# An empirical investigation on the transfer of expatriates within MNCs from a knowledge perspective*

Carmen Astorne-Figari†
*University of Memphis*

Joonhyung Lee‡
*University of Memphis*

2017

**Abstract**

We study the transfer of expatriates within a multinational corporation (MNC) as a means for organizing tacit knowledge. We use data on labor mobility of MNCs headquartered in South Korea. Because of the tacit nature of knowledge and the unique Korean characteristics, unobservable knowledge can be traced by observable labor mobility. We use a model of knowledge hierarchies adapted to MNCs to generate testable hypotheses. First, the use of expatriates in a foreign affiliate increases as communication between South Korea and the host country becomes more difficult. Second, the use of expatriates declines with the scale of the foreign affiliate. Additionally, the extent to which the use of expatriates relates with communication costs and scale depends on the sectoral complexity. These findings are interpreted in light of optimal knowledge allocation between headquarters and foreign affiliates.

JEL Classification: F21, F23

Keywords: MNC; Knowledge; Expatriation

*We would like to thank JaeBin Ahn, Sajal Lahiri, Seunghoon Lee, and Susan Chun Zhu as well as conference and seminar participants at the 2016 Korea America Economic Association workshop (San Francisco), Southern Illinois University (Carbondale), the 2016 spring Midwest International Trade Conference (Rochester), Korea University, and Korea Development Institute for helpful comments. This work was supported in full or in part by a grant from the Fogelman College of Business & Economics at the University of Memphis. This research support does not imply endorsement of the research results by either the Fogelman College or the University of Memphis. All errors are ours.

†Fogelman College of Business and Economics, Department of Economics, University of Memphis, email:cmstrnfg@memphis.edu

‡Corresponding author, Fogelman College of Business and Economics, Department of Economics, University of Memphis, email:jlee17@memphis.edu

# 1 Introduction

We study the use of expatriates as a means of knowledge transmission within multinational corporations (MNCs). A significant proportion of an organization's knowledge is tacit, and embedded in its individual members (Argote and Ingram (2000)). For this reason, communicating tacit knowledge has to involve human interaction, which can be costly (Arrow (1969); Keller and Yeaple (2013)). Hence, moving individuals within an organization is an effective way of transferring tacit knowledge because it enables a more frequent contact with the knowledge source (Kang et al. (2010)). In the context of a MNC, expatriate workers who work in the foreign affiliates can be viewed as a channel for reallocation of tacit knowledge. The importance of labor mobility as a channel for knowledge transfer has long been recognized in the Management literature (Gong (2003); Belderbos and Heijltjes (2005); Brock et al. (2008); Chang et al. (2012)) and relatively more recently in economics literature on MNCs (Fosfuri et al. (2001); Glass and Saggi (2002); Balsvik (2011); Poole (2013)).

To guide the conceptual framework leading to our empirical analysis of the presence of expatriates as a means for knowledge transfer, we investigate Gumpert's (2015) model of MNCs' optimal allocation of knowledge between a parent and a foreign affiliate, which extends the knowledge hierarchy models to MNCs. Knowledge hierarchy models (Garicano (2000); Garicano and Rossi-Hansberg (2006); Caliendo and Rossi-Hansberg (2012)) characterize production as a problem solving process requiring labor and knowledge as inputs, where knowledge is required to solve the problems workers encounter during production. Since there is a trade-off between the cost of learning knowledge and the cost of communicating with those who hold the knowledge, a firm distributes knowledge among organizational layers such that workers in the lower layer specialize in the most frequent problems, and those in higher layers specialize in solving less frequent issues

Gumpert (2015) uses this knowledge hierarchy model to study the allocation of knowledge in MNCs with two organizational layers. We are interested in the case where a firm has two production plants: one in the home country and the other one in a foreign country. Workers (lower layer) are located in each production plant and managers (upper layer) are located in headquarters based in the home country. A firm's total knowledge level is exogenously given, and firms choose the proportion of total knowledge that each group of employees (i.e. headquarters managers, home workers, and foreign workers) must hold. If a production plant lacks the knowledge required to solve a problem, it must communicate with headquarters to be able to solve it, incurring a communication cost that differs by country of operation. It can be argued that communication costs are higher for the foreign production plant due to issues like the change in time zones, language and cultural differences, etc. Therefore, a MNC with a production plant

in a foreign country must take into account an additional communication cost between the foreign production plant and headquarters. This allows for production plants to have different levels of knowledge by country of operation, and generates a duplication of knowledge in the foreign production plant with respect to headquarters. That is, due to communication costs, the foreign production plant can have knowledge that the home production plant does not have. In case problems requiring that level of knowledge arise, the home production plant would acquire this knowledge by communicating with headquarters, whereas the foreign production plant would be able to solve such problems without having to communicate with headquarters.

In the model, this additional knowledge that the foreign plant has is equivalent to a knowledge overlap between the foreign production plant and headquarters. We propose the following interpretation for this overlap: firms can either have the foreign workers learn that specific knowledge overlap or they can managers from headquarters who already have that knowledge to the foreign production plant. We assume that, because of the tacit nature of knowledge, it is cheaper for MNCs to send expatriates than to train the foreign workers. Hence, we take this knowledge overlap between the foreign plant and headquarters to represent the presence of expatriates. If this knowledge overlap increases, more expatriates are expected to be present in the foreign plant. In order to test whether or not this is a valid approach, we generate testable hypotheses using Gumpert's (2015) model as follows.

First, the use of expatriates increases with the communication costs between the home and foreign country. We measure these communication costs using the geographic distance, working hours overlap, and calling costs. The intuition is as follows: as communication between the foreign production plant and headquarters becomes more costly, headquarters would endow more knowledge with the foreign plant in order to save on communication costs (i.e. the knowledge overlap increases). This means that headquarters would send expatriates with upper level knowledge to handle problems in the foreign affiliate.[1]

Second, the use of expatriates decreases with the foreign affiliate scale. If a larger quantity is to be produced in the foreign affiliate, more foreign workers need to be hired, who will need to communicate with headquarters more often. These additional workers also need to learn the knowledge required to do their job. That is, aside from wages, the firm must also incur learning costs and communication costs. However, the firm can reduce these costs by

[1]Our interpretation of expatriates as a means of overcoming communication difficulties is consistent with Antras et al. (2008) and Keller and Yeaple (2013). Antras et al. (2008) argues that the middle managers can be used as a mediator in a situation where communication between home and host country is difficult. While the middle managers are local talents in the host country in their paper, it can be understood as the expatriates who mediate communication between home and host country. Keller and Yeaple (2013) document that disembodied knowledge transfer (i.e. communicating knowledge) will be utilized more when trade costs are high. Disembodied knowledge transfer can be interpreted as the transfer of expatriates who hold tacit knowledge, so they are utilized more for the foreign affiliate that is located far-away from home that is more costly in terms of communication and transportation.

adjusting the allocation of knowledge in each layer, including the home production plant. At the optimum, Gumpert (2015) shows that the knowledge level of home plant increases while that of foreign plant decreases (i.e. the knowledge overlap decreases). Home workers require less communication with headquarters while foreign workers need more communication with headquarters. This means that the managers at headquarters are able to and have to answer questions from the foreign plant more, and therefore the need for expatriates decreases.

We want to allow for the possibility that the relationship between the use of expatriates and the knowledge overlap in the foreign affiliate differs by the characteristics of the sector. In particular, the extent to which knowledge can be reallocated between headquarters and its affiliates depends on sectoral complexity. It can be argued that certain knowledge is held by only a few top managers at the headquarters especially for complex operations. Moreover, the proportion of such knowledge increases with sectoral complexity. That is, help is still needed from the headquarters in both home and foreign plants especially in more complex sectors.[2] This means that the increase in the knowledge overlap generated by higher communication costs is smaller in more complex activities. Therefore, while the higher communication costs increase the use of expatriates, the effect becomes weaker in more complex sectors. Similarly, the decrease in the knowledge overlap generated by an expansion in the foreign affiliate becomes weaker in complex sectors because of the continued need for help from the headquarters. Therefore, while the foreign affiliate scale decreases the use of expatriates, the effect becomes weaker in more complex sectors. In sum, the predictions derived from Gumpert's (2015) model become weaker as sectoral complexity increases.

For our empirical analysis, we rely on the unpublished panel data on foreign affiliates of MNCs headquartered in South Korea between 2007-2011. Our unit of analysis is at the foreign affiliate level. One key advantage of this dataset is the detailed information on employment. It distinguishes between the two types of workers of our interest: expatriated South Koreans and foreign workers. Our variable of interest is the ratio of expatriates with respect to the total number of workers (i.e. the sum of expatriates and foreign workers) in the foreign affiliate. There is an additional important benefit from using South Korea. Korea is ethnically fairly homogeneous, and differs from other countries culturally and linguistically in a very significant way (Alesina and Wacziarg (2003); Fearon (2003); Hofstede et al. (1997); Isphording and Otten

[2]Keller and Yeaple (2013) show that inputs in complex sectors are more likely to be produced at the headquarters and exported to the foreign affiliates because the proportion of upper level knowledge is larger and the knowledge is hard to be communicated in those sectors. In the empirics, we proxy complex activities by R&D intensity and Nonroutineness. These activities are usually referred to as knowledge intensive in the literature. We use the term "more complex" instead of "knowledge intensive" activities in order to avoid the possible confusion between knowledge intensity and knowledge as an input of the production function, as it is used in the knowledge hierarchy literature. For example, IT sector is more complex (knowledge intensive) than Apparel. However, in both sectors, problems that require knowledge (input) to be solved can arise in the production process.

(2013)).[3] These unique features of South Korea generate high communication costs across borders. Moreover, since knowledge includes corporate culture and other entrepreneurial values, which can be subject to Korean idiosincrasy, it would be very costly for foreign workers to be properly trained. For this reason, we can argue that foreign workers have a substantially higher cost of learning knowledge in the case of Korean MNCs and that it is relatively cost-saving to expatriate headquarter managers.

Our empirical results support our hypotheses. First, the use of expatriates is higher when the foreign affiliate is located in a country where communication costs with South Korea are higher. This finding is robust to the inclusion of trust (that Bloom et al. (2012) suggests), trade costs (that Keller and Yeaple (2013) suggests), and sample selection. Second, the use of expatriates declines with the affiliate scale. Additionally, the extent to which expatriates relate with communication costs and the affiliate scale differs across sectors in accordance with our expectations.

Our paper is related to Caliendo et al. (2015), as their empirical analysis is also based on the knowledge hierarchy model of Caliendo and Rossi-Hansberg (2012). While we focus on MNCs, Caliendo et al. (2015) study French firms, taking the average wages of workers as the proxy for knowledge in each hierarchy. Firms change average wages in a certain hierarchy by changing the composition of workers (instead of changing the wages of current employees). Specifically, average wages increase (decrease) when firms hire more (less) experienced workers, particularly at the higher layers, because experience (as opposed to training) provides the knowledge required to solve more infrequent problems. While they interpret the extensive margin of hiring more (less) experienced workers as an increase (decrease) in knowledge, we interpret the use of expatriates within MNCs as an increase (decrease) in knowledge. As aforementioned, Korean idiosyncratic values are more likely to be acquired through experience as opposed to formal training, so hiring expatriates is equivalent to hiring more experienced workers in our case.

This paper contributes to the literature in several ways. First, this paper contributes the MNC literature considering communication between headquarters and its foreign affiliates. This literature has documented that knowledge transfer is subject to communication costs and that MNCs react in different ways to overcome these costs by adjusting the ways to transfer knowledge, investment probabilities, location, and operation. When production requires inputs that are complex, MNCs can overcome communication costs by choosing to produce these complex inputs in the home country. Keller and Yeaple (2013) find that complex inputs are more likely to be produced by parent firms and shipped to foreign affiliates to avoid the inefficiencies resulting from communicating knowledge. Complex knowledge is assumed to be fully embodied in

[3] For example, both Fearon (2003) and Alesina and Wacziarg (2003) rank Korea among the lowest in terms of ethnic, cultural, and linguistic diversity. Isphording and Otten (2013) specifically mention that Korean is a very isolated language.

intermediate inputs and costly communication could be avoided. Bahar (2013) further assumes that the knowledge transfer costs increases not only with the level of complexity (that Keller and Yeaple (2013) investigate), but also with the distance between headquarters and affiliates. He argues that MNCs expand complex activities at shorter geographic locations due to this additional cost. Oldenski (2012) also provides evidence that activities requiring communication of complex knowledge are more likely to occur at headquarters for export. An alternative to home production of inputs to overcome costly communication is to hire local talents in the host country (Antras et al. (2006); Cristea (2015)). A well trained local talent could substitute for knowledge inputs to mitigate the efficiency loss due to costly knowledge transfer. This approach is valid whenever the knowledge required to produce these inputs can be acquired through formal training. However, inputs could require knowledge that can only be acquired through experience. We propose an alternative way of overcoming communication costs for the latter case through the use of expatriates, and investigate the role of expatriation in the transfer of knowledge. In particular, we argue that, because of tacit nature of knowledge and the unique Korean characteristics, this knowledge is more likely to be acquired by experience and, hence, transferring expatriates is a more plausible means than embodied goods or local talents.

Second, our paper contributes to the notion that the access to intangible assets improves with vertical integration. In Rappoport et al. (2015) and Atalay et al. (2014), the transactions within MNCs or multi-plant firms that share the same ownership become less visible, and the benefit of ownership is not for physical transactions but for efficient intra-firm utilization of knowledge. We propose that it is through labor mobility that MNCs (or multi-plant firms) utilize the advantages of internalization, which does not necessarily involve transactions of physical products.

Third, our results are related with the nascent empirical studies exploring the internal organization of firms. It has been documented that firms have 'flattened' as firms expand, i.e. the number of lower level workers per an upper level worker increases as firms grow. If one can argue that expatriated managers are in a higher hierarchy over foreign workers, the negative correlation between the use of expatriates and the scale that we found is consistent with this literature. That is, the number of foreign workers per an expatriated manager increases in a firm's expansion. Rajan and Wulf (2006) use a sample of 300 large U.S. firms for the period 1986 to 1998 to analyze how hierarchies of top-level managers have changed over time. The study shows that the CEO's span of control has increased while the number of layers between division heads and CEOs has gone down during the sample period. Garicano and Hubbard (2007) study the role of hierarchies as a means of organizing production in law firms. They look at the relationship between the ratio of associate lawyers to a partner lawyer and market size. They argue that uncertainty declines as the size of the market increases and find that the

partner lawyer's span of control increases with the market size. Guadalupe and Wulf (2010) pays attention to causality and presents evidence that increasing competition as a result of 1989 Canada-US FTA leads to flatter hierarchies of U.S. firms.[4] In this paper, we document that the MNCs have the tendency of 'flattening', i.e. the expatriated managers deal with more foreign managers as the firm becomes larger.

Fourth, this paper is more broadly related with the technology diffusion literature. Foreign direct investment (FDI) has been considered an important channel of international knowledge diffusion, both through vertical (e.g. Smarzynska Javorcik (2004)) and horizontal (e.g. Keller and Yeaple (2009)) linkages. While we have convincing evidence that MNCs are involved in international knowledge diffusion, the literature is relatively silent about the mechanism by which MNCs transfer knowledge across borders. We do not directly deal with knowledge diffusion. However, knowledge spillovers may happen as knowledge is mobilized through expatriation across borders within a MNC. As an example, Cho (2014) studies this phenomenon based on the same dataset as ours, and documents that the expatriated Korean managers are positively associated with labor productivity of the foreign affiliate. Cho (2014) argues that this correlation is evidence that the expatriated managers transfer knowledge, not that they are simply more efficient than foreign workers.

The structure of this paper is as follows. In Section 2, we investigate Gumpert's (2015) model and generate testable hypotheses. In Section 3, we describe the data and discuss our estimation results. Sections 4 concludes.

## 2 Investigating Gumpert (2015)

Our goal in this section is to introduce a theoretical framework that uses knowledge as an input to generate testable predictions. Gumpert (2015) develops a model of a MNC that uses knowledge and labor as the main production factors. Her model has two types of workers: production workers and managers. One of the cases she develops is that of a MNC with two production plants: one in the home country of the MNC and one in a foreign country. There are knowledge transfers between the home and the foreign country, which are subject to non-negligible communication costs. Since we are interested in exploring the role of expatriate workers as a means for tacit knowledge transfers, we change the interpretations of some variables in her model and make some additional assumptions. All these changes will be explicitly described.

A firm that produces a certain good has production plants in two countries: home ($H$) and foreign ($F$). An entrepreneur owns the firm and provides leadership services at headquarters,

[4] See also Marin and Verdier (2014) that looks at the internal organization from a different framework, i.e. the incentive problem perspective. They look at the internal organization of the headquarters of a MNC.

which is located in the home country $H$.

The firm is characterized by a knowledge level $\bar{z} > 0$, which is the knowledge required to solve all problems arising in the production process. The arrival rate of problems is $\lambda > 0$. The total firm knowledge $\bar{z}$ is the Lebesgue measure on the interval $[0, \bar{z}]$, and may be allocated among all of the firms' workers. In both countries, problems that require knowledge level $z$ to be solved follow a known distribution $G(z)$ as follows:

$$G(z) = 1 - e^{-\lambda z} \tag{1}$$

Workers learn the firm's knowledge by hiring teachers, facing a cost of learning this knowledge. For simplicity, we will assume that the cost of learning knowledge is similar in both countries, that is $c_H = c_F = c > 0$. The entrepreneur pays workers for production, and also covers their cost of learning the firm's knowledge. The firm hires workers and teachers in a competitive market, where wages differ across countries. We assume that wages are lower in the foreign country ($w_F < w_H$). The entrepreneur pays a total of $w_j c z_j + w_j$ per worker in production plant $j$. The first term comes from covering the worker's learning cost, and the second term is just the worker's wage.

We consider two types of workers in this firm: production workers allocated to the home and foreign production plants, and managers allocated to headquarters. The organization of knowledge is as follows. Production workers specialize in the more common problems and managers specialize in the less frequent problems. In particular, production workers have knowledge $[0, z_j]$ and managers have knowledge $[z_h, \bar{z}]$. It must be the case that either managers or production workers learn the firm's knowledge, namely that, in each plant $j$, the following inequality holds.

$$z_j + z_h \geq \bar{z} \tag{2}$$

The problems that managers cannot solve remain unsolved. As we will explain later, there is a trade-off between learning costs and communication costs driving the allocation of knowledge.

Production $q_j$ in each plant $j = H, F$, depends on the number of workers $n_j$ and firm knowledge as follows:

$$q_j = n_j G(\bar{z}) = n_j(1 - e^{-\lambda \bar{z}}) \tag{3}$$

Production is equal to the number of production workers times the probability that the problems encountered during production can be solved using the firm's knowledge $\bar{z}$. Problems that production workers cannot solve (those in the interval $[z_j, \bar{z}]$) will be passed on to managers in headquarters.

When production workers encounter problems that they cannot solve, they must commu-

nicate these problems to managers in headquarters incurring a communication cost $\theta_{jH} > 0$, which differs for each plant $j = H, F$. As is usual in this type of models, the communication cost is borne by the managers in headquarters (the receivers). We assume that there are frictions in cross border communication (i.e. the use of a different language, culture, time zone differences, etc.), so $\theta_{HH} < \theta_{FH}$. To solve all unsolved problems in both production plants, the firm must hire enough managers at headquarters, as shown in Eq. 4.

$$n_h = n_H \theta_{HH} e^{-\lambda z_H} \ + \ n_F \theta_{FH} e^{-\lambda z_F} \tag{4}$$

Each term on the right hand side of Eq. 4 denotes the mass of problems that $n_j$ production workers in country $j$ could not solve given their knowledge $z_j$, multiplied by their cost of communicating with headquarters $\theta_{jH}$. In other words, the term $n_j \theta_{jH} e^{-\lambda z_j}$ denotes production plant $j$'s demand for managers' time. There must be enough managers in headquarters to address these issues in both plants so production can be realized according to Eq. 3.

The firm's total cost function is:

$$\sum_{j=H,F} n_j w_j (1 + c z_j) \ + \ n_h w_H (1 + c z_h) \ + \ w_H \tag{5}$$

where the first term is the sum of the total costs incurred in hiring production workers in each production plant, the second term is the cost of managers in headquarters, and the third term is the entrepreneur's payment for leadership services.

The MNC chooses the levels of knowledge in each production plant $z_j$, the level of upper-level knowledge $z_h$ in headquarters, the number of production workers in each plant $n_j$, and the number of managers in headquarters $n_h$ that minimize the cost of producing $q_H$ units in the home country plant and $q_F$ units in the foreign production plant, given by Eq. 5, subject to the production constraint (Eq. 3) and the knowledge constraint (Eq. 2) for each plant $j$, and the constraint on managers' time (Eq. 4).

When a firm has only one production plant, cost minimization requires that plant-level knowledge not overlap with upper-level knowledge. That is, $z_j = \bar{z} - z_h$ – otherwise, the firm would be wasting resources. However, when the firm has more than one production plant, as in our case, asymmetries in country characteristics generate a knowledge overlap in one of the production plants. This means that some of the firm's knowledge held by headquarters will also be known in one of the two production plants. Intuitively, the knowledge overlap should occur in the country where holding duplicate knowledge is less costly. When choosing the knowledge level of production workers, the firm faces the following trade-off. On the one hand, the firm must pay for production workers to learn this duplicate knowledge. On the other

hand, more knowledgeable production workers require less communication time with managers in headquarters, saving the firm the cost of these managers' time. In other words, the marginal cost of knowledge in production plant $j$ is given by the cost of hiring teachers $w_j c$, while its marginal benefit is given by the demand on managers' time multiplied by cost of managers $\lambda\theta_{jH}e^{-\lambda z_h}w_H(1+cz_h)$[5]. We can then calculate the ratio of marginal cost to marginal benefit of production worker's knowledge in each country, $w_j c/[\lambda\theta_{jH}e^{-\lambda z_h}w_H(1+cz_h)]$. Comparing the marginal cost to marginal benefit ratios for knowledge across countries, it is easy to see that knowledge is less costly in the country where the ratio $w_j/\theta_{jH}$ is the lowest. As stated earlier, the foreign country has lower wages than the home country and cross-border communication is more costly. Therefore, given that the cost of learning is the same in both countries,

$$\frac{w_H}{\theta_{HH}} > \frac{w_F}{\theta_{FH}} \tag{6}$$

which equivalent to the condition in Gumpert (2015)'s Section 2.2 divided by $c$. As shown in Gumpert (2015), condition 6 implies that the knowledge constraint given in Eq. 2 only binds in the home country (and is therefore slack in the foreign country),

$$z_H \;=\; \bar{z} - z_h \;<\; z_F \tag{7}$$

We interpret this overlap in upper-level knowledge in the foreign production plant as follows. All knowledge above $\bar{z} - z_h = z_H$ constitutes upper-level knowledge. Given the communication frictions between the two countries, it is more efficient to allocate some individuals holding upper-level knowledge to the foreign production plant so that some of the issues requiring upper-level knowledge can be solved in site instead of communicating with headquarters. We can divide the interval containing upper-level knowledge $[z_H, \bar{z}]$ into two parts: the knowledge to solve the more frequent upper-level problems, $[z_H, z_F]$, and the knowledge for the less frequent upper-level problems, $[z_F, \bar{z}]$. The former will be solved locally, but the latter will still require communication with headquarters. In order to do this, the MNC can either send workers from headquarters to the foreign production plants or train some of the foreign workers in upper-level knowledge. This is the part where our model slightly departs from Gumpert (2015).

Since this knowledge includes corporate culture and other entrepreneurial characteristics of the home country, we can argue that it has a significant tacit component. In order to be properly trained to occupy an upper-level managerial position, a foreign worker would not only need to learn the home country's language, but also its idiosyncrasy and corporate culture. For this reason, we can argue that foreign workers have a significantly higher cost of learning

[5]The demand on managers' time is calculated by taking the derivative of the right hand side of Eq. 4 with respect to $z_j$ and multiplying it by the cost of hiring managers, $w_H(1+cz_h)$.

this upper-level knowledge so that sending expatriates is less costly. This is especially true for Korean MNCs.

Substituting Eq. 3, Eq. 4 and Eq. 7 into Eq. 5 reduces the entrepreneur's cost minimization problem to:

$$\begin{aligned}\min_{z_F, z_h} \quad & \underbrace{\frac{q_H}{(1-e^{-\lambda\bar{z}})} w_H \left(1 + c(\bar{z} - z_h)\right)}_{\text{cost from home production plant}} \\ & + \underbrace{\frac{q_F}{(1-e^{-\lambda\bar{z}})} w_F (1 + c z_F)}_{\text{cost from foreign production plant}} \\ & + \underbrace{\frac{q_H \theta_{HH} e^{-\lambda(\bar{z}-z_h)} + q_F \theta_{FH} e^{-\lambda z_F}}{(1-e^{-\lambda\bar{z}})} w_H (1 + c z_h)}_{\text{cost from headquarters}} + \underbrace{w_H}_{\text{entrepreneur's wage}}\end{aligned} \tag{8}$$

The first term is the total cost arising from the home production plant. The second term is the total cost arising from the foreign production plant given that it is optimal to send expatriates. The third term is the cost arising from headquarters and the last term is the entrepreneur's payment for leadership services. The first order conditions for minimizing Eq. 8 are given by taking derivatives with respect to $z_h$ and $z_F$ respectively, which yields:

$$\begin{aligned} & - w_H c \frac{q_H}{(1-e^{-\lambda\bar{z}})} \; + \; w_H (1 + c z_h) \lambda \frac{q_H \theta_{HH} e^{-\lambda(\bar{z}-z_H)}}{(1-e^{-\lambda\bar{z}})} \\ & + \; w_H c \frac{q_H \theta_{HH} e^{-\lambda(\bar{z}-z_H)} + q_F \theta_{FH} e^{-\lambda z_F}}{(1-e^{-\lambda\bar{z}})} \; = \; 0 \end{aligned} \tag{9}$$

$$w_F c \frac{q_F}{(1-e^{-\lambda\bar{z}})} \; + \; w_H (1 + c z_h) \lambda \frac{q_F \theta_{FH} e^{-\lambda z_F}}{(1-e^{-\lambda\bar{z}})} \; = \; 0 \tag{10}$$

Eq. 9 and 10 solve for $z_h$ and $z_F$. All choice variables can be written in terms of $z_h$ and $z_F$.

We are interested in generating predictions about the relationship between the number of expatriates hired in the foreign production plant and other key variables that can be tested using our data set. However, this model only distinguishes the total number of workers in each plant $n_j$. Let $\mu \in (0, 1)$ be the proportion of expatriated workers in the foreign production plant, (i.e. $\mu = n_{expats}/n_F$). The total number of workers in the foreign production plant can be decomposed in the following way:

$$n_F = \mu n_F + (1 - \mu) n_F$$

In order to characterize the total number of expatriated workers in the foreign production plant, we need to find an expression for $\mu$ that can be calculated using this model.

Recall that expatriates are in charge of solving problems that require knowledge level in the interval $[z_H, z_F]$. It is sensible to assume that, the higher the proportion of upper-level knowledge $z_F - z_H$ with respect to the total level of knowledge in the foreign production plant $z_F$, the firm will need to expatriate more headquarters workers to the foreign plant to take care of solving all these problems.[6] In other words, the fraction of expatriates to total number of workers in the foreign production plant is increasing in the proportion of problems that require upper-level knowledge. Keeping the number of layers fixed, the total fraction of expatriates is increasing in $\frac{z_F - z_H}{z_F}$.

Given that $z_H = \bar{z} - z_h$, we are interested in comparative statics results involving both $z_h$ and $z_F$. The key parameters that we observe in our data set are the total output in the foreign production plant $q_F$, and the communication costs between the home and the foreign country, captured by $\theta_{FH}$.

Gumpert's model predicts these relationships in accordance with Table 1.[7] As we can see, the total level of knowledge in the foreign production plant $z_F$ increases with the communication costs between the home and foreign country. Since $z_h$ and, accordingly, $z_H$ are not affected by increases in these communication costs, the fraction of expatriates $\mu$ increases with the communication costs between the home and foreign country. Intuitively, as communication between the foreign production plant and headquarters becomes more costly, the foreign production plant requires more time from managers in headquarters. Holding all else constant, the firm would rather send more expatriates with upper-level knowledge to handle more problems in the foreign affiliate, reducing the need for communication with headquarters.

Next, we can observe that both $z_F$ and $z_h$ are decreasing and $z_H$ increasing in $q_F$, which makes $\mu$ decreasing in $q_F$. The intuition for this is as follows: more production in the foreign country generates more unsolved problems, imposing a higher demand for time to communicate with headquarters. Convexity of the cost function requires the marginal cost of $z_h$ to increase in $z_h$ even after accounting for its effect on $z_F$. For this reason, it ends up being more efficient for the MNC to reallocate knowledge between the home plant and headquarters to reduce costs. By increasing production workers' knowledge in the home production plant, the home plant's demand on managers' time decreases and managers can devote more of their time to solve the new problems arising in the foreign production plant. For this reason, the need for expatriates in the foreign production plant decreases when it increases production.

[6] Even though only one expatriate would possess enough knowledge to solve all problems in that interval, an expatriate's time is rival: an expatriate cannot communicate with two different production workers at the same time. Hence our assumption that the proportion of expatriates is increasing in the ratio $(z_F - z_H)/z_H$.

[7] For the exact expressions and procedure, see the comparative statics section in Gumpert (2015).

In sum, using Gumpert (2015)'s model of knowledge as a production factor, and using our interpretation of expatriates as a source of tacit knowledge, we obtain the following testable predictions:

1. *Higher communication costs between the home country and the foreign country require more expatriates in the foreign production plant.*

2. *Higher production in the foreign production plant requires fewer expatriates in the foreign production plant.*

# 3 Empirics

In Section 2, we related unobservable knowledge to observable employees, exploiting the tacit nature of knowledge and the unique characteristics of Korean idiosyncrasy. In particular, we linked the proportion of expatriated workers out of the total number of workers to the share of knowledge overlap of the foreign affiliate (i.e. $\mu = \frac{n_{expats}}{n_F} = \frac{z_F - z_H}{z_F}$). In this section, we examine our hypotheses using MNCs headquartered in South Korea.

## 3.1 Data

We draw on unpublished data from the South Korean Export-Import (EXIM) Bank. Since 2000, the EXIM Bank has been pursuing a benchmark survey of South Korean multinational affiliates abroad. The EXIM Bank has included increasingly more firms in the survey, starting with about 100 parents and their 200 foreign affiliates in 2000 and ending with about 2,400 parents and 4,400 affiliates in 2011. Until 2006, the number of firms and affiliates that are consistently surveyed each year varies too much to make a panel analysis meaningful. For this reason, we use data from 2007 to 2011. During this sample period, we were able to construct a panel dataset based on the affiliate code. We concentrate on manufacturing affiliates that report positive number of production workers because they have more complete data than other sectors. In 2011, manufacturing takes 60%, 51%, and 84% of the data in terms of number of foreign affiliates, their sales, and number of employment, respectively. Manufacturing includes 2,199 parents and 3,455 affiliates.[8] The dataset provides the general information for the foreign affiliates such as their location, two-digit level industry, sales, and employment numbers. After dropping affiliates that do not report employee information, we are left with 1,716 parents and 2,453 foreign affiliates for our empirical analysis.[9] In the process of merging with country level

[8]The survey reports representative affiliate data that are not exhaustive. For example, it does not include the data of all foreign affiliates belonging to a parent firm. At the same time, the information on the parent firm is limited. The only information we have is the arbitrary identification code, so we cannot link each parent to Korea Information System (KIS) value that contain general South Korean firm information.

[9]About 1,000 affiliates do not report employee information.

variables, we lose some observations because some countries do not report trade costs and the variable on trust. In the end, we use 1,693 parents and 2,400 foreign affiliates for our empirical analysis.

The distinctive feature of this data set is that it provides details of employee information. It records the number of affiliate employees categorized by nationality (foreign or Korean) and by the position they hold in the affiliate: Executive, Manager, Sales, or Production. We classify employees in Executive and Manager positions as "managers". Table 2 shows that about 85% of South Koreans are active in management positions rather than in production/sales positions, while about 85% of foreign workers are employed in production/sales positions as opposed to management. Moreover, production work by South Koreans is negligible, as the share of South Koreans is only 1% among all production/sales positions. This is a stark difference from the significant role of South Koreans in management positions, with about 29% of South Koreans. The significant portion of expatriated Korean workers in management positions suggests that their role is problem solving rather than production. Because of the meaningful value and significant variation of the use of expatriates at a managerial position, we focus on managers for our empirical analysis.[10] Our unit of analysis is at the foreign affiliate level. Our variable of interest is the ratio of expatriated managers with respect to the total number of managers (i.e. the sum of expatriated and foreign managers) in the foreign affiliate. As a robustness check, we will extend to not just managers, but also all workers and discuss the results.

If all managers regardless of their nationality were homogeneous, foreign affiliates should hire managers from the host country, especially because expatriates are more expensive.[11] However, the data shows that this is not the case. Table 3 provides the mean value of Korean expatriates share and other affiliate characteristics and breaks the data down according to regions in which the affiliates are active. Overall, Korean expatriates take only about 4% of total employment. When focusing on managerial positions, the share of Korean expatriates increases up to 29.2%. Data also reveals that almost all foreign affiliates (95%) have at least one Korean person in a management position. Not only foreign affiliates are hiring Korean expatriates, but the share of Korean managers is particularly high.

The last two columns provide the number and share of affiliates that are active in each region. The dominant majority of affiliates are located in Asia, particularly in China with 62% of the total number of foreign affiliates in our sample. Indeed in recent years there has been a surge

[10] One can think of Executive as the highest layer, Manager as the second, and Sales or Production as the bottom layer and may be interested in the use of expatriates in each layer. However, as indicated, the share of Koreans in Sales/Production is only 1%. Also, only 0.7% of foreign employees are in Executive positions. In order to conduct meaningful statistical analysis, we combined Executive and Manager together and focus on management positions.

[11] Ghemawat (2007) documents that the average costs associated with expatriated workers are two or three times as high as that of hiring foreign workers. In the case of Korea, Korean Ministry of Foreign Affairs reports the significant costs of expatriating Korean workers to the foreign host country (Rule of Overseas Service Allowance).

of South Korean multinational activity in China. 23% is located in Asia excluding China; 10% is in Vietnam, 2.7% in India, 2.7% in Indonesia, 2.2% in Thailand, and 1.3% in Malaysia. The dominant presence of South Korean FDI in Asia is direct evidence of gravity in FDI because Asian countries are close in distance and culture to South Korea, relative to other regions. At the same time, the ratio of Korean workers out of total employment or that of Korean managers out of total managers is lower in Asia relative to other regions, especially to the Americas. We want to draw particular attention to Asia (excluding China) and Central and South America. Since FDI in both regions is predominantly vertical and labor-intensive, it can be argued that the main difference between them is the geographic and cultural distance from South Korea. In particular, we want to argue that communication costs would be more severe for far-away Americas, so that sending Korean workers would be more effective than costly communication.

Our first hypothesis links these communication costs and the use of expatriates and questions whether they are systematically correlated. The communication costs are proxied by the geographic distance, working hours overlap, and the phone calling costs, following the literature (Gumpert (2015); Bahar (2013); Cristea (2015)). The distance is measured in km between Seoul, South Korea and the capital city of the host country. Working hours overlap is computed as max{10-|time difference in hours|, 0}. The phone calling costs are the phone rates charged per minute. Another typical variable measuring the communication costs is linguistic proximity, which captures difficulties in the direct communication between two individuals. In this paper, we cannot use this variable because Korean is very unique, leading to no linguistic proximity to any language. In fact, this would provide a stronger tendency for Korean MNCs to expatriate Koreans rather than hiring foreign workers when they need intensive communication with the foreign affiliate.

One may think the difference in the use of expatriates by regions reflects the difference in operations. For example, operations in Asia could be more labor intensive and those in Americas more capital intensive, which might be why we see less expatriates in Asia than in Americas. To make sure the region does not simply pick up the differences across sectors, we provide Table 4. It shows that sectoral composition by regions in terms of the number of foreign affiliates is very similar. Still, sectoral characteristics will be absorbed by sector fixed effects in the regression analysis.

More serious concern could arise at the more disaggregate affiliate level. For example, one may expect more expatriates for the foreign affiliate that is vertically linked to headquarters. If the location and such linkages are systematically correlated, it generates the difference in the use of expatriates by regions. It is also possible for the vertical linkages to be correlated with other affiliate characteristics, so vertical linkages need to be controlled. While it is difficult

to figure out the true relationship between each affiliate and headquarters, we partly resolve this issue by controlling for the composition of foreign affiliate sales in the regression analysis. We control for the ratio of exports back to headquarters out of total affiliates sales. The high ratio would represent vertical type relationship while the low ratio horizontal type. The ratio is expected to control for the linkages between affiliate and headquarters that may matter for expatriation.

Table 5 provides the standard deviation, min, and max of key variables. Table 5 also reports sectoral complexity, measured by R&D intensity obtained from The Survey of Research and Development in Korea and Nonroutineness that we modified from Costinot et al. (2011). We will interact sectoral complexity with key variables to explore their possible heterogeneous relationship with the use of expatriates.

By regression method, we want to purge other potential confounding factors that are related with the use of expatriates. For example, the use of expatriates may vary by other country characteristics than the communication costs. It is also possible that each headquarter has a different policy on human resource organization. Further, affiliate characteristics such as vertical linkages with headquarters may influence expatriation and unobserved affiliate characteristics such as affiliate culture could be correlated with internal organization. We will control for these confounding factors using regression method.

### 3.2 Results and Discussion

We first investigate if the use of expatriates is systematically correlated with the difficulty in communication. Our regression equation is :

$$y_{ijct} = \beta * com_c + X's + d_t + d_j + u_{ijct} \qquad (11)$$

where $i$ represents an affiliate, $j$ sector, $c$ country of location, and $t$ year. As indicated, communication costs ($com_c$) is proxied by the geographic distance, working hours overlap, and the phone calling costs. The dependent variable is the proportion of Korean expatriated managers to total number of managers. Using this proportion has an advantage, as it removes from the regression any other unobservable factors that affect human resources decision in the same way irrespective of the country of origin. Sector characteristics are captured by sector fixed effect ($d_j$) and macroeconomic time effect is absorbed by year fixed effect ($d_t$). Control variables, $X's$, are to be discussed below.

Other country characteristics can affect the need for expatriates. For example, if a host country is abundant in skilled labor, headquarters may be able to substitute expatriates with foreign talents. Also, one might be concerned about our measure of communication costs

picking up other country characteristics rather than communication. To avoid these concerns, we control for the average level of education and trade costs between Korea and the host country in the regression analysis. We additionally include per capita GDP to control for wages across borders. GDP is also included to control for market size, which may also matter for the decision on expatriates. We take average level of education from Barro and Lee (2013), and bilateral trade costs between South Korea and partner countries are from World Bank. Per capita GDP and GDP are taken from World Bank World Development Index.

Note that, while our regression analysis is similar to the empirical exercise part of Gumpert (2015), there are two differences. Our analysis is at the affiliate level (as opposed to country level) and, more importantly, our focus is on the transfer of workers from headquarters to foreign affiliates (as opposed to having expatriates in the foreign affiliates and workers being trained in the headquarters altogether). As we argued, due to the tacit nature of knowledge and Korean idiosincrasy, it is hard for foreign workers to be properly trained at the headquarters, so it is important to focus on the transfer of expatriates from headquarters to the foreign affiliate.

The use of expatriates could also be interpreted in an alternative framework. In particular, Bloom et al. (2012) argue that monitoring of foreign affiliates is an important concern for MNCs and find that higher levels of trust between home and host country increases decentralization of MNCs. In our context, if expatriates are interpreted as a tool for monitoring purposes, foreign affiliates located in countries with higher levels of trust should require fewer expatriates so that decisions are decentralized to foreign workers. We will control for trust. We use the same trust variable as Bloom et al. (2012), taken from World Values Survey (WVS).

The few nascent empirical literature on the firm hierarchy considers trade liberalization, market competition, skill and capital intensity, TFP growth, IT adoption, and market size at the country or sector level as potential determinants for human resources(Rajan and Wulf (2006); Garicano and Hubbard (2007); Guadalupe and Wulf (2010)). One should note that these variables were suggested in the firm's decision on human resources typically in the context of a home firm (e.g. the number of positions reporting to a CEO). As far as these variables affect human resource decisions in the same way irrespective of the country of origin, our dependent variable should not be affected. Still, the country level controls and sector fixed effects would control for such possibilities that may matter for expatriation.

Note that our dataset is panel and that communication costs are time-constant at the country level. Using the pooled dataset and allowing the serial correlation in the error terms at the country level (i.e. standard errors are clustered at the country level), the panel random effects model provides the relationship between expatriation and communication costs.

Table 6 reports the regression results of the use of expatriates on the communication costs. Column (1) reports the results with the fixed effects for sectors and years only and column (2)-

(6) with country level controls. Communication proxies are mostly significant irrespective of inclusion of controls. In particular, the finding is robust to the inclusion of trust and trade costs. When all three communication proxies are included in (5), significance becomes weaker because they are strongly correlated.[12] They are jointly significant, however, as the $F - stat$ shows. These results support our argument that Korean MNCs replace direct communication between Korean headquarters and foreign affiliates through the expatriated Korean expatriates when the communication costs are high. Country level controls are mostly not related to expatriates in a significant way.

One econometric issue needs to be pointed out. Note our dependent variable is a fractional response variable that is bounded by 0 and 1. The usual linear estimation is likely to produce predicted variables outside these bounds. Papke and Wooldridge (1996) introduce quasi-maximum likelihood estimator (QMLE) to overcome those shortcomings for the cross-sectional case and Papke and Wooldridge (2008) further extend this method to panel data case and suggest the pooled Bernoulli QMLE. Column (6) reports the result based on QMLE. The sign and significance of the coefficients are the same.

So far, we have been taking the location of affiliates as given. Now, we adjust the econometric model to allow for locational decisions to be endogenous and explicitly model the extensive margin. Human resource decisions are estimated jointly with a selection equation determining entry in a particular foreign market. We consider the cases where affiliate activity is observed plus those where the MNC end up not opening an affiliate in a particular country. Our analysis employs the well-known two-step approach in Heckman (1976). Since selection is based on cross-country variation and the proxies for communication costs are time-invariant, we transform our panel dataset into being cross-sectional by taking the average value of variables over time. In the first step, we run a probit to estimate the probability of the presence of a given MNC in a given host country. From this we obtain the Mills ratio, which addresses the sample selection problem. The total number of cases where affiliate activity is observed and not observed in a particular country is 76,516. The exclusion variable is the World Bank's Cost of Starting a Business, which is independent of the share of expatriates.

Table 7 shows the results. We first report the OLS results in columns (1)-(4) using transformed cross-sectional data.[13] Each proxy for communication costs produces the similar result to Table 6 and statistical significance becomes stronger. Columns (5)-(8) report the results of Heckman approach. The exclusion variable enters with a negative sign, consistent with the hypothesis that host countries in which there are higher fixed costs of starting a business are less likely to attract multinational affiliates. Countries with high GDP are more likely to have

[12] The correlations of the distance with hours overlap and phone costs are -0.82 and 0.34, respectively.

[13] Because the variables are now time-average, this OLS result is the same as panel between effect estimator (i.e. regression of $\bar{y}_i$ on $\bar{x}_i$).

inward FDI. Countries with low level of schooling and per cap GDP draw more FDI from South Korea. This would be because of dominant share of Asian countries as Table 3 has shown. Countries with low trade costs from/to South Korea have more FDI because low trade costs are important factors for transferring goods between headquarters and foreign affiliates. In addition, countries with high trust are more likely to host FDI. Regarding our variables of interest, the coefficients on the communications between OLS and Heckman approach are overall comparable. While the significant Mills ratio indicates that selection is an issue, the extensive margin decision of MNCs does not drive the relationship between the use of expatriates and communication costs.

As a robustness check, we examine whether the result holds when excluding China from the sample. Table 3 has shown the dominant presence of China as the host country. One may wonder whether the result changes significantly by excluding China. Though not reported here, the result remains strong, i.e. communication proxies are statistically significant and robust to trust, trade costs, and sample selection.[14]

Next, we evaluate whether the use of expatriates is systematically correlated with the scale of affiliates. Our goal of this regression exercise is to investigate the correlation between the use of expatriates and scale at the affiliate level while keeping other potential confounding factors fixed as much as possible. For example, two foreign affiliates that differ in terms of scale and use of expatriates but are the same in other characteristics such as sharing the same parent, location, and industry would allow us to examine the correlation. In this regard, we will use panel fixed effects so that intra-affiliate variations are to be used. There are benefits of having fixed effects as follows: First, affiliate fixed effect controls for any sector and host country characteristics including communication costs. Second, the parent firm characteristics can be controlled. For example, the Korean conglomerates, *Chaebols*, that own many foreign affiliates might have different strategies on their human resources than small or medium sized MNCs. The extent to which the parent characteristics affect the use of expatriates in the same way over all its foreign affiliates can be controlled. Third, any unobserved time-invariant affiliate characteristics such as affiliate specific culture that might matter for the use of expatriates can be controlled.

Our regression equation is :

$$y_{it} = x_{it}\beta + d_t + d_i + u_{it} \text{.....} (12)$$

where $i$ represents each affiliate. As indicated, the variable of interest ($x_{it}$) is the scale. The scale is measured by either total number of workers or total sales.[15] Unobserved time-invariant

[14] The results are available upon request.

[15] The results reported in this paper is based on total number of workers. Using sales produce the similar

affiliate characteristics are captured by $d_i$. Macroeconomic time effect is absorbed by year fixed effect ($d_t$). We additionally control for the proportion of exports back to the parent and the parent equity share. The exports back to the parent is expected to control for the vertical linkages between the headquarters and foreign affiliate that may matter for the use of expatriates. The equity share is to control for the strategic dependence. The wholly owned affiliate may be more likely to be managed by expatriates than the partially owned affiliate (Lee (2014); Belderbos and Heijltjes (2005)).

Table 8 reports regression results. Here, standard errors are clustered at the affiliate level to allow for correlation within each affiliate. The results using the traditional fixed effects is reported in column (1). The coefficient on the affiliate scale is significantly negative. As we argued in Section 2, the expanding firm can reduce the cost increase by adjusting the allocation of knowledge. The knowledge level of home workers increases while that of foreign workers decreases. This means that the managers at headquarters are now able to and have to answer questions from the foreign workers, and therefore the need for expatriates decreases. The equity share and the proportion of exports back to the parent turn out be insignificant. It is probably because both variables are relatively time stable. Though not reported here, time-varying country level variables are also controlled.

The negative coefficient is consistent with the finding of flattening firms in the firm hierarchy literature, (i.e. the number of workers in the lower hierarchy relative to that in the higher hierarchy increases with the affiliate scale) because one can argue that expatriates occupy a higher hierarchy than foreign workers.

We control for the parent level characteristics in column (2). The parent firm-level changes such as CEO turnover and mergers might matter for expatriation. While the dataset does not allow us to observe the parent firm-level changes, the parent identification code to which each affiliate belongs is provided. Column (2) includes the parent-year fixed effects so that variations across affiliates sharing the same parent firm at a given year are exploited. The downside is the significant reduction of observations because it requires multiple affiliates sharing the same parent at a given year, and a significant number of observations are only one affiliate per parent. The sample size is reduced into 1,013 affiliates of 343 parents. The coefficient on scale is still statistically significant and its size increases. Column (2) confirms that unobserved headquarters characteristics do not drive our results.

At this point, one may be concerned whether the significant link of scale with expatriation undoes the impact of communication costs on expatriation that are reported in Table 6. In order to investigate the relationship of expatriation with time-invariant communication costs and time-varying scale altogether, we adopt the correlated random effect (CRE) approach. CRE

result in terms of sign and significance.

synthesizes the fixed effects and random effects approaches by allowing the affiliate fixed effect to be correlated with the average level of affiliate controls. In terms of our estimation equation, $y_{ijct} = \beta * com_c + X's + d_t + d_j + x_{it}\gamma + \bar{x}_i\xi + v_{ijct}$, where $x_{it}$ are the affiliate level variables and the affiliate fixed effect is approximated by $\bar{x}_i$. The CRE approach provides a way to include time-invariant variables in what is effectively a fixed effects analysis.[16]

CRE approach in column (3). The coefficients on affiliate level variables are almost the same as column (1) it should be. As for communication costs, they are jointly significant as the $F - stat$ shows. Also, the coefficients are similar to column (5) of Table 6. The extent to which communication costs matter for the use of expatriation is the same irrespective of controlling for the affiliate level characteristics. We additionally examine whether the year of establishment of the affiliate matters for expatriation.[17] The coefficient is positive and significant. The newly established affiliates will need intensive communication with the headquarters than those that were established a long time ago. In order to save on the communication costs, the newly established affiliates would rely more on the expatriates. Including the parent-year fixed effects in column (4) does not change the results. Finally, we consider nonlinearity of our dependent variable in columns (5) and (6). Overall, the sign and significance are similar to the previous FE and CRE approaches.

If one takes the coefficient of column (1), the effect of scale is -0.064.[18] One percent increase of the affiliate scale is associated with 0.064 decrease of the use of expatriates. Since the average ratio of Korean managers out of total managers is 0.292, one percent increase of affiliate scale decreases the ratio into 0.228. Our estimates suggest the affiliate characteristics affect human resources in a significant way.

So far, we have looked at the conditional correlation of the use of expatriates with communication costs and scale and interpreted it according to the knowledge hierarchy framework. One may wonder if our empirical findings can be interpreted in a different way. In particular, the correlation of expatriates with communication costs can be interpreted as expatriates being monitors because far-away foreign operation may need more monitoring. Also, the correlation with the scale can be interpreted by a reverse causal relationship. For example, competition causes affiliates to become flatter in order to survive and survivors prosper; the affiliates that cut extra costs and eliminate inefficiency by becoming flatter become larger; the large affiliates change in scope as affiliates diversify into more businesses or focus on core products by becoming flatter. Though our empirical analysis is not intended to test the knowledge hierarchy model or to construct causality, we want to check whether the knowledge hierarchy framework

[16] Refer to Wooldridge (2010) for details.

[17] The year of establishment cannot be entered separately in panel fixed effect approach because it is time-invariant.

[18] The average partial effect of the scale in nonlinear model (column (5)) is -0.061.

is consistent with our empirical findings.

In what follows, we interact our variables with sectoral complexity. It can be argued that the extent to which knowledge can be reallocated between headquarters and its affiliates depends on sectoral complexity. Especially for complex operations, certain knowledge is held by only a few top managers at the headquarters. Moreover, the proportion of such knowledge increases with sectoral complexity. That is, help is still needed from the headquarters in both home and foreign plants especially in more complex sectors. In terms of model, while $\frac{\partial Z_F}{\partial \theta_{HF}} > 0$, $\frac{\partial Z_H}{\partial q_F} > 0$, and $\frac{\partial Z_F}{\partial q_F} < 0$, the impacts are weaker for complex sectors. In fact, Keller and Yeaple (2013) show that inputs in complex sectors need to be produced at the headquarters and exported to the foreign affiliates because the proportion of upper level knowledge is larger and the knowledge is hard to be communicated in those sectors. In our context, the increase in the knowledge overlap generated by higher communication costs is smaller in more complex activities. Therefore, while the higher communication costs increase the use of expatriates, the effect becomes weaker in more complex sectors. Similarly, the decrease in the knowledge overlap generated by an expansion in the foreign affiliate becomes weaker in complex sectors because of the continued need for help from the headquarters. Therefore, while the foreign affiliate scale decreases the use of expatriates, the effect becomes weaker in more complex sectors.

The results on interactions with communication costs are reported in Table 9. The left column group ((1)-(5)) is based on R&D intensity and the right group on Nonroutineness. The regression equation is the same as that for Table 6 with inclusion of the interaction term and country fixed effects. Note that country specific communication costs and sector specific knowledge intensity are not entered separately because they are absorbed by the fixed effects for country and sector. The coefficients on the interactions are individually or jointly significant and have correct signs. Thus, while higher communication costs increase the use of expatriates, this result is mitigated if the sector is more complex.

Finally, we report the results on interactions with the scale in Table 10. Again, the left column group ((1)-(3)) is based on R&D intensity and the right group ((4)-(6)) on Nonroutineness. Under each group, different estimators are used as the heading of each column represents. The regression equation is the same as that for Table 8 with inclusion of the interaction term. The interaction terms of scale and sectoral complexity is significant and positive. While the scale increase reduces the need for expatriates, they are still required in more complex sectors. Interactions of communication costs and sectoral complexity is still similar to Table 9 irrespective of inclusion of affiliate level variables while significance becomes weaker when Nonroutineness is used.

Our last exercise is a robustness check, extending all the above empirical exercises to not just managers, but also all workers. We replace the dependent variable by the ratio of expatriated

Korean workers out of total number of workers. Though not reported here, the results are overall similar with two differences. First, the size of the coefficients on communication proxies is smaller. Second, when the communication proxies and scale are interacted with sectoral complexity, the interaction terms are insignificant. Because tacit upper level knowledge is more likely to be carried by managers rather than production workers, smaller effects are expected for non-managerial workers.[19]

# 4 Concluding Remarks

The aim of this paper is to study the role of expatriation as a means for knowledge organization for MNCs. The tacit nature of knowledge and the presence of communication costs suggest that labor mobility plays a role in organizing knowledge across countries. We use a knowledge hierarchies model focused on MNCs to obtain testable hypotheses and test these hypotheses using foreign affiliates data from MNCs headquartered in South Korea. As predicted by the model, our data shows that whenever the diffusion of knowledge through communication is difficult, MNCs rely more on expatriates. Also, the proportion of expatriated workers is shown to be systematically related with the scale of the foreign affiliate. As the foreign affiliate expands, the use of expatriates decreases. Moreover, the extent to which the use of expatriates relates with communication costs and scale is shown to depend on sectoral complexity. In general, studying knowledge faces an empirical challenge because of its unobservable nature. In this paper, we argue that, because of the tacit nature of knowledge and Korean idiosincrasy, unobservable knowledge can be traced by observable labor mobility in MNCs headquartered in South Korea.

One might wonder about the generality of our empirical findings. Future research should document whether or not a similar relationship between expatriation and MNC characteristics is observed across different countries. We would expect comparable results for countries such as Japan (less open, uncommon second language), and weaker results for Canada or the United States (more open, common second language). We want to emphasize, however, that our primary interest in using expatriated Korean workers is to employ the unique feature of Korean culture, ethnicity, and language to link to the hardship of communicating tacit knowledge.

# References

Alesina, Alberto, and Romain Wacziarg (2003) ' Fractionalization.' *Journal of Economic Growth* 8(2), 155–94

[19]The results are available upon request.

Antras, Pol, Luis Garicano, and Esteban Rossi-Hansberg (2006) 'Offshoring in a Knowledge Economy.' *The Quarterly Journal of Economics* 121(1), 31–77

_ (2008) *Organizing Offshoring: Middle Managers and Communication Costs*

Argote, Linda, and Paul Ingram (2000) 'Knowledge transfer: A basis for competitive advantage in firms.' *Organizational Behavior and Human Decision Processes* 82(1), 150 – 169

Arrow, Kenneth J (1969) 'Classificatory Notes on the Production and Transmission of Technological Knowledge.' *American Economic Review* 59(2), 29–35

Atalay, Enghin, Ali Hortasu, and Chad Syverson (2014) 'Vertical integration and input flows.' *American Economic Review* 104(4), 1120–48

Bahar, Dany (2013) 'Heavier than Air? Knowledge Transmission within the Multinational Firm.' Working Paper 97711, Harvard University OpenScholar, August

Balsvik, Ragnhild (2011) 'Is labor mobility a channel for spillovers from multinationals? evidence from norwegian manufacturing.' *The Review of Economics and Statistics* 93(1), 285–297

Barro, Robert J., and Jong Wha Lee (2013) 'A new data set of educational attainment in the world, 1950?2010.' *Journal of Development Economics* 104, 184 – 198

Belderbos, Rene A., and Marielle G. Heijltjes (2005) 'The determinants of expatriate staffing by japanese multinationals in asia: Control, learning and vertical business groups.' *Journal of International Business Studies* 36(3), pp. 341–354

Bloom, Nicholas, Raffaella Sadun, and John Van Reenen (2012) 'The organization of firms across countries*.' *The Quarterly Journal of Economics*

Brock, David M, Oded Shenkar, Amir Shoham, and Ilene C Siscovick (2008) 'National culture and expatriate deployment.' *Journal of International Business Studies* 39(8), 1293–1309

Caliendo, Lorenzo, and Esteban Rossi-Hansberg (2012) 'The Impact of Trade on Organization and Productivity.' *The Quarterly Journal of Economics* 127(3), 1393–1467

Caliendo, Lorenzo, Ferdinando Monte, and Esteban Rossi-Hansberg (2015) 'The Anatomy of French Production Hierarchies.' *Journal of Political Economy* 123(4), 000 – 000

Chang, Yi-Ying, Yaping Gong, and Mike W. Peng (2012) 'Expatriate knowledge transfer, subsidiary absorptive capacity, and subsidiary performance.' *Academy of Management Journal* 55(4), 927–948

Cho, Jaehan (2014) 'Intangible capital transfer within multinationals.' Ph.D. dissertation, University of Arizona

Costinot, Arnaud, Lindsay Oldenski, and James Rauch (2011) 'Adaptation and the Boundary of Multinational Firms.' *The Review of Economics and Statistics* 93(1), 298–308

Cristea, Anca (2015) 'The effect of communication costs on trade in headquarter services.' *Review of World Economics (Weltwirtschaftliches Archiv)* 151(2), 255–289

Fearon, James D (2003) ' Ethnic and Cultural Diversity by Country.' *Journal of Economic Growth* 8(2), 195–222

Fosfuri, Andrea, Massimo Motta, and Thomas Ronde (2001) 'Foreign direct investment and spillovers through workers' mobility.' *Journal of International Economics* 53(1), 205–222

Garicano, Luis (2000) 'Hierarchies and the Organization of Knowledge in Production.' *Journal of Political Economy* 108(5), 874–904

Garicano, Luis, and Esteban Rossi-Hansberg (2006) 'Organization and Inequality in a Knowledge Economy.' *The Quarterly Journal of Economics* 121(4), 1383–1435

Garicano, Luis, and Thomas N Hubbard (2007) 'Managerial Leverage Is Limited by the Extent of the Market: Hierarchies, Specialization, and the Utilization of Lawyers' Human Capital.' *Journal of Law and Economics* 50(1), 1–43

Ghemawat, Pankaj (2007) *Redefining Global Strategy: Crossing Borders in a World Where Differences Still Matter* (Harvard Business School Press)

Glass, Amy Jocelyn, and Kamal Saggi (2002) ' Multinational Firms and Technology Transfer.' *Scandinavian Journal of Economics* 104(4), 495–513

Gong, Yaping (2003) 'Subsidiary staffing in multinational enterprises: Agency, resources, and performance.' *The Academy of Management Journal* 46(6), pp. 728–739

Guadalupe, Maria, and Julie Wulf (2010) 'The flattening firm and product market competition: The effect of trade liberalization on corporate hierarchies.' *American Economic Journal: Applied Economics* 2(4), 105–27

Gumpert, Anna (2015) 'The organization of knowledge in multinational firms.' CESifo working paper series No. 5401, CESifo

Heckman, James J. (1976) 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models.' In 'Annals of Economic and Social Measurement, Volume 5, number 4' NBER Chapters (National Bureau of Economic Research, Inc) pp. 475–492

Hofstede, Geert, Gert Jan Hofstede, and Michael Minkov (1997) *Cultures and Organizations: Software of the Mind.* 3rd Edition

Isphording, Ingo E., and Sebastian Otten (2013) 'The costs of babylon : Linguistic distance in applied economics.' *Review of International Economics* 21(2), 177–185

Kang, Jina, Mooweon Rhee, and Ki H. Kang (2010) 'Revisiting knowledge transfer: Effects of knowledge characteristics on organizational effort for knowledge transfer.' *Expert Systems with Applications* 37(12), 8155 – 8160

Keller, Wolfgang, and Stephen R. Yeaple (2009) 'Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States.' *The Review of Economics and Statistics* 91(4), 821–831

Keller, Wolfgang, and Stephen Ross Yeaple (2013) 'The Gravity of Knowledge.' *American Economic Review* 103(4), 1414–44

Lee, Joonhyung (2014) 'The transfer of workers within multinationals and ownership of foreign affiliates.' *Economics Letters* 125(2), 149–152

Marin, Dalia, and Thierry Verdier (2014) 'Corporate hierarchies and international trade: Theory and evidence.' *Journal of International Economics* 94(2), 295–310

Oldenski, Lindsay (2012) 'Export Versus FDI and the Communication of Complex Information.' *Journal of International Economics* 87(2), 312–322

Papke, Leslie E, and Jeffrey M Wooldridge (1996) 'Econometric methods for fractional response variables with an application to 401(k) plan participation rates.' *Journal of Applied Econometrics* 11(6), 619–32

Papke, Leslie E., and Jeffrey M. Wooldridge (2008) 'Panel data methods for fractional response variables with an application to test pass rates.' *Journal of Econometrics* 145(1-2), 121–133

Poole, Jennifer P. (2013) 'Knowledge Transfers from Multinational to Domestic Firms: Evidence from Worker Mobility.' *The Review of Economics and Statistics* 95(2), 393–406

Rajan, Raghuram G., and Julie Wulf (2006) 'The Flattening Firm: Evidence from Panel Data on the Changing Nature of Corporate Hierarchies.' *The Review of Economics and Statistics* 88(4), 759–773

Rappoport, Veronica, Kim J. Ruhl, and Natalia Ramondo (2015) 'Horizontal versus Vertical FDI: New Empirical Evidence about U.S. Multinationals.' *Journal of International Economics*

Smarzynska Javorcik, Beata (2004) 'Does foreign direct investment increase the productivity of domestic firms? in search of spillovers through backward linkages.' *American Economic Review* 94(3), 605–627

Wooldridge, Jeffrey (2010) *Econometric Analysis of Cross Section and Panel Data* (MIT Press)

Table 1: Comparative statics

| | $z_h$ | $z_H$ | $z_F$ |
|---|---|---|---|
| $q_F$ | - | + | - |
| $\theta_{HF}$ | 0 | 0 | + |

Table 2: The role of Korean workers versus foreign workers

| | Managers | Production/Sales | Total |
|---|---|---|---|
| Korean | 85.3% | 14.7% | 100% |
| Foreign | 15.2% | 84.8% | 100% |
| Korean share | 29.2% | 1.3% | |

Table 3: Mean value of key variables by region

| | $\frac{Korean\ managers}{L}$ | $\frac{Korean\ managers}{Managers}$ | $ln(L)$ | Year of establishment | # of affiliates | Share |
|---|---|---|---|---|---|---|
| 1. Average | 0.038 | 0.292 | 4.918 | 2003 | 2400 | |
| | | | | | | |
| 2. By Region | | | | | | |
| China | 0.034 | 0.276 | 4.962 | 2003 | 1531 | 0.624 |
| Asia excluding China | 0.036 | 0.313 | 5.017 | 2003 | 542 | 0.228 |
| N. America | 0.073 | 0.333 | 4.246 | 2001 | 138 | 0.056 |
| C. and S. America | 0.043 | 0.446 | 4.941 | 2004 | 51 | 0.021 |
| Europe | 0.039 | 0.271 | 4.798 | 2005 | 126 | 0.059 |
| Middle East | 0.061 | 0.307 | 4.374 | 2005 | 4 | 0.004 |
| Africa | 0.025 | 0.160 | 4.957 | 1997 | 4 | 0.004 |
| Oceania | 0.055 | 0.249 | 3.713 | 1997 | 4 | 0.004 |

Table 4: Sector composition by region

| Sector | China | Asia excluding China | N.America | C. and S. America | Europe |
|---|---|---|---|---|---|
| Food products | 0.032 | 0.041 | 0.036 | 0.020 | 0.021 |
| Beverage | 0.002 | 0.002 | 0.000 | 0.000 | 0.000 |
| Tobacco | 0.000 | 0.000 | 0.007 | 0.000 | 0.014 |
| Textile | 0.041 | 0.077 | 0.029 | 0.137 | 0.000 |
| Apparel | 0.040 | 0.076 | 0.029 | 0.118 | 0.014 |
| Leather, bag, footwear | 0.020 | 0.041 | 0.000 | 0.000 | 0.007 |
| Wood products | 0.005 | 0.002 | 0.000 | 0.039 | 0.000 |
| Pulp, paper products | 0.007 | 0.009 | 0.007 | 0.000 | 0.000 |
| Publishing, printing products | 0.002 | 0.004 | 0.007 | 0.000 | 0.007 |
| Coal, petroleum products | 0.002 | 0.004 | 0.000 | 0.000 | 0.000 |
| Chemical products | 0.078 | 0.087 | 0.116 | 0.039 | 0.069 |
| Medicine, phamaceutical products | 0.006 | 0.011 | 0.043 | 0.000 | 0.007 |
| Rubber, plastic products | 0.039 | 0.048 | 0.036 | 0.098 | 0.076 |
| Non-metalic mineral products | 0.025 | 0.024 | 0.022 | 0.000 | 0.014 |
| Primary metal products | 0.040 | 0.089 | 0.051 | 0.039 | 0.056 |
| Fabricated metal products | 0.064 | 0.059 | 0.036 | 0.157 | 0.056 |
| Electronics | 0.221 | 0.153 | 0.174 | 0.176 | 0.188 |
| Medical, scientific products | 0.024 | 0.018 | 0.036 | 0.000 | 0.014 |
| Electrical machinery | 0.047 | 0.052 | 0.072 | 0.059 | 0.035 |
| Machinery | 0.092 | 0.033 | 0.072 | 0.039 | 0.063 |
| Vehicle | 0.148 | 0.125 | 0.203 | 0.078 | 0.326 |
| Other vehicle | 0.014 | 0.004 | 0.007 | 0.000 | 0.007 |
| Furniture | 0.007 | 0.006 | 0.007 | 0.000 | 0.007 |
| Other manufacturing | 0.044 | 0.037 | 0.007 | 0.000 | 0.021 |

The pairwise correlation is high and significant. For example, the correlation between China and N. America is 90%.

Table 5: Summary Statistics

| Variable | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|
| $\frac{Korean\,managers}{Managers}$ | 0.292 | 0.278 | 0 | 1 |
| ln(L) | 4.922 | 1.164 | 1.099 | 7.640 |
| ln(sales) | 15.78 | 1.876 | 6.908 | 21.92 |
| Year of establishment | 2003 | 5.261 | 1968 | 2011 |
| Proportion of exports to parent | 0.226 | 0.346 | 0 | 1 |
| Parent's equity share | 91.00 | 20.47 | 0 | 100 |
| ln(Distance) | 7.477 | 0.885 | 6.862 | 9.819 |
| Hours overlap | 7.843 | 2.758 | 0 | 10 |
| ln(Calling costs) | 3.407 | 0.738 | 2.393 | 5.993 |
| ln(per cap GDP) | 9.191 | 0.614 | 7.678 | 11.43 |
| ln(GDP) | 29.23 | 1.456 | 23.84 | 30.37 |
| Schooling | 8.092 | 1.724 | 4.57 | 13.18 |
| Trade costs | 65.169 | 24.464 | 35.112 | 312.91 |
| Trust | 0.493 | 0.176 | 0.028 | 0.661 |
| R&D intensity | 3.185 | 2.202 | 0.410 | 9.010 |
| Nonroutineness | 0.557 | 0.055 | 0.452 | 0.660 |

Table 6: Regression of expatriation on communication costs

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | RE | | | | | QMLE |
| ln(Distance) | 0.029*** | 0.039** | | | -0.012 | -0.082 |
| | (0.006) | (0.019) | | | (0.026) | (0.088) |
| Hours overlap | | | -0.013*** | | -0.014* | -0.060*** |
| | | | (0.004) | | (0.007) | (0.021) |
| ln(Calling costs) | | | | 0.021 | 0.014 | 0.033 |
| | | | | (0.020) | (0.016) | (0.045) |
| ln(GDP) | | -0.000 | -0.007 | 0.008 | -0.002 | -0.012 |
| | | (0.008) | (0.008) | (0.010) | (0.011) | (0.029) |
| Schooling | | -0.002 | -0.009 | 0.001 | -0.011 | -0.032 |
| | | (0.011) | (0.011) | (0.011) | (0.011) | (0.028) |
| ln(per cap GDP) | | -0.018 | -0.011 | -0.003 | -0.000 | -0.017 |
| | | (0.030) | (0.027) | (0.029) | (0.029) | (0.069) |
| Trade costs | | 0.000 | -0.000 | 0.001* | 0.000 | -0.001 |
| | | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| Trust | | 0.037 | -0.042 | -0.087 | -0.076 | -0.352 |
| | | (0.092) | (0.067) | (0.064) | (0.102) | (0.325) |
| F-stat (p-value) | | | | | 0.002 | 0.000 |
| Observations | 6,160 | 6,160 | 6,160 | 6,160 | 6,160 | 6,160 |
| Number of sub | 2,400 | 2,400 | 2,400 | 2,400 | 2,400 | 2,400 |

* significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in the parenthesis are clustered at a country level. The dependent variable is the ratio of Korean managers out of the sum of Korean and foreign managers. Regression includes the fixed effects for sectors and years.

Table 7: Regression of expatriation on communication costs with selection controlled

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | | Heckman second stage | | | |
| ln(Distance) | 0.039** | | | -0.019 | 0.020 | | | -0.223** |
| | (0.020) | | | (0.029) | (0.021) | | | (0.096) |
| Hours overlap | | -0.014*** | | -0.015** | | -0.019*** | | -0.066*** |
| | | (0.004) | | (0.007) | | (0.005) | | (0.024) |
| ln(Calling costs) | | | 0.042*** | 0.030* | | | 0.047*** | 0.038** |
| | | | (0.016) | (0.017) | | | (0.016) | (0.016) |
| | | | | | Selection equation | | | |
| ln(Distance) | | | | | -0.217*** | | | -0.918*** |
| | | | | | (0.024) | | | (0.046) |
| Hours overlap | | | | | | -0.016*** | | -0.198*** |
| | | | | | | (0.006) | | (0.011) |
| ln(Calling costs) | | | | | | | 0.005 | 0.026 |
| | | | | | | | (0.022) | (0.021) |
| ln(GDP) | | | | | 0.327*** | 0.322*** | 0.336*** | 0.203*** |
| | | | | | (0.011) | (0.012) | (0.013) | (0.014) |
| Schooling | | | | | -0.050*** | -0.088*** | -0.076*** | -0.103*** |
| | | | | | (0.014) | (0.014) | (0.013) | (0.013) |
| ln(per cap GDP) | | | | | -0.466*** | -0.496*** | -0.498*** | -0.380*** |
| | | | | | (0.036) | (0.036) | (0.036) | (0.035) |
| Trade costs | | | | | -0.012*** | -0.017*** | -0.016*** | -0.015*** |
| | | | | | (0.001) | (0.001) | (0.001) | (0.001) |
| Trust | | | | | 1.259*** | 1.588*** | 1.537*** | 0.714*** |
| | | | | | (0.103) | (0.098) | (0.099) | (0.110) |
| Cost of starting business | | | | | -0.011*** | -0.011*** | -0.011*** | -0.003*** |
| | | | | | (0.001) | (0.001) | (0.001) | (0.001) |
| $\lambda$ | | | | | 0.152** | 0.168** | 0.134** | 0.313** |
| | | | | | (0.070) | (0.069) | (0.065) | (0.141) |
| F-stat (p-value) | | | | 0.003 | | | | 0.000 |
| Observations | 2,400 | 2,400 | 2,400 | 2,400 | 76,516 | 76,516 | 76,516 | 76,516 |

* significant at 10%, ** significant at 5%, *** significant at 1%. The dependent variable is the ratio of expatriated managers out of the total number of managers.

Table 8: Regression of expatriation on affiliate level variables

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | FE | | CRE | | QMLE | |
| ln(Scale) | -0.064*** | -0.109*** | -0.063*** | -0.104*** | -0.192*** | -0.413*** |
| | (0.013) | (0.021) | (0.012) | (0.022) | (0.037) | (0.061) |
| Parent equity share | 0.000 | -0.001 | 0.000 | -0.001 | 0.001 | -0.002 |
| | (0.000) | (0.001) | (0.000) | (0.001) | (0.001) | (0.004) |
| Proportion of exports back to parent | -0.008 | -0.062 | -0.007 | -0.064 | -0.018 | -0.275** |
| | (0.022) | (0.042) | (0.022) | (0.044) | (0.066) | (0.137) |
| Year of establishment | | | 0.002** | 0.002* | 0.009** | 0.014*** |
| | | | (0.001) | (0.001) | (0.004) | (0.004) |
| ln(Distance) | | | -0.012 | 0.031 | -0.067 | 0.163 |
| | | | (0.032) | (0.034) | (0.104) | (0.111) |
| Hours overlap | | | -0.012* | -0.005 | -0.047** | -0.018 |
| | | | (0.007) | (0.008) | (0.021) | (0.024) |
| ln(Calling costs) | | | 0.017 | -0.011 | 0.063 | -0.053 |
| | | | (0.015) | (0.015) | (0.048) | (0.048) |
| F-stat (p-value) | | | 0.009 | 0.006 | 0.088 | 0.030 |
| Affiliate fixed effects | Yes | Yes | No | No | No | No |
| Parent-year fixed effects | No | Yes | No | Yes | No | Yes |
| Observations | 6,160 | 2,609 | 6,160 | 2,609 | 6,160 | 2,609 |
| Number of affiliates | 2,400 | 1,013 | 2,400 | 1,013 | 2,400 | 1,013 |

* significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in the parenthesis are clustered at an affiliate level. The dependent variable is the ratio of Korean managers out of the sum of Korean and foreign managers. Country level variables and year fixed effects are included. In columns (1) and (2), affiliate fixed effects absorb any affiliate specific time-invariant variables. Column (3)-(6) include the average of time varying affiliate variables.

Table 9: Interactions of communication costs and sectoral complexity

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | RE | RE | RE | RE | QMLE | RE | RE | RE | RE | QMLE |
| | R&D intensity | | | | | Nonroutineness | | | | |
| ln(Distance)*Complexity | -0.009*** | | | 0.001 | -0.006 | -0.257* | | | 0.129 | 0.170 |
| | (0.003) | | | (0.007) | (0.018) | (0.142) | | | (0.185) | (0.650) |
| Hours overlap*Complexity | | 0.003*** | | 0.003 | 0.005 | | 0.109*** | | 0.145** | 0.271 |
| | | (0.001) | | (0.002) | (0.005) | | (0.034) | | (0.061) | (0.187) |
| ln(Calling costs)*Complexity | | | -0.006*** | -0.007** | -0.028*** | | | -0.053 | -0.144 | -0.630 |
| | | | (0.002) | (0.004) | (0.010) | | | (0.103) | (0.132) | (0.425) |
| F-stat (p-value) | | | | 0.000 | 0.000 | | | | 0.000 | 0.005 |
| Observations | 6,160 | 6,160 | 6,160 | 6,160 | 6,160 | 6,145 | 6,145 | 6,145 | 6,145 | 6,145 |
| Number of sub | 2,400 | 2,400 | 2,400 | 2,400 | 2,400 | 2,394 | 2,394 | 2,394 | 2,394 | 2,400 |

* significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in the parenthesis are clustered a country level. The dependent variable is the ratio of Korean managers out of the sum of Korean and foreign managers. Sectoral complexity is measured by the ratio of R&D to output (column (1)-(5)) and Nonroutineness (column (6)-(10)). Regression includes the fixed effects for countries and sectors, so country specific communication costs and sector specific knowledge intensity are not entered separately.

Table 10: Interactions of affiliate scale and sectoral complexity

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | FE | CRE | QMLE | FE | CRE | QMLE |
| | R&D intensity | | | Nonroutineness | | |
| ln(Scale) | -0.109*** | -0.110*** | -0.338*** | -0.315** | -0.316** | -0.915** |
| | (0.022) | (0.023) | (0.069) | (0.131) | (0.132) | (0.401) |
| ln(Scale)*Complexity | 0.015*** | 0.015*** | 0.046*** | 0.453* | 0.456* | 1.302* |
| | (0.006) | (0.006) | (0.017) | (0.233) | (0.235) | (0.713) |
| ln(Distance)*Complexity | | -0.004 | -0.019 | | 0.004 | -0.191 |
| | | (0.007) | (0.019) | | (0.290) | (0.879) |
| Hours overlap*Complexity | | 0.001 | -0.000 | | 0.095 | 0.153 |
| | | (0.002) | (0.006) | | (0.089) | (0.274) |
| ln(Calling costs)*Complexity | | -0.005 | -0.020 | | -0.137 | -0.565 |
| | | (0.004) | (0.013) | | (0.200) | (0.585) |
| F-stat (p-value) | | 0.014 | 0.016 | | 0.137 | 0.203 |
| Observations | 6,160 | 6,160 | 6,160 | 6,145 | 6,145 | 6,145 |
| Number of sub | 2,400 | 2,400 | 2,400 | 2,394 | 2,394 | 2,394 |

* significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in the parenthesis are clustered at an affiliate level. The dependent variable is the ratio of Korean managers out of the sum of Korean and foreign managers. Sectoral complexity is measured by the ratio of R&D to output (column (1)-(3)) and Nonroutineness (column (4)-(6)). In columns (1) and (4), affiliate fixed effects absorb any affiliate specific time-invariant variables. Columns (2), (3), (5), and (6) includes the fixed effects for countries and sectors, so country specific communication costs and sector specific knowledge intensity are not entered separately. The average of time varying affiliate variables are included in columns (2), (3), (5), and (6).