Foreign Employees as Channel for Technology Transfer: Evidence From MNC's Subsidiaries in Mexico*

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Abstract

This paper studies the role of foreign employees as a channel for technology transfer in multinational companies (MNCs). We build a simple model of MNC choice between foreign and domestic management as a function of industry characteristics and of institutional quality. We find that foreign employees are a channel for technology transfer within high-tech MNCs. Further, the reliance of MNCs on foreign employees is U-shaped in terms of institutional quality. Our model implies that we should observe the same pattern between technology transfer and institutional quality. We use a unique dataset that links information on technology transfer and the presence of foreign employees in subsidiaries in Mexico with data on judicial efficiency across Mexican states. The evidence is consistent with the implications of the model and difficult to reconcile with alternative hypotheses.

JEL Code: F23, O33, L24

Keywords: Foreign employees, FDI, Multinational companies, Technology transfer, Institutions

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1 Introduction

The transfer of technology across borders is a key driver of economic development. Multinational activities have been shown to be an important contributing factor to technology transfers. Foreign employees may embody both codified and tacit knowledge, which makes their presence in subsidiaries of MNCs potentially valuable for transferring technology. However, little is known regarding the role that foreign employees play as a channel of international technology transfer occurring through MNCs. Therefore, casting light on their role may enhance our understanding of technology flows across countries.

This paper studies the role of foreign employees as a channel for technology transfer in MNCs as a function of industry characteristics and of local institutions. To this end, we model the MNC decision of whether to use foreign or domestic management. In the model, the MNC faces the following trade-off. On the one hand, foreign employees are more efficient at transferring technology than domestic managers. On the other hand, they are less efficient at managing local inputs. Further, the cost of the local input is higher for foreign employees than for domestic managers, and this depends on the institutional environment. We test the implications of the model using data from subsidiaries in Mexico and find that foreign employees are key catalysts for technology transfer in high-tech industry MNCs. At the same time, institutions may impose barriers which limit or disincentive the employment of foreign employees. We find that when institutions prevent MNCs from hiring foreign employees, technology transfer decreases accordingly. This result is consistent with the hypothesis that foreign employees act as a channel for technology transfer.

We rely on a unique combination of data sources, which allows us to link foreign employees, technology transfer and local institutions for both foreign owned and domestic manufacturing plants in Mexico. To measure the role of foreign employees as drivers for technology transfer in MNCs, we rely on a plant-level innovation survey from Mexico. This includes both information regarding the acquisition of technology from abroad and the employment of foreign employees for the year 2000. To study how institutions may impact the costs of hiring foreign employees, we use data on lawyers perception concerning the level of judicial efficiency - in terms of protecting financial contracts - present in each Mexican state, as collected by ITAM/GMA (1999).

To guide our empirical analysis, we build a model in which we derive the amount of technology transfer and local input employed by the MNC under foreign and domestic management. We then compare the profit of the MNC under a foreign manager and a domestic manager, taking into account (1) how the benefit of foreign employees in terms of technology transfer varies with industry characteristics and (2) how the disadvantage of relying on a foreign employee depends on local institutions. The model produces a set of testable implications as follows.

First, MNCs that belong to high-tech industries and choose a foreign employee will experience a higher level of technological transfer since they rely more heavily on technology inputs. Second, the impact of institutions on the employment of foreign employees follows a U-shaped pattern. In particular, the MNC will find it optimal to rely on a foreign employee either in very poor or in very good institutional environments. In very poor institutional environments, the cost of local inputs is prohibitive and the MNC relies exclusively on technology transfer, for which the foreign employee is more efficient. As institutions improve, MNC demand for local inputs increases, and thus, domestic management is more attractive. However, with further institutional improvements, the cost disadvantage of the foreign employee disappears, making foreign employees beneficial again. Because foreign employees are assumed to be more efficient for technological transfers, the model implies that we should observe a similar U-shaped pattern between institutional quality and the level of technology transfer.

Our empirical analysis is consistent with the main implications of the model. Importantly, the fact that we observe a similar pattern between foreign employees and judicial efficiency and between technology transfer and judicial efficiency provides further support for the hypothesis that foreign employees are a channel for technology transfer in MNCs. This pattern is also hard to reconcile with alternative hypotheses or selection mechanisms, which we discuss in the subsequent analysis. Finally, the mechanism we describe in the paper analyzes technology transfer from the headquarters and therefore should not apply to domestic firms. Reassuringly, we find that foreign employees in domestically owned plants are not associated with technology transfer, which provides further evidence supporting the mechanism described in the paper.

This paper contributes to the literature on the presence of foreign employees in multinational companies (MNCs), which has become an increasingly popular area of study (Belderbos and Heijltjes (2005), Urata et.al (2006)). One stream of literature focuses on the role played by foreign employees. Along these lines, Markusen and Trofimenko (2009) find that plants with foreign experts have experienced increases in the wages of domestic workers and in value added per worker. Another stream of literature focuses on their determinants. For example, Ando et.al (2008) find that the presence of foreign employees in affiliates of Japanese MNCs increases with export orientation. Tan and Mahoney (2006) empirically analyze the choice between hiring expatriates and local CEOs using data from Japanese MNCs. The management literature argues that MNCs need to balance the use of expatriates and local staff in response to the local business environment.[1]

By showing that the role that foreign employees play in fostering technology transfer is specific to high-tech MNCs, this paper contributes to the literature on MNC activities.[2] In particular, the key to the success of MNCs in other countries is the successful transfer of their core knowledge capital, in which they have advantages. This point has long been recognized in the research on foreign direct investment (FDI) (e.g., Markusen, 1984). Studies find that MNCs are more productive, pay higher wages, and are more export oriented than domestic firms (Markusen (2004), Harrison and Rodriguez-Clare (2010) and Yeaple (2013)).

Our findings suggest that foreign employees may be a mechanism that contributes to MNC success. Further, focusing on foreign employees suggests a new channel (the staffing of MNCs) through which institutions act as barriers to technological flows between countries. This is related to the emerging international trade literature on the contracting problems of MNCs. Horstmann and Markusen (1996) argue that local agents may extract information rents due to their superior knowledge of the local environment, influencing the entry mode of MNCs.[3] Branstetter, Fisman and Foley (2006) show that legal reforms on intellectual property rights in countries where subsidiaries locate induce MNCs to transfer more technology.[4] Nunn (2007) shows that judicial quality affects the production of more relation-specific contract-intensive products, which leads to differences in comparative advantages based on judicial quality.[5]

This paper is also related to the literature on the entry cost of MNCs. Markusen (1995) and Ramondo (2014) show that around three quarters of all possible country pairs do not engage in

[1] Egelhoff (1984) and Gupta and Govindarajan (1991) show that expatriates are a means of controlling and processing information. At the same time, the impact of expatriates may be reduced because of local factors. See, for example, Black et al. (1999) and Ricks (1999), who show that administrating the development and mobility of expatriate managers has been a major challenge for most MNCs. Lam and Yeung (2010) find that the impact of staff localization on performance is inverse-U-shaped and that this relationship depends on environmental uncertainty.

[2] See Aitken and Harrison (1999) and Todo and Miyamoto (2006) for studies of the impact of MNCs in the local economy.

[3] Similarly, Cheng Chen (2011) analyzes information asymmetries on the boundaries of the firm as applied to MNCs.

[4] Kesternich and Schnitzer (2009) analyze both theoretically and empirically and find that as political risk increases the foreign ownership share decreases but leverage increases.

[5] For surveys of this literature, see Helpman (2006) and Antràs and Rossi-Hansberg (2010). Antràs, Desai and Foley (2009), Manova, Wei and Zhang (2014), and Bilir, Chor and Manova (2013) analyze the consequences of financial market imperfection on FDI, while we focus on judicial efficiency in general transactions.

multinational production exchanges. Ramondo (2014) shows that bilateral geographical distance and country size are major components of multinational production costs, preventing them from expanding. Burstein and Monge-Naranjo (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 analyzing the role of foreign employees in facilitating international technology transfer.

The rest of the paper is organized as follows. Section 2 presents the model and three testable implications. Section 3 presents the data and summary statistics. Section 4 presents the empirical results. Section 5 presents robustness checks. Section 6 concludes. Section 7 includes a theoretical and data appendix.

2 Model

Section 2.1 describes the basic setup of the model. Section 2.2 presents the results for the relation between technology transfer and expatriates.[6] Section 2.3 discusses the impact of institutional quality on MNC choices. Section 2.4 discusses the impact of technological intensity on the main implications of the model. We include testable implications that we bring to the data in the empirical section.[7]

2.1 Basic setup

Consider an MNC that employs headquarter (H) and domestic inputs (D) to produce a final good (Y) such that $Y_{ij} = \alpha_i(\eta_j lnH) + (1-\alpha_i)lnD$, where i={e,d} denotes expatriate and domestic manager, respectively and j={l,h} denotes low-tech and high-tech industries. We employ a linear-log model, where both headquarter and local inputs exhibit positive but decreasing marginal products, and assume that the expatriate is more efficient at managing the headquarter input and that the local manager is better at dealing with the domestic input. That is, $\alpha_e > \alpha_d$. This reflects the fact that expatriates have previous experience with the multinational's technology, while domestic managers lack this.[8] We also assume that $\eta_l = 0$ and $\eta_h > 0$, which reflects the

[6] In the model we use the word expatriate to denote foreign management. In the empirical analysis we use foreign employees, since this is what we observe in our data.

[7] Most algebra is available in the appendix.

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

assumption that low-tech MNCs subsidiaries are not technologically oriented.[9] The cost of the headquarter input is r and is taken as given by the MNC. We assume that hiring an expatriate or a domestic manager does not influence this cost because the firm is a multinational.

The cost of the domestic input, on the other hand, is higher when hiring an expatriate than a domestic manager. Furthermore, this cost difference depends on the legal quality of the state where the MNC operates. In particular, we assume that the cost of a domestic input equals $w(1 + \frac{c_i}{\lambda_s})$, where w denotes a constant unit cost and where we assume that $c_e = c$ (with $c > 1$) and $c_d = 1$. That is, ceteris paribus, the expatriate faces a higher cost of obtaining the domestic input. Finally, λ_s is a measure of legal quality such that $\lambda \in (0, \lambda^{max})$. That is, we assume that legal quality influences the cost of the domestic input for both an expatriate and a domestic manager. Furthermore, when legal quality is very poor (as λ approaches zero), the cost of the domestic input becomes prohibitive for both domestic and expatriate managers. On the other extreme, as legal quality increases, the difference in the cost of the domestic input between the domestic and expatriate managers converges to zero.

2.2 Technology transfer and expatriates

The MNC chooses H, D and a manager to maximize profits.[10] Given our assumptions, it follows that the MNC uses more headquarter input when relying on an expatriate because the latter is more efficient at dealing with it ($\alpha_e > \alpha_d$). Further, this holds true only for MNCs that belong to the high-tech industry. Given these assumptions we derive Testable Implication 1 as follows:

Testable Implication 1: There is a positive correlation between foreign employees and technology transfer in high-tech industries.

2.3 MNC managerial choice and institutions

The MNC chooses the manager comparing the profit generated under an expatriate and under a domestic manager, given the optimal quantities of domestic and headquarter inputs. Hiring an expatriate manager provides the MNC with an advantage in terms of the use of the headquarter input insofar the MNC is technologically oriented, while the domestic manager provides an ad-

[9] We take this extreme assumption for exposition purposes but it suffices to assume that $\eta_l < \eta_h$ for the main implications to hold.

[10] We normalize the price of the final good to one.

vantage in terms of the use of the domestic input. The reason why the MNC uses less domestic inputs when relying on an expatriate is twofold: The expatriate is less efficient at dealing with the domestic input, and the domestic input is more costly, particularly in poor institutional environments. Therefore, institutions have an impact on the trade-off MNCs face when choosing to rely on an expatriate or a domestic manager.

How does institutional quality influence the MNC managerial choice? When λ approaches zero, the domestic input demand by the MNC tends to zero because the input becomes too costly. In this case, the MNC prefers to hire an expatriate, since the cost of the domestic input is prohibitive for both the domestic and expatriate managers, and the expatriate advantage in terms of the headquarter input dominates. When institutional quality improves, two forces move in opposite directions. On the one hand, improvements in institutions will benefit more an MNC that uses a domestic manager because under a domestic manager, the domestic input demand is higher and it has a bigger weight on production. On the other hand, the elasticity of the domestic input demand is higher for an expatriate than for a domestic manager because the expatriate's relative cost disadvantage in obtaining the domestic input decreases as institutions improve. Our derivations, available in the appendix, show that improvements in institutional quality can have non-linear effects on the managerial choice of MNC and, therefore, on the use of domestic and headquarter inputs. Indeed, as institutions improve, the MNC increases its demand for domestic inputs, which eventually makes the domestic manager more attractive, as it is more productive at transforming this input into output and the domestic manager obtains the input at a lower cost. Yet, as institutional quality further increases, the domestic input demand increases faster for the expatriate, as the cost of the input converges to the cost for the domestic manager, undoing part of the advantage of the domestic manager. This results from the fact that the elasticity of the domestic input demand is higher for the expatriate than for the domestic manager because institutional improvements decrease the cost of the input for the expatriate relatively more than for the domestic manager. When this effect prevails, the expatriate benefits relatively more from the institutional improvement.[11] The impact of institutional quality on the relative elasticities of the domestic input demand of the expatriate and of the domestic manager means that the advantage

[11] In the appendix we discuss the full set of (less interesting) theoretical possibilities. First, it may be that the expatriate advantage in terms of the headquarter input is large enough to outweigh its disadvantage in terms of domestic input, even when improvements in institutional quality lead to an increase in the domestic input demand. Second, it may be that improvements in institutions lead to domestic management without a subsequent reversal as institutions further improve.

of the domestic manager decreases as institutions improve, even if the domestic manager is still more efficient at dealing with the domestic input. In such a case, the expatriate advantage in headquarter input may again outweigh the domestic manager advantage and lead the MNC to hire an expatriate in very good institutional environments.

Based on this discussion, we posit Testable Implication 2:

Testable Implication 2: MNC hiring of foreign employees is U-shaped in judicial efficiency.

Testable Implication 1 and 2 together imply Testable Implication 3 as follows:

Testable Implication 3: Technology transfer in MNC is U-shaped in judicial efficiency.

2.4 Impact of technological intensity

This section analyzes the impact of technological intensity on the relationship between both foreign employees and technology transfer and judicial efficiency. First, note that under the parametric assumption that the productivity of the headquarters input for low-tech plants is zero, the model predicts that Testable Implications 2 and 3 apply only to high-tech plants. In what follows, we relax this assumption and consider the more general assumption that the productivity of headquarters inputs is lower (but not necessarily zero) than for high-tech industries. In doing so, we derive the following corollaries:

Corollary Implication 2: There exists a range of headquarter input productivities ranging between a lower bound (strictly positive) and an upper bound (that tends to infinity) such that the MNC hiring of foreign employees is U-shaped in judicial efficiency for plants whose headquarter productivity lies within that range. The relationship is not U-shaped, on the contrary, for plants with headquarter productivity outside of the range and therefore, for low-tech plants with sufficiently low headquarter input productivity.

Corollary Implication 3: There exists a range of headquarter input productivities ranging between a lower bound (strictly positive) and an upper bound (that tends to infinity) such that MNC technology transfer is U-shaped in judicial efficiency for plants whose headquarter productivity lies within that range. The relationship is not U-shaped, on the contrary, for plants with headquarter productivity outside of the range and therefore, for low-tech plants with sufficiently low headquarter input productivity.

Intuitively these corollaries say that conditional on low-tech plants having sufficiently low productivity of the headquarter input, none of the implications of the paper holds for such plants.

3 Data

To test our three testable implications we rely on three sources of data, which we describe in detail next. First, 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 Estadística y 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 use the data for the manufacturing plants that are part of the production sector. The survey contains information on several aspects of innovative activities: expenditures, human resources and collaborating firms and institutions.

We use the 2002 survey.[12] The survey for the production sector addresses plants with more than 50 employees. The survey uses the Economic Census of 1999 to draw a sample. Among the 11728 plants in the Economic Census of 1999, the plants with more than 500 employees are included in the sample with certainty.[13] Plants with at most 500 employees are sampled with probability depending on whether they have employees (a) between 50 and 100, (b) 101 and 250 and (c) 251 and 500.[14] 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.[15] The key variable is technology transfer, which is defined in the survey as expenses for international technology transfer [egresos por transferencia de tecnología (internacional) in Spanish] and includes the cost for purchase or licence of patents and other non-patented inventions and revelation of know-how. One limitation of the data is that we are not able to distinguish between technology transfers from parents and those from other firms. However, we think that the variable mainly consists of technology transfers 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 is actually larger than the mean of the variable in our sample

[12] The survey was carried out in 1994, 1996 and 1998. There was no survey in 2000. Starting from 2002, the survey has been performed biannually. We use the 2002 wave because its implementation year is closest to the year in which the legal quality data described below were collected.

[13] In some industries, plants with at most 500 employees are surveyed with certainty. Plants for Tobacco, Shipbuilding, Airplane, and Electronic components are included with certainty regardless of the size.

[14] This means that plants with more than 500 employees are overrepresented in the data. We find that the key correlations in the data are similar for these large plants and other plants. The results are available on request.

[15] 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 foreign employees does not change greatly within plants over a few years, which leaves us little variation within plants.

(0.3 percent).

Second, regarding judicial efficiency, we use the data on lawyers' perception of judicial efficiency, in terms of the protection of financial contracts, for each Mexican state collected by ITAM/GMA (1999) as a measure of average local efficiency.[16] The ITAM/GMA study collected the data focusing on the legal enforcement of financial contracts, which fits our model. The measure captures the mean score along several dimensions such as the quality of judges, the adequacy of judicial resources and the efficiency of enforcement of rulings, among others, and mainly reflects variations on λ. The mean and the standard deviation of the measure are 2.78 and 0.56, respectively.

Table 1 presents summary statistics. We report the mean and the standard deviation of the mean of each variable by whether plants have foreign employees.

As Table 1 shows, plants with foreign employees have larger volumes of total sales and employment. The summary statistics for domestic sales and exports show that plants with foreign employees are more export-oriented. Also, plants with at least one foreign employee have a statistically significant greater likelihood of spending a positive amount in technology transfer from abroad. The amount of the expenditure and the ratio of the expenditure on total sales are higher for plants with at least one foreign employee than for plants with no foreign employee although the difference is not statistically significant. 162 out of our sample of 302 foreign plants report having no foreign employees.

Next, we present graphical representations of our main hypotheses.

Figure 1 shows the mean of technology transfer intensity versus foreign employees across industries, ordered by R&D intensity, for both foreign and domestic plants. We use U.S R&D intensity to capture the technological orientation of the MNC because the U.S. is a typical headquarter country.[17] 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 separately report R&D expenditures by industry, thus providing the most reliable industry-level

[16] 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 1 of their paper and note that "While there is some pattern of legal institutions improving as we move north in Mexico, Figure 1 makes clear that geography alone does not explain the variation in judicial effectiveness".

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

Table 1: **Summary statistics of plant variables in 2000 (ESIDET)**

	Plants with no foreign employees	Plants with foreign employees	Total
Log(Total Sales)	12.83***	13.43***	13.11
	(0.11)	(0.12)	(0.08)
Log(Domestic Sales)	11.66	12.04	11.84
	(0.26)	(0.29)	(0.19)
Exporter Dummy	0.80**	0.90**	0.85
	(0.03)	(0.03)	(0.02)
Exports/Total Sales	0.29*	0.36*	0.33
	(0.03)	(0.03)	(0.02)
Domestic Employees	1083.42*	1563.20*	1305.83
	(156.90)	(241.87)	(140.63)
Foreign Employees Share (%)	0.00***	1.06***	0.49
	(0.00)	(0.11)	(0.06)
Dummy (1 if $Transfer > 0$)	0.11***	0.25***	0.18
	(0.02)	(0.04)	(0.02)
Total Transfer	2627.68	5252.75	3844.60
	(1038.18)	(1646.18)	(946.08)
Total transfer/Sales (%)	0.29	0.43	0.36
	(0.09)	(0.10)	(0.07)
Number	162	140	302

Notes: The table reports summary statistics of basic plant variables. The first column shows statistics for plants without foreign employees, while the second shows statistics for plants with foreign employees, and the third column pools all plants together. Standard deviation of the means are in parentheses. Expenditure on technology transfer is in nominal thousand pesos (A dollar was 9.5 pesos at the beginning of 2000). Significance of the test of the equality of the mean of the two groups: * 10 percent, ** 5 percent, *** 1 percent.

information on R&D expenditures. The measure has been used in leading studies in international trade, such as Antràs (2003) and Kugler and Verhoogen (2012), for example. We made the concordance between FTC industry classification and Mexican industry classification by verbal industry descriptions.

In the figure we ranked four-digit manufacturing industries into three quantiles according to the level of R&D intensity. The industries in the lowest quantile are classified as low-tech, the industries in the top quantile are classified as high-tech, while those in the middle quantile are classified as middle-tech. We divide the industries in this way to determine whether the importance of foreign employees is monotonically increasing.

For foreign owned plants, we observe that high-tech plants with foreign employees are spending

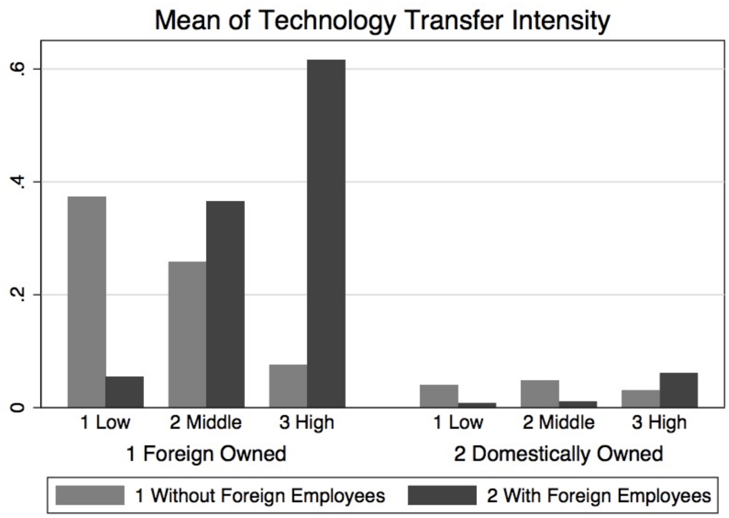

Figure 1: Technology transfer and foreign employees

Notes: Figure 1 shows the mean of technology transfer intensity versus foreign employees across industries, ordering four-digit manufacturing industries into three quantiles according to the level of R&D intensity. The industries in the lowest quantile are classified as low-tech, the industries in the top quantile are classified as high-tech, while those in the middle quantile are classified as middle-tech.

much more on technology purchases than high-tech plants without them. Interestingly, this pattern is less pronounced for mid-tech plants and not present for low-tech. Furthermore, high-tech plants with foreign employees are spending much more on technology purchases than all other plants. Overall, the pattern for foreign owned plants shows that the importance of foreign employees increases as the industry-level R&D intensity increases. For domestic plants, we observe patterns that differ from those of foreign owned plants in two respects. First, the mean level of technology transfer intensity is much lower than that of foreign owned plants, regardless of the level of R&D intensity. Second, although plants with foreign employees have higher technology transfer intensity than plants without them for the most technologically intensive industries, the benefit of foreign employees is not necessarily monotonically increasing in industry-level R&D intensity.

Next, we analyze how the use of foreign employees changes in response to different judicial efficiency levels. To do so, we divide Mexico's 32 states into 5 quintiles, according to judicial efficiency. The left side of Figure 2 plots the fraction of plants with at least one foreign employee for each of the five categories. We find a U-shaped pattern for foreign owned plants. For domestic plants, the fraction of plants with at least one foreign employee is much lower than that of foreign plants over the entire range of judicial efficiency, and more importantly, the fraction does not vary according to the level of judicial efficiency.

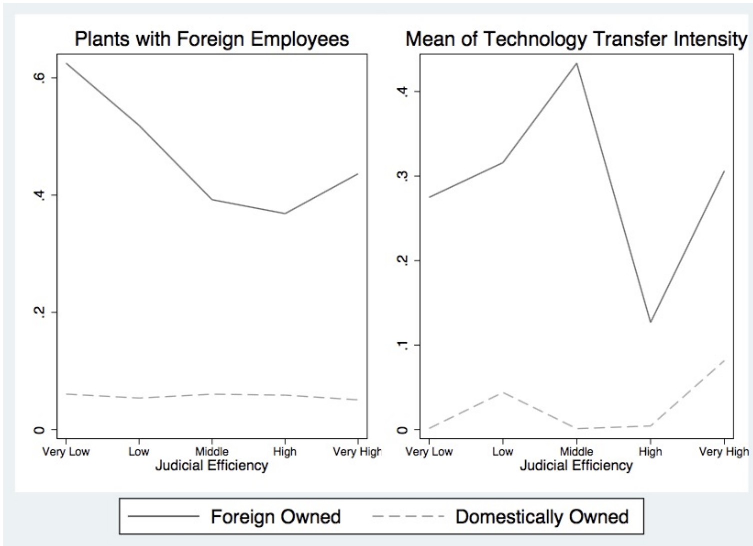

Figure 2: Foreign employees and technology transfer by state judicial efficiency and ownership

Notes: The left panel of Figure 2 shows the fraction of plants with at least one foreign employee for each of five categories of judicial efficiency. We divide Mexico's 32 states into 5 quintiles, according to judicial efficiency. The right panel of Figure 2 plots the average technology transfer intensity of plants located in states of each of the five categories. In both panels the results are shown for foreign owned and domestic plants.

Figure 2 shows a U-shaped pattern for foreign owned plants. For domestic plants, the fraction of plants with at least one foreign employees is much lower than that of foreign plants for the entire range of judicial efficiency, and more importantly, the fraction does not vary according to the level of judicial efficiency. Finally, we analyze how technology transfer intensity varies in response to different judicial efficiency levels. The right side of Figure 2 plots the average technology transfer intensity of plants located in states of each of the five categories. Even for the case of foreign owned plants, we do not see a clear U-shaped pattern.

In order to further investigate the issue, focusing only on foreign owned plants, we divide the observations into two groups. The first group represents plants in the bottom third of the R&D distribution, whereas the second group represents plants in the top two thirds of the R&D distribution. We plot the same variables as before, but for each R&D group.

Figure 3 shows that the U-shaped pattern holds for the both variables when we restrict the observations to the plants in relatively high R&D intensive industries. This is in line with the predictions of the model. We next turn to a presentation of our empirical results.

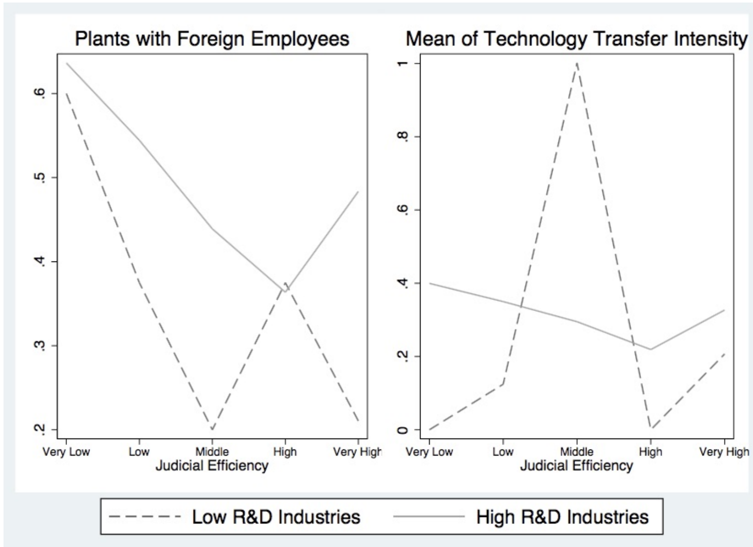

Figure 3: Foreign owned plants. Foreign employees and technology transfer by judicial efficiency and industry.

Notes: The left panel of Figure 2 shows the fraction of foreign-owned plants with at least one foreign employee for each of five categories of judicial efficiency by R&D intensity. The right panel of Figure 2 plots the average technology transfer intensity of foreign-owned plants located in states of each of the five categories by R&D intensity.

4 Empirical Results

We proceed first with Section 4.1 where we investigate Testable Implication 1. In Section 4.2, we investigate whether Mexican states with higher levels of judicial efficiency have more/less foreign employees, which is an examination of Testable Implication 2. In Section 4.3 we explore Testable Implication 3 by investigating the relationship between judicial efficiency and technology transfer. In Section 4.4 we explore the various Corollary Implications by separating the subsample into low-tech and high-tech plants. In Section 4.5 we perform further analysis regarding the extensive and intensive margins of technology transfer, and of foreign employees, respectively. Finally, in Section 4.6 we present and discuss the results for domestic plants.

4.1 Plant-level correlates of foreign employees

In this section, we examine Testable Implication 1, i.e., whether Mexican subsidiaries of MNCs hiring foreign employees that belong to high-tech industries spend more in technology purchases from abroad.

In particular, analyze the correlation between foreign employees and technology transfer with the following regression for the main specifications.

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

where $(TechTransfer/Sales)_{ijs}$ is the expenditure on technology transfer from abroad over sales in plant i in industry j at state s; $D(Foreign\,Expatriates_{ijs})$ is a dummy variable indicating whether plant i in industry j in state s has foreign employees; μ_j is an industry fixed effect and δ_s is a state fixed effect. We include an exporter dummy and the log of the number of employees to control for size and export orientation.[18] The main coefficient of interest is β_2, which according to Testable Implication 1 should be positive.

Table 2 shows the results. Columns (1) to (3) include preliminary specifications, while Columns (4) to (7) test for our Testable Implication 1.

Column (1) of Table 2 shows that foreign employees are positively correlated with technology transfer. Yet, this correlation loses significance when including state fixed effect in Column (2). Column (3) shows that U.S. Industry R&D is positively (but not significantly) correlated with technology transfer. Columns (4)-(7) show that, consistent with Testable Implication 1, there is a positive and significant correlation between foreign employees and technology transfer in high-tech industries. In particular, the coefficient on the interaction term between foreign employees dummy and US industry-level R&D intensity is statistically significant and positive across specifications in Columns (4) to (7). This result is robust to the inclusion of industry controls, or industry fixed effects and to state fixed effects. This suggests that foreign employees are a channel for technology transfer in high tech MNCs, which is the main hypothesis of the paper.

4.2 Regional determinants of foreign employees

This section empirically examines Testable Implication 2. Implication 2 predicts that the impact of local judicial efficiency on the use of foreign employees is U-shaped. More concretely, Testable Implication 2 states that at a low level of judicial efficiency, the dependence on for-

[18]We did not use total sales as an independent variable because it appears in the left-hand-side variable.

Table 2: Regression of the technology transfer on foreign employees. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Technology Transfer: Intensity						
Foreign Employees Dummy	0.262*	0.260	0.219	0.048	0.067	0.113	0.108
	(0.152)	(0.189)	(0.174)	(0.194)	(0.231)	(0.186)	(0.241)
US Industry R&D			0.695	-1.440	-1.164		
			(1.604)	(1.436)	(1.714)		
Foreign Employees Dummy*				3.776**	3.386*	3.333**	3.247*
US Industry R&D				(1.475)	(1.711)	(1.362)	(1.812)
Industry Controls	No	No	Yes	Yes	Yes	No	No
Industry Effects	Yes	Yes	No	No	No	Yes	Yes
State Effects	No	Yes	Yes	No	Yes	No	Yes
R^2	0.195	0.249	0.074	0.037	0.078	0.209	0.252
N	302	302	302	302	302	302	302

Notes: The table reports coefficients on the dummy variable indicating whether plants have foreign employees, industry-level U.S. R&D intensity and their interactions from plant-level regressions of the expenditure on technology transfer from abroad on the combinations of the dummy variable indicating whether a plant has foreign employees, its interaction term with the U.S. industry-level R&D intensity, the log of the number of workers, exporter dummy, industry fixed effects and state fixed effects. The technology transfer measure is the expenditure on technology purchases from abroad divided by total sales. Standard errors are clustered at the industry level and reported in parentheses. The regressions are run for foreign-owned plants only. Significance: * 10 percent, ** 5 percent, *** 1 percent.

eign employees is decreasing in judicial efficiency, while at a high level of judicial efficiency, the dependence on foreign employees is increasing in judicial efficiency.

We run a regression of the following form:

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

$JudicialEfficiency_s$ is the measure of the judicial efficiency at state s. We include an 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 for state-level GDP per capita and its square term, population density, the ratio of skilled workers, the capital city dummy, and the state border dummies. We do so to separate the effect of judicial efficiency from the effect of state-level variables. We cluster standard errors at the state level as the judicial efficiency measure varies at that level. Table 3 reports the marginal effects for the results of the estimation using a Probit model.

Table 3: Regression of the effect of judicial efficiency on the use of foreign employees. ESIDET 2000.

	(1)	(2)	(3)	(4)
Dependent Variable	Foreign Employees Dummy			
Judicial Efficiency	-1.738***	-1.704***	-1.873***	-0.430**
	(0.435)	(0.549)	(0.600)	(0.203)
(Judicial Efficiency)^2	0.291***	0.275***	0.307***	0.094**
	(0.074)	(0.091)	(0.104)	(0.043)
Exporter Dummy			0.148***	0.161***
			(0.054)	(0.059)
Log Worker			0.099***	0.111***
			(0.027)	(0.024)
GDP per capita				-0.024*
				(0.014)
GDP per capita squared				0.0002
				(0.0001)
Skilled Worker Ratio				1.284*
				(0.725)
Distance to the Border				0.116
				(0.171)
Population Density				-0.046
				(0.093)
Mexico City Dummy				-0.183**
				(0.076)
Industry Effects	No	Yes	Yes	Yes
N	302	282	282	282

Notes: The table reports the marginal effects of the explanatory variables from plant-level probit regressions of the foreign employee dummy on judicial efficiency and its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry fixed effects. Some plants are dropped when we include industry fixed effects due to collinearity, leading the changes in the sample size between columns. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Our theory predicts that the effect of judicial efficiency has a U-shaped effect on the reliance of foreign employees. In terms of the coefficients, this implies that β_1 should be negative and β_2 should be positive. Furthermore, the relative magnitude of β_1 and β_2 should be such that the implied level of judicial efficiency in which the dependence on foreign employees is minimized should happen within the range of judicial efficiency in our data. Therefore, $-\beta_1/(2\beta_2)$ should range between 1 and 5.

To interpret the magnitude of the coefficients of interest we first rank the 32 Mexican states into three quantiles according to the level of judicial efficiency, and take the mean of the judicial efficiency of each quantile. We then calculate the impact of an increase of half a standard deviation in judicial efficiency on hiring a foreign employee and technology transfer intensity, respectively. We only increase the judicial efficiency by half of a standard deviation to ensure that our observations stay within their given quantile. Using the coefficients from Specification (3) in Table 3 we find that for a state with low judicial efficiency, the effect of an increase of judicial efficiency by one half of its standard deviation would lead to a reduction in the probability of hiring foreign employees by 15 percentage points. For a state with high judicial efficiency, the effect would be an increase of 4.9 percentage points. For a state with mid-range judicial efficiency, the effect would be a decrease of 4.8 percentage points. Table A3 in the Appendix displays the magnitude interpretation for the coefficients on judicial efficiency and judicial efficiency squared across all the specifications from both Table 3 and Table 4.

For all the specifications, β_1 is negative, while β_2 is positive, which suggests that the results are not sensitive to the inclusion of industry fixed effects and other regional controls. In line with the theory, the relation between judicial efficiency and foreign employees is U-shaped in the range of judicial efficiency and the magnitude of the coefficients implies that $-\beta_1/(2\beta_2)$ range between 1 and 5 for all the columns. Furthermore, this is robust to the inclusion of state controls, in addition to firm controls and industry fixed effects as Column (4) of Table 3 shows.

4.3 Regional determinants of technology transfer

Testable Implication 3 states that at a low level of judicial efficiency, technology transfer is decreasing in judicial efficiency and that a high level of judicial efficiency technology transfer is increasing in judicial efficiency. We run a regression of the same form as before but using the intensity of technology transfer as the dependent variable.

$$(TechTransfer/Sales)_{ijs} = \beta_1 JudicialEfficiency_s + \beta_2 (JudicialEfficiency_s)^2 + (\gamma X_{ijs}) + \mu_j + \epsilon_{ijs}$$

Table 4 shows the results. Only when we control for neither state controls nor industry fixed effects results are not significant (Column (1)). For specifications in Columns (2), (3) and (4) results are significant and consistent with our hypothesis (β_1 is negative, while β_2 is positive). Thanks to controlling for industry and state characteristics, therefore, we are able to capture the U-shaped relation between technology transfer and judicial efficiency that our theory predicts. The results suggest that, consistent with our theory, judicial efficiency reduces the amount of technology transfer in the low judicial efficiency regime, while the opposite is true in the high judicial efficiency regime.

The reason for which the theory predicts a U-shaped pattern between judicial efficiency and technology transfer follows directly from Implications 1 and 2 of the model; namely, (1) foreign employees are positively associated with technology transfer in the MNC because they are more efficient at transferring technology and (2) MNCs are more likely to rely on foreign employees in either very good or very bad institutional environments. This is indeed confirmed by findings in Tables 3 and 4. The fact that we observe this U-shaped pattern in the data very strongly suggests that foreign employees represent an important channel for technology transfer. Empirically, there could be other reasons that judicial efficiency impacts technological transfer. These alternative reasons would have a monotonic impact on technology transfer, as we discuss in detail in the selection issues section of the robustness checks. Either these additional channels are non-existent, or they are less strong than the role of foreign employees as a channel for technology transfer. In sum, the U-shaped relationship between technology transfer and judicial efficiency is consistent with the role that foreign employees play as a channel for technology transfer and is difficult to explain with alternative hypotheses.

4.4 Regional determinants of foreign employees and technology transfer by technological intensity

To test the corollaries derived in the model regarding the impact of technological intensity on the Implications 2 and 3 of the model we classify low-tech plants as plants belonging to the bottom one-third of the R&D intensity distribution and high-tech plants are classified as plants from the top two thirds of the R&D intensity distribution. We present the results with alternative cut-off thresholds in the Appendix. Table 5 presents the effect of judicial efficiency on the hiring of foreign employees (Columns (1)-(4)) and technology transfer intensity (Columns (5)-(6)) by separating plants into low and high-tech, as descrived above.

Table 4: Regression of the effect of judicial efficiency on technology transfer. ESIDET 2000.

	(1)	(2)	(3)	(4)
Dependent Variable		Technology Transfer: Intensity		
Judicial Efficiency	-1.173	-2.287***	-2.267***	-1.433***
	(0.767)	(0.580)	(0.634)	(0.461)
$(\text{Judicial Efficiency})^2$	0.215	0.377***	0.372***	0.303***
	(0.130)	(0.096)	(0.104)	(0.069)
Exporter Dummy			0.335***	0.417***
			(0.115)	(0.110)
Log Worker			-0.041	-0.052
			(0.059)	(0.062)
GDP per capita				-0.066***
				(0.014)
GDP per capita Squared				0.0005***
				(0.0001)
Skilled Worker Ratio				-1.331
				(1.029)
Distance to the Border				-0.143
				(0.175)
Population Density				-0.122
				(0.087)
Mexico City Dummy				-0.139
				(0.122)
Ind Effects	No	Yes	Yes	Yes
$(R)^2$	0.005	0.193	0.204	0.227
N	302	302	302	302

Notes: The table reports coefficients on the explanatory variables of linear regressions of the technology transfer intensity on judicial efficiency and its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry fixed effects. The technology transfer intensity measure is the expenditure on technology purchases from abroad divided by total sales. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Significance: * 10 percent, ** 5 percent, *** 1 percent.

As the results show, the U-shaped relationship only applies to high-tech plants. This is consistent with the model's prediction that there exists a non-zero lower bound threshold of headquarter input productivity, such that for plants with lower headquarter input productivity there is no theoretical reason to observe a U-shape in the data.[19] In particular, the technological

[19] A full exploration of the thresholds for classifying high and low-tech plants is available in the Appendix.

Table 5: Effect of judicial efficiency by technological intensity. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Var.	Foreign Empoyees Dummy				Technology Transfer Intensity			
	Low-tech		*High-tech*		*Low-tech*		*High-tech*	
Judicial Eff.	0.381	0.937	-1.726***	-0.902	5.922	13.458	-2.545***	-2.323***
	(2.723)	(3.151)	(0.512)	(0.655)	(6.150)	(9.437)	(0.531)	(0.704)
(Judicial Eff.)^2	-0.139	-0.205	0.285***	0.177	-1.130	-2.365	0.423***	0.435***
	(0.491)	(0.566)	(0.086)	(0.112)	(1.181)	(1.687)	(0.078)	(0.100)
Firm Control	No	Yes	No	Yes	No	Yes	No	Yes
State Control	No	Yes	No	Yes	No	Yes	No	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	46	46	236	236	58	58	244	244

Notes: Columns (1)-(4) of the table report coefficients on judicial efficiency and its square term from plant-level probit regressions of the foreign employee dummy as the outcome variable, while Columns (5)-(8) of the table report also coefficients on judicial efficiency and its square term of linear regressions of the technology transfer intensity as the outcome variable. This table reports the results when we divide plants into two groups. We ranked four-digit manufacturing industries into three quantiles according to the level of R&D intensity. The first group represents plants in the middle and top R&D intensity quantile (High-tech), whereas the second group represents plants in the bottom R&D intensity quantile (Low-tech). Plant-level control variables include exporter dummy, the log of the number of workers, while state-level control variables include per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density. The all specifications include industry fixed effects. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

intensity of low-tech plants in the data is consistent with the theoretical situation where the productivity of the headquarters input for these plants is below the lower bound identified in Corollary Implication 2 and Corollary Implication 3. In contrast, the results for high-tech plants suggest that the productivity of their headquarters input is below the upper bound. More simply put, this means that the tension we model in the foreign versus domestic employee trade-off is relevant for high-tech plants only. This reinforces the main message of this paper; namely, that the extent to which foreign employees act as a channel for technology transfer depends on the plant's industry technological orientation. Therefore, the impact of institutions on technology transfer should mirror the impact of institutions on foreign employees only for high-tech plants.

4.5 Further analysis

In the first part of this section we perform additional analysis considering the extensive and intensive margins of technology transfer. Second, we analyze the extensive and intensive margins of foreign employees. Finally, we analyze the relationship between technology transfer and judicial efficiency for plants with and without foreign employees.

4.5.1 Extensive and intensive margins of technology transfer

An advantage of using a measure of technology transfer based on expenditures is that it is quantifiable. This means that the measure gives information regarding whether a plant is receiving foreign technology (extensive margin) but also the magnitude (intensive margin). In this section we analyze the nature of the role that foreign employees play as a channel for technology transfer for both margins. In particular, we analyze whether their contribution to technology transfer comes from the extensive and/or intensive margins.[20] To analyze the extensive margin, Columns (1)-(3) of Table 6 replicate the results of Table 2 using a dummy, which is equal one if technology purchases abroad are positive, as the dependent variable. To analyze the intensive margin, Columns (4)-(6) use the same measure as in our baseline analysis (technology purchase intensity) but condition the sample to plants with a non-zero technology purchase.

This additional analysis is both informative and consistent with the model. It suggests that the role that foreign employees play operates through the intensive margin of technology transfer. In the model, conditional on industry, even plants without foreign employees engage in technology transfer. Yet, those same plants would do more technology transfer with the presence of foreign employees. We further revisit the discussion of the extensive and intensive margins in Section 5.1, where we use alternative measures of technology transfer as a robustness check.

4.5.2 Extensive and intensive margins of foreign employees

Our baseline framework considered only the extensive margin of foreign employees (whether foreign employees are present). In this section, we provide further analysis of the role of foreign employees by analyzing whether the intensity of foreign employee presence plays a role. We quantify foreign employee presence using several variables. First, we use the share of foreign employees divided by the total number of employees. Second, we analyze the share of foreign

[20] We thank an anonymous referee for directing us to analyze these margins.

Table 6: Technology Transfer extensive and intensive margins on foreign employees. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
	Extensive Margin			*Intensive Margin*		
Dependent Variable	Technology Transfer Dummy			Technology Transfer Intensity		
Foreign Employees Dummy	0.101	0.112	0.099	-0.596	-0.223	-0.058
	(0.062)	(0.088)	(0.088)	(0.653)	(0.904)	(0.978)
Foreign Employees Dummy*	0.681	0.486	0.507	15.323***	12.624**	11.751**
US Industry R&D	(0.541)	(0.769)	(0.701)	(4.802)	(4.602)	(4.112)
Exporter Dummy			0.136***			-1.738**
			(0.039)			(0.673)
Log Worker			0.002			-0.014
			(0.02)			(0.596)
State FE	No	Yes	Yes	No	Yes	Yes
Sample Restriction	No	No	No	Positive transfer		
R^2				0.827	0.894	0.905
N	302	302	302	53	53	53

Notes: The table reports coefficients on the dummy variable indicating whether plants have foreign employees, industry-level U.S. R&D intensity and their interactions from plant-level regressions of technology-transfer related variables on the combinations of the dummy variable indicating whether a plant has foreign employees, its interaction term with the U.S. industry-level R&D intensity, the log of the number of workers, exporter dummy, industry fixed effects and state fixed effects. Columns (1)-(3) show the results from the regression where the dependent variable is Technology Transfer Dummy, which is a variable equal to one if the plants expenditures on technology transfer are positive. The regressions shown in Columns (4)-(6) use Technology Transfer Intensity as the dependent variable, but are run only for plants that report a positive amount of technology transfers. Standard errors are clustered at the industry level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

employees conditional on having at least one foreign employee. Third, we use a dummy variable equal to one if the plant has multiple foreign employees (strictly more than one). Columns (1)-(4) in Table 7 replicate the results from Table 2 using these alternative measures of foreign employees. Columns (5)-(8) of Table 7 replicate the results from Table 3 using these alternative measures of foreign employees.

We find similar results of the relationship between foreign employees and technology transfer when using the share of foreign employees. This implies that the quantity of foreign employees also plays a role in technology transfer. In Column (5) of Table 7 we find that there is a U-shaped relationship between judicial efficiency and the share of foreign workers. This suggests

Table 7: Multiple presence of foreign employees and share of foreign employees

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Technology Transfer: Intensity				Share		Multiple
Share	7.2739	-1.2929					
	(7.5970)	(6.7681)					
Share*		258.1542***					
Industry R&D		(88.5869)					
Multiple			0.2234	0.0409			
			(0.1638)	(0.2130)			
Multiple*				3.8351**			
Industry R&D				(1.6502)			
Judicial Eff.					-0.0234*	-0.0373	-1.3116**
					(0.0130)	(0.0224)	(0.5689)
(Judicial Eff.)^2					0.0035*	0.0049	0.2408**
					(0.0018)	(0.0031)	(0.0966)
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed Effects	Yes	Yes	Yes	Yes	No	No	No
State-level Controls	No	No	No	No	Yes	Yes	Yes
R^2	0.2424	0.2469	0.2462	0.2507	0.1913	0.3799	
N	302	302	302	302	302	140	271

Notes: Columns (1) and (2) of the table reports coefficients on the share of 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 foreign employees, its interaction term with the U.S. industry-level R&D intensity, the log of the number of workers, exporter dummy, industry fixed effects and state fixed effects. The technology transfer intensities measure is the expenditure divided by total sales. Columns (3) and (4) replicate the analysis of Columns (1) and (2), replacing the share of foreign employees with a dummy variable indicating whether a plant has strictly more than one foreign employee. Standard errors are clustered at the industry level and reported in parentheses. Column (5) of the table reports coefficients on judicial efficiency and its square term of regressions of the share of foreign employees on judicial efficiency and its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry fixed effects. Column (6) replicates the analysis of Column (5) for plants having at least one foreign employee. Column (7) replicates the analysis of Column (6) replacing the dependent variable with a dummy variable indicating whether a plant has strictly more than one foreign employee. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

that the mechanisms at play in the model may apply both to the presence and quantity of foreign employees in MNCs. In Column (6) of Table 7 we further analyze the intensive margin decision. In particular, we restrict the sample to plants with the presence of at least one foreign employee. In this case, we find that there is a U-shaped relationship as well, but that it is not statistically significant. Finally, Column (7) of Table 7 shows that the presence of multiple foreign employees is also U-shaped in judicial efficiency.

Overall, this further analysis suggests that foreign employees are a channel for technology transfer, along both the extensive and the intensive margins. If this is the case, we can further analyze whether technology transfer is U-shaped in judicial efficiency for plants with foreign employees. In particular, the results imply that for plants that count with the presence of at least one foreign employee, the quantity of foreign employees is itself U-shaped in judicial efficiency. Therefore, since having more foreign employees leads to more technology transfer we should find that among these plants technology transfer is also U-shaped in judicial efficiency. On the contrary, we should not observe such a relationship for plants with no foreign employees. We turn to this additional prediction in the next section.

4.5.3 Technology transfer and judicial efficiency for plants with and without foreign employees

In the previous analysis we found that the presence of multiple foreign employees also matters to boost technology transfer. In particular, using the presence of multiple foreign employee and the share of foreign employees we observe similar patterns in the data as when we use the presence of foreign employees. This finding has implications for the relationship between technology transfer and judicial efficiency. In particular we expect that, conditional on foreign employee presence, technology transfer intensity is U-shaped in judicial efficiency. On the other hand, the relationship between technology transfer and judicial efficiency should not follow a U-shaped pattern when considering plants without foreign employees. Table 8 shows the regression of the effect of judicial efficiency on technology transfer for both the subsample of plants with foreign employees and the subsample without.

We find that the relation between technology transfer and judicial efficiency is present only for plants with foreign employees but not for plants without foreign employees. This lends additional direct evidence that foreign employees act as a channel for technology transfer.

Table 8: Regression of the effect of judicial efficiency on technology transfer with and without foreign employees. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Technology Transfer: Intensity					
	With foreign employees			*Without foreign employees*		
Judicial Efficiency	-3.019***	-2.995***	-2.707**	2.487	2.602	7.837**
	(0.837)	(0.894)	(1.082)	(3.179)	(3.486)	(3.452)
(Judicial Efficiency)^2	0.491***	0.487***	0.488***	-0.460	-0.483	-1.411**
	(0.124)	(0.132)	(0.154)	(0.578)	(0.636)	(0.646)
Ind Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Control	No	Yes	Yes	No	Yes	Yes
State Control	No	No	Yes	No	No	Yes
R^2	0.317	0.326	0.365	0.279	0.288	0.311
N	140	140	140	162	162	162

Notes: The table reports coefficients on judicial efficiency and its square term of linear regressions of the technology transfer intensity on judicial efficiency and its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry fixed effects. Columns (1)-(3) show the results from the regression where the sample is restricted to the plants with at least one foreign employee, while Columns (4)-(6) show the results from the regressions run only for the plants with no foreign employee. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

4.6 Domestically-owned plants

In this section, we revisit the predictions on the correlates of foreign employees but for domestically-owned plants. Domestically-owned plants allow us to further investigate the role of foreign employees. By analyzing the correlation between foreign employees and technology transfer in domestically owned plants, we are able to determine whether foreign employees are a channel for technology transfer only in MNCs. If the strength of foreign employees comes from their specific experiences with the MNCs, we should not observe that domestically-owned plants make more technology purchases when hiring foreign employees.

We also analyze the impact of judicial efficiency on the hiring of foreign employees in domestically owned plants. This evidence allows us to rule out omitted variables concerns. In particular, it could be that correlates of judicial efficiency related to the attractiveness of the Mexican state for foreign employees (such as the quality of infrastructure, administration or schooling, among others) may be driving the results. For instance, if one of these factors makes the state more attractive for both foreign employees and for technology transfer, our findings could be spurious. By analyzing whether the presence of foreign employees in different states follows a different pattern for domestically-owned plants than for foreign owned plants, we are able to provide support for our main interpretation of the findings. Finally, we also show results for the impact of judicial efficiency on technology transfer in domestically-owned plants. This analysis allows us to further address the possibility that institutions impact technology transfer in a U-shaped pattern not because foreign employees are a channel for technology transfer but for some other reason.

Table 9 and Table 10 show the analysis of Tables 2, 3 and 4 using the sample of domestically owned plants.

Table 9: Regression of the technology transfer on foreign employees. Domestically owned plants from ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Technology Transfer: Intensity						
Foreign Employees Dummy	0.004	-0.002	-0.011	-0.023	-0.028	-0.009	-0.016
	(0.029)	(0.032)	(0.029)	(0.035)	(0.038)	(0.035)	(0.042)
US Industry R&D			0.201	0.254	0.182		
			(0.491)	(0.441)	(0.517)		
Foreign Employees Dummy*				0.294	0.519	0.087	0.401
US Industry R&D				(0.940)	(0.953)	(1.047)	(1.164)
Industry Controls	No	No	Yes	Yes	Yes	No	No
Industry Effects	Yes	Yes	No	No	No	Yes	Yes
State Effects	No	Yes	Yes	No	Yes	No	Yes
R^2	0.020	0.044	0.007	0.033	0.027	0.051	0.052
N	1071	1071	1071	1071	1071	1071	1071

Notes: The table reports coefficients on the dummy variable indicating whether plants have foreign employees, industry-level U.S. R&D intensity and their interactions from plant-level regressions of the expenditure on technology transfer from abroad on the combinations of the dummy variable indicating whether a plant has foreign employees, its interaction term with the U.S. industry-level R&D intensity, the log of the number of workers, exporter dummy, industry fixed effects and state fixed effects. The technology transfer measure is the expenditure divided by total sales. The difference from Table 2 is that this table reports the results for domestically-owned samples while Table 2 reports the results for foreign-owned plants. Standard errors are clustered at the industry level and reported in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 9 shows that the effect of foreign employees on technology transfer intensity for domestically owned plants is quantitatively smaller (even less than one-tenth) than that for MNC subsidiaries and is statistically insignificant. 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 foreign employees have over local employees derives from their specific experience and/or connections with the MNCs they work at.

Table 10: Regression of the effect of judicial efficiency on technology transfer. Domestically owned plants from ESIDET 2000.

	(1)	(2)	(3)	(4)
Dependent Variable	Foreign Employees Dummy		Technology Transfer: Intensity	
Judicial Efficiency	0.356	0.481*	0.073	0.135
	(0.268)	(0.284)	(0.083)	(0.139)
(Judicial Efficiency)^2	-0.070	-0.087*	-0.012	-0.019
	(0.049)	(0.052)	(0.011)	(0.019)
Firm Control	No	Yes	No	Yes
State Control	No	Yes	No	Yes
Industry Effects	Yes	Yes	Yes	Yes
R^2			0.020	0.036
N	704	704	1071	1071

Notes: Columns (1) and (2) of the table report the marginal effects of judicial efficiency and its square term from plant-level probit regressions of the foreign employee dummy on judicial efficiency and its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry fixed effects. Columns (3) and (4) report coefficients on judicial efficiency and its square term of linear regressions of technology transfer on the same set of the variables described above. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for domestically-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

Columns (1) and (2) of Table 10 show that the results regarding the impact of judicial efficiency on foreign employees are not significant or in the opposite sign. This rules out omitted variable concerns that some characteristics of the state that correlate with judicial efficiency increase the attractiveness for the presence of foreign employees and for technology transfer.[21] To the extent that these characteristics have the same impact for foreign employees in domestic and foreign owned plants, not finding a U-shaped pattern for domestic plants is reassuring. It suggests that these potentially omitted variables are not driving the correlation between foreign employees and judicial efficiency in our sample of MNC plants. Furthermore, the only specification where judicial efficiency and its square term significantly correlate with foreign employees has the opposite sign than for MNC plants. This is further evidence that a different logic applies for domestically-owned

[21]These characteristics could include local living conditions or administrative complexities that impact the adaptation costs of foreign employees, decreasing the attractiveness of the state in a way unrelated to the mechanism described in the paper.

plants.

Finally, Columns (3) and (4) of Table 10 show that the results concerning the impact of judicial efficiency on technology transfer are not significant either. This confirms that when foreign employees do not act as a channel for technology transfer (i.e., for domestically-owned plants) institutions do not impact the extent of technology transfer. This provides further support against the speculation that technology transfer may be more productive in states where foreign employees may adapt better.

Overall, the analysis of domestic plants rules out potential omitted variable concerns and suggests that foreign employees are a channel for technology transfer that is specific to MNCs and therefore related to MNC-specific human capital.

5 Robustness Checks

This section presents a series of robustness checks. In subsection 5.1 present results using alternative measures of technology transfer. In section 5.2 we address selection issues regarding the entry choice of plants in a given state.

5.1 Alternative measures of technology transfer

The measure of technology transfer used in the main analysis of the paper is based on survey responses to the question "expenses for international technology transfer which includes the cost for purchase or license of patents and other non-patented inventions, revelation of know-how, and technical assistance."[22]

The main concern about this measure comes from the possibility that technology purchase may capture only part of the actual technology transfer activities. In particular, non-purchased transfers of technology, for example via informal communication channels, are likely to occur but are not accounted for in our main measure. To address this issue we have exploited a qualitative source of information available in the survey which we discuss next.

The survey includes a question addressed to plants that answer zero to the technology related expenditure questions in the main body of the survey. These plants are asked to explain whether

[22] INEGI sends trained persons (enumerators) to plants and get the companies to fill the survey. While we know how much is spent on technology transfer, the survey does not record how much of it occurs over the phone, and over visits of HQ managers to the affiliates. 80 percent of affiliates in our dataset answer zero.

they obtain technology through other means, and, if yes, to explain, in words, how they do so. The original question, in spanish, and its english translation is available in the appendix. For example, one of the plants answers: “A traves de nuestra matriz en Indianapolis (USA)”, which translates as “Through our headquarter in Indianapolis (USA)”. This means that, indeed, there is evidence that plants that are doing zero purchases of technology transfers are receiving technology transfers using other means.[23]

In this section, we present the results obtained using this additional source of qualitative information. To do so, we have codified this source through a keyword search. Our goal was to capture whether plants mention if the technology comes from abroad in order to identify instances of international technology transfer. We report the keywords and codification procedure in detail in the appendix. It is important to emphasize that this information is only available for the set of plants that reported doing no technology purchases.

With this codification we construct two new variables as follows. First, we create a dummy variable, “Non-Purchased Transfer”, which is equal to one if the plants answer to the question includes a reference to a foreign origin. “Non-Purchased Transfer” can only be constructed for plants with no purchases of technology, which means that their technology transfer occurs through other channels. Second, we combine this additional measure with the measure used in the main analysis of the paper to create a broad measure of technology transfer that captures both types of transfer of technology, that is, purchased and non-purchased. In particular, we create a dummy variable, “Broad”, equal to one if the plant spends a positive amount on technology transfer through purchases (Technology Transfer Dummy = 1) or if the plant claims to receive non-purchased technology transfers from abroad (Non-Purchased Transfer = 1).

In Tables 11 and 12 we display the main results of the paper using these alternative measures of technology transfer as dependent variables. For the sake of comparison, we also include the results when using only Technology Transfer Dummy. We do not compare the results to the ones using Technology Transfer Intensity because “Non-Purchased Transfer” and “Broad” relate only to the extensive margin. This means that using these alternative measures as robustness checks allows us to address concerns regarding the measurement of the extensive margin of our baseline technology transfer measure, but not of the intensive margin.

Table 11 presents the marginal effect coefficient results of probit regressions for the regression

[23]We thank an anonymous referee for making us this consider this possibility.

of technology transfer, measured in different ways, on foreign employees. In particular, Column (1) of Table 11 replicates the results using "Technology Transfer Dummy"'. Column (2) of Table 10 shows the results using "Non-Purchased Transfer" as dependent variable. Column (3) of Table 11 shows the results using "Broad" as dependent variable. For Columns (1)-(3), Table 11 presents the marginal effect coefficients on foreign employees and the interaction with R&D intensity, as well as the same set of control variables used in the regression in Table 2, respectively.

Table 11 : Regression of alternative technology transfer measures on foreign employees ESIDET 2000.

	(1)	(2)	(3)
	Baseline	*Other measures*	
Dependent Variable	Technology Transfer Dummy	Non Purchased Transfer	Broad
Foreign Employees	0.099	-0.1008	0.0810
	(0.088)	(0.1028)	(0.1110)
Foreign Employees* Industry R&D	0.507 (0.701)	3.3019** (1.4325)	1.9980** (0.9699)
State fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes
N	302	187	262

Notes: The table report the marginal effects of the explanatory variables from plant-level probit regressions of technology transfer dummy variables on the dummy variable indicating whether plants have foreign employees, industry-level U.S. R&D intensity and their interactions. All the regressions control the log of the number of workers, exporter dummy for, industry fixed effects and state fixed effects. This table reports regressions using three different dependent variables, all of which are dummy variables. In Column 1 the dependent variable indicates whether plants reported positive expenditures on technology transfer. In Column 2 the dependent variable indicates whether plants reported technology acquisition from abroad. This answer was in response to the last part of the survey, in which plants who do not report any technology transfer expenditures were asked if they had acquired technology through other means. Finally, in Column 3 the dependent variable indicates whether plants acquired technology through either of the two means. Standard errors are clustered at the industry level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

Table 12 presents the results for the technology transfer, measured in different ways, on judicial efficiency and its squared term. We show the results for a specification without state controls in Columns (1)-(3) and with state controls in Columns (4)-(6). Again, we include the results using

"Technology Transfer Dummy" in Columns (1) and (4) to facilitate comparison and discussion. We next discuss the results using these alternative measures and compare them to the ones obtained with our main measure.

Table 12: Regression of different technology transfer measures on judicial efficiency ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	*Other measures*		*Baseline*	*Other measures*	
Dependent Variable	Technology Transfer Dummy	Non Purchased Transfer	Broad	Technology Transfer Dummy	Non Purchased Transfer	Broad
Judicial Efficiency	-0.990**	-0.711**	-1.259***	-0.421	0.087	0.005
	(0.407)	(0.317)	(0.283)	(0.352)	(0.297)	(0.343)
(Judicial Efficiency)^2	0.146**	0.114**	0.193***	0.083	0.007	0.032
	(0.061)	(0.046)	(0.044)	(0.054)	(0.039)	(0.047)
State Control	No	No	No	Yes	Yes	Yes
Plant Control	Yes	Yes	Yes	Yes	Yes	Yes
Ind Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	226	207	274	226	207	274

Notes: The table reports the marginal effects coefficients on judicial efficiency and its square term from plant-level probit regressions of alternative technology transfer measures as dependent variables. In Columns (1) and (4), the dependent variable indicates whether plants reported positive expenditures on technology transfer. In Columns (2) and (5), the dependent variable indicates whether plants reported technology acquisition from abroad. This answer was in response to the last part of the survey, in which plants who do not report any technology transfer expenditures were asked if they had acquired technology through other means. Finally, in Columns (3) and (6), the dependent variable indicates whether plants acquired technology through either of the two means. Plant-level control variables include exporter dummy, the log of the number of workers, while state-level control variables include per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density. All the specifications include industry fixed effects. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Significance: * 10 percent, ** 5 percent, *** 1 percent.

As the results show, our findings are robust to using these alternative measures of technology transfer. In particular, we observe the exact same pattern between these measures and the technology transfer dummy for the regression of technology transfer on judicial efficiency and judicial efficiency squared. On the other hand, with regard to the regression of technology transfer on foreign employees and its interaction term with the R&D intensity measure, we find when using the alternative measures that foreign employees do play a role at the extensive margin, while we do not find this for the baseline measure.

Overall, these results are interesting and suggest that our hypothesis that foreign employees serve as a channel for technology transfer also holds for less quantifiable transfers of technology. If concerns regarding the measurement of technology transfer are more relevant for the extensive than for the intensive margin (because other types of transfers may take place but go unrecorded), our analysis helps us address these concerns. We cannot, however, address concerns regarding the measurement of transfer intensity. While this is a limitation of the qualitative information we use, in the sense that it provides no information on the amount of technology transfer, we believe that this is more generally true when trying to measure technology transfer intensity for informal channels (or other channels) that may be difficult to observe and quantify. Doing so may require plant-level specific surveys to measure the amount of time involved in these type of transfer activities or other proxies measuring less easily quantifiable instances of transfer. We believe this could be a fruitful avenue for future research.

While the results found with the qualitative information available in the survey are supportive of our main hypothesis, we also explore our results using an indirect proxy for technology transfer. Specifically, we analyze imported intermediate materials. Imported intermediate products for MNC subsidiaries can capture the inputs sent by headquarters (HQ input), which is facilitated by the transfer of foreign employees in our framework. Therefore, we can use the importation of intermediate products to complement our analysis of technology transfer. Furthermore, Keller and Yeaple (2013) argue that imports from headquarters can embody the HQ knowledge and empirically find evidence consistent with this claim.

Unfortunately, expenses on intermediate materials imported from parents are not available in the data we analyze. However, Ruhl (2013) documents that the ratio of intra-firm transactions in total US exports to Mexico (Mexican imports from the US) is between 30 and 40 percent. Since the share of intra-firm transactions in trade by MNCs must be higher than this number, imports from parents are likely to occupy a significant fraction in expenses on imported intermediate materials by foreign owned plants.[24]

Our main data set does not include expenses on imported intermediates. Therefore, another plant-level survey, *Encuesta Industrial Anual* (EIA) [annual industrial survey], is linked to the data set. The EIA is a longitudinal plant level data set, compiled by INEGI. The EIA covers

[24] Ramondo, Rapoport and Ruhl (2015) document important heterogeneity of reliance on intra-firm transactions among MNCs, which we acknowledge as a potential limitation of our approach in this section.

plants in each industry from the largest plants to plants where the sample covers 85 percent of domestic sales in each industry.[25]

We replicate the main analysis of the paper replacing technology transfer measures with the share of the cost of imported intermediate materials over total non-wage cost as the dependent variable.

Table 13 shows the results. Columns (1) and (2) show the relation between imported intermediate materials and foreign employees. Column (3) shows the relation between imported intermediate materials and judicial efficiency.

Column (1) of Table 13 shows that there is no statistically significant correlation between technology transfer and foreign employees for all manufacturing industries. Column (2) shows that we do find a statistically significant correlation in technology intensive industries. This is in line with Testable Implication 1.[26] Furthermore, we also find a statistically significant U-shaped relation between imported intermediate materials and judicial efficiency (Column (3)). Overall, therefore, we find that the ratio of imported intermediate materials over total materials behaves in a very similar way to technology transfer.

However, there are both conceptual and practical limitations to analyzing imported intermediate products in our setting. First, it will be difficult to capture technology transfer with regards to knowledge that is not easily coded. We have addressed this issue partially in the previous section with the analysis of alternative technology transfer measures that draw on qualitative answers from the survey. Second, as stated already, imports of intermediate products are not necessarily from headquarters.

This exercise makes it clear that no single measure can fully capture all the dimensions of technology transfer. Yet, we find similar patterns in the data for all of the three different measures used in the paper (purchased technology transfer, non-purchased technology transfer and import of intermediate inputs). Using three measures from different sources of data and two different surveys gives us confidence in our results.

[25] The use of another survey unrelated to innovation activities may also mitigate the concern about measurement.

[26] It is also worth mentioning that the technological content of imported intermediate materials may be higher for high-tech industries, and therefore, this measure may be a less noisy proxy for technology transfer for this type of firms. It is plausible that for industries that are less technological intensive, imported intermediate materials may be a very noisy proxy for technology transfer. Furthermore, the fact that we find that foreign employees are not significantly associated with the import of inputs (for example, raw materials) whose content may require less MNC-specific human capital.

Table 13: Regression of the imported intermediates on foreign employees. ESIDET 2000.

	(1)	(2)	(3)
Dependent Variable		Imported Intermediates/Costs	
Foreign Employees Dummy	0.007	-0.032	
	(0.026)	(0.029)	
Foreign Employees Dummy*		0.7480*	
Industry R&D		(0.4030)	
Judicial Efficiency			-1.107*
			(0.623)
(Judicial Efficiency)^2			0.158*
			(0.084)
Industry fixed effects	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes
State-level Controls	No	No	Yes
State fixed effects	Yes	Yes	No
R^2	0.642	0.647	0.542
N	131	131	131

Notes: Columns (1) and (2) of the table report coefficients on the dummy variable indicating whether plants have foreign employees, its interaction term with U.S. R&D intensity at the industry level from plant-level regressions of the expenditure on imported intermediate inputs on the combinations of the dummy variable indicating whether a plant has foreign employees, its interaction term with the U.S. industry-level R&D intensity, and the log of the number of workers, exporter dummy, industry and state fixed effects. Standard errors are clustered at the industry level and reported in parentheses. Column (3) reports coefficients on judicial efficiency and its square term of linear regressions of imported intermediate inputs on judicial efficiency and its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry xed effects. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

5.2 Selection issues

So far plant's margin of choice 'to enter' or 'not to enter' into a state has been taken as given. In what follows, we check whether our results are robust to considering selection issues arising from this margin of choice. In particular, we address the possibility that plants with specific characteristics (at the plant and industry levels) select into particular states and that this drives our results.

We address selection issues in two ways. First, we consider specific alternative hypotheses related to plants foreign ownership status and productivity. This helps us address selection issues arising at the plant level. Second, we correct for sample selection bias using the two-step Heckman estimation procedure to address selection issues arising from industry characteristics. Doing so is important because even if our analysis includes industry fixed effects whenever possible, it could be the case that some industries may be overrepresented in states with particular characteristics.

5.2.1 Selection issues: alternative hypotheses

We first address the following productivity story where 1) plant productivity explains differences in technology transfer and 2) technology transfer is U-shaped on judicial efficiency only because productivity itself is U-shaped in judicial efficiency. This productivity story relies on the assumption that plants that are very productive are relatively more likely to select into states with either very low or very high judicial efficiency. While we cannot think of an intuitive mechanism for which the productivity of plants should be U-shaped in judicial efficiency, we explore this hypothesis because productivity is an important driver of MNCs comparative advantge. It is, therefore, important to rule our that plants productivity drives selection into states and explains our findings.

We address this potential selection issue by running two types of additional regressions. First, we analyze whether foreign ownership status is influenced by judicial efficiency, by regressing the dummy for foreign ownership on judicial efficiency for the subsamples both of foreign-owned and domestically-owned plants. Second, we analyze whether productivity is related to judicial efficiency for the sample of foreign-owned plants. We use both value added per worker and export orientation as proxy of productivity.

Table 14 shows the results.

Columns (1) and (2) of Table 14 show that judicial efficiency does not significantly impact

Table 14: Regression of the effect of judicial efficiency on entry and productivity measures. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
			Productivity Measure			
Dependent Variable	Foreign Ownership Dummy		Export/Sales		Value Added/Worker	
Judicial Efficiency	0.382	-0.015	-0.553**	-0.247***	-0.928	-0.617*
	(0.293)	(0.047)	(0.234)	(0.056)	(1.807)	(0.329)
(Judicial Efficiency)^2	-0.063		0.049		0.049	
	(0.043)		(0.034)		(0.262)	
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes
State Control	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2			0.438	0.436	0.489	0.489
N	1315	1315	302	302	137	137

Notes: For Columns (1) and (2), the table reports the marginal effects of the judicial efficiency, its square term of probit regressions of the foreign ownership dummy on judicial efficiency, its square term, exporter dummy, the log of the number of workers, state-level per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density, and industry fixed effects. Some firms are dropped when we include industry fixed effects due to collinearity, leading to the changes in the sample size between columns. For Columns (3) and (4) the table reports the coefficients of the judicial efficiency and its square term of the linear model regressions of the export/sales ratio on the same set of variables. For Columns (5) and (6) the table reports the coefficients of the judicial efficiency and its square term of the linear model regressions of the value-added per worker on the same set of variables. Standard errors are clustered at the state level and reported in parentheses. The regressions in Columns (1) and (2) use both foreign-owned plants and domestically-owned plants from ESIDET. The regression in Columns (3) and (4) use only foreign-owned plants from ESIDET. The regression in Columns (5) and (6) use only foreign-owned plants from the ESIDET-EIA linked data set. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

foreign plants entry. Columns (3)-(4) show the results when using export/sales ratio and show that there is a U-shaped pattern between export/sales ratio and judicial efficiency. Yet, the square term of judicial efficiency is not significant. More importantly, the magnitude of the coefficients suggests that the bottom level of exports happens when judicial efficiency is equal to 5.5. Since this is out of the range of the judicial efficiency variable in the data, it suggests that there is a monotonically decreasing pattern between judicial efficiency and the export/sales ratio. This is further confirmed by Column (4). We find similar results when using labor productivity as dependent variable in Columns (5)-(6), measured as value added per worker. Overall this suggests that firms in good institutional environments are less productive. Therefore, a simple selection story based on productivity should predict that firms that would do less technology transfer and that would not hire foreign employees would select into very good judicial efficiency environments. If that was the case, we should observe a negative correlation between judicial efficiency and technology transfer, which is at odds with the U-shaped pattern that we observe in the data. To conclude, although we find some evidence of selection, it does not explain our main findings.[27]

5.2.2 Selection issues: two-step estimation procedure

In addition to the selection issues that could arise from the alternative hypotheses we studied in the previous section, our analysis could suffer from other types of selection bias. In particular, insofar as the cost of entry into a state may influence plants from different industries differently, the industry composition of the plants that we observe in the data in a given state could be biased. To address this issue we exploit the two-step Heckman estimation procedure, which we describe next in detail.

Concerning the first stage, we rely on an entry-cost variable to predict the entry of a plant into a state. In particular, we use the variable "Ease of starting a business" from the source Doing Business in Mexico (2007).[28] This variable captures in a single ranking the number of procedures, time and monetary costs involved in starting a business for each Mexican state. We believe that this measure satisfies the exclusion restriction insofar as once established, a foreign plant will not

[27] We also find it difficult to reconcile the U-shaped relation between judicial efficiency and the employment of foreign employees with the hypothesis that MNCs use foreign employees as a means of control since in that case their value would decrease as judicial efficiency (the degree of legal protection of contracts) increases.

[28] Although there is a 7-year difference from the year of our main analysis (2000), this report is the earliest in which the information is published for Mexican states.

have to incur these costs again, and therefore we do not expect them to have any clear impact on the use of foreign employees and technology transfer ex post. This is not the case, for example, for measures concerning the obtention of credit or enforcement of a contract, because those costs are recurrent and may potentially influence or be influenced by the MNCs strategic choices. As a robustness check, we also add “Ease of registering property” as an additional exclusion restriction variable. While the results are unchanged qualitatively, by doing so we believe that the exogeneity restriction is less plausible for this measure because registering property may be a variable cost for certain types of economic activities of plants.

Nevertheless, the results in this section should be taken with caution for the following reasons. There may be doubt about the validity of the exclusion restriction. For example, the ease of starting a business may motivate plants to send foreign employees to establish a business. Yet this is a minor concern because we see no reason why, after this initial choice, the ease of starting a business would have an impact on the hiring of foreign employees once the plant is installed in a specific state. A more important concern is the fact that the independence assumption is not likely to be satisfied, because plants located in one state may depend on location and existing conditions in other states as well. Finally, one caveat of this analysis is that our exclusion restriction variable is available only for 2007 onward, which could lead to potential endogeneity concerns. With these caveats in mind, we believe it is still useful to perform a two-step estimation, to see whether there is evidence of selection bias.

Table 15 presents the results of the estimation procedure. Column (1) shows the first stage where we estimate a probit regression of plant presence in a particular state on the “Ease of starting a business rank” variable, and the plant, state and industry characteristics that we also include in the second stage. Columns (2) and (3) show the results for the second stage, where following the procedure we exclude the variable “Ease of starting a business ranking” and add the “Inverse Mills ratio” constructed from the first stage. Column (2) presents the results with a foreign employee dummy as the dependent variable and Column (3) for “Technology transfer intensity” as the dependent variable.

As Column (1) of Table 15 shows, the ease of starting a business has a positive and significant impact on entry of plants into a state. Note that the Ease of starting a business ranking measure is decreasing, meaning that as the value increases it becomes more costly to start a business. Regarding the evidence of selection bias, the coefficient on the Inverse Mills ratio in the second

Table 15: Two-step estimation. ESIDET 2000.

	(1)	(2)	(3)
	First stage	*Second stage*	
Dependent Variable		Foreign Employees Dummy	Technology Transfer Intensity
Judicial Efficiency	0.066	-1.023**	-1.800**
	(0.054)	(0.484)	(0.646)
(Judicial Efficiency)^2	-0.014*	0.190**	0.369***
	(0.008)	(0.081)	(0.110)
Exporter Dummy	0.0004	0.131**	0.409***
	(0.006)	(0.055)	(0.113)
Log Worker	0.0001	0.090***	-0.050
	(0.003)	(0.020)	(0.063)
GDP per capita	0.001	-0.023**	-0.069***
	(0.003)	(0.010)	(0.014)
GDP per capita squared	-0.00001	0.0001	0.0005***
	(0.00001)	(0.0001)	(0.0001)
Distance to the Border	-0.011	0.097	-0.119
	(0.014)	(0.151)	(0.173)
Population Density	0.005	0.018	-0.091
	(0.018)	(0.089)	(0.116)
Mexico City Dummy	0.185***	-0.740**	-0.527
	(0.042)	(0.302)	(0.605)
Skilled Worker Ratio	-0.029	0.790	-1.489
	(0.099)	(0.609)	(1.199)
Ease of Starting a Business (rank)	-0.001**		
	(0.000)		
Inverse Mills Ratio		-0.564*	-0.365
		(0.295)	(0.534)
Industry Effects	Yes	Yes	Yes
R^2		0.228	0.228
N	6946	302	302

Notes: Column (1) of the table reports the marginal effects of the judicial efficiency, its square term and other explanatory variables from plant-state level probit regressions of the dummy indicating whether a plant is located in a given state as the dependent variable. Ease of starting a business is the excluded variable. The regression is used as the first stage of the Heckman two-step procedure. Column (2) reports the marginal effects of the judicial efficiency, its square term and other explanatory variables from plant-level probit regression where the dependent variable is the dummy indicating whether a plant have at least one foreign employee. Column (3) reports the coefficients on the same explanatory variables of the regression using the technology transfer intensity as the dependent variable. The inverse mills ratio from the first stage regression is included in the regression shown in Columns (2) and (3). Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

stage estimations suggests that there is some evidence of selection bias in the regression for Foreign employees dummy, but not for Technology transfer intensity. More importantly, the U-shaped relation that we find in the main analysis of our paper remains significant after correction for selection bias, which provides additional supporting evidence, albeit imperfect in this case, regarding the main findings of the paper.

6 Conclusion

This paper investigates the role of foreign employees as a channel for technology transfer in high-tech MNCs. Thus, we rely on a unique dataset combining information on technology transfer and foreign employee presence in foreign owned and domestic Mexican plants for the year 2000 together with the judicial efficiency data of the state where the MNC locates. To guide the empirical analysis, we build a simple model where the MNC faces the following trade-off. On the one hand foreign employees are more efficient at dealing with the headquarter technology. On the other hand, the cost of local inputs is higher for a foreign employee than for a domestic one. Further, the cost disadvantage of the foreign employee decreases as institutions improve. We posit that firms belonging to technologically intensive industries are the ones that benefit from foreign employees. We then analyze the institutional environments in which MNCs do not rely on foreign employees and whether these consistently predict that MNCs engage in less technology transfer. If so, this should provide further support for the hypothesis that foreign employees are indeed a channel for technology transfer.

The evidence confirms the main implications of the model concerning the role of foreign employees as a channel for technology transfer. When institutional quality is either very bad or very good, MNCs are more likely to rely on foreign employees and, therefore, engage in more technology transfer. We do not find equivalent results for domestically owned plants. This suggests that the human capital provided by foreign employees is MNC specific and provides further support for the mechanism described in the paper. The domestic plants evidence also allows us to rule out omitted variable concerns. Because the MNC choice of state is not random, we provide a detailed analysis of possible selection issues both at the industry and plant level. We also perform robustness checks including alternative measures of technology transfer and of foreign employees.

By providing a unified analysis of the role of foreign employees as a channel for technology transfer, this paper suggests that to obtain a smooth flow of technology, both foreign plants and foreign employees may be necessary. Managerial scarcity should therefore be understood not only as the result of a deficit in human capital investments at the country level or in the local economy. At the company level, our results imply that training programs involving on-the-job experience at the headquarters of MNCs may be crucial. At the country level, visa policies and educational investments may need to take into account that foreign employees and domestic managers are imperfect substitutes.

Future work may extend our analysis of the role of foreign employees in different institutional environments, as well as in other countries. In particular it would be interesting to study the role of foreign employees in plants operating in different institutional environments/countries under the same headquarters. More broadly it may also be relevant to study whether foreign employees contribute to fostering or preventing inter-industry positive spillovers to local firms (Jacorcik (2004) and Blalock and Gertler (2008)). Finally, surveying the managerial practices of foreign employees, along the lines of Bloom et al. (2012), may be a promising avenue for future research.

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7 Appendix

7.1 Model Appendix

7.1.1 Baseline

The profit function of the MNC is

$\pi_{ijs} = \alpha_i(\eta_j lnH) + (1-\alpha_i)lnD - rH - w(1+\frac{c_i}{\lambda_s})D.$

The optimal inputs demands are $H^*_{ij} = \frac{\alpha_i \eta_j}{r}$ and $D^*_i = \frac{1-\alpha_i}{w(1+\frac{c_i}{\lambda})}$. It follows from our assumptions that $H^*_{ej} > H^*_{dj}$ for $j = h$ and that $D^*_e < D^*_d$.

Using the optimal quantities of domestic and headquarter inputs, and simplifying, the profit function equals to

$\pi_{is} = \alpha_i ln\frac{\alpha_i}{r}$ + (1-α_i)$ln\frac{1-\alpha_i}{w(1+\frac{c_i}{\lambda_s})} - 1$

For the rest of the model we only consider MNCs belonging to high-tech industries, since only MNCs in these industries face a trade-off when choosing between an expatriate and a domestic manager. To avoid extra notation we assume that $\eta_h = 1$.[29]

The MNC chooses the manager comparing the profit generated under an expatriate and under a domestic manager. The difference in profit can be expressed as follows:

$$\pi_e - \pi_d = \underbrace{\alpha_e ln\frac{\alpha_e}{r} - \alpha_d ln\frac{\alpha_d}{r}}_{>0} + \underbrace{(1-\alpha_e)ln\frac{1-\alpha_e}{w(1+\frac{c}{\lambda})} - (1-\alpha_d)ln\frac{1-\alpha_d}{w(1+\frac{1}{\lambda})}}_{<0}$$

To solve the managerial choice of the MNC for a generic state with judicial efficiency equal to λ, we first write the derivative of profit with respect to institutional quality, $\frac{\delta\pi_i}{\delta\lambda}$ for i={e,d}, as a function of three components with an economic interpretation: the weight of the domestic input in production, $(1-\alpha_i)$, the inverse of institutional quality, $\frac{1}{\lambda}$, and the elasticity of the domestic input demand with respect to institutional quality, $\epsilon_{D_i,\lambda}$. In particular, $\frac{\delta\pi_i}{\delta\lambda} = (1-\alpha_i)\frac{1}{\lambda}\epsilon_{D_i,\lambda}$.

Mathematically, we are interested in the sign of $\frac{\delta(\pi_e-\pi_d)}{\delta\lambda}$.

$\frac{\delta(\pi_e-\pi_d)}{\delta\lambda} = (1-\alpha_e)\frac{1}{\lambda}\epsilon_{D_e,\lambda} - (1-\alpha_d)\frac{1}{\lambda}\epsilon_{D_d,\lambda}$ where $\epsilon_{D_e,\lambda} = \frac{c}{\lambda+c}$ and $\epsilon_{D_d,\lambda} = \frac{1}{\lambda+1}$.

Note that $(1-\alpha_e)\frac{1}{\lambda} < (1-\alpha_d)\frac{1}{\lambda}$ (since $\alpha_e > \alpha_d$) and that $\epsilon_{D_e,\lambda} > \epsilon_{D_d,\lambda}$ (since $c > 1$).[30]

Theoretically, therefore, the difference in profit can be positive or negative depending on the

[29] Therefore we do not keep track of the subscript j.

[30] If we assume $c = 1$, the expatriate does not have a relative disadvantage in buying the domestic input that depends on institutional quality. In that case, the elasticity of the domestic input demand would be the same for both the domestic and the expatriate manager. As a consequence, improvements in institutions would unambiguously push the MNC to switch management from foreign to domestic, as $\frac{\delta(\pi_e-\pi_d)}{\delta\lambda} < 0$.

sign of the following expression, which we obtain rearranging the previous equation as follows: $\frac{\epsilon_{D_d,\lambda}}{\epsilon_{D_e,\lambda}} - \frac{1-\alpha_e}{1-\alpha_d}$ or in a more reduced way $R(\lambda, c) - \alpha$ where $R(\lambda, c) \equiv \frac{\epsilon_{D_d,\lambda}}{\epsilon_{D_e,\lambda}} = \frac{\lambda+c}{c(\lambda+1)}$ and $\alpha \equiv \frac{1-\alpha_e}{1-\alpha_d}$ where $\alpha \in (0, 1)$ and $R(\lambda, c) > 0$.

Therefore,

$\frac{\delta(\pi_e - \pi_d)}{\delta\lambda} < 0$ when $R(\lambda, c) > \alpha$ (1)

$\frac{\delta(\pi_e - \pi_d)}{\delta\lambda} = 0$ when $R(\lambda, c) = \alpha$ (2)

$\frac{\delta(\pi_e - \pi_d)}{\delta\lambda} > 0$ when $R(\lambda, c) < \alpha$ (3)

Because α does not change with institutional quality, all we need to check is how $R(\lambda, c)$ changes with λ. In particular, $\frac{\delta R(\lambda,c)}{\delta\lambda} = \frac{c(\lambda+1)-c(\lambda+c)}{c^2(\lambda+1)^2} < 0$ since we assume that $c > 1$.

We can distinguish three cases based on conditions (1)-(3):

1. $\pi_e - \pi_d > 0$ for all values of λ and the MNC chooses an expatriate regardless of λ. In this case the expatriate advantage in terms of the headquarter input is large enough to outweigh its disadvantage in terms of domestic input even when improvements in institutional quality lead to an increase in the domestic input demand that increases the advantage of having a domestic manager.

2. Condition (1) holds for all values of λ, and there exists λ^l such that the MNC chooses an expatriate when $\lambda < \lambda^l$ and a domestic manager when $\lambda > \lambda^l$. In this case, as institutions improve, the MNC increases its demand for domestic inputs, which eventually makes the domestic manager more attractive, as it is more productive at transforming this input into output and the domestic manager obtains the input at a lower cost.

3. Condition (3) holds for some value λ^c such that $\lambda^c < \lambda^{max}$, and there exist λ^l and λ^u such that the MNC chooses an expatriate when $\lambda < \lambda^l$, a domestic manager when $\lambda^u > \lambda > \lambda^l$ and an expatriate manager when $\lambda > \lambda^u$, where $\lambda^{max} > \lambda^u > \lambda^c$. When $\lambda < \lambda^u$ the same logic as in case 2 applies.

7.1.2 Extension

In the baseline model we assume that a subsidiary whose MNC belongs to the low tech industry uses no headquarters input in the production function. Such a subsidiary, therefore, cannot obtain an increase in the productivity of headquarters inputs through hiring a foreign employee. Under this assumption, Implications 2 and 3 from the baseline model should not hold for low-tech industries.

In this section we relax this extreme assumption, that for low-tech industries $\eta_l = 0$, and assume a milder version of it, namely that $\eta_l < \eta_h$. That is, the weight of headquarters inputs in the production function of a low-tech industry plant is strictly lower than that of a high-tech industry plant, but is not necessarily zero.

Let η_j denote the relative weight of headquarters inputs in the production function for industry j, where $j = (l, h)$ denotes the low- and high-tech industry categorization, respectively.

Let us define η_{min} and η_{max}, such that:

- There exists a value of $\eta_{min} \to 0$ such that for all relevant ranges of judicial efficiency ($\lambda > 0$), an MNC belonging to an industry with $\eta_j \leq \eta_{min}$ hires a domestic employee regardless of the value of judicial efficiency.
- There exists a value of $\eta_{max} \to \infty$ such that for all relevant ranges of judicial efficiency ($\lambda > 0$), an MNC belonging to an industry with $\eta_j > \eta_{max}$ hires foreign employees regardless of the value of judicial efficiency.

These thresholds define the weights of the headquarters inputs in low-tech and high-tech plants for which the tension that the model trade-off describes may or may not apply.

Based on these thresholds, we can formalize Corollaries 2 and 3, as presented in the main body of the paper, in the following way:

- *Corollary Implication 2*: For plants with $\eta_j \in [\eta_{min}, \eta_{max}]$ the hiring of foreign employees is U-shaped in judicial efficiency. The relationship is not U-shaped for plants with $\eta_j \notin [\eta_{min}, \eta_{max}]$, which is a condition satisfied by low-tech plants with $\eta_l < \eta_{min}$.
- *Corollary Implication 3*: For plants with $\eta_j \in [\eta_{min}, \eta_{max}]$ technology transfer is U-shaped in judicial efficiency. The relationship is not U-shaped for plants with $\eta_j \notin [\eta_{min}, \eta_{max}]$, which is a condition satisfied by low-tech plants with $\eta_l < \eta_{min}$.

7.2 Additional Results

Table A1 and Table A2 show the impact of technological intensity on the relationship between both foreign employees and technology transfer and judicial efficiency using alternative classification criteria for low-tech plants and high-tech plants. In particular, we use various cut-off thresholds of the R&D intensity distribution. We present results using the most stringent specification, which includes firm and state controls as well as industry effects.

Table A1: Effect of judicial efficiency on foreign employees by technological intensity. Threshold analysis. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.			Foreign Empoyees Dummy			
		Low-tech			*High-tech*	
Judicial Efficiency	0.937	0.812	-1.127	-0.902	-1.028	-2.792
	(3.151)	(2.663)	(0.883)	(0.655)	(0.681)	(2.962)
(Judicial Efficiency)^2	-0.205	-0.177	0.190	0.177	0.198*	0.553
	(0.566)	(0.488)	(0.141)	(0.112)	(0.113)	(0.551)
Sample cut R&D	$< 1/3$	$< 1/2$	$< 2/3$	$> 2/3$	$> 1/2$	$> 1/3$
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes
State Control	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	46	77	165	282	236	117

Notes: Columns (1)-(6) of the table report coefficients on judicial efficiency and its square term from plant-level probit regressions of the foreign employee dummy as the outcome variable. Columns (1)-(3) of the table report the results when we divide plants into the plants belonging to the industries whose R&D intensity is below the bottom third, the bottom half and the bottom two thirds of the R&D intensity distribution respectively. Columns (4)-(6) of the table report the results when we divide plants into the plants belonging to the industries whose R&D intensity is at least above the bottom third, the bottom half and the bottom two thirds of the R&D intensity distribution respectively. Plant-level control variables include exporter dummy, the log of the number of workers, while state-level control variables include per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density. All specifications include industry fixed effects. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

Table A1 presents the effect of judicial efficiency on the hiring of foreign employees by separating plants into low and high-tech groups according to three different R&D intensity thresholds. More concretely, we use the bottom one-third, the bottom half and the bottom two-thirds of the R&D intensity as alternative definitions of low-tech plants (Columns (1)-(3)) and we use the top two-thirds, top half and top third of the R&D intensity distribution as alternative definitions of high-tech plants (Columns (4)-(6)). The results show that the U-shaped relationship predicted by the model only applies to high-tech plants, regardless of the particular threshold employed.

Table A2: Effect of judicial efficiency on technology transfer intensity by technological intensity. Threshold analysis. ESIDET 2000.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Var.			Technology Transfer: Intensity			
		Low-tech			*High-tech*	
Judicial Efficiency	13.458	7.889	1.391	-2.323***	-2.459***	-4.018***
	(9.437)	(5.760)	(0.910)	(0.704)	(0.780)	(1.342)
(Judicial Efficiency)^2	-2.365	-1.376	-0.211	0.435***	0.457***	0.760***
	(1.687)	(1.029)	(0.137)	(0.100)	(0.113)	(0.204)
Sample cut: R&D	$< 1/3$	$< 1/2$	$< 2/3$	$> 2/3$	$> 1/2$	$> 1/3$
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes
State Control	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.238	0.206	0.232	0.270	0.282	0.269
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	58	94	184	244	208	118

Notes: Columns (1)-(6) of the table report coefficients on judicial efficiency and its square term from plant-level linear regressions of the technology transfer intensity as the outcome variable. Columns (1)-(3) of the table report the results when we divide plants into the plants belonging to the industries whose R&D intensity is below the bottom third, the bottom half and the bottom two thirds of the R&D intensity distribution respectively. Columns (4)-(6) of the table report the results when we divide plants into the plants belonging to the industries whose R&D intensity is at least above the bottom third, the bottom half and the bottom two thirds of the R&D intensity distribution respectively. Plant-level control variables include exporter dummy, the log of the number of workers, while state-level control variables include per capita GDP and its square term, the distance to the border, the dummy variable indicating the capital metropolitan area, skilled worker ratio, population density. All specifications include industry fixed effects. Standard errors are clustered at the state level and reported in parentheses. The regressions are run for foreign-owned plants only. Signicance: * 10 percent, ** 5 percent, *** 1 percent.

Table A2 presents the effect of judicial efficiency on technology transfer intensity by separating plants into low and high-tech groups according to three different R&D intensity thresholds. More concretely, we use the bottom one-third, the bottom half and the bottom two-thirds of the R&D intensity as alternative definitions of low-tech plants (Columns (1)-(3)) and we use the top two-thirds, top half and top third of the R&D intensity distribution as alternative definitions of high-tech plants (Columns (4)-(6)). We find that, again, the U-shaped relationship predicted by the model only applies to high-tech plants, regardless of the particular threshold employed as criteria to classify plants into the low-tech and high-tech categories.

Table A3 displays the magnitude interpretation of the coefficients for judicial efficiency and judicial efficiency squared, across specification, based on the regressions presented in Table 3 and Table 4. To achieve this, we ranked the 32 Mexican states into three quantiles according to their level of judicial efficiency, and we take the mean of the judicial efficiency for each quantile to calculate the impact of half a standard deviation increase in judicial efficiency. We only increase the judicial efficiency by half of a standard deviation to ensure that our observations stay within their given quantile. As the table shows, we observe a U-shaped pattern for the various specifications.

Table A3: Magnitude Interpretation Tables 3 and 4 of the paper. ESIDET 2000.

	Table 3 by specification			
Judicial Efficiency	(1)	(2)	(3)	(4)
Low	-0.132	-0.142	-0.15	-0.006
Middle	-0.035	-0.05	-0.048	0.025
High	0.055	0.035	0.049	0.055
	Table 4 by specification			
Judicial Efficiency	(1)	(2)	(3)	(4)
Low	-0.065	-0.185	-0.185	-0.033
Middle	0.005	-0.055	-0.06	0.07
High	0.075	0.065	0.06	0.17

Notes: This table shows the magnitude interpretation of the impact of an increase of half standard deviation of judicial efficiency on the probability of hiring foreign employees and of technology transfer intensity. We distinguish whether the increase of half standard deviation of judicial efficiency takes place in the low, middle or high range of judicial efficiency. The low, middle and high ranges are equal to the three quantiles of the judicial efficiency distribution among the 32 Mexican states. We take the mean of the judicial efficiency of each quantile in calculating the magnitudes displayed in the table. Each column represents the magnitudes using each corresponding specification in Tables 3 and 4.

7.3 Data Appendix

7.3.1 Description of the main plant-level variables

This subsection lists the main variables of the paper from the INEGI survey, and provides the exact question number of the survey. For reference and to allow identification of the variables in the survey, we also include the original question in Spanish.

Foreign ownership:

Question 3: "Defina el origen del capital de la empresa mediante la participación de cada uno de los siguientes sectores: 3.1 Privado, 1.2: Con participación de capital extranjero."

Number of workers:

Question 4: "Cuál fue el promedio anual de trabajadores que laboraron en la empresa (excluya al personal subcontratado) durante el periodo de enero a diciembre de 2000 y 2001?"

Domestic employees:

Question 4.1: "Nacional."

Foreign employees share:

Question 4.2: "Extranjero."

Total sales:

Question 5: "Anote en miles de pesos el total de las ventas netas anuales de los productos o servicios realizados por la empresa durante 2000 y 2001."

Exports:

Question 5.2: "Exportaciones."

Technology transfer:

Question 26: "Anote en miles de pesos el monto de los gastos efectuados por adquisición de tecnología en 2000 y 2001, de acuerdo a los siguientes conceptos, del exterior" with individual categories including the cost for purchase or licence of patents and other non-patented inventions, revelation of know-how, and technical assistance corresponding to:

26.1.1. “Compra de patentes”

26.1.2. “Compra de inventos no patentados”

26.1.3. “Revelación de Know-how”

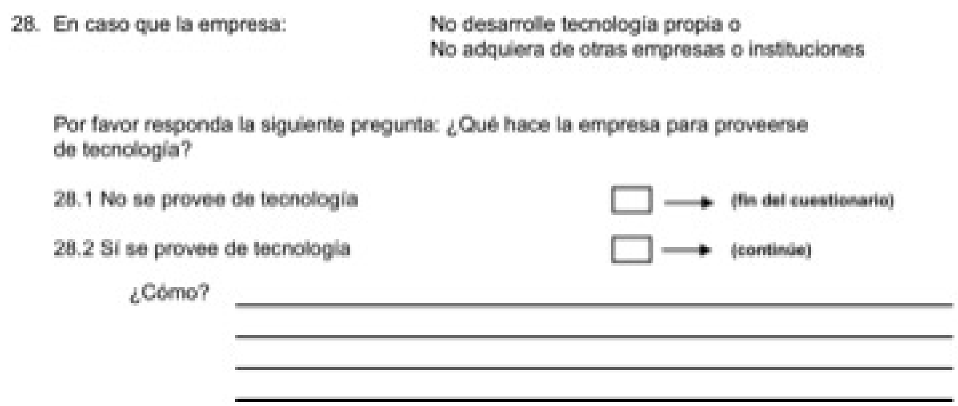
26.1.4. “Regalías por licencias de patentes”

26.1.5. “Regalías por derechos de propiedad industrial (marcas, modelos y franquicias)”

26.1.6. “Pagos por estudios técnicos, consultorías y trabajos de ingeniería.”

7.3.2 Description of the coding procedure of qualitative technology transfer measure

We rely on the last question from the survey which contains qualitative answers to question about a plants’ technology obtainment.



28. En caso que la empresa: No desarrolle tecnología propia o No adquiera de otras empresas o instituciones

Por favor responda la siguiente pregunta: ¿Qué hace la empresa para proveerse de tecnología?

28.1 No se provee de tecnología → (fin del cuestionario)

28.2 Sí se provee de tecnología → (continúe)

¿Cómo?

Figure 4: Question 28 of the survey.

This question is translated as follows:

28. If the plant does not develop its own technology or does not purchase it, please answer the following question : How does the plant obtain technology? 28.1 It does not (end of the survey) 28.2 Yes, it does (continue) How ?

We next include a non-exhaustive list of keywords used to generate the dummy “Non-Purchased Transfer” measure, where we code the variable as one if the response included one or more words from the list. The following is an extract of the list of words: Extranjero, extranjera, exterior, America, Norteamerica, Internacional, fuera, mundo, mundial, E.U.A, EUA, EU, USA, U.S.A, Estados Unidos, Canada, Europa, Europeo, Europea, Francia, Francesa.

7.3.3 Description of the main industry-level variables

This subsection lists the variables used in the paper from the EIA survey to construct industry-level variables. We provide the exact question number of the survey. For reference and to allow identification of the variables in the survey, we also include the original question in spanish.

Export ratio:

Export ratio=Exports/Total sales

Question 27: Exports. "Ventas netas al mercado extranjero (exportaciones)".

Question 28: Total sales. "Total de las ventas netas".

Value added ratio:

Value added ratio=(Total sales-Cost)/Total sales

Question 20: Cost. "Total de costos y gastos".

Labor productivity:

Labor productity=(Total sales-Cost)/Total employment

Question 1: Total employment. "Personal ocupado total (Incluya obreros y empleados)"

Imported intermediate ratio:=(Foreign input)/Cost

Imported intermediate ratio=(Foreign input)/Cost

Question 7: Foreign input. "Materias primas y partes y componentes importados consumidos".

Renumeration per worker:

Renumeration per worker=(Total wage bill)/Total employment

Question 4 and 5: Total wage bill. "Total de remuneraciones (Incluya Salarios, Sueldos, Indemnizaciones, Liquidaciones, Prestaciones Sociales y Contribuciones Patronales a la seguridad social)".

7.3.4 Description of state-level variables

We next describe how we constructed each state-level variable of the paper. The raw data as well as the code could be obtained through the corresponding author for replication purpose.

Judicial Efficiency.

We use Instituto Tecnológico Autónomo de México and Gaxiola Moraila y Asociados, S.C. (ITAM/GMA). 1999. La Administración de Justicia de las Entidades Mexicanas a Partir del Caso de la Cartera Bancaria. Mexico City. We use the average of seven individual measure, following Laeven, Luc and Christpher Woodruff, C. 2007. The Quality of the Legal System, Firm Ownership, and Firm Size. *Review of Economics and Statistics*, Vol. 89(4): 601-614.

Ease of Starting a Business.

We use the Doing Business in Mexico 2007. We use the variable Ease of starting a business (rank). This variable captures in a single ranking the number of procedures, time and monetary costs involved in starting a business for each Mexican state.

http://www.doingbusiness.org/Reports/Subnational-Reports/Mexico

Distance to the US border.

We calculate the minimum road distance from the center of each municipality to each customs on the US-Mexico border. Then, we take the minimum distance for each municipality. Since our main regional variable (judicial effciency) varies at the state level, we calculate take the mean of the municipality-level minimum distance to the customs to calculate state-level distance to the customs. The road and other input for processing geographical information is downloaded at the INEGI website.

http://www3.inegi.org.mx/sistemas/mapa/espacioydatos/

Population, GDP, Areas.

Population, GDP and areas at the state level as of 2000 for each state was downloaded at the INEGI website. We calculate GDP per capita and population density using these variables.

Skilled worker ratio.

We use micro-level data ENEU (Encuesta Nacional de Empleo Urbano [National Survey of Urban Employment]) of 2000. Among the people from 15 to 65 years, we regard those who have at least 12 years of education as skilled population. Then we take the share of the skilled population workers in the people from 15 to 65 years. The micro-level data can be obtained at the INEGI website.

http://www.inegi.org.mx/est/contenidos/proyectos/encuestas/hogares/historicas/eneu/default.aspx