

Return Migration and Distributed R&D in Multinationals – A Study Using Micro Data

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Abstract

Is the phenomenon of multinational firms (MNCs) conducting distributed R&D across emerging markets related to the return migration of engineers and scientists from the U.S. to emerging markets? I hypothesize that local inventors at emerging market R&D centers of MNCs face constraints in securing resources from the headquarters for knowledge creation projects and that returnees can act as resource brokers. I then test for whether or not reporting to a returnee manager leads to higher patenting. I test this using hand-collected employment, travel, demographic and patent data for 1315 inventors at a Fortune 50 multinational R&D center in India. To account for endogeneity and selection in measuring the impact of returnee managers, I consider new graduates, for whom manager assignment is plausibly random. I find that having a returnee manager leads to higher patenting. I also find support for the resource brokerage role of returnees - having a returnee manager leads to higher patenting but not higher headquarter co-patentees or patent citations back at the headquarters. In summary, this is one of the first empirical studies of return migration and multinationals using firm level micro data.

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I. Introduction

Is the phenomenon of multinationals setting up R&D centers in emerging markets related to the return migration of scientists and engineers from the U.S. to countries such as China and India? Though the literature has seen a lot of independent interest in these two phenomena, there have been no prior studies which integrate the two. In this paper, I use micro data of returnees at a Fortune 50 R&D center in India and study whether return migration facilitates knowledge creation at distant R&D centers of multinationals.

Since the mid 1990s, a large number of multinational firms have set up R&D centers in China, India and other emerging markets. To quote Gereffi et al. (2008), “China now boasts nearly 1,000 MNC R&D centers, mostly clustered in Beijing and Shanghai....in India, an estimated 150 of U.S. Fortune 500 firms had established R&D centers as of 2005”. The list of firms setting up R&D centers in China and India include Cisco, GE, Microsoft and Texas Instruments². From a theoretical standpoint, exploiting cross border knowledge has been accepted as the received theory for why MNCs exist. Starting with Caves (1971), the literature has posited that MNCs exist because of their ability to exploit knowledge more efficiently inside the firm than through external markets. To quote Kogut and Zander (1993), “the multinational corporation arises not out of the failure of markets for the buying and selling of knowledge, but out of its superior efficiency as an organizational vehicle by which to transfer knowledge across borders”³. There have also been several empirical studies, mostly based on survey data that have explored the mechanisms used by MNCs for cross border knowledge exploitation⁴. However, there is little prior research that uses employment and other micro data to study the constraints faced by MNCs in creating knowledge at these emerging market R&D centers, and the mechanisms used to overcome the constraints.

² Engardio et al., 2003, Rai, 2003, etc.

³ As Gupta and Govindrajan (2000) point out, the internalization of intangible assets argument was originally advanced by Hymer (1960) and has been reiterated by several studies including Buckley and Casson (1976), Caves (1971, 1982), Ghoshal (1987), Kindleberger (1969) and Porter (1986).

⁴ There is also a rich literature, starting with Bartlett and Ghoshal (1990) and Kogut and Zander (1993) that looks at distributed innovation by multinationals. The geographically distributed innovation network of multinationals has been outlined by Bartlett and Ghoshal (1990) and Frost (2002); Kogut and Zander (1993) show that knowledge that is difficult to codify is more efficiently transferred within the firm and the subsequent literature has studied knowledge flows between multinational headquarters and subsidiaries in relation to factors such as knowledge stock, motivational disposition and transmission channels (Gupta and Govindrajan, 2000) and corporate socialization mechanisms (Bjorkman et al. 2004). Researchers have explored several questions in this context including what multinationals do to protect intellectual property in developing countries; in a recent paper, Zhao (2006) establishes that technologies developed by multinationals in emerging markets are highly related to the proprietary firms' internal resources, thus reducing the probability of local innovation.

Zhao (2006) highlights one of the constraints faced by MNCs in conducting R&D in China and India – inadequate intellectual property rights. However MNC R&D centers in emerging markets face several other constraints, notably accessing resources and knowledge localized at the headquarters (HQ) and other global locations. Prior research⁵ has documented that knowledge is localized unless mediated by inventor mobility and/or interpersonal ties. Local inventors at the emerging market R&D centers of MNCs initially lack the inventor ties back at the headquarters and other global R&D locations. This may be less of a constraint if the emerging market R&D center primarily leverages local knowledge and the primary motive for setting up the emerging market R&D center is “home base augmenting” (Kuemmerle, 1997; Cantwell, 1989; Florida, 1997; Kogut and Chang, 1991). However other researchers such as Zhao (2006) have also shown that MNC R&D centers in China and India work on technologies that are subsequently integrated into large global applications. In that case, lack of inventor ties back at the headquarters and other global R&D locations adversely affects local inventors at the emerging market R&D center. Local inventors also face an additional constraint - in securing resources to fund knowledge creation projects. Given the geographic distance and ex ante non codifiability and tacitness of new ideas, often there is information asymmetry between the sponsors of knowledge creation projects and inventors at emerging market R&D centers. In addition, local inventors in emerging market locations also face constraints in competing for and securing top management attention. Prior research in strategy, notably the Bower-Burgelman process model (Bower 1970; Burgelman, 1983a, 1983b, 1983c) outlines the role of front-line managers who champion new initiatives and middle level managers who broker such initiatives and in doing so put their reputation of good judgment and organizational career at stake. A related literature is focused on ‘issue selling to top management’ (Dutton and Ashford, 1993). Local inventors at emerging market R&D centers are often constrained by the lack of prior track record and credibility in championing and brokering new initiatives.

How do emerging market R&D centers of multinationals overcome the constraints in securing resources and accessing knowledge that resides at the headquarters and other global locations? In this paper, I hypothesize that multinationals leverage their internal organization and internal labor resources in ensuring that emerging market R&D centers are able to secure funds

⁵ Key papers include Almeida and Kogut (1999), Rosenkopf and Almeida (2003), Singh (2005), Agrawal, Kapur and McHale (2008)

and knowledge that reside in other global locations. Specifically, I test whether returnee inventors have a positive effect on knowledge creation by their direct reports.

Several prior theory and empirical papers discuss cross border mobility in the context of the multinational firm. Edstrom and Galbraith (1977) hypothesize that the transfer of managers within MNCs creates “international, verbal, information networks” and that these verbal networks allow for decentralized control. Ghoshal and Bartlett (1989) argue that a high level of normative integration between the headquarters and the subsidiary facilitates the creation, adoption and diffusion of innovation by the subsidiary. They relate their argument to received theory and argue that for any organization to engage in the act of creating knowledge two sets of conditions must be met: the act must be feasible, and it must be desirable. For subsidiaries of a multinational company, local resources are necessary to meet the condition of feasibility, and normative integration is necessary to meet the condition of desirability. Such integration is typically the result of a high degree of organizational socialization and is achieved through extensive travel and transfer of managers between the headquarters and the subsidiary. Alternative mechanisms are joint-working teams, task forces, and committees.

Cross border mobility of inventors is closely related to another phenomenon which has started receiving renewed interest in the literature – the return migration of scientists and engineers from the U.S. to countries like China and India. Zucker and Darby (2007) find that in the period 1981-2004 there was a strong tendency for “star scientists” in several science and technology fields in the US to return for at least some period to their country of origin (especially to China, Taiwan and Brazil) in order to promote the start-up of high tech firms. Song et al. (2001) show that engineers who moved from the U.S. to Korea or Taiwan built their subsequent innovations based upon the knowledge of their previous firms in the U.S. Based on case studies and field interviews, the authors argue that these mobile engineers have played significant roles in the technological catching-up of Korea and Taiwan. Several studies (Borjas and Bratsberg 1996, Dustmann and Weiss 2007) show that the percentage of migrants who return within 10 to 20 years to their country of origin is substantial (between 25 and 30% of the initial group). There is also recent evidence that returnees may be particularly concentrated among the highly

educated (Batista et al. 2007), and are often among the most successful of them (Zucker and Darby, 2007)⁶.

However, there is very little prior empirical analysis that uses employee level data to study how reverse migration affects local knowledge creation within multinational firms. Though a large number of MNC R&D centers are managed by returnees and other expats⁷, there are no prior empirical papers that use employee level data to test how returnees affect knowledge creation within multinationals. To quote Caves (1998), the analysis “rests on much cited, but indisputably thin, bodies of survey evidence”. In this paper, I use hand-collected data for 1315 inventors in a Fortune 50 multinational R&D center in India. Of the 1315 inventors, 104 are returnees, i.e. individuals who are ethnically Indian and have varying degrees of tenure at the U.S. headquarters. I use data on employment and patenting records over time. I also use hand collected data on online virtual communities to code demographic and college ties between employee pairs. In addition, I use specific knowledge of HR practices related to recruiting fresh graduates in attempting to account for selection and endogeneity. To test the effect of returnee managers on local knowledge creation, I consider new graduates, for whom manager assignment is plausibly random. In summary, I have two major findings: (i) Local employees who report to returnee managers file more patents (odds ratio ~ 4). This result is robust to the ‘college new hires’ exclusion criterion, controlling for patenting by the manager; (ii) the evidence also suggests that returnee ties helps local inventors secure resources for patenting. Using micro-data, I attempt to control for several alternative hypotheses for why returnee managers might help local employee patenting. The results have implications for how MNCs should organize cross border R&D.

The rest of this paper is organized as follows: Section II presents the theoretical framework, Section III reviews the empirical specifications and construction of the dataset, Section IV presents the results while Section V concludes the paper. References, tables and figures are at the end. A stylized theoretical model is presented in the appendix.

⁶ Dustmann and Weiss (2007) show using UK data that the tendency of migrants to return to their country of origin is much stronger among workers in highly skilled occupations. Similarly, Gundel and Peters (2008) show a much higher return rate for the highly educated compared with the less educated. Case studies on returnees affecting local knowledge creation include that on the high tech (IT) sectors in India (Commander et al. 2004) and in the Hsinchu Science Park in Taipei (Luo and Wang 2004)
⁷Zedtwitz (2004) studied 12 MNC R&D labs in China and finds that "More than two thirds of the initial R&D directors were non-Chinese and had no or little China experience before being assigned to the job. Among the Chinese R&D directors, most had significant overseas experience. Only in one case a local Chinese was hired to head up the R&D lab"

II. Theoretical Framework

The literature on multinationals has emphasized the role of market imperfections (e.g. transport costs and market power) in determining patterns of multinational activity. As Antras, Desai and Foley (2006) document, this literature has explored ‘horizontal’ and ‘vertical’ motivations of why multinationals exist⁸. Multinationals have also been hypothesized to exist because of their ability to transfer and exploit knowledge more effectively and efficiently in the intra-corporate context than through external market mechanisms. As Gupta and Govindrajana (2000) point out, the internalization of intangible assets argument, originally advanced by Hymer (1960), has been subjected to numerous confirmatory empirical tests and is now widely accepted as the “received theory” on why MNCs exist⁹. Researchers have also pointed out that multinational firms leverage their internal organizations to exploit cross border market imperfections. Antras et al. (2006) document that MNCs leverage internal capital flows in the presence of weak institutional environments in emerging markets¹⁰. Desai, Foley and Hines (2004) study affiliates of 3,700 U.S. multinational firms operating in more than 150 countries and conclude that MNC affiliates use internal capital markets opportunistically when external finance is costly and when there are tax arbitrage opportunities¹¹. Zhao (2006) studies how multinational firms leverage their internal organizations in relation to cross border R&D. She analyzes how MNCs are able to conduct R&D in countries such as China and India, despite the relatively weak IP protection laws. The main hypothesis is that technologies developed by emerging market R&D centers have strong internal linkages to other global technologies and are integrated into large R&D projects for global applications. In this paper, I posit that MNCs use yet another aspect of their internal organizations to conduct R&D in emerging markets – internal labor resources and cross border mobility. Local inventors in emerging market R&D centers face constraints related to accessing knowledge and securing funds resident at the headquarters and

⁸ As Antras et al. (2006) summarize, the horizontal FDI view represents FDI as the replication of capacity in multiple locations in response to factors such as trade costs, as in Markusen (1984), Brainard (1997), Markusen and Venables (2000), and Helpman, Melitz and Yeaple (2004). The vertical FDI view represents FDI as the geographic distribution of production globally in response to the opportunities afforded by different markets, as in Helpman (1984) and Yeaple (2003). Caves (1996) and Markusen (2002) provide particularly useful overviews of this literature.

⁹ Buckley and Casson, 1976; Caves, 1971, 1982; Ghoshal, 1987; Kindleberger, 1969; Porter, 1986; Teece, 1981.

¹⁰ The authors show that weak institutional environments limit the scale of multinational firm activity but increase the share of that activity that is financed by multinational parents through FDI flows.

¹¹ The authors document that affiliates borrow less from external sources and more from their parents in countries with underdeveloped credit markets and weak creditor protections and greater parent lending replaces approximately three-quarters of the reduction in external borrowing.

other global locations. Just as MNCs use their internal capital markets in countries with weak institutions, I hypothesize that they use their internal labor resources, (i.e. returnee inventors) in securing resources and/or accessing knowledge.

Local inventors in emerging market R&D centers of MNCs face constraints in accessing knowledge resident at the headquarters and other global locations. There is a large body of literature that documents that new knowledge creation is achieved through the recombination of existing and new knowledge and that physical distance constraints the search for distant knowledge. Seminal papers in this area include Levinthal and March (1993) who introduce the concept of “spatial myopia” and Rosenkopf and Almeida (2003) who document that mobility of active inventors can serve as “bridges to distant contexts”.¹² In fact, there is an extensive literature that suggests inventor mobility as a mechanism to bridge distant contexts and distant inventor ties. In the geography of innovation and agglomeration literature, several prior papers have studied the effect of spatial proximity and mobility of scientists and engineers on knowledge creation and knowledge sharing between firms. Some of the seminal papers in this area include Jaffe, Trajtenberg and Henderson (1993) and Saxenian (1994), an excellent summary of this literature is provided by Breschi and Lissoni (2001)¹³. There are several key insights from this literature: first, knowledge created and shared has both “codified” and “non-codified” components. Secondly, spatial proximity and co-location might facilitate knowledge sharing through contractual and market based channels such as the labor market (Almeida and Kogut, 1999) or licensing and formal collaboration networks (Mowery and Ziedonis, 2004). And finally, researchers have also pointed out that knowledge sharing might happen through non-market based social ties. Several recent papers use mobility, co-invention networks and ethnic ties to try and tease apart the effects of spatial and social proximity on knowledge sharing. Agrawal, Kapur and McHale (2008) show that spatial and social proximity both increase the probability of knowledge flows between individuals, though the marginal benefit of geographic

¹² In fact Rosenkopf and Almeida, 2003 show that mobility of inventors facilitates knowledge flows regardless of geographic proximity and helps firms bridge distant contexts related to technological distance. 2000). Other seminal papers include Cohen and Levinthal (1990) who document that firms, recognize and absorb external knowledge close to their existing knowledge base. A related paper is by Haas (2005) that examines the roles of cosmopolitans and locals in transnational teams that work on knowledge-intensive projects. The author proposes that cosmopolitan and local team members can help their teams to acquire and apply knowledge more effectively by bringing both internal and external knowledge. The empirical finding is that cosmopolitans offered more benefit than locals. In a related recent paper, Haas (2008) finds that in a multinational firm context, teams that deliver higher quality projects are characterized by “embedded autonomy” – extensive use of knowledge from sources outside the team combined with control over critical task decisions

¹³ . Other key papers in this area include Arrow, 1962; Stephan, 1996; Almeida and Kogut, 1999; Klepper and Sleeper, 2005

proximity is greater for inventors who are not socially close. Given that local inventors in emerging market R&D centers are ex ante constrained by geographic distance and lack of inventor ties at the headquarters and other global R&D centers, I hypothesize that local inventors face constraints in accessing knowledge residing in other global locations and that ties to returnees might facilitate knowledge sharing.

Local inventors face an additional constraint - that of securing resources to fund knowledge creation projects. This is related to two specific issues – (i) information asymmetry constraints between sponsors of knowledge creation projects and local inventors, (ii) constraints in securing top management attention for new strategic initiatives. Sponsors of new knowledge creation projects often reside at the headquarters and other global R&D locations. Anecdotally, in the multinational setting that I study, I find that funds for new knowledge creation projects are allocated by product managers who are exclusively resident at the headquarters. Given the tacitness and ex ante non codifiability of new knowledge creation ideas, these sponsors face information asymmetry in ascertaining the quality of the proposed ideas¹⁴. Local inventors at emerging market R&D centers are also constrained by the lack of prior credibility in championing and brokering new strategic initiatives. This relates to the Bower-Burgelman process model of strategy making in firms. In this model, intra-organizational strategy-making is conceived of comprising four sub-processes: two interlocking bottom-up core processes of 'definition' and 'impetus' and two overlaying corporate processes of 'structural context determination' and 'strategic context determination. 'Definition' is a cognitive process in which strategic initiatives are developed primarily by front-line managers who usually have specific knowledge on technology and are closer to the market. Impetus is a largely sociopolitical process by which these strategic initiatives are continually championed by front-line managers, and are adopted and brokered by middle managers who, in doing so, “put their reputations of good judgment and organizational career at stake” (Burgelman 1983, Bower 1986, Noda and Bower, 1996, etc.). However local inventors and local managers at emerging market MNC R&D centers are ex ante constrained by lack of prior track record within the firm. Consequently they face constraints in championing and brokering new strategic initiatives. There is also a related body

¹⁴ Knowledge could also remain “non-codified” (Agrawal, 2006) because inventors do not have incentives to codify them, as in knowledge out of failed experiments or is costly to codify. There is also a rich literature on how ‘tacitness’ and causal ambiguity leads to stickiness of knowledge transfer across borders. Seminal papers in this area include Polanyi (1967), Nelson and Winter (1982) and Szulanski (1996).

of research focused on “issue selling to top management.” Dutton and Ashford (1993) theorize that middle level managers use “upward influence” in seeking the time and attention of top management¹⁵. A related paper is by Birkinshaw (1997) who analyzes the antecedents of “internal market” initiatives within multinationals¹⁶. This stream of work also benefits from the internal capital markets theory literature, notably Gertner, Scharfstein and Stein (1994) and Stein (1997)¹⁷. Given this literature, I hypothesize that ties to returnees could help local inventors define, broker and influence the process of seeking resources for their knowledge creation ideas.

In summary, I hypothesize that ties to returnees could either or both affect knowledge sharing or resource seeking. The theory literature on multinationals has long studied the effects of cross border mobility of employees. Edstrom and Galbraith (1977) document that the transfer of managers is used by some multinational organizations to develop a process of control based on socialization. This is hypothesized to socialize managers and create international, verbal information networks, which combined, permit greater decentralization than the impersonal bureaucratic strategy. Ghoshal and Bartlett (1989) document the positive impact of normative integration through organizational socialization and dense intra and inter-unit communication on an MNC subsidiary's ability to contribute to knowledge creation tasks¹⁸. A related paper is by Kostova and Roth (2003) who argue that it is important for MNCs to build social capital as a private and a public good, since both can serve as informal mechanisms facilitating the coordination of cross-border activities. The authors also refer to the micro-macro process of social capital formation, where a central role is played by certain key boundary-spanning

¹⁵ A recent paper on issue selling is by Dutton et al. (2002)

¹⁶ An "internal market initiative" needs high parent-sub communication, strong proven resources (credibility) and a geocentric perspective in the parent company. It terms of process, an internal market initiative needs also needs high internal selling

¹⁷ Stein (1997) examines the role of the corporate headquarters in allocating scarce resources to competing projects within a firm. His model concludes that unlike a bank, the headquarters is vested with control rights, allowing it to engage in "winner-picking" - the practice of actively shifting funds from one project to another. Stein's model makes use of two assumptions: first, there are binding credit constraints which prevent funding of all projects inside the firm and second, the headquarters has the incentive and the authority to engage in winner-picking. Here, he follows Gertner, Scharfstein, and Stein (1994) in stressing the role of control rights in making the headquarters an effective intermediary.

¹⁸ A related paper here is by Ghoshal et al. (1994). The authors document that lateral networking mechanisms such as joint work in teams, taskforces, and meetings have significant positive effects on the frequency of both subsidiary-headquarters and inter subsidiary communication. The main theoretical argument here is that Information is transformed whenever it is transferred, and information interpretation requires the development and use of a consensually validated grammar for creating meaning out of ambiguous and equivocal information (Weick 1969). It is in creating this shared meaning system that the networking mechanisms and organizational processes may play a vital role.

individuals, employed at a subsidiary and who had previous direct contact with the headquarters¹⁹.

Finally, given that I am studying individuals within multinational firms, my work is related to the literature in personnel economics. Here I am guided by several papers, notably, Baker, Gibbs and Holmstrom (1994), Gibbons and Waldman (1999), Lazear (1992) and Gibbons (1996)²⁰. As Baker, Gibbs and Holmstrom (1994), [BGH (1994) hereafter] state, “internal labor market (ILM) theory is quite different from the traditional economic theory of the firm based on individuals contracting on the spot market²¹”. One of the key concepts in this literature is the concept of “careers in organizations.” To quote BGH (1994), “we find evidence that an internal labor market is at work allocating people to jobs...careers within the firm are often long and involve a number of job changes”²², BGH (1994) also identify “promotion fast tracks” or serial correlation in promotion rates and in wage changes. BGH (1994) then go on to document the importance of both the “employee’s rate of learning” and the “firm’s learning about ability” in how career progression actually happens²³. The firm’s learning about the ability of employees relates to the classical information asymmetry problem between firms and employees, Gibbons and Waldman (1999) build on this and talk about “on-the-job human-capital acquisition” and “role of learning” as the building blocks of formal model on wage and promotion dynamics. In summary, the concepts of ‘career dynamics’, ‘career fast tracks’ and ‘firm learning about employees’ are the core concepts on which I build my analyses.

¹⁹ A similar point is made by Monteiro and Birkinshaw (2008) who study intra-firm knowledge transfers in MNCs and document that “isolated subsidiaries were typically given an expatriate manager who was personally well connected and who was able to build the relationships with other units that subsequently led to knowledge sharing”

²⁰ An excellent commentary on this literature is provided by Baker and Holmstrom (1995)

²¹ BGH (1994) draw extensively from Doeringer and Piore’s 1971 and 1985 books on internal labor markets and quote Doeringer and Piore in outlining how internal labor markets are different from external labor markets, “the internal labor market is defined by an enterprise...Entry into such markets is limited to particular jobs or ports of entry. The pricing of labor, and its allocation from the point of entry to other work positions, is governed by administrative rules and customs. These rules and customs differentiate members of the internal labor market from outsiders and accord them rights and privileges which would not otherwise be available. Typically, these “internal” rights include certain guarantees of job security, opportunities for career mobility, and equity and due process in treatment at the workplace.” In addition, Wachter and Wright (1990) point out that “the distinguishing characteristic of the internal labor market...is that firms and workers incur substantial sunk cost investments.”

²² Researchers have used several ways to identify career progressions in organizations – Lazear 1992 uses rank ordering of jobs by wages, BGH (1994) identify patterns in observed job transitions and Baron, Davis-Blake and Bielby (1986) ask whether formal job ladders exist.

²³ To quote BGH (1994), “Ability is also an important determinant of career dynamics. When we compare the subsequent career performance of new hires into a level versus those promoted into the level, we find that while the average level of attainment of the groups is fairly similar, the variance of outcomes for new hires is greater. This strongly suggests that the firm uses lower-level job performance to learn about the innate abilities of employees and uses this information in its subsequent promotion decisions. ...indeed, it appears that ability interacts with human capital in that workers accumulate human capital at varying rates. Our data on career dynamics suggest that the most useful way to think about workers’ abilities is as the rate at which they accumulate human capital. Fast learners seem to have the most career success in this firm”.

So far, the internal labor markets literature has not specifically looked at multinational firms. Past studies of internal labor markets focus on single country (U.S.) firms, BGH (1994) for example study a “medium sized U.S. firm in a service industry.” I couldn’t find studies using personnel records from multinational firms. As a result, the literature has not addressed several questions that relate to career paths of employees in multinational firms and I posit the following three questions as examples of research questions that need to be explored: (1) the literature has so far thought of career paths as vertical movements (mostly upward) in a stable hierarchy. However, it is not known for instance how moving between multinational affiliates (e.g. from the head-quarters to the subsidiary and then back to the head-quarters) affect career dynamics of individuals; (2) in thinking about how a firm “learns” about new employees, the literature has not addressed whether multinational firms face additional information asymmetry problems in distant subsidiaries compared to their home markets. (3) Finally, the literature has predominantly focused on new hires acquiring “on-the-job human capital” and has not addressed the issue of “on-the-job social capital acquisition” by new hires. Gibbons (1996) in fact says, “It would be interesting to consider whether the theoretical or econometric tools of labor economics can shed any new light” on “the effects of...social networks.”

III. Empirical specifications and construction of the dataset

III.A. Setup

In my empirical work, I follow the established tradition in the economics literature of empirical work within inside firms. Lazear (1992) and BGH (1994) are key prime examples of this tradition and both of their studies focus on a single firm²⁴. Ichniowski and Shaw (2003) use the term “insider econometrics” to describe this body of work and define insider econometrics as “productivity studies that combine extensive field work to assemble useful organization-level data sets with rigorous econometric hypothesis testing of the effects of organization-specific determinants of productivity”. Using guidelines prescribed by Ichniowski and Shaw (2006), I followed a three-step process in conducting my analyses. In the first step, I conducted field research within the Indian R&D center of technology multinational TechMNC to gain an

²⁴ Other examples of single firm empirical work include Lazear’s (2000) study of piece rates in windshield installation. Researchers have also done similar work with data from more than one firm: Ichniowski, Shaw, and coauthors work with 45 production lines of 20 companies in the U.S. integrated steel industry (Ichniowski et al., 1997).

insider's understanding of the knowledge creation process at this MNC subsidiary. TechMNC is a Fortune 50 company that started its Indian R&D center in the late 1990s. The center was incubated by a group of 12 returnee employees from the U.S. headquarters and has steadily grown to over 1300 employees over the next decade. The Indian R&D center is the largest R&D set-up for this MNC outside the United States. Around 8% of the employees at this center are returnees. I was able to conduct structured interviews with the entire set of top managers at TechMNC's India R&D center and with a sample of mid and entry employees. These interviews led to insights on the knowledge creation process within this multinational subsidiary (e.g. the budget constrained nature of patent filing), useful in informing the theoretical framework. In the second step I hand-collected data on employment, patenting records, as well knowledge of HR processes and of individuals that would help me try and account for endogeneity and selection issues. This data was collected from multiple data-sources in the firm and had to be cleaned and codified as explained later. In the final step, I ran econometric analyses to identify two key empirical questions that I outline in the next sub-section.

III.B. Empirical questions

The theoretical arguments presented in Section II lead to the following empirical question in the context of multinational firm subsidiaries: whether returnee inventors and their direct reports exhibit higher patenting compared to local hires. As the model in the appendix indicates, local hires of returnee managers should have a higher probability of getting the knowledge projects funded compared to local hires of local managers (in the model presented in the appendix, this will be true if $\frac{P_E + P_L}{2} > P_L$). This in turn should be reflected in higher rates of patenting for returnees and returnee direct reports, compared to local hires. Given the prior literature on R&D productivity and knowledge spillovers and insights from structured interviews, I consider patenting as a measure of knowledge creation and the dependent variable for my specifications. However, the analyses are subject to concerns around endogeneity and selection. Using the guidelines prescribed by Ichniowski and Shaw (2006), I collect data on specific HR processes to try and account for endogeneity and selection. The next sub-section summarizes my identification strategy.

III.C. Do returnees and their direct reports patent more?

I first test for whether returnee inventors and their direct reports have higher patenting rates compared to local hires. The micro data allows me to control for several alternative hypotheses for why the assignment of returnees and travel to the HQ might lead to higher local patenting. Based on the literature review, I hypothesize two main hypotheses for why ties to returnees might be related to higher knowledge transfers to subsidiaries: (i) returnees facilitate issue selling with HQ sponsors and help local inventors secure resources; (ii) returnees help local inventors access knowledge and/or inventor ties at the headquarters. There could be other reasons why returnees might positively affect patenting of local direct reports: (iii) selection based on ability: high ability returnees select high ability direct reports to work for them, (iv) selection based on common demographics or college ties: returnees help direct reports connect with headquarter based ethnic, college or home state networks, (v) returnees by design work in areas that generate more patents. However, prior studies do not use micro-data in the form of employment or demographic to test these alternative hypotheses²⁵.

Firstly, given that I am dealing with count data, in the base case I use insights from Hausman Hall and Griliches (1984) and Wooldridge (1999) to run a Poisson model adjusted for quasi-maximum likelihood estimation and robust standard errors²⁶. I also run several alternative specifications using Zero Inflated Negative Binomial, Poisson with robust standard errors and results are reported in the section on robustness checks. In these regressions, patenting is the dependent variable and I use both patent counts (*num_pat_fil_i*, *num_pat_gr_i*) and whether or not the inventor has filed a patent (*has_filed_patent_i*) as the dependent variable. The two main independent variables are dummies for whether or not the inventor is a returnee (*is_returnee_i*) and whether or not the manager of the employee is a returnee (*is_mgr_returnee_i*). I also control

²⁵ Bjorkman et al. (2004) for example count the number of returnees in an MNC subsidiary and relate that measure to knowledge transfer.

²⁶ In dealing with count data like patents or publications, Azoulay, Zivin and Wang (2008) summarize the advantages of choosing a Poisson model adjusted for QML standard errors: “Because the Poisson model is in the linear exponential family, the coefficient estimates remain consistent as long as the mean of the dependent variable is correctly specified (Gourieroux et al. 1984). QML (i.e., “robust”) standard errors are consistent even if the underlying data generating process is not Poisson. In fact the Hausman et al. estimator can be used for any non-negative dependent variables, whether integer or continuous (Santos Silva and Tenreiro 2006), as long as the variance /covariance matrix is computed using the outer product of the gradient vector (and therefore does not rely on the Poisson variance assumption). Further, QML standard errors are robust to arbitrary patterns of serial correlation (Wooldridge 1997), and hence immune to the issues highlighted by Bertrand et al. (2004) concerning inference in DD estimation”.

for tenure, organizational group and job title of the individual employee²⁷ and run the following specification:

$$(1) E(Y_i|X_i) \sim \exp(X_i\beta + Z_i\gamma)$$

Where, Y_i indicates the count dependent variables (either patents filed or patents granted) and

$X_i \in \{is_returnee_i, is_mgr_returnee_i\}$

$Z_i \in \{patenting_by_mgr_i, tenure_i, org_group_i, job_title_i, social_ties_between_emp_mgr_i\}$

It is conceivable however, that equation (1) is affected by selection and endogeneity issues. As an example, it is possible that returnee managers systematically select direct reports who have higher ability and this selection issue might affect the coefficient on *is_mgr_returnee_i*. To try and address this concern, I employ the following identification strategy: I only consider local employees who are new graduates. I then identify whether patenting rates of these new graduates is affected by whether or not they are assigned a returnee versus a local manager. Interviews with HR managers at TechMNC revealed that the allocation of new graduates to either returnee or local managers could be considered to be a plausible random assignment for two main reasons. (i) Selection of “limited number of high potential” graduates from only the top colleges and (ii) Assignment of manager prior to socialization opportunities between new graduates and prospective managers.

TechMNC started recruiting new Indian graduates in a big way only in 2003 and has hired an average of 57 new graduates in the subsequent four years²⁸. This is in contrast to Indian IT services firms who recruit hundreds if not thousands of new graduates every year. The limited number of college recruits has allowed TechMNC to visit only the “top 25 to 30 colleges of India” and select the “best of talent”²⁹. In fact, TechMNC has also been rated by a reputed industry survey³⁰ as the “most preferred employer amongst engineering graduates for four years in a row”. As a result, TechMNC has had the bargaining power to recruit only the very best candidates in these colleges and the new graduates selected by TechMNC are relatively homogeneous as far as their CV and other pre-recruitment academic indicators are concerned. In

²⁷ For tenure, I have 6 dummy variables corresponding to the following categories: less than 1 year, 1-2 years, 2-4 years, 4-6 years, 6-10 years and 10years+. For job titles, I have the following 5 categories: software development, program management, SDET, other IT and business. I also have 6 dummy variables corresponding to the various organizational groups at TechMNC

²⁸ In the group of fresh college recruits, there were only 4 employees who had tenure more than 4 years

²⁹ Quotations from head of HR at TechMNC

³⁰ Conducted by AC Nielsen

addition, for purely administrative reasons, the assignment of new graduates to managers happens quite early in the process of induction training, prior to any real opportunities for new graduates and prospective managers to socialize and get to know each other. Despite this, I collect data on pre-treatment indicators for the group of new graduates (e.g. whether the new graduate studied at the elite IITs or at other colleges, whether the graduate has ethnic or college ties with the future manager) and find that these pre-treatment indicators do not systematically predict assignment of a new graduate to a returnee or local manager. More details are in the section on robustness checks.

Given the plausible randomness of assignment of new graduates to either returnee or local managers, subsequent patenting activities of new graduates, controlling for organizational group, tenure, patenting by manager, etc. should be indicative of whether direct reports of returnee managers have an advantage in filing patents. Hence, for the group of new graduates, I run the regression based on equation (1). Here, patenting is the dependent variable and the coefficient of interest is on whether or not the inventor's manager is a returnee (*is_manager_returnee*). In addition, to rule out several of the alternative hypotheses outlined earlier, I control for tenure, organizational group and job title and prior patenting by the manager. This controls for the possibility that returnees, by design are assigned projects that have a higher propensity of patenting and as a result, their direct reports exhibit higher patenting as well. This also controls for all the other possible reasons for why returnees and their direct reports would both exhibit high patenting (e.g. selection based on ability, returnees and their direct reports bring in complementary skills, etc.) Also, given the prior literature in knowledge spillovers³¹ suggests that ethnic and social networks are related to knowledge sharing, I control for ethnic and other demographic/college ties between the employee and his/her manager (*social_ties_bet_emp_mgr*). This controls for the possibility of selection based on demographic similarities and college ties.

III.D. Testing the ‘resource seeking’ and ‘knowledge sharing’ hypotheses

In Section II, I had outlined two possible hypotheses for why cross border mobility could lead to higher patenting. The first hypothesis was related to a ‘knowledge sharing’ explanation, where by mobility leads to bridging of distant contexts and distant inventor ties. The second

³¹ Notably, Agrawal, 2006; Agrawal, Kapur and McHale, 2008 and Breschi and Lissoni, 2001

hypothesis was related to ‘resource seeking’ where returnees facilitate brokering of initiatives and helps ‘issue selling’ to senior managers. To test for the validation of either or both these hypotheses, I exploit the organizational design of TechMNC. In this firm, R&D is distributed across four global locations (at the headquarters in the U.S., a center in U.K., China and India). However resource allocation for patenting projects is controlled by product teams, which all reside at the U.S. headquarters. I then conduct the following test to validate either or both the hypotheses: I check for whether returnee ties leads to higher patenting (both resource seeking and knowledge sharing hypotheses) as well as whether returnee ties lead to higher backward citations to other global patents/higher number of global co-patentees (knowledge sharing hypothesis).

///.E. Preparing the dataset

As part of my fieldwork within TechMNC, I collected data on employment records, patenting records, social networks, travel records and other variables for all inventors who were on the payroll as of December 2007, this yielded a cross-sectional dataset of 1315 inventors. The data was made available from multiple sources and needed considerable cleaning and coding. Table 1a summarizes employment and personal records of inventors and summary statistics related to patenting is reported in Table 1b. I collected travel records for 2 years (2006 and 2007), patent filings for 5 years (2004-2008) and patent grants for 14 years (1994-2007).

The main dependent variable is the number of patents filed (*num_pat_fil*). I also run robustness checks with number of patent grants (*num_pat_grants*) and whether or not the inventor has filed a patent (*has_filed_patent*) as the dependent variable. I also employ non-patent based dependent variables as described in the section on robustness checks. The key independent variables relate to whether or not the inventor is a returnee (indicated by the dummy variable *is_returnee*) and whether or not the inventor has a returnee manager (indicated by the dummy variable *is_manager_returnee*). Of the total number of inventors, around 8% are returnees and for each returnee inventor, I collected information on both total tenure at TechMNC and when the inventor moved to the emerging market R&D location. The main control variables relate to tenure, organizational group and job title.

In addition, I control for the effect of common demographics and common educational ties between the employee and his or her manager. Such ties could be of various types and I control

for the following social ties – college networks, ethnic ties and home-state ties. To identify social relationships, for each inventor, I collected information on their membership within ‘virtual communities’. Employees at TechMNC can voluntarily join virtual communities online³². The virtual communities are used to post information on the topic of interest and plan events. In addition to social and knowledge based groups, I collected information on virtual groups related to IT administration and general administration. Employees of TechMNC’s India R&D center have membership on 12,680 virtual communities and I physically coded them as ‘social’ (653 communities), ‘knowledge’ (9,456 communities), ‘admin’(486 communities), ‘organizational’(431 communities) and ‘IT admin’ (1,654 communities) based on the ‘name’ and ‘description’ of each group and using rules determined jointly with TechMNC executives. Using the name and description’ of each social group, I also classified the 653 social groups into the following categories – college ties, ethnic ties and home state ties. In the next step, for all 1315 employees, I then identified which groups they belong to. Data is available for 1279 out of the 1315 employees and this yields 152,101 inventor-virtual group rows. In the final step, for each manager-direct report pair, I identified social ties between individual inventors and their managers and create 6 dummy variables to indicate common ethnic ties (*mgr_shares_ethnicity*), college ties (*mgr_shares_college*) and home-state ties (*mgr_shares_homestate*). I also form a composite index (*mgr_shares_soc_reln_index*) with equal weights for these individual ties. The data is presented in Table 1c. The appendix has details on virtual communities and the coding rules.

IV. Results

IV.A. Summary trends

Figure 1 plots the fraction of inventors who file a patent for different organizational groups. Here I consider both returnee and local inventors and for local inventors, I consider the effect of the main independent variable in question – whether or not the local inventor has a returnee or local manager. As the graphic indicates, among local inventors, there is wide variance in the fraction of inventors who file a patent. For local inventors who have a returnee manager, the

³² These virtual communities are similar to Facebook communities, however these are specific to TechMNC and reside on the company intranet.

fraction of inventors who file a patent is 0.15. For local inventors who have a local manager, the fraction of patenting is quite low (0.05).

[FIGURE 1 ABOUT HERE]

IV.B. Do returnees and their direct reports patent more?

Next, I conduct econometric analyses to test for whether being a returnee and reporting to a returnee manager leads to higher rates of patent filing. In doing so, I employ specification 1 and the identification strategy for new graduates. Results are presented in Table 2a-2e. In the base specification reported in Table 2a, Column 1 tests for whether returnees exhibit higher patent filing rates and confirms the summary trends: controlling for tenure, organizational groups and job titles, only returnees in the highest tenure bracket (tenure more than 10 years) exhibit higher patent filing compared to local employees³³. In fact, returnees in the tenure group less than 1 year and tenure group between 2-4 years exhibit lower patent filings compared to the average local inventor. Columns 2-5 test for whether reporting to a returnee manager leads to higher patenting and the results indicate strong support for a statistically significant relation between being connected to a returnee manager and higher patent filings. Column 2 tests for this relation controlling for tenure, returnee status of the inventor and organizational groups. In addition, columns 3-5 control for social ties between the inventor and his/her manager.

However, the most interesting results are presented in columns 4 and 5. In these two columns, I employ the identification strategy discussed in Section III.C and only consider inventors who are new graduates. Column 4 considers all new graduates and column 5 considers new graduates with 1-2 years tenure. Here, the coefficient of interest is on the dummy variable *is_manager_returnee* and both these columns confirm a positive and highly statistically significant effect of having a returnee manager on local employee patenting. In fact, I get a larger positive coefficient on the *is_manager_returnee* dummy variable for new graduates compared to the general sample.

Next, I look at the coefficients on the control variables. Manager patenting (measured by *mgr_prior_patent_grants*) has a negative effect on patenting for direct reports. This negative effect is statistically significant for new graduates and this allows me to control for several of

³³ In fact, the 37 returnees in this tenure group file almost 6 times more patents than the average local inventor

the alternative hypotheses of why returnee manager direct reports might exhibit higher patenting. Among the demographic ties, I find that common college and ethnic ties with one's manager have a negative effect on the patent filings of a direct report. These results allow me to control for the hypothesis that there is selection of direct reports based on common demographics or social relationships.

[TABLE 2a ABOUT HERE]

IV.C. Resource vs. knowledge brokerage role of returnees

I then test for the resource brokerage and knowledge brokerage roles of returnees - whether having returnee ties helps local inventors access distant knowledge, distant resources or both. For this I consider two sets of dependent variables – (i) patent counts/whether or not the inventor has patented and (ii) number of headquarter co-patentees/number of citations to headquarter patents. The first set of dependent variables are related to both the resource and knowledge brokerage roles of returnees, the second set of dependent variables are related to only a knowledge brokerage role. Results are reported in Table 3 and indicate that having a returnee manager does not lead to higher number of headquarter co-patentees or a higher number of backward citations to patents filed at the headquarters and other global locations. This suggests evidence of a resource seeking story (related to securing resources from headquarter based product teams) vis-à-vis a knowledge sharing story. Collectively, I interpret these results as local inventors leveraging returnee managers to gain funding for knowledge creation projects.

[TABLE 3 ABOUT HERE]

IV.D. Robustness checks

Next, I subject my main result, 'the returnee manager effect' to a battery of robustness checks.

I first check for whether the assignment of returnee versus local managers to new graduates is indeed plausibly random and run the following test: I test whether manager assignment can be predicted using pre-treatment variables like educational institution and ethnic/college links between new graduates and prospective managers. To do this, I create a pre-treatment variable '*is_newhire_iit*' to account for whether the new graduate went to the elite Indian Institute of Technologies (IITs) versus other national and state level engineering colleges

in India. I also create three other pre-treatment variables, ‘*mgr_shares_college*’, ‘*mgr_shares_ethnicity*’ and ‘*mgr_shares_homestate*’ to account for college, ethnic and home-state ties between the new graduate and the prospective manager. Given that all these pre-treatment variables should create a systematic bias towards being allocated a returnee manager, I test for whether such a systematic bias exists. Being from an IIT does not predict future manager assignment with any statistical significance, having a college tie with one’s manager has a negative effect on being assigned a returnee manager and being from the same ethnicity has a positive effect of being assigned a returnee manager. In summary, the pre-treatment variables do not suggest any systematic bias in manager assignment and validates the plausible randomness of manager allocation to new graduates.

Next, I test for whether local managers with strong headquarters relationships at the have the same effect on their direct reports as returnee managers. This would validate or invalidate my proposition that direct reports are able to leverage the ties of their returnee managers in the headquarters in securing patent filing funds. To test this, I replicate Table 2a using the mirror image variable of *is_mgr_returnee*. Here I use *is_mgr_local* (dummy set to 1 if the employee has a local manager) as my main independent variable. Given that travel to the headquarters seems to be valid mechanism for building social relationships at the headquarters, I also interact *is_mgr_local* with number of trips made by the manager to the headquarters (*is_mgrlocal*times_hqtrips*). I find that having a local manager has a negative effect on patent filings but if the local manager travels to the headquarters, there is a compensating positive effect on patenting, though not statistically significant. This result is robust to choice of specification (Poisson with QML standard errors versus zero inflated negative binomial) and is robust to controlling for the employee’s own travel to the headquarters. In summary, local managers who build their social relationships in their headquarters start looking like returnee managers, the more and more they travel³⁴.

Next, I test the returnee manager effect using alternate specifications, alternative dependent variables and subject the result to falsification tests. First, I replicate Table 2a using a zero inflated negative binomial (ZINB) specification and Poisson with robust standard errors and get similar results (positive and statistically significant coefficient on *is_mgr_returnee*;

³⁴ Detailed analyses available with author

dummy variable using same set of controls³⁵). Results are in Tables 2b-2c. As a robustness check, I also use a propensity scores based matching analysis to analyze the effect of having a returnee manager on patent filings. As Table A1 indicates, the average treatment effect of having a returnee manager on patent filings is positive and statistically significant. I estimate the propensity scores using several pre-treatment covariates including organizational group, functional area, job title and returnee status and run several matching algorithms including n-nearest neighbor, radius, kernel and local linear matching³⁶.

As a robustness check, I use a different dependent variable (patents granted instead of patents filed) and the results stay consistent. I also use ‘*has_filed_patent*’ (dummy set to 1 if inventor files at least one patent) as the dependent variable and the results stay consistent. Results are reported in Tables 2d-2e. In addition, I use a different set of dependent variables not related to patenting. Given the virtual community data described earlier, I count the number of online knowledge communities for each inventor (*num_grps_know*). I find that having a returnee manager leads to a positive and statistically significant effect on number of online knowledge groups an inventor belongs to. However, when I conduct the same analyses using number of IT administration groups an inventor belongs to (*num_grps_IT*), I do not get this effect. The argument here is that the number of knowledge groups should be an indicator of knowledge creation and sharing efforts of an employee, however the number of IT admin groups should not be directly related to knowledge creation and sharing efforts of an employee. In the former case, having a returnee manager has a positive effect (just like patents), in the latter case, having a returnee manager does not have a positive effect.

Also, instead of using manager patent grants as a control variable, I use manager patent filings as a control variable and the results remain consistent. I also repeat the regressions of Table 2a for various sub-samples of the population and get the following results: the effect of having a returnee manager on higher patent filings is positive and significant for groups that are more involved in intellectual property development; however there is no effect for groups that

³⁵ In the ZINB specification, to identify ‘inflate’, the equation that determines whether or not the count is equal to zero, I use returnee status and organizational group

³⁶ A useful summary of various matching algorithms is provided by Caliendo and Kopeinig (2006). I also account for the bias correction issue documented by Abadie and Imbens (2006). The authors analyze the asymptotic efficiency of n-nearest neighbor matching when n is fixed and show that the simple matching estimators include a conditional bias term of order $O(N^{-1/k})$ where k is the number of continuous covariates. Additionally they suggest a new estimator for the variance that does not require consistent non-parametric estimation of unknown functions. This approach is codified by Abadie et al. (2004) and the relevant Stata command is *nnmatch*

are not directly involved in intellectual property development (e.g. testers) are considered as a sub-sample. Finally, instead of using multiple measures of demographic and college ties between managers and direct reports, I use the composite index of social ties (*mgr_shares_soc_reln_index*) and the results remain consistent.

V. Discussion

Is the phenomenon of multinationals setting up R&D centers in emerging markets related to the return migration of scientists and engineers from the U.S. to countries such as China and India? Though the literature has seen a lot of independent interest in these two phenomena, there have been no prior studies which integrate the two. In this paper, I use micro data (employment, travel and demographic records) of returnees at a Fortune 50 R&D center in India and study whether return migration facilitates knowledge creation at distant R&D centers of multinationals.

In summary, I have two major findings: (i) for local inventors, being assigned a returnee manager increases probability of patenting (odds ratio ~ 4). This result is robust to the ‘new graduates’ exclusion criterion and controls for patenting by the manager, common demographic and college ties between manager and direct report and tenure, organizational group dummies; (ii) based on the evidence presented in Tables 2-3, I get support for the resource seeking explanation for why returnee ties leads to higher patenting. While having a returnee manager leads to higher patent filings (Tables 2a-2e), as Table 3 indicates, having a returnee manager does not lead to higher number of headquarter co-patentees or a higher number of backward citations to patents filed at the headquarters and other global locations³⁷. This suggests evidence of a resource seeking story (related to securing resources from headquarter based product teams) vis-à-vis a knowledge sharing story³⁸. Collectively, I interpret these results as local inventors leveraging returnee managers to gain funding for knowledge creation projects³⁹. To try and account for endogeneity and selection issues, I use knowledge of HR practices (e.g. using the new graduate exclusion criterion).

³⁷ In robustness checks, I interact number of virtual knowledge communities that a manager belongs to with the *is_manager_returnee* dummy and find no positive and statistical relation between this interaction term and patenting by the direct report. This gives further credence to the ‘resource seeking’ hypothesis

³⁸ An early hypothesis to explain this finding is based on the fact that the Indian R&D center of TechMNC is involved in exploratory research rather than exploiting knowledge from other global locations. This is based on the Levinthal and March, 1981 framework. This also relates to the home base augmenting motive of opening R&D centers in emerging markets, forwarded by Kuemmerle (1997)

³⁹ Consistent with the theoretical framework in Section III, these results suggest that over time local employees build their own credibility and social relationships at the HQ and do not require returnee co-authors on their patents (as P_L increases)

My study has several limitations. Given that I study one single firm setting, further analysis is needed before the results can be generalized to a broader set of multinational firms across a broader set of emerging markets⁴⁰. Secondly, though there is a long tradition in the innovation literature of using patents as the measure of knowledge creation, future work should consider other plausible measures of knowledge creation⁴¹. In addition, though the theoretical model presented in the appendix suggests that TechMNC might be acting optimally in its assignment strategy of returnees and local inventors, I do not fully explore the economic costs (litigation, opportunity costs) of allowing even one patent to potentially fall through the cracks. Finally, in future work I plan to explore how returnees are different from other kinds of expatriates and other ways in how returnees make a unique contribution to local knowledge creation (e.g. by engaging local partners).

However, my results make several contributions to the literature. Most importantly, I find evidence that returnees help local inventors seek resources for knowledge creation projects. Though prior literature has extensively documented the effect of mobility on knowledge sharing (by bridging distant contexts/inventor ties), this study provides empirical evidence that inventor mobility could also have an effect on intra-firm resource allocation. In line with the Bower-Burgelman model and related to the ‘issue selling’ framework by Dutton and Ashford, I find that cross border mobility helps better define, broker and seek resources needed for local knowledge creation ideas. This empirical finding brings together two important literatures that are arguable not fully integrated – the literature on inventor mobility and the literature on intra-firm resource allocation. In summary, intra-firm mobility of inventors in multinational firms could have a much bigger impact on knowledge creation than hypothesized by the studies that only consider at the effects of inventor mobility on knowledge sharing⁴². I also fill a gap in the literature by using micro data (employment, travel, patenting records and social relationship data) to study how

⁴⁰ Further analysis is needed to check whether returnees and cross border mobility is an effective mechanism across various typologies of MNCs as summarized by Bartlett and Ghoshal (1989) – transnationals, multinationals, global and international. Also, the organization of TechMNC (distributed R&D centers and centralized product teams all resident in the HQs) has an effect on my result. It allows me to tease out the ‘knowledge sharing’ and ‘resource seeking’ hypotheses. But the analysis needs to be repeated in organizations where both R&D and resource allocation are de-centralized and both R&D and resource allocation are centralized to arrive at a more general finding

⁴¹ As an example, in future work, I plan to use number of different virtual knowledge communities that an inventor is member of, as the dependent variable.

⁴² My results also make a contribution to the literature on knowledge sharing and knowledge spillovers. Though several researchers (most recently Agrawal, 2006, Agrawal, Kapur and McHale, 2008 and Breschi and Lissoni, 2001) have studied the impact of inventor mobility and ethnic/inventor/social networks on knowledge sharing between firms, that literature has not studied how cross border employee mobility and social networks influence knowledge creation inside firms.

knowledge creation in MNCs is related to the cross border mobility of returnees and local inventors. Prior empirical work in this literature is almost entirely based on survey data and the use of micro data and knowledge of HR practices and personal events of individual inventors allows me to try and control for several alternative hypotheses. In summary, just like the prior literature has shown that MNCs tap internal capital markets in emerging markets, I posit that MNCs leverage internal labor markets (returnees) in distant subsidiaries. Though arguably only a first step, this line of research could lead to an ‘internal labor markets view of multinationals’.

Finally, given that this one of the first studies of returnees inside multinational firms, my results are also relevant to the ethnic Diaspora and return migration literatures (Zucker and Darby 2007; Kerr, 2008; Nanda and Khanna, 2009)⁴³. More generally, my research contributes to the literature that looks at constraints to organizational creativity. Researchers like Woodman et al. (1993) outline several constraints to creativity within organizations, including group norms, group diversity, culture, group cohesiveness, etc. My research points out to yet another constraint to organizational creativity - the imperfect distribution of firm social capital to employees. This relates to the way cross-border R&D is organized and to the centralization of patent filing funds, in this case. This also leads to the question of whether centralizing the resourcing decision (as an example to product teams located at the headquarters) results in sub-optimal outcomes.

Anecdotal evidence from TechMNC suggests that centralizing patent resourcing decisions with the HQ based product teams might result in both “good ideas generated by local employees falling through the cracks” and “delay in filing patents”. Delay in filing patents in turn could lead to firms like TechMNC infringing patents filed by other firms and costly litigation⁴⁴. Future research can explore in further detail how centralizing vs. de-centralizing the resourcing decision and relationships between product teams on one hand and R&D teams on the other, affects knowledge creation within multinational firms.

⁴³ There is also a growing literature (Saxenian and Hsu, 2001; Saxenian, 2006) on the theme of ‘brain circulation’ that has studied the effect of highly skilled labor moving from developed to developing economies, Saxenian and colleagues point out several mechanisms by which high skilled migrants help emerging market clusters: they are often a conduit of technology transfer, financial flows and bring in their reputational strengths to emerging market firms. A recent paper in this literature by Oettl and Agrawal (2008) also outlines the concepts of ‘national learning by immigration’ (when a mobile inventor moves cross-border, the inventor’s new country gains from her arrival above and beyond the firm that recruited her) and ‘firm learning from Diaspora’ (the firm that lost the inventor also gains by receiving increased knowledge flows from that individual’s new country and firm). A related literature outlines how connections to co-ethnics in more developed markets might benefit emerging market individuals and firms.

⁴⁴ In structured interviews, I document several examples of patent filings that were delayed because of the initial inability of local employees to secure HQ patent filing funds. Data for this exercise comes from around 30 field interviews I conducted at TechMNC during 2007 and 2008.

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TABLE 1a - SUMMARY STATISTICS OF EMPLOYMENT AND PERSONAL RECORDS

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>fraction tenure < 1yr</i>	1202	0.25	0.43	0	1
<i>fraction tenure = 1-2 years</i>	1202	0.34	0.47	0	1
<i>fraction tenure = 2-4 years</i>	1202	0.28	0.45	0	1
<i>fraction tenure = 4-6 years</i>	1202	0.04	0.20	0	1
<i>fraction tenure = 6-10 years</i>	1202	0.06	0.24	0	1
<i>fraction tenure >10years</i>	1202	0.03	0.18	0	1
<i>fraction jobtitle = business</i>	1315	0.01	0.11	0	1
<i>fraction jobtitle = other IT</i>	1315	0.05	0.22	0	1
<i>fraction jobtitle = software</i>	1315	0.41	0.49	0	1
<i>fraction jobtitle = program mgmt</i>	1315	0.11	0.31	0	1
<i>fraction jobtitle = testing</i>	1315	0.33	0.47	0	1
<i>fraction org grp1</i>	1202	0.28	0.45	0	1
<i>fraction org grp2</i>	1202	0.06	0.23	0	1
<i>fraction org grp3</i>	1202	0.07	0.25	0	1
<i>fraction org grp4</i>	1202	0.15	0.35	0	1
<i>fraction org grp5</i>	1202	0.08	0.26	0	1
<i>fraction org grp6</i>	1202	0.37	0.48	0	1
<i>fraction_is_returnee</i>	1315	0.08	0.27	0	1
<i>fraction_mgr_is_returnee</i>	1118	0.33	0.47	0	1
<i>returnee_tenure_at_subsidiary(years)</i>	104	2.44	2.05	0	10
<i>fraction_married_2006or2007</i>	1315	0.04	0.19	0	1
<i>fraction_kids_2006or2007</i>	1315	0.02	0.15	0	1

Notes:

This data was collected from multiple sources within TechMNC: tenure, job title and organizational group data for individual employees, was collected from personnel records. Returnee status and returnee relocation data was collected from HR. Data on employee marriages and child-births was collected from individual team administrative assistants. The assistants maintain a log of these events as TechMNC presents a personal gift voucher to employees who get married or who have children.

TABLE 1b - SUMMARY STATISTICS OF TRAVEL AND PATENTING RECORDS

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>num_trips_HQ</i>	1315	0.40	0.85	0	7
<i>num_trips_US</i>	1315	0.47	1.01	0	11
<i>num_trips_China</i>	1315	0.01	0.09	0	2
<i>pat_fil_2004</i>	1315	0.01	0.17	0	5
<i>pat_fil_2005</i>	1315	0.01	0.09	0	2
<i>pat_fil_2006</i>	1315	0.05	0.30	0	3
<i>pat_fil_2007</i>	1315	0.10	0.54	0	11
<i>pat_fil_2008</i>	1315	0.04	0.25	0	3
<i>pat_gr_1994</i>	1315	0.00	0.03	0	1
<i>pat_gr_1995</i>	1315	0.00	0.10	0	3
<i>pat_gr_1996</i>	1315	0.00	0.08	0	2
<i>pat_gr_1997</i>	1315	0.01	0.18	0	5
<i>pat_gr_1998</i>	1315	0.01	0.24	0	7
<i>pat_gr_1999</i>	1315	0.00	0.06	0	1
<i>pat_gr_2000</i>	1315	0.01	0.12	0	3
<i>pat_gr_2001</i>	1315	0.00	0.09	0	3
<i>pat_gr_2002</i>	1315	0.02	0.23	0	6
<i>pat_gr_2003</i>	1315	0.01	0.10	0	2
<i>pat_gr_2004</i>	1315	0.01	0.12	0	3
<i>pat_gr_2005</i>	1315	0.01	0.14	0	3
<i>pat_gr_2006</i>	1315	0.02	0.20	0	4
<i>pat_gr_2007</i>	1315	0.01	0.08	0	2

Notes:

1. This data was collected from multiple sources within TechMNC: data on patent grants and patent filing was collected from the intellectual property management group.
2. Data on employee travel was collected from the travel desk, this data was a list of trips made by employees and listed employee name, dates of travel and airport codes.
3. I then had to merge this data to the personnel records using the employee names (and accounting for abbreviations, spelling mistakes, etc.) and had to count number of trips to the headquarters and other locations using the airport codes.

TABLE 1c - SUMMARY STATISTICS OF SOCIAL AND KNOWLEDGE NETWORKS

Variable	Obs	Mean	Std. Dev.	Min	Max
num_grps_social	1279	11.99	9.48	0	73
num_grps_know	1279	67.25	50.37	0	392
num_grps_admin	1279	15.15	16.81	2	83
num_grps_local	1279	27.57	14.46	0	89
num_grps_org	1279	5.14	4.16	0	37
mgr_shares_college	1078	0.01	0.12	0	1
mgr_shares_ethnicity	1078	0.01	0.12	0	1
mgr_shares_homestate	1078	0.003	0.06	0	1

Notes:

1. This data was collected from multiple sources within TechMNC: data on patent grants and patent filing was collected from the intellectual property management group.
2. To identify social relationships, for each inventor, I collected information on their membership within ‘virtual communities’. Employees at TechMNC can voluntarily join virtual communities online. The virtual communities are used to post information on the topic of interest and plan events. In addition to social and knowledge based groups, I collected information on virtual groups related to IT administration and general administration.
3. Employees of TechMNC’s India R&C center have membership on 12,680 virtual communities and I physically coded them as ‘social’ (653 communities), ‘knowledge’ (9,456 communities), ‘admin’(486 communities), ‘organizational’(431 communities) and ‘IT admin’ (1,654 communities) based on the ‘name’ and ‘description’ of each group and rules determined jointly with TechMNC executives.
4. Using the name and description’ of each social group, I also classified the 653 social groups into the following categories – college ties, ethnic ties and home state ties
5. In the next step, for all 1315 employees, I then identified which groups they belong to. Data is available for 1279 out of the 1315 employees and this yields 152,101 inventor-virtual group rows. In the final step, for each manager-direct report pair, I identified social ties related to common ethnicity, college and home town

TABLE 2a: RETURNEES, RETURNEE DIRECT REPORTS AND PATENTING (BASE SPECIFICATION)

	Dependent Variable				
	(1) num_pat_fil	(2) num_pat_fil	(3) num_pat_fil	(4) num_pat_fil	(5) num_pat_fil
manager_is_a_returnee	-	0.66** (0.28)	0.77*** (0.29)	1.97*** (0.69)	2.77** (1.10)
prior_pat_grants_of_mgr	-	-0.02 (0.03)	-0.02 (0.03)	-10.43*** (0.64)	-0.87*** (0.33)
mgr_shares_college_tie	-	-	-0.47 (0.72)	-17.04*** (1.09)	-15.71*** (0.95)
mgr_shares_ethnic_tie	-	-	0.24 (0.44)	-16.02*** (1.41)	-
mgr_shares_homestate_tie	-	-	-28.15*** (0.57)	-	-
is_returnee *(tenure_less_than1yr)	-13.65*** (0.79)	-13.96*** (0.94)	-25.08*** (1.08)	-	-
is_returnee *(tenure_1-2yrs)	1.03 (1.00)	1.18 (0.80)	0.96 (0.69)	-	-
is_returnee *(tenure_2-4yrs)	-16.51*** (0.33)	-16.75*** (0.38)	-28.74*** (0.40)	-	-
is_returnee *(tenure_4-6yrs)	-0.41 (0.83)	-0.38 (0.84)	-0.09 (0.87)	-	-
is_returnee *(tenure_6-10yrs)	-0.56 (0.55)	-0.13 (0.51)	-0.44 (0.46)	-	-
is_returnee *(tenure_more_than10yrs)	18.19*** (0.59)	18.21*** (0.66)	15.77*** (0.86)	-	-
tenure_1-2yrs	1.49*** (0.57)	1.46** (0.58)	2.22*** (0.77)	2.98** (1.34)	-
tenure_2-4yrs	3.02*** (0.52)	2.95*** (0.52)	3.64*** (0.72)	2.61** (1.21)	-
tenure_4-6yrs	3.84*** (0.59)	3.77*** (0.60)	4.39*** (0.80)	-14.81*** (2.07)	-
tenure_6-10yrs	4.36*** (0.61)	3.77*** (0.59)	4.48*** (0.79)	4.71*** (1.55)	-
tenure_more_than10yrs	-14.12*** (0.00)	-14.21*** (0.00)	-11.00*** (1.22)	-	-
Dummies for org groups	Yes	Yes	Yes	Yes	Yes
Sample	Entire sample	Entire sample	Entire sample	Fresh college hires only	Fresh college hires with tenure 1-2 yrs
N	1202	1118	1045	215	73

Notes:

- Column 1 analyzes effect of being returnee on patenting. Columns 2-5 analyze effect of having returnee manager on patenting. Columns 4 and 5 are of main interest as they consider only new graduates. Column 4 considers all new grads and column 5 considers new grads with tenure between 1-2 years
- As the base specification, I use weighted quasi-maximum likelihood (QML) Poisson and to implement a QML Poisson model, I use the generalized linear model with Poisson family and use the iterative reweighted least square option
- *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level

RAJ CHOUDHURY – RETURN MIGRATION AND DISTRIBUTED R&D IN MULTINATIONALS

TABLE 2b: RETURNEES, RETURNEE DIRECT REPORTS AND PATENTING (ADDITIONAL SPECIFICATION 1)

	(1)	(2)	(3)
	num_pat_fil	num_pat_fil	num_pat_fil
manager_is_a_returnee	0.77*** (0.29)	1.82*** (0.68)	2.77** (1.10)
prior_pat_grants_of_mgr	-0.02 (0.03)	-11.34*** (1.92)	-0.88*** (0.28)
mgr_shares_college_tie	-0.47 (0.72)	-19.62*** (1.32)	-17.85*** (1.36)
mgr_shares_ethnic_tie	0.24 (0.44)	-19.98*** (1.04)	-
mgr_shares_homestate_tie	-13.23*** (1.00)	-	-
is_returnee *(tenure_less_than1yr)	-11.19*** (1.17)	-	-
is_returnee *(tenure_1-2yrs)	0.96 (0.69)	-	-
is_returnee *(tenure_2-4yrs)	-14.85*** (0.40)	-	-
is_returnee *(tenure_4-6yrs)	-0.09 (0.87)	-	-
is_returnee *(tenure_6-10yrs)	-0.44 (0.46)	-	-
is_returnee *(tenure_more_than10yrs)	16.38*** (0.56)	-	-
tenure_1-2yrs	2.22*** (0.77)	2.50 (1.30)	-
tenure_2-4yrs	3.64*** (0.72)	3.12*** (1.18)	-
tenure_4-6yrs	4.39*** (0.80)	-37.48*** (1.92)	-
tenure_6-10yrs	4.48*** (0.79)	5.35*** (1.35)	-
tenure_more_than10yrs	-11.61*** (0.93)	-	-
Dummies for org groups	Yes	No	Yes
Sample	Entire sample	Fresh college hires only	Fresh college hires with tenure 1-2 yrs
Pseudo R2	0.29	0.46	0.48
N	1045	215	73

Notes:

1. This table summarizes results for an additional specification to test the effect of having a returnee manager
2. Here, I use a Poisson specification with robust SEs; robust standard errors are in parentheses
3. Column 1 relates the effect of having a returnee manager on patenting; columns 2 and 3 test the same for all college hires and college hires with very low tenure respectively
4. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level

RAJ CHOUDHURY – RETURN MIGRATION AND DISTRIBUTED R&D IN MULTATIONALS

TABLE 2c: RETURNEES, RETURNEE DIRECT REPORTS AND PATENTING (ADDITIONAL SPECIFICATION 2)

	(1)	(2)	(3)
	num_pat_fil	num_pat_fil	num_pat_fil
manager_is_a_returnee	0.77*** (0.25)	2.04** (1.02)	2.61*** (0.88)
prior_pat_grants_of_mgr	-0.01 (0.02)	-17.13*** (2.03)	-2.71*** (0.27)
mgr_shares_college_tie	-0.57 (0.65)	-29.47*** (0.99)	-37.19*** (1.41)
mgr_shares_ethnic_tie	0.61 (0.42)	-25.88*** (1.48)	-
mgr_shares_homestate_tie	-15.02*** (1.00)	-	-
individual_is_returnee	-0.97* (0.38)	-	-
tenure_1-2yrs	2.28*** (0.76)	2.95 (1.86)	-
tenure_2-4yrs	3.59*** (0.74)	2.23 (1.38)	-
tenure_4-6yrs	4.33*** (0.81)	-27.09*** (2.03)	-
tenure_6-10yrs	4.59*** (0.79)	4.80*** (1.83)	-
tenure_more_than10yrs	5.32*** (0.92)	-	-
Dummies for org groups	Yes	Yes	Yes
Sample	Entire sample	Fresh college hires only	Fresh college hires with tenure 1-2 yrs
N	1045	215	73

Notes:

1. This table summarizes results for an additional specification to test the effect of having a returnee manager
2. Here, the specification is ZINB. For the inflate parameters, I use whether or not the individual is a returnee and organizational dummies
3. Column 1 relates the effect of having a returnee manager on patenting; columns 2 and 3 test the same for all college hires and college hires with very low tenure respectively
4. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level

TABLE 2d: RETURNEES, RETURNEE DIRECT REPORTS AND PATENTING (ADDITIONAL SPECIFICATION 3)

	(1)	(2)	(3)
	has filed_pat	has filed_pat	has filed_pat
manager_is_a_returnee	0.70*** (0.20)	1.59** (0.67)	1.89* (1.07)
prior_pat_grants_of_mgr	-0.01 (0.02)	-10.83*** (0.65)	-0.79** (0.33)
mgr_shares_college_tie	0.25 (0.71)	-16.76*** (1.05)	-15.73*** (0.95)
mgr_shares_ethnic_tie	0.30 (0.32)	-16.11*** (1.27)	-
mgr_shares_homestate_tie	-15.28*** (0.81)	-	-
tenure_1-2yrs	1.84** (0.76)	2.21* (1.18)	-
tenure_2-4yrs	3.09*** (0.72)	2.30* (1.23)	-
tenure_4-6yrs	3.43*** (0.76)	-15.11*** (2.04)	-
tenure_6-10yrs	3.62*** (0.74)	2.84** (1.35)	-
tenure_more_than10yrs	3.63*** (0.78)	-	-
Dummies for org groups	Yes	Yes	Yes
Sample	Entire sample	Fresh college hires only	Fresh college hires with tenure 1-2 yrs
N	1045	215	73

Notes:

1. Column 1 relates the effect of having a returnee manager on patenting; columns 2 and 3 test the same for all college hires and college hires with very low tenure respectively
2. Here, the specification is QML Poisson with dependent variable being whether or not the individual has filed a patent
3. Column 1 relates the effect of having a returnee manager on patenting; columns 2 and 3 test the same for all college hires and college hires with very low tenure respectively
4. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level

RAJ CHOUDHURY – RETURN MIGRATION AND DISTRIBUTED R&D IN MULTINATIONALS

TABLE 2e: RETURNEES, RETURNEE DIRECT REPORTS AND PATENTING (ADDITIONAL SPECIFICATION 4)

	(1)	(2)	(3)
	num_pat_fil	num_pat_fil	num_pat_fil
manager_is_a_returnee	2.55*** (0.67)	7.00** (6.52)	8.39 (11.06)
prior_pat_grants_of_mgr	0.98 (0.03)	-	-
mgr_shares_college_tie	1.31 (1.26)	-	-
mgr_shares_ethnic_tie	2.06 (1.44)	-	-
mgr_shares_homestate_tie	-	-	-
individual_is_returnee	0.88 (0.37)	-	-
tenure_1-2yrs	7.40** (5.86)	12.36* (18.36)	-
tenure_2-4yrs	32.13*** (24.44)	16.58* (27.75)	-
tenure_4-6yrs	55.41*** (46.99)	-	-
tenure_6-10yrs	76.38*** (64.59)	30.08* (57.58)	-
tenure_more_than10yrs	88.65*** (87.80)	-	-
Dummies for org groups	Yes	Yes	Yes
Sample	Entire sample	Fresh college hires only	Fresh college hires with tenure 1-2 yrs
Pseudo R2	0.28	0.3	0.23
N	1040	159	53

Notes:

1. Column 1 relates the effect of having a returnee manager on patenting; columns 2 and 3 test the same for all college hires and college hires with very low tenure respectively
2. Here, the specification is Logit with dependent variable being whether or not the individual has filed a patent. The coefficients on the independent variables measure the odds ratio
3. Column 1 relates the effect of having a returnee manager on patenting; columns 2 and 3 test the same for all college hires and college hires with very low tenure respectively
4. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level

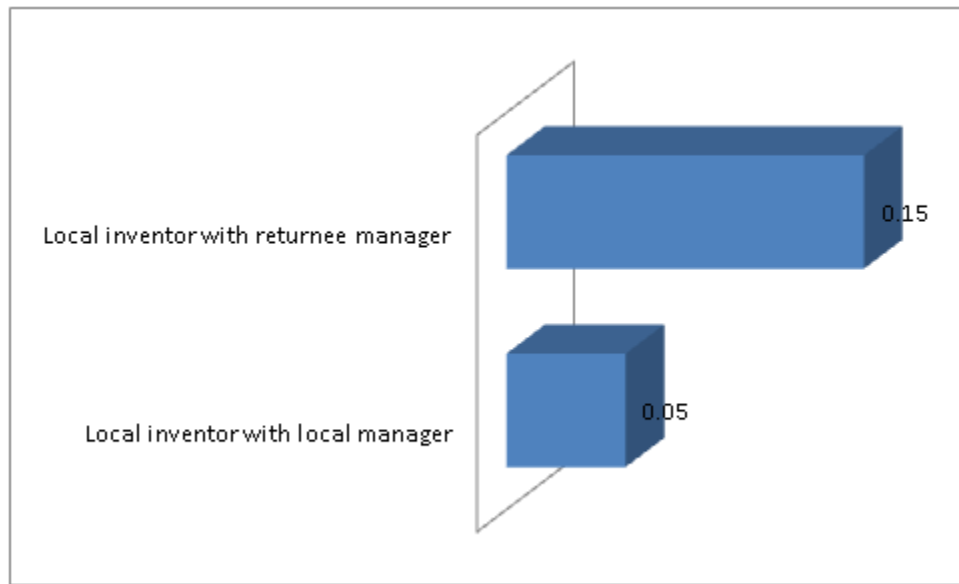
TABLE 3: REGRESSION RESULTS - TESTING FOR KNOWLEDGE BROKERAGE STORY

	(1)	(2)	(3)
	avg_HQ_inventors_fil_pats	avg_HQ_inventors_fil_pats	avg_self_cites
manager_is_a_returnee	-0.25 (0.18)	0.14 (0.28)	0.70 (0.80)
prior_pat_grants_of_mgr	0.01 (0.01)	0.03 (0.03)	-0.05 (0.04)
avg_tot_inventors_fil_pats	0.33*** (0.03)	-	-
avg_tot_cites	-	-	0.20*** (0.04)
individual_is_returnee	0.44 (0.32)	-0.47 (0.50)	-0.87 (0.61)
tenure_1-2yrs	0.83** (0.35)	-0.87 (1.64)	-
tenure_2-4yrs	0.73*** (0.28)	-0.90 (1.50)	-
tenure_4-6yrs	0.42 (0.27)	-1.01 (1.53)	-
tenure_6-10yrs	0.37 (0.36)	-0.44 (1.63)	-
tenure_more_than10yrs	0.59 (0.47)	-0.25 (1.58)	-
Dummies for org groups	Yes	Yes	Yes
Pseudo R2	0.37	-	0.5
Model	Poisson with robust standard errors	ZINB	Poisson with robust standard errors
N	108	108	29

Notes:

1. This tables reports results for checking whether returnee managers play a knowledge brokerage role and whether ties to a returnee manager leads to either a higher number of headquarter co-patentees or a higher number of backward citations to patents filed at the headquarters and other global locations
2. Columns 1-2 test for whether having a returnee manager leads to a higher number of headquarter co-patentees while column 3 tests for whether having a returnee manager leads to a higher number of backward citations to patents filed at the headquarters and other global locations
3. As the table suggests, I do not find evidence of a knowledge brokerage story

FIGURE 1 – Fraction of employees who file a patent, effect of having returnee manager



Notes:

1. This graphic compares the fraction of employees who file a patent, by different organizational groups
2. The independent variable of interest is whether or not the local inventor has a returnee manager
3. Among local inventors who have a returnee manager, the fraction of inventors who file a patent is around 0.15. Among local inventors who have a local manager, the fraction of inventors who file a patent is around 0.05.

TABLE A1: ROBUSTNESS CHECKS USING PROPENSITY SCORE MATCHING ANALYSES
EFFECT OF HAVING RETURNEE MANAGER AND HQ TRAVEL ON PATENTING (USING ALL EMPLOYEES)

Treatment: Manager is expat Outcome variable = num_pat_fil						
Matching Algorithm		ATT	SE	ATE	SE	N
Nearest neighbor (bias corrected) nnmatch command						
	M=2	0.07	0.07	0.09*	0.05	1118
	M=4	0.06	0.07	0.12**	0.05	1118
	M=10	0.06	0.06	0.10**	0.05	1118
Radius matching (caliper=0.05)		0.08	0.07	0.06	-	1045
Kernel matching						
	bw(0.2)	0.16**	0.07	0.11	-	1045
	bw(0.5)	0.17**	0.06	0.13	-	1045
	bw(0.6)	0.18***	0.06	0.14	-	1045
Local linear matching (bw=0.2)		0.14***	0.00	0.09	-	1045

Notes:

1. Nearest neighbor bias corrected uses the algorithm specified by Abadie Drukker Herr and Imbens (2004)
2. To generate propensity scores, I use data on organizational groups, functional area, job title, tenure, returnee status, whether manager is returnee, etc.
3. All estimates use common support region which drops incomparable units in both the treatment and control groups
4. For Kernel matching, I use the Epanechnikov kernel option

Appendix: Stylized Model

In this section, I model the decision of an MNC subsidiary to hire a local versus a returnee inventor. The subsidiary decision is driven by three considerations: (i) the difference in unobserved ability of the two inventors, (ii) the probability that the two inventors are able to secure headquarter funding for their respective projects modeled as a function of their social capital at the headquarters and (iii) the difference in salary costs for the two inventors. I use a highly stylized framework and comparative statics to analyze how the gaps in ability, social relationships and salaries affect this decision and how this might change over time. In constructing this framework, I use both prior theoretical concepts as well assumptions formulated from interviews with executives of the technology multinational firm that I study.

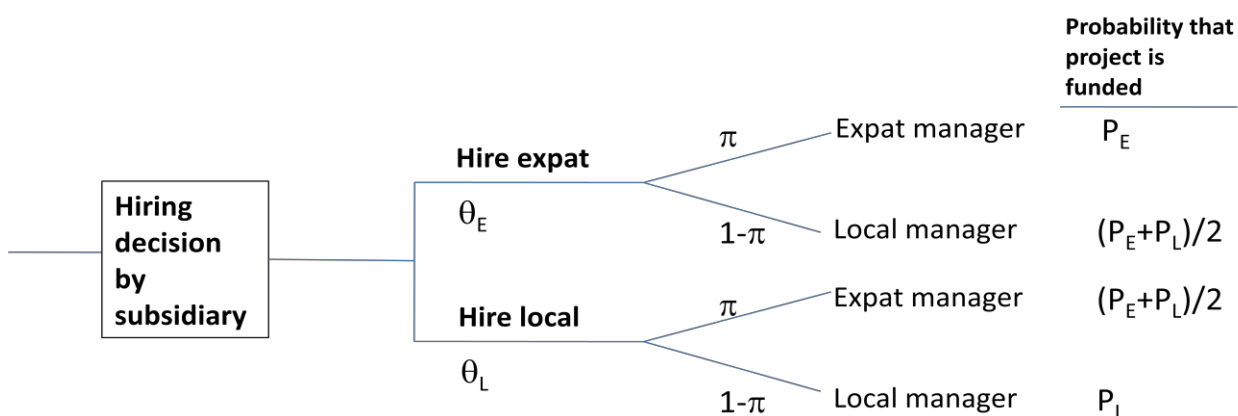
I assume that the technology multinational ('TechMNC') has two R&D locations: the headquarters (HQ) and the emerging market subsidiary (S) and the subsidiary is faced with a recruiting decision of whether to hire a returnee inventor or instead, hire a local inventor. The returnee manager has unobserved ability θ_E and the local manager has unobserved ability θ_L . Both the returnee manager and local manager are being considered for a specific R&D project at the subsidiary and the technological value of the project is measured by the unobserved ability of the inventor who works on the project. The subsidiary utility is maximized by securing a patent for the technology created and a larger stock of patents not only acts as a reputational signal for the subsidiary as a whole, securing a patent increases the social status of individual inventors⁴⁵. Here, the implicit assumption is that patenting is a measure of knowledge creation at this MNC subsidiary.

I model the patent filing process at TechMNC as a budget constrained process and this implies that not every idea that applies for patent filing funds receives the same. There is considerable competition among individual inventors in securing patent filing funds. Based on the Stein (1997) framework, I assume a mediating role for HQ in allocating resources to competing knowledge creation projects and assume that patent filing funds only reside with

⁴⁵ In discussions with subsidiary managers of TechMNC, several benefits of being granted a patent for a locally developed technology emerge. Most of the subsidiary projects are components of larger headquartered projects and a higher stock of patents acts as a reputational signal for the subsidiary in securing new projects from the head-quarters. In addition, securing a patent acts as a reputational signal for TechMNC inventors among their larger communities. One of the established social practices at TechMNC is for each patent holder to get a 'patent cube', a small plaque, at the end of the patent grant. During my field-work at TechMNC, I have found inventors prominently displaying their patent cubes on their cubicle desks and during interviews I have found that a higher stack of patent cubes on an inventor's cubicle desk signals higher status for the inventor in his/her project team and larger community

‘HQ’. However this is not a restricting assumption and I relax this last assumption in the appendix⁴⁶. I also assume that there is information asymmetry across cross-border teams for technologies at the pre-patent filing stage. This information asymmetry is related to the tacitness and non-codifiability of the knowledge developed at the pre-patent filing stage, a concept well documented in the literature. The information asymmetry is also related to the geographical distance between ‘HQ’ and ‘S’.

Returning to the recruiting decision of the subsidiary, I assume that whether or not the technology developed by the new recruit will receive patent filing funds will depend on two parameters: (i) the quality of technology measured by the unobserved ability of the inventor (θ_E or θ_L) and (ii) the ability of the inventor and his/her manager to secure headquarter funding for the technology⁴⁷. I model this using the following figure:



In case the subsidiary hires a returnee inventor and the returnee inventor receives a returnee manager, the probability that the project is funded is equal to P_E . In case a local inventor is hired and the local inventor receives a local manager, the probability that the project is funded is equal

⁴⁶ The fact that patenting is a budget constrained process is a key insight that comes out of the field interviews with managers of TechMNC. Here, inventors submit a list of ideas every quarter requesting for patent filing funds and only a fraction of the ideas receive the same. There is also considerable competition among individuals in securing patent filing funds as is evinced by the social prestige attached to receiving a ‘patent block’. However, the fact that I assume the entire funds are available with the headquarters is not a restricting assumption. In a more general model, the subsidiary shares the total funds available for patenting. The predictions of the model do not change as long as the subsidiary has less funds than local ideas seeking funds

⁴⁷ In a more general version of this model, one could relax the resourcing decision from being a purely patent filing decision to a more general decision of whether or not to fund a new and ex-ante non codifiable technology

to P_L . In the two other cases (local hire with returnee manager and returnee hire with local manager), the probability that the project is funded is equal to $(P_E+P_L)/2$.

I now outline the payoffs to the subsidiary in case it hires a returnee (V_E) and in case it hires a local inventor (V_L). Following the outline presented above,

$$\text{Payoff from hiring returnee } (V_E): \pi\theta_E P_E + (1 - \pi)\theta_E \frac{P_E+P_L}{2} - C_E$$

$$\text{Payoff from hiring local } (V_L): \pi\theta_L \frac{P_E+P_L}{2} + (1 - \pi)\theta_L P_L - C_L$$

$$\text{Let } \Delta V = V_E - V_L.$$

$$\text{For simplicity, I also assume that } \theta_E = 1, \frac{\theta_L}{\theta_E} = \theta \text{ and I assume } P_E = P_L + \delta$$

Simple calculations yield that

$$(1) \Delta V = \frac{\pi\delta}{2} + P_L + \frac{\delta}{2} - \frac{\pi\theta\delta}{2} - \theta P_L - \Delta C$$

$$\text{Here, } \Delta C = C_E - C_L$$

Further simplification of (1) yields that for $\Delta V > 0$,

$$(2) \delta > 2\left[\frac{\Delta C + P_L(\theta - 1)}{1 - \pi(\theta - 1)}\right]$$

This is the condition for the subsidiary to hire the returnee inventor over the local inventor. Condition (2) provides a cutoff value for incremental probability that the project of the returnee inventor will be funded and also implies that as $\Delta C \uparrow$, $P_L \uparrow$ or $\theta \uparrow$, $\delta \uparrow$. In other words, as the salary differential between the returnee and local inventor (ΔC) goes up or the probability that the project of the local inventor gets funded (P_L) increases or the ability gap between the local and returnee inventors (θ) increases, the returnee inventor needs a compensating increase in probability that his/her project gets funded. Comparative statics also yields the following results:

$$\frac{\partial \Delta V}{\partial \theta} = -\left(\frac{\pi\delta + 2P_L}{2}\right) < 0$$

and

$$\frac{\partial}{\partial \delta} \frac{\partial \Delta V}{\partial \theta} = -\left(\frac{\pi}{2}\right) < 0$$

This implies that as the ability gap between the local and returnee inventor increases, the difference in payoff from hiring the returnee inventor reduces. However, this reduction in payoff goes down as the returnee inventor increases the probability that his/her project will be funded.

Comparative statics also yield that

$$\frac{\partial \Delta V}{\partial \delta} = \frac{\pi}{2} + \frac{1}{2} - \frac{\pi\theta}{2}$$

This implies that an increase in probability that the returnee inventor is able to get his/her project funded doesn't always lead to a higher subsidiary payoff from hiring the returnee inventor. The subsidiary payoff only increases in case $\theta < \frac{1}{\pi} + 1$, i.e. in case the ability gap between the local and returnee inventors is less than the computed upper-bound. Comparative statics also yields that

$$\frac{\partial}{\partial \theta} \frac{\partial \Delta V}{\partial \delta} = -\frac{\pi}{2} < 0$$

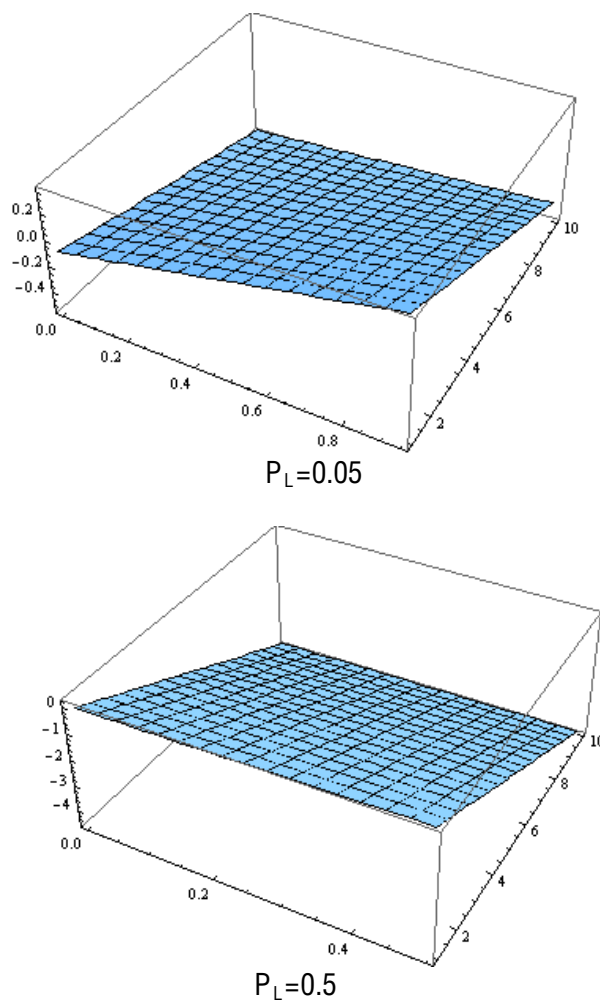
This implies that the increase in subsidiary payoff from increasing the returnee inventor's probability of getting his/her project funded itself reduces as the ability gap between the local and returnee inventors does up. Lastly, the model helps create an understanding of the subsidiary decision making process over a period of time. One would expect the probability that the local inventor is able to secure funding for his/her project to increase over time as the local inventor establishes social connections with headquarter decision makers. Using condition (2), this would imply a higher P_L which in turn would require a higher δ if the returnee inventor is to add value. In other words, over time the returnee inventor needs a higher and higher compensating probability of getting his/her project funded. This would imply that over the long term, the subsidiary should hire lesser number of returnee and higher number of local inventors.

Figure A1 illustrates the predictions of the model. Both the top and bottom panels outline the difference in payoff from hiring the returnee over the local inventor (ΔV) as a function of ' δ ' (the additional probability that the returnee can get the project funded) and ' θ ' (the ratio of the abilities of the local and returnee inventors). The top panel outlines the case when the local inventor assigned to a local manager has a low probability of getting his project funded ($P_L=0.05$). The bottom panel outlines the case when the local inventor assigned to a local manager has a high probability of getting his project funded ($P_L=0.5$). Inspection of the top panel suggests that the difference in payoff from hiring the returnee and local inventors takes

both negative and positive values based on set of values taken by the parameters δ and θ . The figure also confirms that the additional payoff by hiring a returnee inventor increases with ' δ ' and decreases with ' θ '. As the returnee inventor increases the probability of funding a project, ΔV increases, similarly as the local inventor ability increases vis-à-vis the returnee inventor, ΔV decreases. However, the bottom panel suggests that with high values of P_L , there is no additional payoff from hiring a returnee inventor ($\Delta V < 0$). This implies that over time, as local inventors build their credibility and social relationships at the HQ and as P_L increases, the subsidiary may not benefit from hiring a returnee inventor.

[FIGURE A1 ABOUT HERE]

FIGURE A1 – Additional subsidiary payoff in hiring returnee over local inventor



Notes:

1. Based on the theoretical framework presented in Section II, this graphic illustrates the additional subsidiary payoff in hiring a returnee over a local inventor. The difference in payoff is plotted on the Z-axis. The difference in payoff is given by the expression $\Delta V = \frac{\pi\delta}{2} + P_L + \frac{\delta}{2} - \frac{\pi\theta\delta}{2} - \theta P_L - \Delta C$
2. The two parameters of interest are δ (the additional probability that the returnee can get the project funded, plotted on the X axis) and θ (the ratio of the ability of the local inventor to the ability of the returnee inventor, plotted on the Y axis). I also parameterize the models as follows: I assume $\pi=0.08$. The parameter π is the probability of being assigned a returnee manager and I assume this to be equal to 0.08, given that 8% of my sample employees are returnees. I also assume θ can take values between 1 and 10 and assume that $\Delta C=0.1$. This is the additional cost of hiring a returnee over hiring a local inventor. I assume $C_L=0$ and $C_E=0.1$ leading to $\Delta C=0.1$.
3. Additionally, in the top panel, I assume that $P_L=0.05$. This is the probability that the local inventor gets his project funded if he gets a local manager. This implies that δ takes values between 0 and 0.95 in the top panel. For the bottom panel I assume $P_L=0.5$. This implies that δ takes values between 0 and 0.5 in the bottom panel.
4. Inspection of the top panel suggests that the difference in payoff from hiring the returnee and local inventors takes both negative and positive values based on set of values taken by the parameters. This panel also confirms the analyses presented in Section II. The additional payoff by hiring a returnee inventor increases with ' δ ' and decreases with ' θ '. As the returnee inventor increases the incremental probability of funding a project, ΔV increases, similarly as the local inventor ability increases vis-à-vis the returnee inventor, ΔV decreases.
5. Inspection of the bottom panel suggests that when P_L increases from 0.05 to 0.5, the additional payoff from hiring a returnee inventor is always negative. That is, in the long run as the local inventor has a high probability of getting his project resourced, there is no value addition by hiring a returnee inventor.