Management Structure and Technological Composition of FDI: Evidence From MNC's Subsidiaries in Mexico*

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Abstract

Multinational companies (MNCs) spread technology across countries. This paper analyzes the presence and technological composition of their subsidiaries in developing countries as a function of local judicial inefficiency (and uncertainty) and of subsidiaries management (foreign vs local CEO). Using Mexican plant-level data, we start by confirming existing management studies on the benefits and costs of expatriates; Expatriates are indeed associated with higher amounts of technology transfer but not all subsidiaries employ them. Guided by this finding, we build a model that derives MNCs profits (and thus entry decision) as a function of their managerial choice. In the model, production is a function of two potentially complementary inputs: technology (transferred from the headquarter) and a local input, provided by a local supplier. While expatriates, contrary to local managers, have MNCs specific human capital highly complementary with the technology transferred, they lack local knowledge and have to give up information rents when designing an incentive compatible contract for the local supplier. The model predicts that expatriates are positively correlated with technology transfer, more valuable both for high tech MNCs and in locations with lower uncertainty. Regarding entry, the model predicts that the presence of MNCs will be lower in locations with high local inefficiency. Further, uncertainty discourages entry of high-tech MNCs. Empirical analysis finds a robust set of correlations consistent with the model, but hard to reconcile with alternative explanations.

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I. Introduction

Economists and policy makers have increased attention to Multinational companies (MNCs) as key in the spread of technological and organizational advances across countries. The economics literature has documented that MNCs are more productive, pay higher wages, and are more export oriented than domestic firms (Markusen, [2002], and Harrison and Rodriguez-Claire, [2009]). Their presence is likely to be associated with inter-industry positive spill-overs to local firms (Blalock [2002], Jacorcik [2004] and Blalock and Gertler [2008]. Recent research suggests that the extent of such spill-overs depends on the technology of MNCs subsidiaries (see for example, Todo and Miyamoto [2006].)

If the technology level of MNCs matters for spill-over effects, then what factors determine it? Answering this question requires investigating the quantity and technological composition of FDI flows, which further requires analyzing determinants of transfer of technology within MNCs. The management literature argues that expatriates are key for technology transfer within multinationals[1] but argues also that expatriates' strength may be reduced because of local uncertainty.[2] This suggests that local uncertainty may determine technology composition of FDI through MNC's choice of employing expatriates. This is the idea that we build our paper upon.

We proceed as follows in showing, theoretically and empirically, how local conditions (captured by local inefficiency and uncertainty) determine the quantity and technological composition of FDI flows. We start by confirming management studies on the costs and benefits of expatriates, related to adapting to local conditions and technological transfer respectively, by drawing on confidential plant-level innovation survey from Mexico for the year 2000. We use these as motivation for the assumptions of a model of subsidiaries managerial choice and entry decision. We find that the employment of expatriates is more valuable for high tech MNCs and in locations with lower uncertainty over the extent of local inefficiency. Regarding the amount and composition of FDI flows, we find that the presence of MNCs will be lower in locations with high local inefficiency

[1] Egelhoff (1984) and Gupta and Govindarajan (1991) show that expatriates are MNC's means of controlling and processing information

[2] See for example Black et. al (1999) and Ricks (1999) that show administrating the development and mobility of expatriate managers has been a major challenge for most MNCs.

and that higher uncertainty discourages entry from high-tech MNCs. We are not aware of any paper that analyzes both theoretically and empirically MNCs' choice of foreign employees and its implication on technology transfer and the type and amount of FDI flows developing countries attract.[3]

To confirm that there are costs and benefits associated with the employment of expatriates documented by management studies, Table I shows the summary statistics regarding technology transfer of MNCs' subsidiaries in Mexico and shows suggestive evidence that MNCs are facing a trade off when choosing between expatriates, who know better their firms, and local managers, who know better local conditions.[4] Namely, statistics of expenditure on the acquisition of technology from abroad for Mexican subsidiaries of MNCs and employment of expatriates shows that plants with at least one foreign employee have a statistically significantly higher likelihood of spending a positive amount in technology transfer from abroad. The amount of the expenditure as well as the ratio of the expenditure on total sales are also statistically significantly higher for plants with at least one foreign employee than for plants with no foreign employee. However, 209 out of our sample of 391 foreign plants report having no foreign employees, despite their apparent strength on technology transfer, consistent with the argument of the management literature that there are costs associated with their employment.[5]

Guided by these findings, we build a model that analyzes MNCs entry decision and their choice of the subsidiary CEO, that is, whether the Headquarter (HQ) appoints an expatriate or a local CEO. The model allows us to analyze the consequences of MNCs technological intensity and local conditions for MNCs managerial choice, the amount of technology transfer, and the quantity and composition of FDI flows. These guide us towards further empirical investigation. Similarly to Antràs (2005), we distinguish two inputs in the production function of the MNC subsidiary,

[3]Tan and Mahoney (2006) analyze empirically the determinants of the choice between expatriates and local managers. Markusen and Trofimenko (2009) analyze theoretically and empirically the consequence of the use of foreign experts on workers. We will turn below.

[4]Subsidiaries of MNCs are defined as plants that report a foreign capital ratio bigger than 33 %. The choice of this threshold does not affect the qualitative results in this paper. We explain the data in Section IV.

[5]An illustrative example of the trade off between transmission of technology and local knowledge can be also found in the field study by Carrillo and Hinojoza (1999) in which a German autoparts firm has two subsidiaries in Mexico. The high end subsidiary employs a German CEO while the low end subsidiary employs no German.

Table I. Technology Transfer of Mexican Subsidiaries of Multinational Firms.

	Plants with no foreign employees	Plants with foreign employees	Total
Dummy (1 if $Transfer > 0$)	0.09***	0.21***	0.15
	(0.02)	(0.03)	(0.02)
Total Transfer	1999.43**	5496.73**	3626.08
	(914.36)	(2755.95)	(1370.12)
Total transfer/Sales (%)	0.20**	0.45**	0.32
	(0.06)	(0.10)	(0.06)
Number	209	182	391

Notes: The table reports summary statistics of amount spent on technology transfer from abroad. The first column is the statistics for plants without any foreign employee, while the second with at least one foreign employee, and the third for all plants pooled together. Standard deviation of the means in parentheses. Expenditure on technology transfer is in nominal thousand pesos (A dollar was 9.5 pesos in the beginning of 2000). Significance of the test of the equality of the mean of the two groups: * 10 percent, ** 5 percent, *** 1 percent.

which we call technology and local inputs respectively. The choice of subsidiary CEO affects the efficiency of the technological transfer and the cost of obtaining the local input. We allow for complementarities between the technology and the local inputs in the subsidiaries production function, as they are critical to determine the technological composition of FDI as a function of local conditions.[6]

The technology input depends both on the amount of technology transferred and on the subsidiary CEO. In particular, we assume that expatriates are more efficient in handling the information and technology than local CEOs because of their prior experiences within the firm. That is, expatriates, contrary to local managers, have MNCs' specific human capital highly complementary with the technology transferred. The complementarity of the HQ technology and the CEO human capital, implies that the advantage of expatriates is bigger in more in high-tech MNCs.[7] Yet, they lack local knowledge and have to give up information rents when designing

[6]Similar types of complementarity and their implications have been stressed in trade and development literature. For example, Kremer (1993) proposed O-ring type production function that captures complementarity and explores the cumulative implication of the complementarity on the difference of the wealth of nations. Kugler and Vahoogen (forthcoming) show that plants producing higher-quality outputs use higher-quality inputs, providing evidence on complementarity. Nunn (2008) shows that judicial quality affects the production of more relation-specific contract-intensive products which leads to difference in comparative advantages based on judicial quality.

[7]This is not the only way to model the advantages of expatriates. In our companion paper, Santacreu-Vasut and Teshima (2011), which stems from the earlier version of the paper based on Santacreu-Vasut (2010), use

an incentive compatible contract for the local supplier. In particular, we assume that the local input is provided by a local supplier whose cost of effort is known to the local CEO but not to an expatriate, because the former is familiar with the local environment. This implies that local CEOs have advantages over expatriates CEOs in this dimension. Thus the appointment of the CEO will determine the efficiency of technological adoption and the extent of information asymmetries between the CEO and the local supplier. In terms of entry, we derive the fixed cost of entry that makes a multinational indifferent between entering or not as function of the amount of technology transferred and the probability of high local inefficiency.

In short, the model predicts that (1) MNCs engaging in more technological transfer are more likely to employ expatriates, and more so in technology intensive industries, (2) MNCs rely less on expatriates when uncertainty about the degree of local inefficiency is high due to the expatriate's lack of local knowledge, (3) the presence of MNCs will be lower for locations with high local inefficiency (worst judicial institutions), (4) High tech MNCs presence will be lower in areas with higher local uncertainty.

In the empirical section of the paper we confirm these predictions. To do so, we complement the plant-level innovation survey with data on lawyers' perception about the judicial efficiency of each Mexican state, in terms of protecting financial contracts, collected by ITAM/GMA (1999). First, Mexican subsidiaries of MNCs hiring foreign employees spend more in technology purchase from abroad, and this correlation is stronger in industries whose R&D intensity is high in the U.S., a typical headquarter country. Second, we find a U-shape relationship between judicial efficiency and the use of foreign employees, which is consistent with the interpretation that higher uncertainty over local conditions increases the value of local management. Third, we find that Mexican states with higher levels of judicial efficiency attract more foreign firms, but there is a U-shape relation between judicial efficiency and technology intensity of entering MNCs, which is measured by the U.S. R&D intensity of the MNC's industry.

In the section following the main analysis, we discuss alternative explanations regarding the use

Hermalin (1998) leadership theory to model the transfer stage as information transmission problem. They also discuss implications of the model that can arise only from the respective models. Distinguishing between them is not the aim of this paper, however.

of expatriates and provide robustness checks. First, we discuss how an alternative explanation that regards expatriates as means of control over subsidiaries cannot fully explain the finding that local uncertainty reduces the value of relying on expatriates. Second, we examine whether the predictions regarding the correlates of expatriates hold also for domestically owned plants. They should not, if technology transfer relies crucially on firm-specific experience of expatriates. Consistent with this argument, we do not find that the use of foreign employees is correlated with technology transfer. Finally, to rule out a simple alternative productivity-driven explanation in which more productive MNCs employ expatriates and at the same time excel in all activities such as exports and domestic sales, we provide evidence that the reliance on foreign employees is positively correlated with export status, but not with domestic sales for MNCs.

This paper is related to several strands of literature. First, this paper is related to the literature on spill-overs effect of FDI. Javorcik (2004) found that foreign plants lead productivity growth of the plants in the supplying industries of those plants.[8] Recent papers explore mechanisms of spill-over effects by analyzing what kind of plants are benefitting more.[9] They suggest that the technology of MNCs subsidiaries determines the extent of spill-over effect to local firms. We aim to answer what determines this technology level. Branstetter, Fisman and Foley (2006) shows that legal reforms on intellectual property rights in countries where subsidiaries locate induce MNCs to transfer more technology. We are pointing out additional channels through which host countries' conditions or policies could affect technology transfer within MNCs and also the technology composition of entering MNCs. Markusen and Trofimenko (2009) are also close to this paper in the sense that they also focus on foreign employees. They find that plants with foreign experts have experienced increases in wages of domestic workers and on the value added per worker. Our paper is different from Markusen and Trofimenko (2009) in two senses. First we explicitly model the choice of MNCs on using foreign employees in their subsidiaries and confirm the model's predictions. Second, we also analyze the entry decision of MNCs both theoretically and empirically.

[8]Note that there could also be negative effects arising from competition. See Aitken and Harrison (1999), for example.

[9]See, for example, Blalock and Gertler (2007) and Todo and Miyamoto (2006)

This paper is also related to the literature on the entry decision of MNCs.[10] Markusen (1995) and Ramondo (2008) empirical evidence shows that around three quarters of all possible country pairs do not engage in multinational production exchanges. Ramondo (2008) shows that bilateral geographical distance and country size are major components of multinational production costs, preventing them from expanding.[11] Burstein and Monge-Narajnjo (2009) explain the unrealized exchanges through the scarcity of managers in the local economy that makes replication of technology across countries impossible. We complement these studies by providing micro-level facts and by modeling how fixed entry cost affect not only the magnitude of FDI but its composition.[12] Our analysis highlights the role of complementary between technology and local inputs, which is similar to the one proposed by Kremer (1993) and further analyzed in Kugler and Verhoogen (forthcoming), in creating differential cost of entry for MNCs depending on their technology intensity.

Finally, this paper is related to an emerging international trade literature on MNCs' strategy.[13] Recent papers by Antràs (2003, 2005), Antràs and Helpman (2004) and Feenstra and Hanson (2005) extend the property rights models of Grossman and Hart (1986) and Hart and Moore (1990) to explain the MNCs' organizational choice. A series of papers by Grossman and Helpman (2002, 2004, 2005) analyze this choice using the transaction-cost approach. See Lin and Thomas (2008) comparing the empirical predictions of the two approaches above.[14] Puga and Trefler (2010) extend the model of formal and real authority by Aghion and Tirole (1997) to explain the rise of local innovation in developing countries.[15] Tan and Mahoney (2006) analyze empirically the choice between expatriates and local CEOs using data of Japanese MNCs and relate the findings to agency theory. Our paper differs from the papers above in that we focus on the organizational

[10] For this and next strands of literature, Markusen (2004) is a standard textbook.

[11] She argues that plants face a fixed and exogenous cost to replicate the productivity level of the "source" plant that is country pair specific.

[12] Nocke and Yeaple (2008) analyze theoretically the composition of FDI arising from MNCs' choice of greenfield investment or in cross-border acquisitions, while Kesternich and Schnitzer (2009) analyze both theoretically and empirically find that as political risk increases the foreign ownership share decreases but leverage increases

[13] For surveys of this literature, see Helpman (2006) and Antràs and Rossi-Hansberg (2010).

[14] For an earlier study to investigate the role of informational asymmetries and knowledge nonexcludability in determining the choice between direct investment and licensing, see Ethier and Markusen (1996).

[15] Hanson and Xiang (2010) also extend Aghion and Tirole (1997) to analyze the characteristics of U.S. denominations.

choice of MNCs in developing countries and its implication on technology transfer and on the impact of judicial efficiency on composition of FDI.[16]

The paper is organized as follows: In section II, we present the model and its predictions. Section III presents data, and Section IV main empirical results. Section V discusses alternative explanations. Section VI concludes. Theoretical results not derived or proved in the text are found in the appendix.

II. The Model

We build a simple model of multinationals choice of their subsidiary CEO and entry decisions in foreign markets. In the model, multinationals have to choose between who is best at adopting the technology, i.e. the expatriate, and who is best at dealing with local conditions, i.e. the local manager. This trade off depends on the technological intensity of the subsidiary production and the uncertainty of local conditions and determines the expected profits from entry.

The first section describes the assumptions of the model. The second section presents the multinational's choice of their subsidiaries CEO. The third section presents the entry decision. Proofs and derivations not found in the text are available in the appendix.

II.A. Assumptions

The value of the subsidiary production, V, is an increasing function of a technology input, t, and a local input, x. That is, $V = F(t, x)$. We will impose more assumptions on V later on.

The technology input, t, depends on the amount of technology transferred from the headquarters, denoted by θ and on the efficiency of the subsidiary CEO when adopting the technology (h_e if he is an expatriate and h_l if he is a local).

We assume that the amount of technology transferred by multinationals belonging to the high tech industry, θ_H, is higher than the amount transferred by those in the low tech industry, θ_L.

[16] In this sense, this paper is complementary to Nunn (2008) that analyzes the impact of judicial quality on the comparative advantages of countries.

Consistent with findings in the management literature, we assume that $h_e > h_l$, that is, the efficiency of the subsidiary CEO is higher if he is an expatriate. This captures firm specific human capital, reflecting the fact that the expatriate has previous experience with the multinational's technology while the local manager is newly exposed to it.[17][18] Further, we assume that the efficiency of the CEO is complementary to the amount of technology transferred. That is, $t = g(h_i, \theta)$ where g is an increasing function in each of its inputs and whose cross partial derivative is positive. It follows that the marginal value of the CEO efficiency is increasing in the amount of the technological transfer, and therefore, higher for multinationals belonging to the high tech industry. Finally, we assume that the subsidiary CEO is risk neutral and his compensation is a fraction of the profits of the subsidiary.

Regarding the local input, we assume that x is the quality of an input provided by a local supplier. The local supplier enjoys utility: $w - d(x)$ where w is a wage and $d(.)$ the cost of providing the input and is an increasing, convex and thrice differentiable s.t $d(0) = 0$, $d'(0) = 0$. Let $d_i(x) = \lambda_i x^2$ and normalize his reservation utility U_r to zero. $\lambda_i = \{2, 1\}$ captures the inefficiency of the local supplier. It may be high, with probability q_H, or low, with probability $1 - q_H$. The distributional properties of λ_i are common knowledge. Consistent with management studies we assume that the subsidiary manager knows the realization of λ_i if he is local while he does not if he is an expatriate.

Finally, we assume that the multinational faces a positive and exogenous cost of entry, C.

II.B. Multinational's Choice of Subsidiary CEO

Conditional on entry, the multinational chooses the subsidiary CEO that maximizes expected

[17] A case study of German plants in Mexico by Carrillo and Hinojoza (1999) support this interpretation. In particular, in their study German employees are said to be used for the "introduction of new product or process" (translation from Spanish)

[18] Instead of interpreting h as the efficiency of the CEO, we can interpret h as the fraction of the technology transferred that remains within the firm (not sold to local competitors, for example). In this view the assumption $h_e > h_l$, reflects the fact that the HQ has higher control of the technologies transferred when employing foreign managers instead of local ones. Expatriates, in this view, are much less likely to defect and start competing operations/firms. We revisit this issue in the empirical section and show that this interpretation does not fit the facts.

profits. In addition to contributing to the technology input with his human capital, the subsidiary CEO designs the contract offered to the local supplier. In what follows we derive the conditions regarding the technological intensity of the multinational and local conditions that determine multinational's choice.

For a given amount of technology transfer, θ, the technology input is equal to $g(h_e, \theta)$ if the CEO is an expatriate and equal to $g(h_l, \theta)$ if the CEO is local. That is, the gain in technology input from hiring an expatriate is equal to $g(h_e\theta) - g(h_l, \theta)$. Given the complementarity assumption between the CEO efficiency and the technology transferred, multinationals engaging in more technology transfer, (higher θ), will find it more valuable to rely on expatriates. Yet, expatriates, contrary to a local manager, are less familiar with local conditions. While the local manager can offer a state contingent to the local supplier that guarantees the later his reservation utility, the expatriate has to design a state contingent contract that not only guarantees participation but that is also incentive compatible. In particular, the local manager proposes two possible contracts, H and L.[19]

Contract H is characterized by $w_H^l = \frac{1}{8}$ and $x_H^l = \frac{1}{4}$ and Contract L is characterized by

$w_L^l = \frac{1}{4}$ and $x_L^l = \frac{1}{2}$

The expatriate manager offers a state contingent contract to maximize the profits s.t participation and incentive constrains.[20] In particular, he proposes two possible contracts, H and L, to the local supplier where H is characterized by a quality level of the local input and wage (x_H^e, w_H^e) such that $w_H^e = \frac{1}{2[\frac{1}{q_H}+1]^2}$ and $x_H^e = \frac{1}{2[\frac{1}{q_H}+1]}$

and L is characterized by a quality level and wage pair x_L^e, w_L^e

$w_L^e = \frac{1}{4[\frac{1}{q_H}+1]^2} + \frac{1}{4}$

and $x_L^e = \frac{1}{2}$

The expatriate ensures the quality level of the local input is optimal when local inefficiency

[19]The derivation is available in the appendix. In the appendix we also show that if the expatriate manager offered the contract designed by the local CEO, the supplier would have incentives to fool him and extract rents from him.

[20]The derivation is included in the appendix.

is low.[21] Yet, to ensure the supplier chooses contract L when he turns out to be efficient, the expatriate gives him a higher wage for this quality, which corresponds to an information rent. Also note that the quality level of the local input is lower than optimal when local inefficiency is high. This results from the expatriate optimally choosing to distort contract H to make it less attractive to the supplier when he is efficient. This allows the manager to contain the wage in the efficient scenario, and therefore, the amount of information rents he has to pay for.

It follows that the multinational's expected profits depend on its managerial choice. They are a function of local conditions, summarized by the probability of high local inefficiency, q_H and of the amount of technology transferred, θ.[22] We denote expected profits by $\Upsilon^L(q_H, \theta)$ and $\Upsilon^E(q_H, \theta)$ depending on whether the CEO is local or expatriate respectively.

For simplicity, assume that the production function is an additive function of the local and technology inputs. That is, technology and the local input are perfect substitutes.[23] In that case, the profits of the subsidiary when hiring a local manager are equal to

$\Upsilon^L(q_H, \theta) = \frac{1}{4} - \frac{1}{8}q_H + g(h_l, \theta)$

And the profits of the multinational when hiring an expatriate are equal to

$\Upsilon^E(q_H, \theta) = q_H(x_H^e - 2{x_H^e}^2) + (1 - q_H)(x_L^e - \frac{1}{4}{x_H^e}^2) + g(h_e, \theta)$ which are equal to

$q_H(x_H^e - x_L^e) - q_H{x_H^e}^2 + x_L^e - {x_H^e}^2 - \frac{1}{4} + \frac{1}{4}q_H + g(h_e, \theta)$

When choosing between an expatriate and a local manager the multinational compares the profits it generates as function of its technological characteristics and local conditions.

Expatriates boost the value of the technology input, since they are more efficient at dealing with the firm's technology. In particular, relying on an expatriate increases the subsidiary profits by $g(h_e\theta) - g(h_l, \theta)$. Because of the complementarity assumption between managerial efficiency and technology transfer (cross partial derivative of $T = g(h_i, \theta)$ is positive) and the assumption that high tech firms engage in more technology transfer (higher θ), expatriates are more valuable to high tech firms, leading to hypothesis 1.

[21] This result is commonly known as "efficiency at the top".

[22] Note that q_H also captures the variance of local inefficiency

[23] The following results do not depend on this assumption. We relax this assumption and explore the role of potential complementarities to analyze the composition of FDI derived from the entry decision.

Hypothesis 1: Technology transfer and the use of expatriates are positively correlated. This correlation is stronger for multinationals belonging to technology intensive industries.

Note that because we argue that an expatriate CEO is more efficient at adopting the technology due to firm specific human capital (experience and connection with the HQ technology), we should not expect to observe these results for domestically-owned plants.[24]

Yet, expatriates are worse at dealing with local conditions, and generate lower profits from the local input. In particular, relying on an expatriate decreases the subsidiary profits by

$q_H(x_H^e - 2{x_H^e}^2) + (1 - q_H)(x_L^e - \frac{1}{4}{x_H^e}^2) - \frac{1}{4} - \frac{1}{8}q_H$.

which is a convex function of q_H, as we show in the appendix, leading to hypothesis 2.

Hypothesis 2: There is a U-shape relation between the use of expatriates and the probability of high local inefficiency, q_H.

The intuition behind this result is as follows. The expatriate, contrary to the local manager, ignores local conditions. This informational disadvantage implies that he has to design an incentive compatible contract that is a function of whether the local supplier is highly inefficient or not and give up information rents. In particular, the expatriate needs to given incentives to the supplier to choose contract L when he is efficient.[25] In particular, the information rent is equal to $R(q_H) = w_L^e - w_L^l = \frac{1}{4[\frac{1}{q_H}+1]^2}$, and the expected information rent is $ER = (1 - q_H)R(q_H)$. First, note that $ER > 0$ for all $0 < q_H < 1$ and $ER = 0$ when $q_H = 0$ or $q_H = 1$. Second, note that the ER is maximized when $q_H = 0.56$. That is, middle range values of q_H are associated with higher information rent costs, exactly because the higher the uncertainty the most valuable information is. This explains that we expect the use of expatriates to be lowest when local uncertainty is highest (for mid range values of q_H). Note that, therefore, it is not the degree of local inefficiency that matters but how uncertain local conditions are.

[24] While we model expatriates choice as a consequence of technology transfer as a shortcut, expatriates are both a cause and a consequence of technology transfer, which we take as given. In the companion paper Santacreu-Vasut and Teshima (2011) we endogeneize the amount of technology transfer relying on a dynamic leadership theory .

[25] When he is inefficient the local supplier has no incentives to pretend he is efficient and select the efficient contract.

Because the knowledge of local CEOs is only valuable for foreign firms, we should not expect to observe this result for domestically-owned plants.

Therefore the multinational will choose its subsidiary manager comparing the gain and loss the expatriate and the local generate in the technology and local input respectively. Figure I illustrates a situation in which the expatriate is chosen only when uncertainty over local conditions is low. That is, the gain the expatriate generates in terms of technology input is not high enough to cope with its lack of local knowledge when it is most critical.

Figure II illustrates, on the other hand, a situation in which the expatriate is always chosen given that his contribution to the technology input is higher than the loss generated in terms of the local input regardless of the amount of local uncertainty.

II.C. Entry decision

The multinational will decide to enter if expected profits are higher than the fix cost of entry, C and will not enter if they are lower. Because profits are a function of managerial choice, entry will be determined by the technological characteristics of the multinational and of the degree of local uncertainty and local inefficiency. This section explores the consequences of the entry decision for the amount and composition of FDI that a location attracts as a function of local conditions both in terms of local inefficiency and uncertainty.

First, note that regardless of the managerial choice of the multinational, subsidiary profits are a decreasing function of local inefficiency. This is intuitive, since higher local inefficiency increases the cost of obtaining the local input from the local supplier, and therefore, decrease profits. Therefore, we expect lower amounts of FDI flowing to locations with worst local conditions. Regarding local uncertainty, note that it is irrelevant for the profits of subsidiaries employing a local manager since he knows local conditions and does not have to provide incentives to the local supplier to provide high quality input when he is efficient. In particular, profits under a local manager are a linear function of q_H. This is not the case of subsidiaries employing expatriates, whose profits are a convex function of q_H. Therefore, we expect the relation between the amount

of FDI and local conditions to be non linear. We combine both results in hypothesis 3.

Hypothesis 3: There is a negative relation between local inefficiency and the volume of FDI that a location attracts. Further, this relation is non linear.

We now analyze how local conditions are related to the composition of FDI in terms of technological intensity. To do so, we need to analyze the joint impact of the local input and the technology input for the subsidiary's profits and therefore, impose a more realistic structure on the production function. Kugler and Vahoogen (forthcoming) show that plants producing higher-quality outputs use higher-quality inputs, providing evidence on complementarity. Guided by this and other findings discussed in the introduction, we assume that local inputs and technology are complementary.

When the probability of high local inefficiency increases both high tech and low tech multinationals will experience a drop in profits. This drop in profits will make entry cost less affordable leading to multinationals existing. Because the technology input is lower in low tech firms, this type of firms have overall lower profits and will exit first, while high tech firms that have higher technology input (and so higher overall profits) may still be able to afford the entry cost. Yet, high tech firms demand higher quality of the local input to the local supplier than low tech ones, since inputs are complementary and the former transfers more technology than the later. A change in local inefficiency will, consequently, have an additional effect via its effect on local uncertainty. In particular, higher uncertainty (increases in inefficiency from low levels, and decreases in inefficiency from high levels) will lead to high tech multinationals to exit. The reason is as follows. High tech multinationals benefit from hiring expatriates in terms of technology input. Further, because of their high value technology input, they demand high quality local input. When uncertainty increases, the information rents the expatriate has to give the local supplier reach their maximum. Yet, while switching to a local manager would save the firm these extra costs it will drop profits coming from the technology input. The complementary in inputs means, therefore, that high tech firms will be the most hurt at high levels of local uncertainty and are the most

likely to exit in these ranges of local inefficiency.

Therefore we predict the following:

Hypothesis 4: Assume that technology and local input are complements in the multinational's production function. The relation between local inefficiency and the technological intensity of FDI that a location attracts is U-shape.

III. Data

The source of information is the *Encuesta Sobre Investigación y Desarrollo de Tecnología* (ESIDET) [Survey on Research and Development of Technology]. This is a confidential survey carried out by the Instituto Nacional de Estadísticas, Geografía (INEGI) [National Institute of Statistics and Geography] of Mexico for the Consejo Nacional de Ciencia y Tecnología (CONACYT) [National Council of Science and Technology]. It has surveys for three sectors: production, education, and government. We will use the data for production, which includes both manufacturing and service sectors. The survey contains information on several aspects of innovative activities: expenditures, human resources and collaborating firms and institutions. We use the 2002 surveys. Each survey elicits information for the previous two years, but for this paper we focus on the cross-sectional variation and report the result for 2000.[26] The key variable is technology transfer, which is defined in the survey as expenses for international technology transfer [egresos por transferencia de technología (internacional)] and includes the cost for purchase or licence of patents and other non-patented inventions, revelation of know-how, and technical assistance. One limitation of the data is that we are not able to distinguish between technology transfer from parents and from other firms. However, we think that the variable mainly consists of technology transfer from the headquarters, as Branstetter, Fisman and Foley (2006) suggest that the mean of royalties paid by affiliates to their headquarters is 0.7 percent (after the patent reform for all the countries), which

[26]The qualitative results do not change if we use 2001. The advantage of using a panel would be to allow for plant-fixed effects, but the use of expatriates does not change within plants much over a few years, which leaves us little variation within plants.

is actually larger than the mean of the variable in our sample (0.3 percent).

III.A. Summary Statistics

Table II presents summary statistics. We report the mean and the standard deviation of the mean of each variable by whether plants have foreign expatriates. Plants with expatriates have larger volumes of total sales and employment. The summary statistics for domestic sales and exports show that plants with expatriates are more export-oriented. We do not find a statistically significant difference of the number of domestic employees. Plants with foreign expatriates have on average 12 foreign employees.

IV. Empirical Results

We proceed in the following way. We first investigate Hypothesis 1, i.e., whether Mexican subsidiaries of MNCs hiring foreign employees spend more in technology purchase from abroad, and if this correlation is stronger in industries whose R&D intensity is high in the U.S., a typical headquarter country.[27] In the following section, we investigate whether Mexican states with higher levels of judicial efficiency (an inverse measure of local inefficiency whose increase will also increase local uncertainty at low levels and decrease it at high levels) find more/less expatriates and foreign firms, which is an examination of Hypothesis 2. Finally, we also explore whether the entry and the technological composition of foreign firms are consistent with Hypotheses 3 and 4, by investigating the relation between the judicial efficiency and foreign ownership as well as technological intensity of entering plants.

IV.A. Plant-level correlates of expatriates

The theory prediction that we confirm in this section is Hypothesis 1: technology transfer is positively correlated with the use of expatriates and more so for technology intensive industries.

[27] Over the second half of 1990s and the first half of 2000s, over 60 percent of FDI towards Mexico originates the U.S. See for example Cuevas et. al. 2005.

It is important to note that we are not directly identifying the causality of either the causes or the consequences of MNCs' decision regarding expatriates. The theory predicts correlates of expatriates both as causes and consequences and more importantly the theory predicts that this correlation is stronger for plants or industries with some characteristics.

First, we analyze the correlation between expatriates and technology transfer. We run the following regressions.

$$\begin{aligned}(Tech\,Transfer/Sales)_{ij} &= \beta_1 D(Foreign\ Expatriates_{ij}) \\ &+ \beta_2 D(Foreign\ Expatriates_{ij}) * R\&D\ Intensity_j \\ &+ \beta_3 Exporter\ Dummy_{ij} + \beta_4 Log(Employees_{ij}) + \mu_j + \epsilon_{ij}\end{aligned}$$

where $(TechTransfer/Sales)_{ij}$ is the expenditure on technology transfer from abroad over sales; $D(Foreign\ Expariates_{ij})$ is the dummy variable indicating whether a plant i in industry j has foreign expatriates, and μ_j is a industry fixed effect. We control for the exporter dummy and the log of the number of the employees to control for size and export orientation.[28]

The measure of $R\&D\ Intensity_j$ deserves detailed explanation. This is R&D intensity at the industry level and corresponds to the value of technology for the headquarter. We draw this information from a standard source, the U.S. Federal Trade Commission (FTC) Line of Business Survey from 1974 to 1977. The Line of Business Survey required firms to report separately R&D expenditures by industry, thus providing the most reliable industry-level information on R&D expenditures. The measure has been used in leading studies in international trade, such as Antràs (2003) and Kugler and Verhoogen (forthcoming), for example. We made the concordance between FTC industry classification and Mexican industry classification by verbal industry descriptions.

Table III shows the results. We find significant positive effects of foreign employees on the intensity of technology transfer even after controlling for size (log employment), exporter-dummy and industry dummies. The results indicate that plants with foreign employees have a 0.2-0.3 %

[28] We did not use total sales for independent variables because it appears in the left hand side variable.

higher technology transfer intensity, which is economically very large.[29] This is consistent with theory prediction that plants that rely more on expatriates are more likely to introduce technology from the parents abroad. Columns (1)-(4) confirm that this is true for both all the industries and for manufacturing industries. Column (5) confirms our prediction that the correlation is stronger for more R&D intensive industries. Furthermore, the coefficient on the expatriate dummy is exactly zero, which indicates that there is no relation between expatriates and technology transfer for a (hypothetical) industry with zero R&D intensity. This is consistent with the assumption that expatriates efficiency is complementary to technology transfer. These results suggest that foreign expatriates may be a big determinant of the technology transfer from the parent MNCs to their subsidiaries and this relation is stronger for R&D intensive industries.

IV.B.Regional Determinants of Foreign Employees

This section examines empirically Hypothesis 2, which predicts that the effect of local inefficiency and uncertainty on the use of expatriates is U-shaped. We use the data on lawyers' perception about the judicial efficiency, in terms of protecting financial contracts, of each Mexican state collected by ITAM/GMA (1999) as measure of average local efficiency[30]. The ITAM study collected the data focusing on the legal enforcement of financial contracts, which fits our model. The measure captures the mean score along dimensions such as the quality of judges, the adequacy of judicial resources or the efficiency of enforcement of rulings, among others, and mainly reflects variations on q_H (the probability that local inefficiency is high). The mean and the standard deviation of the measure are 2.78 and 0.56, respectively.

Hypothesis 2 states that at a high levels of q_H (low level of judicial quality), the dependence on expatriates is decreasing in judicial quality, while at a low levels of q_H, the dependence on

[29]Note that the average intensity is 0.3 %.

[30]This measure has been used by Laeven and Woodruff (2007), who discuss it in detail. Briefly, the measure is the mean score along several dimensions such as the quality of judges, the adequacy of judicial resources, the efficiency of enforcement of their rulings, the efficiency of the judicial administration, completeness of property registries and the adequacy of local legislation related to contract enforcement. They also make the geographic pattern of the variable in Figure I of their paper and note that "While there is some pattern of legal institutions improving as we move north in Mexico, Figure I makes clear that geography alone does not explain the variation in judicial effectiveness."

expatriates is increasing in judicial quality.

We run the regression of the following form:

$$D(ForeignExpariates_{ijs}) = \beta_1 JudicialEfficiency_s + \beta_2 (JudicialEfficiency_s)^2 + (\gamma X_{ij}) + \mu_j + \epsilon_{ijs}$$

$Judicial\ Efficiency_s$ is the measure of the judicial efficiency at state s. We control the exporter dummy and the log of the total number of employees in some specifications to control for export orientation and the size of the subsidiaries. We also control GDP per capita and its square terms as it is correlated with the judicial efficiency.[31] We do so to separate the effect of judicial efficiency from any effect of richness of the state. Our theory predicts that the effect of judicial efficiency (representing $1 - q_H$) has a U-shaped effect on the reliance of expatriates, therefore indicating that β_1 should be negative, while β_2 should be positive. We cluster standard errors at the state level as the judicial efficiency varies at that level.

Table IV shows the results of the estimation using Probit. The table reports the marginal effects. For both all the industries (Columns (1) to (3)) and manufacturing (Columns (4) to (6)), β_1 is negative while β_2 is positive. The comparisons across (1), (2) and (3) as well as across (4), (5) and (6) show that the results are not sensitive to the inclusion of industry fixed effects and other controls. The results suggest that, consistent with our theory, judicial efficiency reduces the likelihood on employing foreign employees in the low judicial efficiency regime while the opposite is true in the high judicial efficiency regime.

The results indicate that one standard deviation increase from the mean in judicial efficiency is associated with a decrease of about 3 to 5 percent points in the likelihood of employing foreign employees while the same decrease lead to 20 to 25 percent point increase in probability of employing them. (The mean is 46.5 percent).[32] The level of judicial efficiency that predicts the

[31] Unreported analysis of judicial efficiency suggests that it is not statistically correlated with GDP or with population.

[32] The mean level of judicial efficiency is at the low efficiency region. Therefore, if judicial efficiency increases, the predicted likelihood of relying on foreign employees decreases first until the bottom of the U-shape and increases after it, while if judicial efficiency decreases from the mean, the predicted likelihood of relying on foreign employees increases monotonically (This asymmetry happens anywhere not at the bottom).

lowest probability of employing foreign employees is about 3.1, which is about 0.3 standard deviation positively away from the mean. One standard deviation away from this point in either way implies about 10 to 13 percent point increase in the probability of employing foreign employees. The magnitude of coefficients indicate that the only state that is in the high judicial efficiency regime is Aguascalientes which has by far the best score (4.59) while the second best state has a score of 3.4. If we exclude Aguascalientes, the square term of judicial efficiency loses significance, but the judicial efficiency itself is statistically significantly negative, confirming that all the other states are in the low judicial efficiency regime. This is in line with the theory indicating that an increase in judicial efficiency in that regime leads to less dependance on expatriates.[33]

IV.C. Regional Determinants of Foreign Entry and Technology Contents of FDI

Now we turn to our predictions on entry and the technology composition of foreign firms, i.e. Hypotheses 3 and 4. Hypothesis 3 states that there will be more entry of foreign firms associated with an increase in judicial efficiency because judicial efficiency increases the profit of MNCs. The rate of the increase in profit associated with higher judicial efficiency depends on the choice of subsidiary CEOs: the profit is a linear function of judicial efficiency when the CEO is local and non-linear if the CEO is an expatriate. Therefore, we include the square term of judicial efficiency in the regression to capture the potential nonlinear effects. In terms of the technological intensity of the entering foreign plants, Hypothesis 4 states that there is a U-shape relation between judicial efficiency and the technology intensity of entering MNCs. Under the low judicial efficiency regime, an increase in judicial efficiency (which rises uncertainty) will lead to lower technology intensity because of the two reasons. First, increasingly low-tech firms generate positive profits that cover the entry cost. Second, while an increase in judicial efficiency decreases cost directly for all the firms, higher uncertainty accompanied with an increase in judicial efficiency from the bottom will

[33]Following Laeven and Woodruff (2007), we also used the share of indigenous population in 1900s and the indicator of crop production as instrumental variables for judicial efficiency. However, these instrumental variables are weak in the sense that the F value for the first stage regression is only 2.5 and lead to effects quantitatively too large, though qualitatively consistent with our theory.

decrease the profit disproportionately for high tech firms because of the complementarity between technology and local inputs. Under the high judicial efficiency regime, an increase in judicial efficiency (which decreases uncertainty) may lead to higher technology intensity because while increasingly low-tech firms keep entering, high tech firms find it profitable to enter again as costs associated with local uncertainty decrease.

Therefore, we run the following regressions to confirm the predictions stated in the previous paragraph:

$$D(ForeignOwnership_{ijs}) = \beta_1 JudicialEfficiency_s + \beta_2 (JudicialEfficiency_s)^2 + (\gamma X_{ij}) + \mu_j + \epsilon_{ijs}$$

and

$$R\&DIntensity_{js} = \beta_1 Judicial\ Efficiency_s + \beta_2 (Judicial\ Efficiency_s)^2 + (\gamma X_{ij}) + \epsilon_{ijs}$$

Note that we cannot control for industry effects in the latter regression because $R\&DIntensity$ is defined at the U.S. industry level, allowing variations only at the industry level. Note also that the sample for the foreign ownership equation now includes all the plants, i.e. non-foreign plants from ESIDET. We control the same set of variables as in the previous regressions of foreign employees: exporter dummy, the log of the total number of employees, GDP per capita and its square terms. We again cluster standard errors at the state level.

Table V shows the results. The first to fourth columns show the results of the Probit estimation of the effect of judicial efficiency on likelihood of foreign ownership, while the fifth and sixth columns show the results of OLS estimation of the effect of same uncertainty on $R\&DIntensity$ defined at the U.S. industry level of the foreign firms that the state attracts. The first to the forth columns suggest that one standard deviation (0.56 point) increase in the judicial efficiency from the mean is associated with about 3 to 4 percent increase in the likelihood of the plants in

the area being classified as foreign owned (the mean is 21 percent). This implies that the highest point for predicted entry level is above the maximum potential judicial efficiency, so that entry is always increasing in judicial efficiency for the values of judicial efficiency we observe in Mexico. Next, we investigate the effect of judicial efficiency on technological composition. Column (5) suggests that without any controls there may be no effect of judicial efficiency on the technology level of incoming MNCs. However, the full specification in the sixth column suggests that there is a statistically significant non-linearly effect of judicial efficiency on technology intensity. The magnitudes from the two specifications are similar. The magnitude of β_1 and β_2 of Column (6) suggests the lowest point for predicted $R\&DIntensity$ level is attained when the judicial efficiency is about 3.06, roughly a half point standard deviation higher from the mean. This suggests that the relation between judicial efficiency and the foreign employees exhibit a U shape relation, similar to the one between judicial efficiency and the use of foreign employees in the previous subsection. This is because there is an inverse U-shape relation between judicial efficiency and uncertainty, and uncertainty reduces profit of high-tech MNCs disproportionately because of the complementarity between local inputs and technology. Overall, judicial efficiency affects the technological composition of entering MNCs through its impact on their choice of managerial choice, and its impact depends on the initial level.

V. Alternative Hypotheses

V.A. Expatriates as Means of Controls over Subsidiaries

An alternative explanation regarding the use of expatriate is that MNCs may be relying on them as means of control over subsidiaries. It is worth mentioning that we find difficult to reconcile the U-shape relation between judicial efficiency and the employment of foreign employees with this alternative explanation. If MNCs use them as means of control, then the value of them would decrease as judical efficiency (the degree of legal protection of contracts) increases and local uncertainty decreases. Then we would observe either a monotonically decreasing relationship be-

tween the use of foreign employees and judicial efficiency or an inverse U-shape relationship, which is at odds with the U-shape pattern we find. We do not deny the role of expatriates as controls over subsidiaries in general, but in terms of their relation with local uncertainty, the increased benefit of them as means of controls seems to be dominated by the increase cost associated with their disadvantage in managing local conditions. Thus, and since this cost was also crucial in explaining the U-shape relation between judicial efficiency and the technological composition, it appears that the complementarity between the ability of expatriates and technology as well as the one between technology and inputs are crucial factors explaining the relation between the judicial efficiency between and technological component of MNCs.

V.B. General Human Capital

We assumed that the strength of expatriates comes from their specific experiences with the MNCs. Although all of the hypotheses hold even if we assume that the strength of expatriates comes from their human capital in general, it would be interesting and important to see which is more realistic as it allows us to further investigate the nature of technology transfer. To do so we revisit the predictions on the correlates of expatriates, but for domestically-owned plants. Domestically-owned plants serve as a kind of the "control group" for our analysis, because the factors that we model on the choice of expatriated are specific only to MNCs. For example, we argue that expatriate CEOs are better at transferring technology because of their specific experience and connection with HQs. If this is true, domestically-owned plants with foreign employees would perform no better than those without foreign employees in terms of technology transfer.

Table VI shows the same analysis as the one we showed in Table III, namely the regression of technology transfer intensity on the dummy variable indicating whether a plant employs foreign employees and other controls with industry fixed effects, but for domestically-owned plants. The effect of expatriates on technology transfer intensity for domestically-owned plants is quantitatively smaller (even less than one tenth) than that for MNC's subsidiaries and statistically

insignificant. For example, having foreign employees is associated with (statistically nonsignificant) 0.007% point increases in the technology transfer intensity for all the industries (Column 1), while it was 0.27% for subsidiaries (Table III: Column 1). This pattern is robust across columns, namely regardless of whether we analyze the whole industry or the manufacturing industries only, sometimes even the sign flipping. In short, the presence of foreign employees is not correlated with technology transfer from abroad for domestically-owned plants. This is consistent with the hypothesis that the advantage that expatriates CEO have over local CEO comes from his specific experience or/and connections with the MNCs they work. This together with the analysis for subsidiaries also suggests that in order for a smooth flow of technology, both foreign plants and foreign employees may be necessary.

V.C. Simple Productive Stories: Exports vs Domestic Sales

Finally, we run regressions of the following form to examine more systematically whether plants with foreign expatriates are more likely to have higher total sales, export sales and domestic sales. We run the following regression:

$$Y_{ij} = \beta_1 D(Foreign\ Expariates_{ij}) + \beta_2 Log(Employees_{ij}) + \mu_j + \epsilon_{ij}$$

Columns (2) and (3) of Table VII show that both the exporter dummy and exports sales are positively correlated with the use of foreign employees. Column (4) shows that domestic sales are not statistically significantly correlated with the use of expatriates. The fact that we do not find positive significant correlation between expatriates and domestic sales allows us to rule out the cases where (a) high productive firms choose expatriates for reasons unrelated to our model and drives everything or where (b) some other factors are affecting both productivity and choice of expatriates. Finally, Column (1) shows that total sales as a whole is positively correlated with the use of foreign employees.

VI. Conclusion

In this paper we have analyzed the presence and technological composition of subsidiaries of MNCs in developing countries as a function of local judicial inefficiency (and uncertainty) and of subsidiaries management (foreign vs local CEO). Guided by management studies on the role of expatriates for technology transfer within MNCs, and their difficulty in adapating to local conditions, we started by confirming that expatriates are indeed associated with higher amounts of technology transfer but that not all subsidiaries employ them. Mexican plant level data reveals that plants relying on foreign employees are more likely to engage in technology transfer, and more so in R&D intensive industries. The magnitude of these results suggests that foreign employees may be a big determinant of the technology transfer from the parent MNCs to their subsidiaries. This has a implication on visa/immigration policies, as restrictive visa policies towards expatriates are likely to come at the cost of lower technology transfers from abroad.

To guide further empirical investigation we build a model that derives MNCs's profits (and thus entry decision) as a function of their managerial choice. In the model, production is a function of two potentially complementary inputs: technology (transferred from the headquarter) and a local input, provided by a local supplier. While expatriates have MNCs' specific human capital highly complementary with the technology transferred, they lack local knowledge and have to give up information rents when designing an incentive compatible contract for the local supplier. We found that because expatriates are more efficient at adopting MNCs' technology transfer (complementarity with technology) they are more valuable for high tech MNCs. Yet, in highly unstable economies they are unable to manage well the incentive problem of the local supplier and have to give up high information rents. Using data on lawyers' perception about the judicial efficiency of each Mexican state collected by ITAM/GMA (1999) as measure of average local inefficiency we find that judicial efficiency reduces the likelihood on employing foreign employees in the regime with low level of judicial quality while the opposite is true in high level judicial quality regime. This is consistent with the U-shape relation between local uncertainty and expatriates

predicted in the theory.

Regarding multinationals entry decision, our model shows that developing countries may face different effects of improving legal quality on attracting high-tech MNCs: its improvement may attract more FDI but its composition will be biased towards firms in low-tech or high-tech industries depending on whether the legal quality is very low initially or not. In particular, locations with higher uncertainty will attract less high-tech FDI. In the data we find that an increase in judicial quality is associated with more entry of foreign firms, while there is a U-shape relationship between the judicial efficiency and technological composition. One of the robustness checks shows that there is no relation between foreign employees and technology transfer for domestically owned plants. Given that foreign plants characteristics are likely to affect their impacts on local economy, MNC's choice of their subsidiary CEO and entry decisions have important consequences in the local economy.

What these suggest all together is that (i) in order for a smooth flow of technology, both foreign plants and foreign employees may be necessary; (ii) further there is a complementarity between technology and local inputs; and (iii) local uncertainty is important determinant of (lack of) technology transfer and the presence of subsidiaries of high-tech MNCs because local uncertainty significant reduces the benefits of expatriates.

Regarding future work, we plan to investigate, both theoretically and empirically, the impact of the quantity-composition relation of FDI we have found on economic development to explore further the mechanism behind the spill-over effects of FDI. Also, in this paper, we have focused on the role of foreign employees in technology transfer, not dealing with their roles in local innovative activities or training.[34] Foreign employees may be complements or substitutes to different types of local innovative activities and training, which would have consequences on their impacts on the local economy.[35] Thus, exploring what type of innovative/training activities

[34]We have already mentioned that Markusen and Trofimenko (2009) analyzed the relation between foreign employees and the wages of local employees at the plant level. They suggest that this is due to training. However, they do not have a direct measure of training.

[35]Cohen and Klepper (1996) and Dingra (2011) proposes a theory that the different type of innovative activities, more specifically product innovation and process innovation, have differential implications on the evolution of market structure and the welfare effect of trade liberalization, respectively, and Teshima (2008) show evidence that import competition stimulated Mexican plants' process innovation but not product innovation.

are complement/substitutes with foreign employees seems a promising area of future research to understand their roles and their implications on development.

Appendix I. Model's Appendix

Appendix I.A. First Best Contract offered to local supplier from the Local CEO

The local CEO is familiar with the local environment and he is able to offer a contract contingent on the realization of λ_i. In particular, he chooses (x_j, w_j) to max $x_j - w_j$ s.t $w_j - c(x_j) = 0$ for $j = H, L$. The optimal contract, which achieves first best effort levels, is to offer $(w_j^l = \frac{1}{4\lambda_j}, x_j^l = \frac{1}{2\lambda_j})$ for $j = H, L$ where $\lambda_H = 2$ and $\lambda_L = 1$.[36] That is, when local inefficiency in the local economy is high, the manager offers a low wage and demands a low level of effort. Vice versa when local inefficiency is low.

Appendix I.B. Can the expatriate offer the "local CEO contract" to the local supplier?

Is the first best solution available to the expatriate manager?

No. In particular, in the low cost scenario, the worker has an incentive to fool the manager and pretend to have high cost of effort. This is so because in the high cost scenario, the worker is given his reservation utility. If in reality he has a lower cost of effort such a contract can only leave him better off. In particular, $u(x_H^l, w_H^l; \lambda_L) = \frac{1}{8} - \frac{1}{16} > 0$.

That is, if the expatriate tries to mimic the local CEO offer, he will invariably obtain low levels of efforts from the supplier, which will obtain a positive rent when their marginal cost will be low.

[36] The superscript, l, denotes the solution under the local CEO.

Appendix I.C. Derivation of contract offered by expatriate to the local supplier

The profit in the local input is equal to

$$q_H(x_H - w_H) + (1 - q_H)(x_L - w_L) \tag{1}$$

and the four constraints are:

$$IC_H : w_H - \lambda_H x_H^2 \geq w_L - \lambda_H x_L^2 \tag{2}$$

$$IC_L : w_L - \lambda_L x_L^2 \geq w_H - \lambda_L x_H^2 \tag{3}$$

$$IR_H : w_H - \lambda_H x_H^2 \geq 0 \tag{4}$$

$$IR_L : w_L - \lambda_L x_L^2 \geq 0 \tag{5}$$

where $\lambda_H = 2$ and $\lambda_L = 1$.

IR_H and IC_L will be binding. Consequently IR_L will be satisfied and slack. Given that it is optimal to set $x_L > x_H$, IC_L will also be satisfied and slack.[37]

IR_H becomes $w_H = 2x_H^2$ and IC_L becomes $w_L = x_H^2 + x_L^2$

Plugging in the objective function, and maximizing we find the result found in the main text.

Appendix I.D. Convexity of loss in local input under expatriate

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The profits under a local manager are a linear function of q_H. We only need to show that

[37] If IR_L was binding then IR_H would not be satisfied. If $x_L > x_H$ and IC_H was binding then IC_L would not be satisfied.

the profits under an expatriate manager are a convex function of q_H. In particular, $\frac{\delta \Upsilon^E(q_H,\theta)}{\delta q_H} = (x_H - x_L) + \frac{\delta x_H}{\delta q_H}(q_H - 2q_H x_H - 2x_H) - {x_H}^2 + \frac{1}{4} < 0$

since $\frac{\delta \Upsilon^E(q_H,\theta)}{\delta q_H}$ simplifies to $(x_H - x_L) - {x_H}^2 + \frac{1}{4}$

because $q_H - q_H 2x_H - 2x_H = \frac{q_H(\frac{1}{q_H}+1) - q_H - 1}{\frac{1}{q_H}+1} = 0.$

and $(x_H - x_L)\epsilon(-\frac{1}{2}, -\frac{1}{4})$ and $x_H^2 > 0$

and

$\frac{\delta^2 \Upsilon^E(q_H,\theta)}{\delta q_H} = \frac{\delta x_H}{\delta q_H}(2 - 4x_H - 2\frac{\delta x_H}{\delta q_H}(1 + q_H)) > 0$

since $\frac{\delta x_H}{\delta q_H} = \frac{1}{2}\frac{1}{(\frac{1}{q_H}+1)^2 {q_H}^2} > 0$ and $2 - 4x_H - 2\frac{\delta x_H}{\delta q_H}(1 + q_H) = \frac{3}{1+q_H} > 0.$

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Table II: Summary statistics of plant variables in 2000 (ESIDET)

	Plants with no foreign employees	Plants with foreign employees	Total
Total Sales	1528.0	1897.9	1699.7
(in thousand)	(392.6)	(572.5)	(338.6)
Log(Total Sales)	12.68***	13.25***	12.95
	(0.11)	(0.10)	(0.08)
Domestic Sales	1216.0	1003.1	1117.1
(in thousand)	(361.6)	(195.3)	(213.)
Log(Domestic Sales)	12.28**	12.71**	12.48
	(0.14)	(0.14)	(0.10)
Exports	312.0	894.8	582.6
(in thousand)	(154.3)	(398.1)	(202.7)
Exporter Dummy	0.69***	0.82***	0.75
	(0.03)	(0.03)	(0.02)
Exports/Total Sales	0.28*	0.35*	0.31
	(0.03)	(0.03)	(0.02)
Domestic Employees	1246.52	1472.24	1351.32
	(198.51)	(189.81)	(138.06)
Foreign Employees	0.00***	12.82***	5.95
	(0.00)	(2.14)	(1.04)
Number	209	192	391

Notes: The table reports summary statistics of basic plant variables. The first column is the statistics for plants without expatriates, while the second for plants with expatriates, and the third for all plants pooled together. Standard deviation of the means in parentheses. Sales and exports are in million nominal pesos (A dollar was 9.5 pesos in the beginning of 2000). Significance of the test of the equality of the mean of the two groups: * 10 percent, ** 5 percent, *** 1 percent.

Figure I: Multinationals choice of subsidiary CEO and local uncertainty.

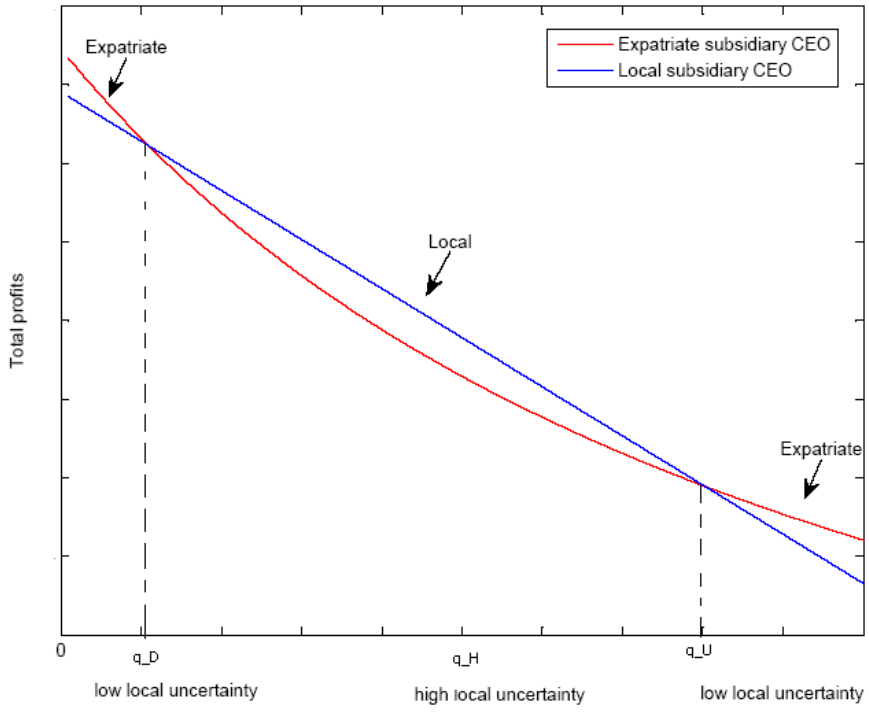

Figure II: Multinationals choice of subsidiary CEO and local uncertainty.

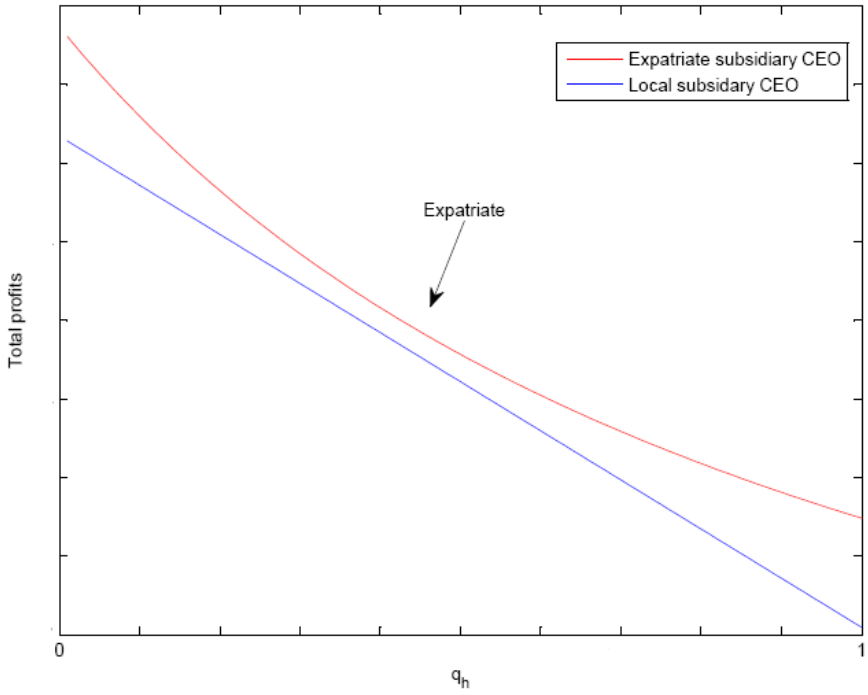

Table III: Regression of the technology transfer on expatriates. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Technology Transfer: Intensity				
Method	All Industries		Manufacturing Only		
Expatriates Dummy	0.2695**	0.2331*	0.3201***	0.3039***	-0.0000
	(0.1260)	(0.1257)	(0.1071)	(0.1155)	(0.1785)
Expatriates Dummy*					3.7652*
Industry R&D					(2.2291)
Exporter Dummy		0.4104***		0.1913	0.3876**
		(0.1485)		(0.1211)	(0.1710)
Log Employment		-0.0282		-0.0442	-0.0510
		(0.0503)		(0.0573)	(0.0648)
R^2	0.1774	0.1933	0.0318	0.1690	0.2029
N	391	391	297	297	297

Notes: The table reports coefficients on the organizational form (the dummy variable indicating whether plants have foreign employees), its interaction term with U.S. R&D intensity at the industry level, the log of the number of employees and exporter dummy from plant-level regressions of the expenditure on technology transfer from abroad on the combinations of the dummy variable indicating whether a plant has expatriates, its interaction term with the U.S. industry-level R&D intensity, the log of the number of workers, exporter dummy and industry fixed effects. The technology transfer intensities measure is the expenditure divided by total sales. Robust standard errors in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table IV: Regression of the effect of judicial efficiency on expatriates. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
Industry	All Industries			Manufacturing		
Dependent Variable	Expatriates Dummy					
Judicial Efficiency	-1.554***	-1.568***	-1.526***	-1.711***	-1.696***	-1.685***
	(0.503)	(0.554)	(0.533)	(0.438)	(0.550)	(0.541)
(Judicial Efficiency)^2	0.254***	0.249***	0.252***	0.286***	0.274***	0.286***
	(0.082)	(0.092)	(0.091)	(0.074)	(0.092)	(0.099)
Exporter Dummy (d)			0.240***			0.163***
			(0.057)			(0.057)
Log Employees			0.082***			0.105***
			(0.024)			(0.029)
GDP per capita			-0.007			-0.010*
			(0.005)			(0.006)
(GDP per capita)^2			0.000			0.000*
			(0.000)			(0.000)
Industry Effects	No	Yes	Yes	NO	Yes	Yes
N	391	349	349	301	281	281

Notes: The table reports marginal effects of the judicial efficiency, its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term on the dummy variable indicating whether a plant has foreign employees. Some firms are dropped when we include industry fixed effects due not collinearity, leading the changes in the sample size between Columns (1) and (2)(3) and between Columns (4) and (5)(6). The results for all the industries are shown in Columns (1)-(3), while the results for manufacturing industries are shown in Columns (4)-(6). Standard errors are clustered at the state level and reported in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table V: Regression of the effect of judicial efficiency form on foreign entry and R&D intensity. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
Industry	All Industries		Manufacturing			
Dependent Variable	Foreign Ownership Dummy				R&D Intensity	
	Probit				OLS	
Judicial Efficiency	0.461***	0.442**	0.433**	0.360*	-0.071	-0.055*
	(0.169)	(0.190)	(0.207)	(0.214)	(0.052)	(0.029)
(Judicial Efficiency)^2	-0.071***	-0.071**	-0.064**	-0.056*	0.009	0.009**
	(0.025)	(0.028)	(0.031)	(0.032)	(0.008)	(0.004)
Exporter Dummy	0.221***	0.203***	0.232***	0.189***		0.003
	(0.023)	(0.021)	(0.026)	(0.025)		(0.010)
Log Employees	0.049***	0.058***	0.056***	0.064***		0.001
	(0.007)	(0.008)	(0.015)	(0.018)		(0.001)
GDP per capita	-0.001	-0.002	-0.002	-0.003		-0.001*
	(0.002)	(0.002)	(0.002)	(0.002)		(0.000)
(GDP per capita)^2	0.000	0.000	0.000	0.000		0.000**
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
					0.033	0.108
Industry Effects	No	Yes	No	Yes	No	No
N	1955	1709	1413	1325	297	297

Notes: The table reports coefficients marginal effects of the judicial efficiency, its square term, exporter dummy, log of the number of workers, state-level GDP per capita and its square term on the dummy variable indicating whether a plant has foreign ownership (Columns (1) to (4)) and on U.S. R&D intensity of the industry that firms belong to (Columns (5) and (6)). The analysis of foreign ownership (Columns (1) to (4)) uses all the firms including non-foreign plants while the analysis of R&D intensity (Columns (5) and (6)) uses only foreign plants. Some firms are dropped when we include industry fixed effects due not collinearity, leading to the changes in the sample size between Columns (1) and (2) and between Columns (3) and (4). Standard errors are clustered at the state level and reported in parentheses. in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table VI: Regression of the technology transfer on expatriates. Domestically-owned plants from ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Technology Transfer: Intensity				
Method	All Industries		Manufacturing Only		
Expatriate Dummy	0.0073	-0.0149	0.0205	0.0105	-0.0049
	(0.0175)	(0.0212)	(0.0217)	(0.0215)	(0.0148)
Expatriate Dummy*					0.4715
R&D Intensity					(0.4851)
Exporter Dummy		0.0523		-0.0009	-0.0009
		(0.0362)		(0.0157)	(0.0157)
Log Employees		0.0177*		0.0141*	0.0142*
		(0.0106)		(0.0080)	(0.0080)
r2	0.1073	0.1106	0.0401	0.0460	0.0461
N	1558	1558	1100	1100	1100

Notes: The table reports coefficients on the organizational form (the dummy variable indicating whether plants have foreign employees), its interaction term with U.S. R&D intensity at the industry level, the log of the number of employees and exporter dummy from plant-level regressions of the expenditure on technology transfer from abroad on the combinations of the dummy variable indicating whether a plant has expatriates, its interaction term with the U.S. industry-level R&D intensity, the log of the number of workers, exporter dummy and industry fixed effects. The technology transfer intensities measure is the expenditure divided by total sales. Robust standard errors in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table VII: Regressions of the total sales, exports and domestic sales on expatriates, ESIDET 2000.

	(1)	(2)	(3)	(4)
Dependent Variable	Log Total Sales	Exporter Dummy	Log Exports	Log Domestic Sales
Expatriates Dummy	0.39***	0.11***	0.50**	0.09
	(0.12)	(0.041)	(0.21)	(0.42)
Log Employment	0.80***		0.91***	0.41*
	(0.07)		(0.12)	(0.22)
R^2	0.59	0.40	0.48	0.33
N	391	391	293	391

Notes: The table reports coefficients on the expatriates dummy from plant-level regressions of the log of sales, exporter dummy, the log of exports and the log of domestic sales on the expatriate dummy and the log employment and industry fixed effects. Robust standard errors in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent.