Foreign Direct Investments and Spillovers through Workers' Mobility[†]

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Abstract

We analyze a model where a multinational firm can use its superior technology in a foreign subsidiary only after appropriate training of local managers. Technological spillovers from foreign direct investment arise when such managers are later hired by a local firm. Benefits for the host economy may also take the form of the rent that trained managers receive by the foreign affiliate to prevent them from moving to local competitors. We study conditions under which technological spillovers occur. We also show that under certain circumstances the multinational firm might find it optimal to resort to export instead of foreign direct investment, to avoid dissipation of its intangible assets.

Key words: Multinational corporations, externalities, training, labor mobility.

JEL Classification: F23, J63, O12.

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1 Introduction

The existence of spillovers from multinational enterprises (MNEs) has often been indicated as one of the reasons why foreign direct investments (FDIs) might benefit a host economy[1]. Spillovers might take different forms.

First, there might exist backward and forward linkages between foreign affiliates and local firms (Lall, 1980, Rodriguez-Clare, 1996). Second, foreign affiliates might increase local firms' productivity through 'demonstration effects'. For instance, 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 which will 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 previously acquired.

In this paper, we are concerned with the last form of spillovers, and we present a model where (technological or managerial) spillovers take place due to the mobility of workers which have been instructed by a MNE's subsidiary. 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., see ILO, 1981 and Lindsey, 1986), and empirical research seems to indicate that MNEs offer more training to technical workers and managers than local firms do (Gerschenberg, 1987, Chen, 1983). At their early stages affiliates rely more intensively on expatriates , but subsequently they tend to replace them with (cheaper) local workers who have been properly trained in the meanwhile (UNLTC, 1993).

We build a model where subsidiaries of MNEs and local firms compete for the services of local workers who have been previously instructed by the MNEs. As a result, the MNEs will manage to keep the instructed workers only if they offer better conditions than the local firms do. MNEs have often been found to pay higher wages than domestic firms for similar job positions (UNLTC, 1993, Aitken, Harrison and Lipsey, 1995). However, it has also been reported that there exists high mobility of trained workers from foreign affiliates to local firms (e.g., see Gerschenberg, 1987, Katz, 1987, ILO, 1981, World Investment Report, 1992). We are not aware of any empirical study

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[1] See Blömstrom and Kokko (1996) for an extensive review of spillover effects of the activities of MNEs.

which links these two phenomena, but our analysis suggests they are related.

Our model helps identify the circumstances under which workers' mobility takes place. We find that the so-called 'joint-profit effect' (or 'efficiency effect') plays an important role here. If the profit made by the MNE when it can use the technology as a monopolist is higher than the aggregate profit made by the MNE and the local firm when both can use the technology, then spillovers will not occur. This is a result which is similar to the one obtained in the literature which studies persistence of monopolies. More generally, technology will not diffuse to the local firms when they attach a lower value than the foreign affiliate to it. This might be the case, for example, when some complementary assets not possessed by the local firms are needed to use efficiently the know-how brought by workers.

Finally, a MNE might anticipate that by investing abroad and instructing local workers to use some particular technology might lead either to spillovers of knowledge to local firms or to higher wages to prevent workers from moving. Therefore, it might choose exports instead of FDIs to protect intangible assets or to avoid the payment of rents to trained workers. Although our feeling is that this is unlikely to be a major variable in determining the choice between exports and FDIs, anecdotal evidence confirms that such a motivation might sometimes be behind the choice of exporting.

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. At the time, the German chemical industry had a significant competitive edge over international competitors and more specifically over the Japanese industry, then at its infant stage. IG Farben resorted to exports and avoided as much as possible FDI (and licensing) in order to minimize the diffusion of knowledge to competitors.

Other game theoretical models have dealt with the existence of spillovers from internationalization choices of firms, even though 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 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 after having obtained the basic technology from the licensor. Motta (1996) and Siotis (1997) analyze decisions between exports and FDIs 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

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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 a simple model and draws some first general results. Section 3 expands our analysis and considers first the case of asymmetric information between the MNE and the local firm about the value of a trained manager and second some alternative contract specifications not considered in the basic model. Section 4 studies a parametric example to perform some comparative statics on how certain variables affect the existence of spillovers as well as the choice between exports and FDIs. Section 5 concludes the paper.

2 The model

A firm h (the 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 product. This knowledge has been accumulated prior to the game and it is exogenously given in our model. It has not been commercialized yet by firm h in a foreign country, on which market we focus[2].

Firm h can either serve the foreign market through exports or establish a local subsidiary (i.e., make a FDI). We assume that both modes of involvement give rise to positive profits, and 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 manager is properly informed about the new technology and that the relevant knowledge cannot be transmitted without oral communication or on-the-job training.

Apart from the MNE, there also exists a local firm f which could sell the product if it knew how the technology works. One might think of such a firm as a company which is producing goods in a related industry. We exclude the possibility of licensing agreements as a way of technology transfer 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 $t = 0$, firm h decides whether to export or make a FDI. When exporting, the firm will make use of production facilities and properly trained managers located in the home country. When investing in the host market,

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[2]Firm h might be the only firm in the world endowed with the new technology. Alternatively, it might be the only one that considers to serve that foreign market.

instead, the firm will have to incur a fixed cost G, which includes all the expenses which should be made to operate in a less well-known foreign environment. Note that the local firm does not have to incur this cost since it is already familiar with the local market. We also assume that it is too expensive for the MNE to move in a stable way a manager from the parent company to the affiliate, for instance because an expatriate worker would ask for too high a relocation allowance, or because the MNE is located originally in a country with much higher labor costs, which make it less costly to train and hire local workers[3].

The only possible channel to transfer knowledge is to train a local manager. Therefore, if FDI is chosen, a staff of supervisors comes from the headquarters to the affiliate and instructs a local worker. Then they move back to their home country[4]. The total cost of training a local worker is F.

The worker who receives training is hired from a pool of identical untrained workers. She is paid the reservation wage $\bar{w}$ which is normalized to zero. We assume that it is impossible for the MNE to write a legally binding contract which obliges the worker to stay with the company for two periods. Initially, we also assume that the worker is wealth-constrained and that she cannot borrow on the financial market, so that the first period wage must be non-negative. We discuss these assumptions in section 3.2.

After receiving proper training, the local manager (henceforth we shall refer to her as the 'informed' manager) has acquired all the necessary expertise, knowledge and information to produce the good. At period $t = 1$, production takes place, the good is sold and first-period profits are realized. Since in this first period of the game the local firm is not aware of the new technology, firm h is a monopolist in the market. Its profit is $\Pi_{M,h}^{E,1}$ in the case of exports and $\Pi_{M,h}^{I,1} \geq \Pi_{M,h}^{E,1}$ in the case of FDI (gross of set up and training costs).

Afterwards, firm f realizes that it could also appropriate the technology by hiring the informed manager. The MNE would like to retain her within the company to avoid the dissipation of the rents associated with its knowledge-based asset.

We model this process by assuming that each firm simultaneously and independently makes a take-it-or-leave-it offer to the informed manager. The

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[3]This assumption is made to reproduce what seems to be a realistic situation, but the analysis would not change much if we assumed that foreign managers might work abroad on a permanent basis.

[4]Alternatively one can think that a local manager is sent abroad to receive the proper education at the parent company.

firm who offers more hires the manager and has to pay 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 with the highest valuation of the manager hires her (this assumption is made to guarantee equilibrium in pure strategies). In this section we assume firms have symmetric information about the value of the informed manager. In section 3 we study the case of asymmetric information. Also note that we are assuming away the possibility that the local frim might hire workers located in the home country of the MNE. Therefore, no spillovers can occur when the MNE chooses to export.[5]

We shall focus on the equilibrium where the firm with the highest willingness to pay for the informed manager will hire her by offering exactly the maximum willingness to pay of the rival[6]. This implies that the informed manager will appropriate some of the informational rent associated to the knowledge of how the new technology operates.

The willingness to pay for the informed manager of each firm depends on the outside options. We assume that if firm f does not hire the informed manager in the second period it does not have any other possibility to acquire the technology and therefore it will make zero profits (imitation is therefore ruled out in our model). If the MNE loses the informed manager, it can either call back the staff from the headquarters to instruct another local manager (and incur another cost F) or it can resort to export from the home country to serve the host country in the second period. Instead, the MNE would never prefer to export after having established a subsidiary and kept the informed manager within the company (by assumption $\Pi_{M,h}^{I,2} \geq \Pi_{M,h}^{E,2}$).

Note also from Figure 1 that firm h might want to establish a local subsidiary after having served the market through exports in the first period.

After the MNE decides about exports or FDI, production takes place and the second-period payoffs are realized.

Let us briefly summarize some pieces of notation before solving the game. Denote by $\Pi_{k,i}^{s,t}$ the profit earned by firm $i = h, f$, in period $t = 1, 2$, where

[5]It seems reasonable to assume that it would be more difficult for the local firm to identify informed workers if they are in another country, and/or to attract such workers from abroad if identified.

[6]There are other equilibria where both firms offer a wage between the lowest and the highest valuation of the manager and the firm with the highest valuation hires her. However, in these equilibria the firm with the lowest valuation is playing a weakly dominated strategy (compared to offering its own valuation of the manager) and therefore we disregard them.

$k = M, D$ (M, for 'monopoly' when only firm h has the technology; D, for 'duopoly' when the local competitor also has it) and $s = I, E$ (I stands for FDI and E for exports). The superscript s is used only in the profit expressions of the MNE. Also, denote $v_i^{\max}$ as the maximum willingness to pay for the informed manager of firm i.

We look for the sub-game perfect equilibrium in pure strategies of the game. It is straightforward to solve the model by backward induction. For expositional reasons we focus initially only on the configurations we consider more interesting. To this purpose, we introduce two further assumptions[7].

A1: $\Pi_{M,h}^{I,2} - G - F \geq \Pi_{M,h}^{E,2}$;

A2: $\Pi_{D,h}^{I,2} - F \geq \Pi_{D,h}^{E,2}$.

The first assumption says that the profits from FDI in the second period (net of set up costs and training costs, which are sunk at the last stage of the game) are never smaller than the profits from exports. This guarantees that, in the second period, the MNE always runs a subsidiary in the foreign country. The second assumption narrows the set of possible alternatives available to the MNE when the informed manager is hired by the local firm. It imposes that, in the second period, it is always more profitable to keep the foreign affiliate active (this requires the training of another local manager) than to shut it down and resort to exports. In other words, these two assumptions say that the MNE never exports in the second period.

Finally, the following additional assumptions allow us to focus on non-trivial equilibria:

A3: $\Pi_{M,h}^{I,2} > \Pi_{D,h}^{I,2}$;

A4: $\Pi_{D,f}^2 \geq F$.

Assumption A3 says that a firm makes larger profits when it is a monopolist than when it is a duopolist. If this did not hold, as in cases of strong complementarities with the local firm's production, the MNE would have an incentive to reveal its technology to the local firm, and spillovers would trivially occur.

Assumption A4 says that the MNE has to pay more to avoid that the manager is hired by the other firm (see below) than to train a second manager. If it did not hold, then spillovers would never occur under A3, since the MNE would always keep the worker.

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[7]These assumptions could be relaxed without changing the main results (see also section 4), but at the cost of making the analysis far more complex.

A crucial step to find the equilibrium solutions is to identify the outcome of the hiring process. The firm with the highest willingness to pay will hire the informed manager during the second period. The local firm's maximum willingness to pay for the informed manager is $v_f^{\max} = \Pi_{D,f}^{I,2}$, since it cannot obtain more than the duopoly profits in the second period. Instead, the maximum offer of the MNE is given by the difference between the monopoly profit it would earn if it kept the informed manager and the duopoly profit (net of the cost of training a second local worker) it would earn if it lost the informed manager to the local competitor: $v_h^{\max} = \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F$.

Therefore two situations are possible: either (a) $v_h^{\max} \geq v_f^{\max}$, and the MNE keeps the manager by paying her $w = \Pi_{D,f}^{I,2}$; or (b) $v_h^{\max} < v_f^{\max}$, and the local firm hires the informed manager by paying her $w = \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F$. In the latter case a *technological spillover* occurs[8], since the local firm manages to appropriate some payoff relevant information which it can acquire only by hiring a worker which has been previously trained by the MNE.

Note also that in both cases the manager enjoys an informational rent which puts her total two-period income above that earned by all other workers which were ex-ante identical[9].

There are three possible equilibrium situations in the version of the game restricted by assumptions A1 to A4. 1) The MNE establishes a foreign subsidiary in the first period but it loses the informed manager in the second period to the local firm: there exists a technological spillover. The MNE then instructs another manager and competes with firm h in the second period. 2) The MNE also makes a FDI in the first period but keeps a monopoly position in the second period, since it keeps the informed manager. 3) The MNE exports in the first period and avoids both dissipation of its knowledge and an extra wage bill. Since the technology decays after two periods, in the second period the MNE will invest locally to enjoy higher profits (by assumption A1).

These are the conditions under which these equilibrium regimes will arise:

- 1) *fdi + fdi (with spillover)*:

[8]Although we label it 'technological' for evocative reasons, the spillover concerns more generally the payoff relevant knowledge possessed by the MNE, whatever its nature.

[9]The crucial assumptions here are that the MNE cannot force a worker to stay within the firm for two periods and that the manager is wealth constrained. See section 3.2 for the outcome of the game if these assumptions were relaxed.

- (1a) $\Pi_{M,h}^{I,1} + \Pi_{D,h}^{I,2} - F \geq \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2}$;
- (1b) $\Pi_{M,h}^{I,2} - \Pi_{D,f}^{2} < \Pi_{D,h}^{I,2} - F$.

- 2) *fdi + fdi (without spillover)*:

  - (2a) $\Pi_{M,h}^{I,1} \geq \Pi_{M,h}^{E,1} + \Pi_{D,f}^{2}$;
  - (1b) does not hold: $\Pi_{M,h}^{I,2} - \Pi_{D,f}^{2} \geq \Pi_{D,h}^{I,2} - F$.

- 3) *exports + fdi*:

  - (3a) $\Pi_{M,h}^{I,1} \leq \Pi_{M,h}^{E,1} + \min \left\{ \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F, \Pi_{D,f}^{2} \right\}$.

The above conditions are of straightforward interpretation. Condition (1a) says that firm h prefers to invest rather than to export (and vice versa) when it anticipates that spillovers would occur if it made a FDI. Condition (1b) determines the result of the hiring process (which takes place if firm h has established a local affiliate): if it holds, the informed worker will be hired by the local firm f (and vice versa). If condition (2a) holds then firm h prefers investing abroad to exporting when it anticipates that it would keep the informed worker (paying her a rent) in the second period. Condition (3a) states that exports are chosen when neither (1a) or (2a) hold.

To better interpret the results, let us introduce the following definition:

Definition: *We say that the 'joint profit' effect holds (does not hold) if the sum of the gross profits of two duopolists is smaller or equal (larger) than the gross profits of a single monopolist.*[10]

By inspection of the equilibrium conditions above one can infer the following:

Remark 1: *A sufficient condition for technological spillovers never to arise is that the 'joint profit' effect holds.*

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[10]With homogenous goods, the joint-profit condition is satisfied under both quantity and price competition. If goods are independent, it does not hold for either form of competition. For any given degree of product differentiation, it is more likely to hold under quantity than under price competition, since in the former case market competition is less strong and duopoly profits higher.

The 'joint profit' effect implies that $\Pi_{M,h}^{I,2} \geq \Pi_{D,f}^2 + \Pi_{D,h}^{I,2}$. This is sufficient to ensure that condition (1b) does not hold and the local firm will not hire the informed manager. This result is reminiscent of the 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 off potential entrants (e.g., Tirole, 1988, and Budd et al.,1993).

Note that for the technological spillovers to occur at equilibrium the fact that the 'joint profit' effect does not hold is not enough. Two conditions are needed. Firstly, duopoly profits *net* of the cost of training a second worker must be superior to the monopoly profit (the joint-profit effect has been defined gross of training costs). Secondly, the MNE should not find it more advantageous to resort to export in the first period to avoid the dissipation of technological advantage in the second period.

The 'joint profit' effect does not hold when the duopolists are not fiercely competing against each other. This could be due, for instance, to the local firm producing a good which is only an imperfect substitute, or even complementary, to the one produced by the MNE[11].

The following two remarks are related to the type of knowledge acquired by the informed manager and the contribution it can give to the profit of the local firm.

> **Remark 2**: *The lower is the value of the informed manager for the local firm, the more likely the MNE keeps her.*

> **Remark 3**: *Conditional on the MNE keeping the informed manager in the second period, the lower is the value of the manager for the local firm, the more likely is FDI in the first period.*

Remark 2 states that the lower $\Pi_{D,f}^2$, the more difficult for the local firm to hire the informed manager. When the manager is more productive in the MNE, the local firm will attach lower value than the affiliate to her, and will offer her a lower salary. This could be the case when there exist complementarities between the (physical or intangible) assets of the MNE and the manager's expertise.

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[11]Anecdotal evidence and case studies report that local firms in less developed countries often specialize in specific inputs or services for the MNE. For instance, Pack (1993) reports that the destination of former trained local managers of MNEs in the chemical industry in Taiwan during the mid 1980s was an entirely different sector of activity for a third of the cases. When local firms compete against the MNE they try to differentiate the product they sell from the one produced by the MNE.

When the local firm attaches less value to the informed manager, the MNE will have to pay a lower informational rent to her. Remark 3 says that since it is less costly to avoid the dissipation of knowledge associated to the FDI strategy, such a strategy is more likely to occur at equilibrium. For instance, in the extreme case where the informed manager might be productive only if she can use special facilities uniquely possessed by the MNE, then the MNE could keep the worker by paying her the reservation wage and there is no risk of dissipating technology: exports would never be chosen in the first period.

3   Extensions

In this section we deal with two different extensions. In the first one, we analyze the case of asymmetric information between the MNE and the local firm about the value of the informed manager. In the second, we analyze other contractual arrangements which have sofar been excluded.

3.1   Asymmetric information case

In this subsection we assume that the local firm observes the existence of the MNE's superior technology, but it does not know the exact profit it would obtain by hiring the informed manager. This might happen because the local firm does not know how the knowledge accumulated by the local manager interacts with the (exogenous) assets possessed by the firms. Instead, the MNE knows exactly the value the local manager brings to the local firm.

For simplicity the value that the informed manager gives to the local firm is either high or low. Local firm's profits are $\Pi_{D,f}^2$ (gross of the wage paid to the manager) in the former case. In the latter case the local firm's gross profits are 0.[12] If the MNE keeps the manager, its gross profits in the second period are $\Pi_{M,h}^{I,2}$. If the MNE does not keep the manager, its second period profits are $\Pi_{D,h}^{I,2} - F$ if the manager is of high type, and $\Pi_{M,h}^{I,2} - F$ if she is of low type.

The local firm has the prior belief that the manager gives high value with probability $\widetilde{\theta}$, $0 < \widetilde{\theta} < 1$. After the MNE has chosen whether to export or invest in the first period, the local firm updates its belief about whether the manager is of high or low type. We denote by θ the updated belief.

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[12]Following the above example, this occurs if the manager is unable to exploit her knowledge once separated from some assets possessed uniquely by the MNE.

Finally, we keep assumptions A1 to A4.

3.1.1 The Equilibrium of the Game

We look for a perfect bayesian equilibrium of the game by solving it backwards[13].

3.1.2 The Second Period

In the second period there are two different nodes to consider since the MNE has the possibility either to invest or to export in the first period.

(a) First, we look at the node where the MNE chooses FDI in the first period. Here, there are two different cases depending on whether the local firm's valuation of the manager, $\theta\Pi_{D,f}^2$, is lower or higher than the MNE's highest valuation, $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F$.

(a1): $\theta\Pi_{D,f}^2 \leq \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F$.

The MNE plays according to different strategies depending on the manager's type. The local firm, on the other hand, cannot observe the manager's type, and it always plays according to the same strategy. It can be shown that:

> **Lemma 1:** *The following mixed strategies constitute an equilibrium in the second period of the game when the local firm holds the belief θ, where $0 < \theta < 1$. The local firm randomizes among all offers $y \in [0, \theta\Pi_{D,f}^2]$ according to the distribution function $Z(\cdot)$, where*
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> $$Z(y) = \frac{\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 - (\Pi_{D,h}^{I,2} - F)}{\left[\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F) - y\right]}. \qquad (1)$$
>
> *If the manager is of low type the MNE offers 0; if she is of high type the MNE randomizes among all offers $x \in [0, \theta\Pi_{D,f}^2]$ according to the distribution function $H(\cdot)$, where*

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[13]As tie-breaking rule we assume that the MNE wins all ties in case (a1) and the local firm wins all ties in case (a2). As before the choice of the tie-breaking rule is due merely to technical reasons.

$$H(x) = \frac{(1-\theta)x}{\theta(\Pi_{D,f}^2 - x)}.\qquad (2)$$

Proof. See the Appendix.

Corollary 1: *The MNE's expected profit in equilibrium is:* $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2$ *if the manager is of high type, and* $\Pi_{M,h}^{I,2} - [1 - \gamma(\theta)]F$ *if she is of low type, where*

$$\gamma(\theta) \equiv \frac{\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 - (\Pi_{D,h}^{I,2} - F)}{\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F)},\qquad (3)$$

which is the (positive) probability that the local firm offers a zero wage to the informed worker[14].

The expected equilibrium profit of the local firm is 0.

Proof. See the Appendix.

Notice that if $\theta = 1$ or $\theta = 0$ the mixed strategy equilibrium described above collapses. Since $\theta = 1$ corresponds to the symmetric information case, we consider the same equilibrium as in the previous section where the local firm offers $\Pi_{D,f}^2$ for the informed manager. For $\theta = 0$ the local firm offers 0 to the manager and the MNE keeps her.

(a2): $\theta\Pi_{D,f}^2 > \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F.$

In this case the local firm has the highest expected valuation of the manager both when she is of high and low type. In the equilibrium we shall focus on, the local firm offers $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F$ for the informed manager, and hires her[15]. The MNE offers F when she is of low type and $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F$ when she is of high type.

(b) If the MNE chooses to export in the first period, A1 guarantees that second period profits are $\Pi_{M,h}^{I,2} - F - G.$

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[14]The fact that the local firm puts positive probability mass on the zero wage bid implies that the MNE might keep the manager even when she is of low type. In this case, the MNE keeps the worker at zero cost and saves the training cost F.

[15]Here, as in the basic model, there exist other equilibria where the MNE offers more than its valuation of the manager. Since offering more than its own valuation is a weakly dominated strategy, as before, we disregard these equilibria.

3.1.3 The First Period

If firm h chooses FDI in the first period, its second period profits, conditional on θ, depend on the manager's type. The mode of serving the market in the first period (exports or FDI) can therefore potentially signal the type of manager to the local firm. First, we show that no separating equilibrium generically exists. Then, we characterize the pooling equilibria and finally the semiseparating equilibria.

In a separating equilibrium the MNE chooses different actions for different manager's types, and the local firm can infer the manager's type from the MNE's first period action. However, the following holds:

> **Lemma 2:** *Generically, no separating equilibrium exists when the equilibrium in the second period is as given in Lemma 1.*

Proof. See the Appendix.

In a pooling equilibrium the MNE chooses the same mode of internationalization (either exports or FDI) for both types of managers. It is possible to prove that:

> **Lemma 3:** *The MNE chooses to export in the first period for both types of managers if:* $\Pi_{M,h}^{I,1} \leq \Pi_{M,h}^{E,1} + [1 - \gamma(\theta)]F$.
>
> *It chooses to make a FDI in the first period if:*
>
> $$\Pi_{M,h}^{I,1} \geq \Pi_{M,h}^{E,1} + \min\left\{\widetilde{\theta}\Pi_{D,f}^2, \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F\right\}.$$

Proof. See the Appendix.

Finally, the following lemma identifies the only possible semi-separating equilibrium.

> **Lemma 4:** *The only semi-separating equilibrium is one where MNE chooses FDI when the manager is of high type, and randomizes between FDI and exports when she is of high type. This equilibrium holds for:*
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> $$\Pi_{M,h}^{I,1} < \Pi_{M,h}^{E,1} + Min\left\{\widetilde{\theta}\Pi_{D,f}^2, \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F\right\}. \qquad (4)$$

Proof. See the Appendix.

Notice that lemmas 2 to 4 characterize the equilibrium of the game for the whole parameter space.

Conclusions

We now summarize the analysis of the asymmetric information case, and compare its equilibrium outcome with that obtained under symmetric information. The three pooling equilibrium solutions and the conditions under which they arise are the following.

- 1') *fdi + fdi (with 'probability one' spillover[16])*:

  - (1a) $\Pi_{M,h}^{I,1} + \Pi_{D,h}^{I,2} - F \geq \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2}$;
  - (1b') $\Pi_{M,h}^{I,2} - \widetilde{\theta}\Pi_{D,f}^{2} < \Pi_{D,h}^{I,2} - F$.

- 2') *fdi + fdi (without 'probability one' spillover)*:

  - (2a') $\Pi_{M,h}^{I,1} \geq \Pi_{M,h}^{E,1} + \widetilde{\theta}\Pi_{D,f}^{2}$;
  - (1b') does not hold: $\Pi_{M,h}^{I,2} - \widetilde{\theta}\Pi_{D,f}^{2} \geq \Pi_{D,h}^{I,2} - F$.

- 3') *exports + fdi*:

  - (3a') $\Pi_{M,h}^{I,1} \leq \Pi_{M,h}^{E,1} + [1 - \gamma(\theta)]F$.

In the first equilibrium, the MNE makes a FDI for both types of manager, and the local firm hires her in the second period with probability one. In the second equilibrium, the MNE invests in the first period for both types of manager, and the local firm hires the high type manager with positive probability. In the third equilibrium, exports are chosen by the MNE for both types of manager in the first period, and no spillover will occur in the second.

These results show that technological spillovers always arise with some probability unless exports are chosen. However, it would be incorrect to conclude necessarily that technological spillovers are more likely to occur under asymmetric information. Indeed:

> **Remark 4:** *The equilibrium with FDI and 'probability one' spillovers is less likely to arise under asymmetric information.*

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[16]With an abuse of terminology we use the word 'spillover' to identify any situation where turnover occurs. Obviously, the local firm might in many instances hire a manager who turns out to be ex-post of low type.

This follows immediately from the observation that the condition (1b')
is more restrictive than (1b), its equivalent under symmetric information.

From the comparison of the equilibrium conditions under symmetric and
asymmetric information we can also state the following.

Remark 5: *FDI is more likely to occur under asymmetric information.*

The conditions under which the MNE prefers FDI to exports are given
by (1a) and (2a) under symmetric information, and by (1a) and (2a') under
asymmetric information. The remark follows from (2a') being less stringent
a condition than (2a). Remark 5 has its mirror image in the following:

Remark 6: *Exports are less likely to occur under asymmetric information.*

To see this result, note that condition (3a') is stronger than condition
(3a) because $[1 - \gamma(\theta)] F < \Pi_{M,h}^{I,2} - \Pi_{D,f}^2 + F$ (from A3) and $[1 - \gamma(\theta)] F < \widetilde{\theta} \Pi_{D,f}^2 < \Pi_{D,f}^2$ (as shown in the Appendix).

Remarks 4 to 6 only concern pooling equilibria. If we also include the
area with a semi-separating equilibrium, the regions where FDI and exports
can occur are larger than indicated by conditions (1') to (3'). However the
region where exports are chosen under asymmetric information is always
smaller than under symmetric information. This follows from (3a') and (4)
being a more stringent condition than (3a).

The intuition behind Remarks 5 and 6 is as follows. Under asymmetric
information the local firm offers less to the manager than under symmetric
information[17]. This makes FDI more attractive compared to the exports,
as the MNE has to pay less to keep the manager. Exports are less likely to
be chosen, and FDI is more likely to be chosen, relative to the symmetric
information case.

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[17]There are two reasons why the local firm offers less to the manager under asymmetric
information than under symmetric information: 1) for a given $\Pi_{D,f}^2$ the informed manager
has a priori a lower expected value under asymmetric information, since she is worthless to
the local firm with probability $(1 - \theta)$; 2) the MNE is better informed about the manager's
type than the local firm is. The MNE therefore offers more to the manager when she is
of high type firm than when she is of low type. The local firm's probability of hiring a
manager of high type is therefore lower than θ. Hence, the local firm offers, in expected
terms, less than the prior expected value of the manager, $\theta \Pi_{D,f}^2$.

3.2 Different contractual arrangements

In this subsection we study how our results change by introducing contractual arrangements which differ from the one considered so far. For simplicity we use the symmetric information framework.

3.2.1 Two-period binding contract

A two-period contract rules out the possible turnover of the informed manager in the second period. Thus, spillovers do not arise and the informed manager is hired at the reservation wage ($w = 0$). In this case, the model reduces a simple one-period decision between FDI and exports. This suggests that spillovers through workers' mobility are more likely to arise in countries where clauses binding workers to their employers are illegale. In some countries, there exist 'confidentiality clauses' and other clauses which make the hiring of trained managers more costly, thus reducing spillovers.

3.2.2 No wealth constraint

If the informed manager 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 $w = -\Pi_{D,f}^2$ if she will stay at the subsidiary or $w = -\Pi_{M,h}^{I,1} + \Pi_{D,h}^{I,2} - F$ if she will move to a local firm). This pushes to zero the two-period compensation of the informed manager (no informational rents can arise).

It is easy to see that under the set of assumptions we have imposed, exports are never chosen at equilibrium. FDI is always the first period internationalization strategy and the existence of technological spillovers is driven by inequality (1b).

3.2.3 The Manager Buys the Affiliate

Suppose the MNE sells the affiliate to the manager in the second period. The manager then internalizes the loss the MNE incurs if the local firm acquires the better technology. In the second period the manager has an income of $\Pi_{M,h}^{I,2}$ if she stays with the MNE, and $(\Pi_{D,h}^{I,2} - F)$ plus the wage in the local firm if she leaves[18].[19]

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[18]Here, it is assumed that the MNE then brings in another manager.

[19]We have assumed that technology is not contractible, and it is therefore an issue whether the manager ex-post would be willing to reveal her knowledge to the local firm.

Case 1: $\Pi_{M,h}^{I,2} \geq (\Pi_{D,h}^{I,2} - F) + \Pi_{D,f}^2$

In equilibrium the local firm offers $\Pi_{D,f}^2$ to the manager, but she stays with the MNE as it gives the highest income. The price of the affiliate is decided in a bargaining process between the MNE and the manager. The manager will pay up to $\Pi_{M,h}^{I,2}$, and the MNE will not accept a price lower than the profit it obtains if the manager does not buy the affiliate, $\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F)$. The price has therefore to belong to $[\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F), \Pi_{M,h}^{I,2}]$, but which price actually arises depends on the bargaining power of the two parties. If the MNE has all the bargaining power, FDI is always preferred to exports. If on the other hand the manager has all the bargaining power, the analysis in section 2 is unaltered.

Case 2: $\Pi_{M,h}^{I,2} < (\Pi_{D,h}^{I,2} - F) + \Pi_{D,f}^2$

In this case the manager leaves the MNE even if she is the residual claimant. Selling the affiliate to the manager does therefore not change the outcome of the game.

To summarize, selling the affiliate to the manager does not change her decision between leaving or staying with the MNE. The region with FDI and spillover is therefore the same as in section 2. In the region where the MNE keeps the manager, the MNE can however reduce the manager's informational rents by selling her the affiliate (as long as the MNE has some bargaining power vis-a-vis the manager). FDI becomes therefore relatively more attractive compared to exports and the region with exports is reduced.

4   A parametric example

Here we analyze the same game discussed in section 3 but we introduce a parametric model to gain insights about the role played by some economic variables. We also relax assumptions A1, A2 and A4 and keep A3 for expositional convenience. For simplicity we use the symmetric information framework.

We adopt a version of a model proposed by Singh and Vives (1984). Assume that in the foreign country identical consumers are endowed with a

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In our model this problem can however be overcome by a simple contract making the manager's wage conditional on the second period profit of the local firm.

utility function of the following form:

$$U(x_h, x_f, z) = x_h + a x_f - \frac{1}{2} \left(x_h^2 + x_f^2 + 2g x_h x_f \right) + z \qquad (5)$$

where z is a good produced in a competitive numeraire sector and x_h, x_f are differentiated goods produced at zero marginal cost respectively by the MNE and by the local firm (if it obtains the technology).

The parameter a introduces an asymmetry between the two goods which are symmetric for $a = 1$. If $a < 1$ the local firm has a cost disadvantage with respect to the MNE; if $a > 1$, it has a cost advantage[20].

The goods are substitutes, independent or complements according to whether $g > 0$, $g = 0$ or $g < 0$ respectively. We assume $g \leq 1$, with $g = 1$ corresponding to the case where x_h and x_f are perfect substitutes[21]. The degree of product differentiation is measured by $1/g^2$, so that a decrease in g raises differentiation between the products.

From the utility maximization of the consumers and from $X_{it} = S_t x_i$, with $i = h, f$ and $t = 1, 2$, one obtains the following inverse demand structure:

$$p_i = 1 - \frac{X_{it} + g X_{jt}}{S_t}, \qquad i, j = h, f; i \neq j, \qquad (6)$$

where S_t is the size of (i.e., the number of consumers in) the foreign market in period $t = 1, 2$ and X_h, X_f are total quantities sold by each firm.

We assume that if a duopoly structure emerges in the second period, firms compete in quantities[22]. We also denote by τ ($0 \leq \tau \leq 1$) the unit export cost (transportation cost or tariff) which the MNE has to bear when serving the foreign market through exports[23].

Since this model is identical to the one analyzed in section 3 we only need to replace the implicit payoff expressions obtained there by the following

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[20]Note that with $a < 1$ and $c_f = 0$ (where c_f is the constant marginal cost of production of good x_f) the model is identical to one where $a = 1$ and $c_f = 1 - a$.

[21]A reduction in g also increases the global expenditure of the consumers - thus increasing market size, a feature present in other models of product differentiation. It would be possible to rewrite the demand functions so that the parameter g does not affect aggregate demand. The qualitative results being unchanged, we have preferred to maintain this formulation which simplifies the presentation.

[22]Assuming price instead of quantity competition does not affect the qualitative results of the paper: it just makes it more likely for the 'joint-profit' effect to hold and hence more difficult for spillovers to occur at equilibrium.

[23]In this specific model, parameter τ might also be interpreted as the production cost advantage of the host country with respect the home country.

18

closed form expressions:

$$\Pi_{M,h}^{I,t} = \frac{S_t}{4}; \qquad \Pi_{M,h}^{E,t} = \frac{S_t \left(1 - \tau\right)^2}{4}; \qquad t = 1, 2. \qquad (7)$$

$$\Pi_{D,h}^{I,2} = S_2 \left(\frac{2 - ga}{4 - g^2}\right)^2; \qquad\qquad \Pi_{D,f}^2 = S_2 \left(\frac{2a - g}{4 - g^2}\right)^2. \qquad (8)$$

$$\Pi_{D,h}^{E,2} = S_2 \left(\frac{2 - 2\tau - ga}{4 - g^2}\right)^2; \qquad \Pi_{D,f}^2(E) = S_2 \left(\frac{2a - g + \tau g}{4 - g^2}\right)^2. \qquad (9)$$

Note that the last expression (9) was not needed in section 2 since we were assuming that the MNE would never export in the second period.

Finally, to simplify notation we normalize to one the sum of market sizes over the two periods, denoting by μ and $1 - \mu$ the foreign country market size respectively in period 1 and 2. Variables such as G and F should therefore be reinterpreted as divided by the sum of market sizes. Assumptions A1 and A2 can be restated as:

A1': $(2 - \tau)\tau \geq 4\frac{G+F}{1-\mu}$;

A2': $(2 - \tau - ag)\tau \geq \frac{F}{1-\mu}\frac{\left(4-g^2\right)^2}{4}$.

Inequalities A1' and A2' are not any longer assumptions[24], but they are needed to identify in which branch of the game tree we locate (see Figure 1).

To simplify the presentation we fix the values of all parameters but g and a (the degree of product differentiation and the degree of asymmetry between duopolists) and analyze the solution in the plane (a, g). Then we make comparative statics exercises by changing the value of one of the previously fixed parameters.

The benchmark case is reported in Figure 2, which is drawn for the following values: $G = \frac{1}{32}, F = \frac{1}{32}, \mu = \frac{1}{2}, \tau = 0.3$. The loci (1a), (1b) and (2b) define the equilibrium outcomes of the game. They correspond to the conditions we had analyzed in section 2, and therefore we do not repeat comments on their interpretation. The locus representing A1' is omitted from the graph because such inequality is satisfied for the values considered

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[24]The only assumption we still keep is A3, which turns out to be satisfied for values of $g > 0$. If this assumption was removed, there would exist a complementarity between the goods produced by the MNE and the local firm. The former would therefore have an incentive to reveal its technology to the latter, and spillovers would trivially arise.

in this figure. The locus representing A2' has been reported for completeness but it plays no role.

Let us now discuss the results obtained. First, as pointed out in section 2, only when the products are rather imperfect substitutes (low values of g) can technological spillovers exist. Put differently, the weaker product market competition the more likely that the local firm will hire the informed manager. Second, technological spillover is more likely to occur the more symmetric the firms are. When a is very small the local firm has no chance to hire the informed manager. When a is very large the MNE anticipates the duopoly structure which would arise in period 2 if it made a FDI, and chooses to export in the first period in order to avoid it. Third, exports may be chosen in the first period either to avoid the dissipation of the technology to the local competitor, or to save second period extra wage to the informed manager. In either case, the incentive to resort to an export strategy is the stronger the more substitutable the goods (higher g) and the more efficient the local competitor (higher a).

Now that we have built this benchmark case we can do some comparative statics.

In Figure 3(i) we show the effect of an increase in transportation costs or tariffs (τ rises from 0.3 to 0.4). Since the export strategy is more costly, the region where FDI occurs at equilibrium expands (the curve (2a) shifts to the right). This can be thought of as the traditional 'tariff-jumping' motivation for FDI and it is a well-known outcome (see Motta, 1992). However, the increase in τ also reduces the profitability of resorting to exports to avoid dissipation of technology or extra wage. Hence, spillovers are more likely to occur at equilibrium (both curves (1a) and (2a) shift to the right). This implies that tariffs or other similar policy instruments might be used to attract new technology into the country. According to Siotis (1997), this is precisely the policy followed by the European Commission to appropriate leading technology possessed by the Japanese in the parts and components consumer electronics industry. He reports that Japanese firms had used only exports and avoided licensing agreements and FDIs 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.

Figure 3(ii) illustrates the changes due to a reduction in training costs F. When F decreases the MNE offers less for the informed manager because

20

its outside option becomes more valuable (it is less costly to bring new instructors into the foreign country). This shifts the (1b) curve upwards and makes spillovers more likely. Further, the decrease in training costs F also implies that the MNE would save less by resorting to exports in the first period (condition (1a) is relaxed and the associated curve shifts upwards), and this increases the region where FDI-cum-spillovers arises. Any policy which might decrease such costs would therefore be welcome if it helped create spillovers which otherwise would not arise. A higher level of education in the local workforce, which would make it easier the instruction of local managers, might be an example of such a situation.

Figure 3(iii) shows the effects of a decrease in μ, that is an increase in the relative importance of second period profits. Obviously, this increases the value attached to preserving the technology (future profits are relatively more important), which in turn explains the existence of a larger region where exports are chosen in the first period of the game. It has often been observed that modes of internationalization tend to evolve over time, with exports being used in the early periods of foreign involvement, followed by FDI in later periods. For instance Nicholas (1983) reports that 88 percent of his sample of British MNEs in the pre-1939 period sold their products initially through exports before converting to direct sales or production branches. There are probably other stories which explain better this evolution - like the desire to know better a market before committing important resources (Horstmann and Markusen, 1996) - but our results suggest that the attempt to keep the technological potential intact might also play a role in certain circumstances.

Finally, Figure 3(iv) shows the effect of an increase in G, the fixed costs which should be incurred to operate a foreign subsidiary in a country where a firm had not been previously established. While the result of such an increase is obvious and expected (exports are more likely), we report this diagram especially as an example of what happens when inequality A1' is not satisfied. Indeed, under the parameters' configurations chosen we have that the MNE chooses to export in both periods.

The analysis of this simple parametric model confirms the main intuitions obtained from the more general models studied in section 2 and 3. It also allows us to gain some insights on how specific variables affect the possibility to observe spillovers through workers' mobility. In particular, spillovers are more likely to occur the more similar the technological capabilities of the MNE and the local firm (a is close to 1); the higher transport costs and tariffs; the higher the educational level of the local workforce, which implies

lower training costs; the lower the degree of substitutability g between the goods produced by the MNE and the local firm (this makes it more likely for the 'efficiency' or 'joint-profit' effect underlined in section 2 to hold).

The last point deserves further comments. The fact that the informed manager is hired by a local firm which is not a close competitor of the MNE implicitly requires that the knowledge acquired by the manager is broad enough. Therefore, the result that spillovers occur more frequently when the degree of substitution between goods is low can be reinterpreted as saying that spillovers are more frequent when the MNE gives its manager a broader know-how. In other terms, one should expect workers having general skills to be more easily involved in moving from MNE to local firms.

Welfare

In our model the different equilibrium configurations can be easily ranked in terms of welfare of the host country. FDI is preferred to exports, since it saves transport costs (which benefits consumers), it raises government revenues if the affiliate's profit is taxed, and it gives informational rents to the local manager. In turn, FDI with spillovers is preferred to a situation where after FDI the affiliate keeps the manager, since by hiring her the local firm would make profit that it could not earn otherwise.

The fact that FDI is always better than export is obviously the result of the simple structure of our model. It is well known that there exist circumstances where FDI is detrimental to the host country. For instance, the establishment of a foreign affiliate might pre-empt the entry of a local firm (see Motta, 1992), or foreign affiliates might rely on imports from the home country, thus displacing host production (Rodriguez-Clare, 1996). The model is therefore not adequate to evaluate whether FDI is welfare improving or not with respect to exports.

This qualification made, one can wonder whether - within the framework developed here - there exists any policy instrument which a host country might use to improve its welfare. The comparative statics exercise carried out in this section would seem to suggest such a conclusion. In certain regions of parameter values, by giving a subsidy to finance (part of) the fixed costs of the MNE, by contributing to the expenses incurred to train local workers, or by raising a tariff, the local government can attract FDIs and facilitate the creation of spillovers. Specifically, this improvement occurs when these interventions would change the equilibrium outcome in a given region of the parameter space. For instance, Figure 3(ii) shows that there exists a region where a decrease in training costs might result in an equilib-

22

rium with spillovers, whereas no spillovers would have arisen in the absence of government intervention.

Nevertheless, the welfare improvement is conditional on the change in the equilibrium outcome, and entails an important discontinuity.[25] If the government is not able to predict the outcome of the game with sufficient precision, it might give a subsidy to the MNE when spillovers would take place anyhow; or it might give a subsidy which is insufficient to move the equilibrium outcome to a region with spillovers. The subsidy might therefore result in a welfare loss for the host country, or might not improve it. This implies that strong informational requirements are needed to ensure that a government can intervene to improve welfare. Extreme caution must therefore be taken before arriving at any strong policy conclusion.

5   Summary and conclusions

Spillovers have often been treated as a 'black box' mechanism, where their nature is left unspecified. In this paper we provided a specific mechanism through which technology and knowledge might unvoluntarily move from a firm towards others located in the same country. Therefore, this 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 FDIs might occur due to workers' mobility. A MNE can transfer a superior technology to its foreign affiliate only after having trained local managers. Once informed, these managers can later be hired by a local firm and technological spillovers might occur. Even when such spillovers do not take place, the host country welfare might improve because of the informational rent that trained managers receive by the MNE to prevent them from moving to a local firm.

We have also showed that in some circumstances a MNE might prefer to resort to exports rather than FDIs, precisely to avoid dissipation of superior technology to local rivals and/or the payment of informational rents to local workers.

Our model helps identify the conditions under which a MNE keeps the informed workers, and those under which they leave to a local firm. The results are consistent with the industrial organization literature on persis-

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[25]See Horstmann and Markusen (1992) for similar discontinuities in equilibria in a model of choice between FDI and exports.

tence of monopolies. Spillovers arise (the monopoly ceases to exist) when the 'joint-profit' (or 'efficiency') effect holds, that is, when industry profits are higher if both firms can use the technology. This is more likely to happen when the local and the MNE are not close competitors, and when the knowledge acquired by the workers is broad rather than specific.

We have also analyzed how other variables would affect the existence of such spillovers induced by workers' mobility. In particular, we have found that spillovers are the more likely to arise the more similar the technological levels of local firms and MNEs, and the lower the costs of training the local workforce.

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6 Appendix

6.1 Proof of Lemma 1 and Corollary 1

The MNE plays according to different strategies depending on the manager's type. The local firm, on the other hand, cannot observe the manager's type, and it plays according to the same strategy. We use the following notation: x is the MNE's offer to the manager when she is of high type, q is its offer when she is of low type, y is the local firm's offer. $Z(\cdot)$ is the cumulative distribution function used by the local firm to randomize its offers. The MNE randomizes according to $H(\cdot)$ when the manager is of high type. The corresponding density functions are $h(\cdot)$ and $z(\cdot)$. $H(y,x)$ is $H(\cdot)$ as a function of x evaluated at y, and $Z(x,y)$ is $Z(\cdot)$ as a function y evaluated at x. $E(\Pi_i^2)$ is the expected second period equilibrium profit of firm i.

First, we derive the local firm's equilibrium strategy, and the MNE's equilibrium strategy when the manager is of high type. To find these strategies we assume that the MNE's equilibrium strategy is $q = 0$ when the manager is of low type. Then, we verify that $q = 0$ is indeed an equilibrium.

Consider the problem of the local firm. No matter the belief it holds, it will never offer more than $\Pi_{D,f}^2$. In equilibrium the local firm randomizes according to the density function that maximizes its expected profits given

26

$H(\cdot)$. It follows from the equilibrium strategies given in Lemma 1 that the MNE does not put positive probability on any offer in the equilibrium support, and $z(\cdot)$ therefore solves the following maximization problem:

$$Max_{z(y)} \int_0^{\Pi_{D,f}^2} z(y)\left[\theta H(y,x)(\Pi_{D,f}^2 - y) + (1-\theta)(0-y)\right] dy \qquad (10)$$

where $\left[\theta H(y,x)(\Pi_{D,f}^2 - y) + (1-\theta)(0-y)\right]$ is the expected pay-off from playing y given θ, $q = 0$, and $H(\cdot)$. From (10) it follows that the local firm never offers more than $\theta\Pi_{D,f}^2$, its expected valuation of the manager. The MNE wins all ties and therefore will not offer more than $\theta\Pi_{D,f}^2$. In the equilibrium we construct, both firms randomize among all offers in the interval $[0,\theta\Pi_{D,f}^2]$. The local firm only plays a mixed strategy if all offers bring the same expected pay-off given θ and $H(\cdot)$. Hence, it has to hold for all $y \in [0,\theta\Pi_{D,f}^2]$ that:

$$\theta H(y,x)(\Pi_{D,f}^2 - y) + (1-\theta)(0-y) = E(\Pi_f^2). \qquad (11)$$

From (11) one obtains:

$$H(x) = \frac{E(\Pi_f^2) + (1-\theta)x}{\theta(\Pi_{D,f}^2 - x)}. \qquad (12)$$

Now, consider the problem of the MNE. In equilibrium the MNE randomizes according to the density function that maximizes its expected profits given $Z(\cdot)$. Therefore $h(\cdot)$ solves:

$$Max_{h(x)} \int_0^{\theta\Pi_{D,f}^2} h(x)\left[Z(x,y)(\Pi_{M,h}^{I,2} - x) + (1-Z(x,y))(\Pi_{D,h}^{I,2} - F)\right] dx \qquad (13)$$

where $\left[Z(x,y)(\Pi_{M,h}^{I,2} - x) + (1 - Z(x,y))(\Pi_{D,h}^{I,2} - F)\right]$ is the expected profit from playing x. In equilibrium all offers in $[0,\theta\Pi_{D,f}^2]$ have to give the same expected pay-off given $Z(\cdot)$. Hence, for all $x \in [0,\theta\Pi_{D,f}^2]$:

$$Z(x,y)(\Pi_{M,h}^{I,2} - x) + [1 - Z(x,y)](\Pi_{D,h}^{I,2} - F) = E(\Pi_h^2). \qquad (14)$$

From (14) one obtains:

$$Z(y) = \frac{E(\Pi_h) - (\Pi_{D,h}^{I,2} - F)}{\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F) - y}. \qquad (15)$$

27

Since the maximal offer of both firms is $\theta\Pi_{D,f}^2$, then $H(\theta\Pi_{D,f}^2) = 1$ and $Z(\theta\Pi_{D,f}^2) = 1$. From (15) and (12) it follows:

$$E(\Pi_h^2) = \Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 , \qquad\qquad E(\Pi_f^2) = 0. \qquad (16)$$

Finally, inserting (16) respectively in (15) and (12) one obtains the distribution functions given in Lemma 1.

In deriving $H(\cdot)$ and $Z(\cdot)$ we have been assuming that $q = 0$. The only thing left to show is therefore that $q = 0$ is a best response to $Z(\cdot)$. If the MNE loses the manager, its second period profit is $\Pi_{M,h}^{I,2} - F$, while if it keeps her, its second period profit is $\Pi_{M,h}^{I,2} - q$. Therefore the MNE's expected profit from playing q is given by:

$$Z(q,y)(\Pi_{M,h}^{I,2} - q) + (1 - Z(q,y))(\Pi_{M,h}^{I,2} - F). \qquad (17)$$

By inserting (15) in (17) and maximizing with respect to q, it is easy to show that $q = 0$ is the best response to the strategy of the local firm. *QED*

6.2   Proof of Lemma 2

We have two candidate separating equilibria: 1) the MNE exports when the manager is of high type, and does FDI when the manager is of low type; 2) the MNE chooses FDI when the manager is of high type, and exports when the manager is of low type.

In the first candidate equilibrium the MNE's profit is given by $\Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G$ if the manager is of the high type.

Now, suppose that the MNE instead of exporting would deviate and do FDI in the first period. The local firm would hold the belief $\theta = 0$ in the second period, and the MNE's two-period profit would be $\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2}$. Due to exporting costs we have that $\Pi_{M,h}^{I,1} \geq \Pi_{M,h}^{E,1}$, thus implying that the MNE would deviate: the first candidate cannot be an equilibrium.

The proof showing that the second candidate equilibrium cannot be sustained as an equilibrium follows the same lines and we omit it for shortness. *QED*

6.3   Proof of Lemma 3

We have to distinguish two different cases: 1) $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F \geq \widetilde{\theta}\Pi_{D,f}^2$; 2) $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F < \widetilde{\theta}\Pi_{D,f}^2$. For each case there are two possible pooling

equilibria: one where the MNE chooses FDI for both types of managers, and another where it chooses exports.

Case 1: $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F \geq \widetilde{\theta}\Pi_{D,f}^{2}$

Let us first consider the pooling equilibrium where the MNE chooses FDI in the first period. As the MNE chooses FDI for both types of manager, the local firm's belief in the second period is $\theta = \widetilde{\theta}$. We look first at the MNE's choice when the manager is of the high type. If the MNE plays the equilibrium strategy, the two-period expected profit is (see Corollary 1):

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \widetilde{\theta}\Pi_{D,f}^{2}. \tag{18}$$

If the MNE would deviate and choose to export in the first period, it would earn:

$$\Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G. \tag{19}$$

Hence, the MNE does not deviate when the manager is of the high type iff.:

$$\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1} \geq \widetilde{\theta}\Pi_{D,f}^{2}. \tag{20}$$

Instead, if the manager is of low type, we have from Corollary 1 that the MNE's expected profit is:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \left[1 - \gamma(\widetilde{\theta})\right]F. \tag{21}$$

Therefore, the MNE does not deviate from the equilibrium strategy iff.:

$$\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1} \geq \left[1 - \gamma(\widetilde{\theta})\right]F. \tag{22}$$

Next, note that $\left[1 - \gamma(\widetilde{\theta})\right]F \leq \widetilde{\theta}\Pi_{D,f}^{2}$. Then, by replacing expression (3) into this inequality and simplifying, one finds that the inequality holds insofar as $\Pi_{M,h}^{I,1} \geq \Pi_{D,h}^{I,2}$, which holds by assumption A3. Hence, the condition for the existence of the pooling equilibrium where the MNE chooses FDI in the first period is given by (20).

In the other candidate equilibrium the MNE exports in the first period for both types of managers. In this equilibrium we need to specify the out-of-equilibrium-belief, as how much the local firm offers to the manager in the second period depends on the belief the local firm holds. For simplicity,

29

we assume that the out-of-equilibrium belief is $\theta = \widetilde{\theta}$. The MNE has an equilibrium profit of

$$\Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G \tag{23}$$

for both types of managers. If the MNE deviates and chooses FDI, the profit is

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \widetilde{\theta}\Pi_{D,f}^2 \tag{24}$$

if the manager is of the high type and

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \left[1 - \gamma(\widetilde{\theta})\right] F \tag{25}$$

if she is of low type. Therefore, the MNE will not deviate iff.:

$$\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1} \leq Min\{\widetilde{\theta}\Pi_{D,f}^2, \left[1 - \gamma(\widetilde{\theta})\right] F\} = \left[1 - \gamma(\widetilde{\theta})\right] F. \tag{26}$$

Case 2: $\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} + F < \widetilde{\theta}\Pi_{D,f}^2$

In the pooling equilibrium where the MNE invests in the first period, the local firm always hires the informed manager in the second period. The equilibrium profit is therefore

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{D,h}^{I,2} - F$$

if the manager is of the high type, and

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - F$$

if she is of low type. If the MNE deviates, the profit is

$$\Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G.$$

The MNE does not deviate for any type iff.:

$$\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1} \geq \Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F). \tag{27}$$

In the equilibrium where the MNE chooses exports in the first period, the condition for no deviation is the same as in case 1:

$$\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1} \leq \left[1 - \gamma(\widetilde{\theta})\right] F \tag{28}$$

QED

6.4 Semi-Separating equilibria

For each manager's type the MNE can choose FDI, or exports, or to randomize between the two. There are therefore nine candidate equilibria to consider. Four of the candidate equilibria have already been analyzed as they are separating or pooling. Here we study the remaining five semi-separating equilibria.

Candidate equilibrium 1

The MNE chooses FDI when the manager is of low type, and randomizes between FDI and exports when the manager is of high type. In the latter case, the MNE plays FDI with probability p and exports with probability $1 - p$. If the local firm observes FDI, we have from the Bayes' rule:

$$\theta = \frac{p\widetilde{\theta}}{p\widetilde{\theta} + (1 - \widetilde{\theta})}. \tag{29}$$

We have two different cases: 1) $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 \geq \Pi_{D,h}^{I,2} - F$ and 2) $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 < \Pi_{D,h}^{I,2} - F$.

Case 1: $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 \geq \Pi_{D,h}^{I,2} - F$

First, consider the MNE's strategy when the manager is of high type. Since the MNE randomizes between FDI and exports, the two options have to give the same expected pay-off:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 = \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G. \tag{30}$$

From (30) one obtains:

$$\theta = \frac{\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1}}{\Pi_{D,f}^2}. \tag{31}$$

From $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 \geq \Pi_{D,h}^{I,2} - F$ and (31) it follows:

$$\Pi_{M,h}^{I,2} - (\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1}) \geq \Pi_{D,h}^{I,2} - F. \tag{32}$$

Inequality (32) is a necessary condition for the equilibrium to exist, but not a sufficient condition, since $0 < p < 1$ also has to be fulfilled. It follows from (29) and (31) that:

$$\theta = \frac{\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1}}{\Pi_{D,f}^2} = \frac{p\widetilde{\theta}}{p\widetilde{\theta} + (1 - \widetilde{\theta})} \Leftrightarrow$$

31

$$p = \frac{(1 - \widetilde{\theta})(\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1})}{\widetilde{\theta}\left[\Pi_{D,f}^{2} - (\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1})\right]}. \tag{33}$$

Expression (33) takes values in the $(0, 1)$-interval iff.:

$$\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1} < \widetilde{\theta}\Pi_{D,f}^{2}. \tag{34}$$

Inequality (34) is another necessary condition for the equilibrium to exist.

Consider the MNE's strategy when the manager is of low type. The MNE chooses FDI iff.:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - [1 - \gamma(\theta)]\, F \geq \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G \tag{35}$$

where the LHS is the profit from choosing FDI and RHS is the profit from exports. By substituting expressions (3) and (31), inequality (35) reduces to:

$$\Pi_{M,h}^{I,2} \geq \Pi_{D,h}^{I,2}$$

which is always satisfied given A3. Therefore, inequalities (32) and (34) are sufficient conditions for the existence of the semi-separating equilibrium.

Case 2: $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^{2} < \Pi_{D,h}^{I,2} - F$

The MNE randomizes between exports and FDI only if they give the same expected profit, i.e.:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{D,h}^{I,2} - F = \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G. \tag{36}$$

Clearly, equality (36) does not hold generically.

Candidate equilibrium 2

The MNE chooses FDI when the manager is of high type, and randomizes between FDI and exports when she is of low type. We need again to identify two different cases: 1) $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^{2} \geq \Pi_{D,h}^{I,2} - F$ and 2) $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^{2} < \Pi_{D,h}^{I,2} - F$.

Case 1: $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^{2} \geq \Pi_{D,h}^{I,2} - F$

Consider the MNE's strategy when the manager is of the low type. The MNE randomizes between FDI and exports only if they give the same payoff, i.e.:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - [1 - \gamma(\theta)]\, F = \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G. \tag{37}$$

By substituting for the value of $\gamma(\theta)$ one obtains:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \left[1 - \frac{\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 - (\Pi_{D,h}^{I,2} - F)}{\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F)} \right] F = \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G$$

from which one derives:

$$\theta = \frac{(\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1}) \left[\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F) \right]}{\Pi_{D,f}^2 F}. \tag{38}$$

The MNE chooses FDI when the manager is of high value if:

$$\Pi_{M,h}^{I,1} - F - G + \Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 \geq \Pi_{M,h}^{E,1} + \Pi_{M,h}^{I,2} - F - G \tag{39}$$

where the LHS is the profit if FDI is chosen and the RHS is the profit from exporting. By substituting (38) in (39) one obtains:

$$\Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} \leq 0. \tag{40}$$

It follows from A3 that inequality (40) is never satisfied, so the candidate equilibrium is not an equilibrium.

Case 2: $\Pi_{M,h}^{I,2} - \theta\Pi_{D,f}^2 < \Pi_{D,h}^{I,2} - F$

Following the argument used in case 2 of candidate equilibrium 1, it is easy to show that also the candidate equilibrium Case 2 is not an equilibrium.

Candidate equilibrium 3

The MNE randomizes between FDI and exports for both types of manager. If the MNE randomizes between exports and FDI, θ has to be given by (38) when the manager is of low type and (31) when the manager is of high type. Given that the local firm cannot observe the manager's type, θ must be the same for both types. Hence,

$$\theta = \frac{\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1}}{\Pi_{D,f}^2} = \frac{(\Pi_{M,h}^{I,1} - \Pi_{M,h}^{E,1}) \left[\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F) \right]}{\Pi_{D,f}^2 F} \Leftrightarrow$$

$$F = \left[\Pi_{M,h}^{I,2} - (\Pi_{D,h}^{I,2} - F) \right] \Leftrightarrow \Pi_{M,h}^{I,2} - \Pi_{D,h}^{I,2} = 0. \tag{41}$$

From A3 it follows that (41) does not hold, so candidate equilibrium 3 is not an equilibrium.

33

There are two candidate equilibria left out: 4) The MNE chooses exports when the manager if of low type, and randomizes between FDI and exports when the manager is of high type, and 5) The MNE chooses exports when the manager is of high type and randomizes between FDI and exports when the manager is of low type. It can be shown, along the same lines as in the previous proofs, that these equilibria do not exist generically. To save space, proofs are omitted. *QED*