spillovers from FDI might occur due to workers' mobility. A MNE can transfer a superior technology to its foreign affiliate only after having trained a local worker. Once trained, this worker can later be hired by a local firm and technological spillovers might occur. Even when such spillovers do not take place, the host country's welfare might improve because of the wage that the trained worker receives from the MNE to prevent her from moving to a local firm.

We have also shown that in some circumstances the MNE might prefer to export rather than to invest, precisely to avoid diffusion of superior technology to the local rival and/or the payment of rents to the trained worker.

Our model helps to identify the conditions under which a MNE retains the

trained worker, and those under which she leaves to a local firm. The results are consistent with the industrial organization literature on persistence of monopolies. Technological spillovers arise (the monopoly ceases to exist) when the 'joint-profit' effect does not hold, that is, when industry profits are higher if both firms can use the technology. This is more likely to happen when the local firm and the MNE do not compete fiercely in the product market (or sell in independent or vertically related markets), when on-the-job training is general rather than specific, and when the absorptive capability of the local firm is high. We have accordingly identified some empirical predictions to which our model gives rise.

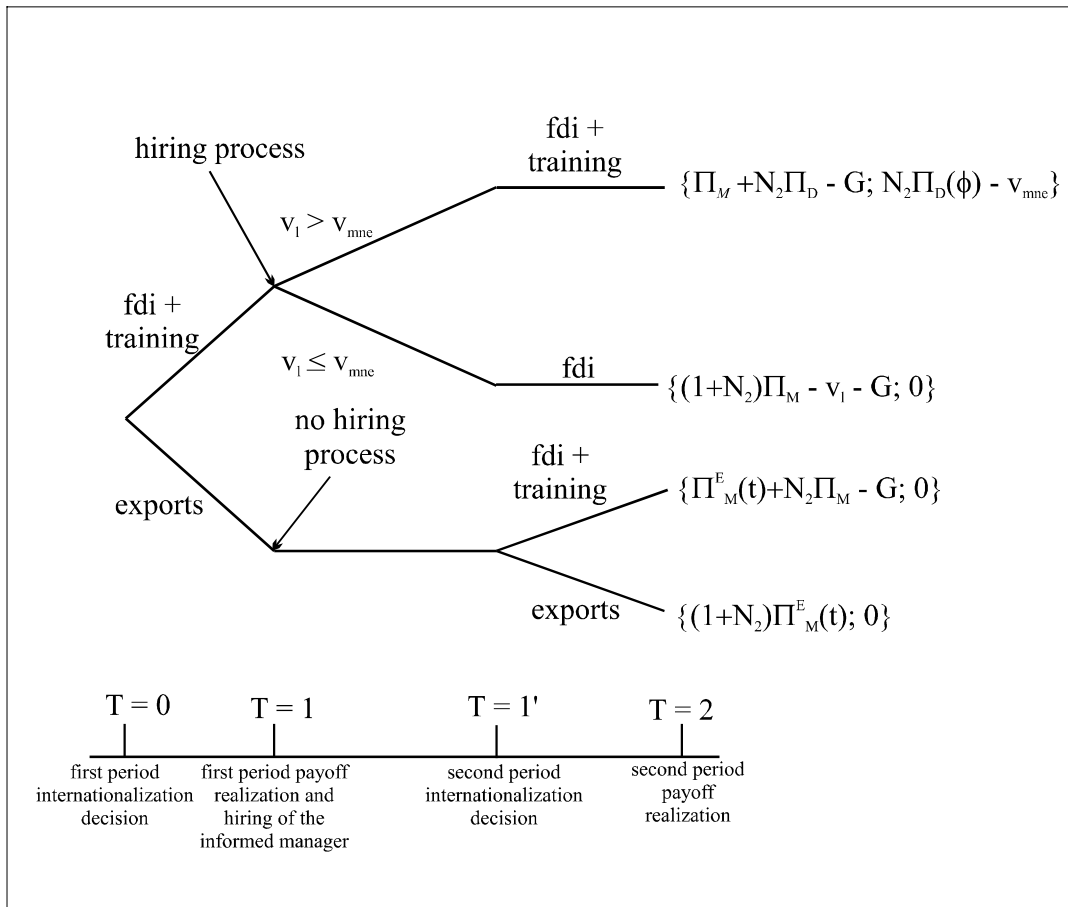
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Figure 1: *The game tree.*



Notes:

1. In brackets are respectively the payoffs of the MNE and of the local firm.
2. $v_1 = N_2\Pi_D(\phi) - k$; $v_{mne} = N_2(\Pi_M - \Pi_D(\phi))$.

Figure 2: *The Equilibrium Outcome.*

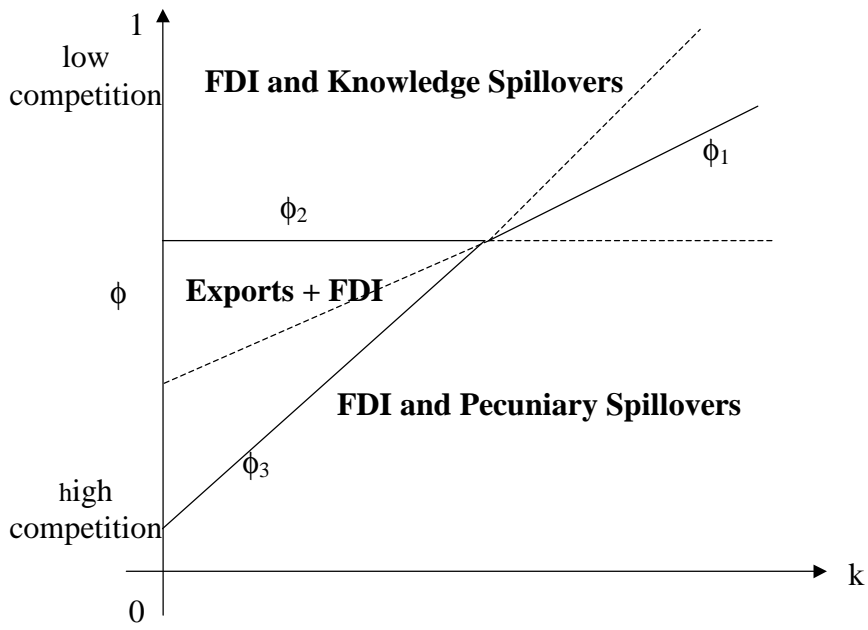


Figure 3(i): *The effect of an increase in t .*

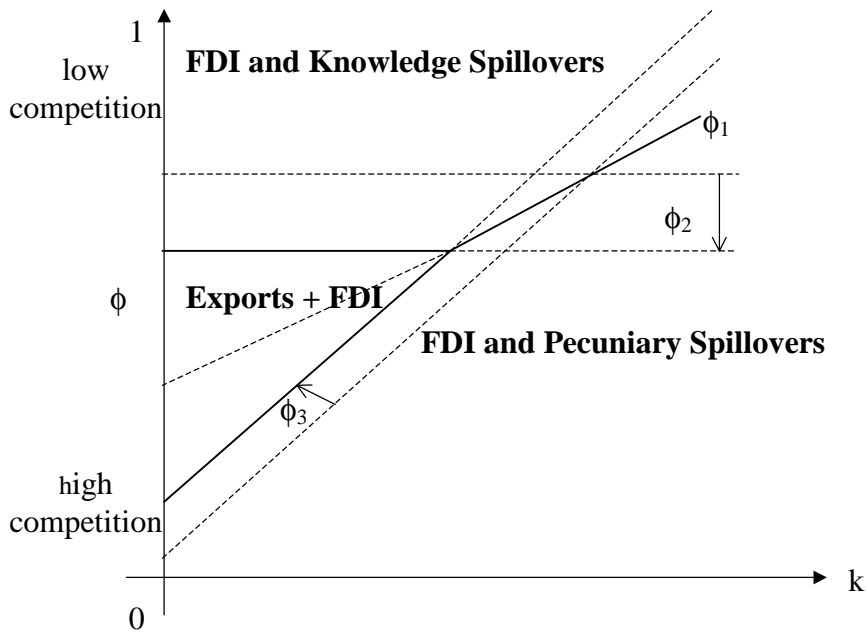


Figure 3(ii): *The effect of an increase in N_2 .*

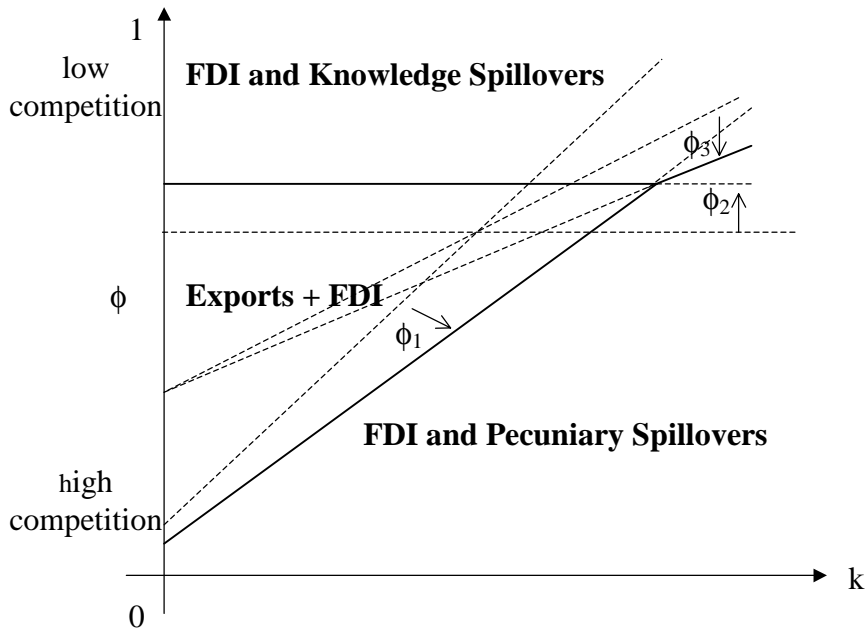


Figure 4: *Non-monotonicities in N_2 .*

