

Seeking Resources or Seeking Knowledge? A Study of Mobility and Knowledge Creation Using Micro Data

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Abstract

I study the effect of inventor mobility on knowledge creation and make two significant departures from prior literature. In contrast to prior studies based on large patent datasets or surveys, I use employment, travel and demographic data for 1315 inventors at an emerging market R&D center of a Fortune 50 multinational. Also, the prior literature has focused on how mobility helps inventors access distant knowledge. In contrast I hypothesize that mobility could additionally help inventors secure resources centralized at a distant location. To test this and to account for endogeneity and selection, I consider inventors who could not travel because they got married/had children and match them to similar inventors without such constraints. I find that not being to travel leads to lower patenting over the next two years. I also find support for the resource seeking hypothesis - travel to the headquarters leads to higher patenting, however travel to non-headquarter R&D locations in Europe and Asia does not have the same effect. Given the centralization of resources at the headquarters for the MNC that I study, I argue that in this context mobility of inventors is related to securing resources for knowledge creation.

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1. Introduction

In this paper, I study the effect of inventor mobility on knowledge creation and make two significant departures from prior literature. In contrast to prior studies based on large patent datasets, I use employment, travel and demographic data for 1315 inventors at an emerging market R&D center of a Fortune 50 multinational (MNC). Also, the prior literature has focused on how mobility helps inventors access distant knowledge. In contrast, I hypothesize that mobility could help distant inventors secure resources centralized at the headquarters. In doing so, I integrate two previously unrelated strands in the innovation and strategy literature – the literature on mobility and knowledge creation and the literature on resource allocation inside the firm.

There is a large body of research in the innovation and strategy literature that documents that new knowledge creation is achieved through the recombination of existing knowledge. 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 inventors can serve as “bridges to distant contexts”. 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 key papers in this area include Jaffe, Trajtenberg and Henderson (1993) and Saxenian (1994) and an excellent summary of this literature is provided by Breschi and Lissoni (2001). Several other papers discuss cross border mobility in the context of the multinational firm. Edstrom and Galbraith (1977) hypothesize that the mobility 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.

However, this literature has solely focused on the effect of mobility in accessing distant knowledge and in doing so, has not explored a second possible effect of mobility – that mobility could help distant inventors secure centralized resources.

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There is however a disconnected yet rich strand of research in the strategy literature that looks at resource allocation inside the firm. 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. A related literature is focused on ‘issue selling to top management’ (Dutton and Ashford, 1993). However, this literature has not explored how mobility could help resource allocation and whether mobile inventors could act as resource brokers. I hypothesize that this might especially be true in the case of firms where resource allocation might be centralized at the headquarters.

In this paper, I try to integrate these two strands of the strategy and innovation literature. I argue that for firms where resource allocation is centralized at the headquarters, mobile inventors who travel from the distant subsidiaries to the headquarters might have preferential access to resources.

My empirical context relates to a Fortune 50 multinational firm where the headquarters are in the U.S. and one of the largest R&D centers is in India. Prior studies of how inventor mobility affects knowledge creation rely mostly on large patent datasets such as the USPTO or on surveys. In contrast, I collect micro data for 1315 inventors at the R&D center and study for whether travel to the headquarters helps local inventors secure resources for knowledge creation projects. I use data on employment, month-wise travel records and patenting records over time. I also use data on membership in online virtual communities to code ethnic, home-state and college ties between employee pairs. In addition, I use specific knowledge of personal events (e.g. which employees get married and have children) to account for selection and endogeneity.

To test for the effect of local employees traveling to the corporate headquarters, I consider employees who could not travel because they got married/had children and match them to similar employees without such constraints. In summary, I have two major findings: (i) Travel to the U.S. headquarters has a positive effect on local employee patenting (odds ratio ~ 2), however (ii) travel to other international locations in Europe or China does not have this effect. Given the centralization of resources at the headquarters for the MNC I study, I argue that travel to the headquarters helps local inventors secure resources for knowledge creation. This result is robust to the ‘had children or got married’ matching experiment. Using micro-data, I attempt to control for several alternative hypotheses for why returnee managers and HQ travel might help local employee patenting.

The rest of this paper is organized as follows: Section 2 presents the theoretical framework, Section 3 reviews the empirical specifications and construction of the dataset, Section 4 presents the results while Section 5 concludes the paper. References, tables and figures are at the end.

2. Theoretical Framework

There is a large body of research in the strategy literature that documents that new knowledge creation is achieved through the recombination of existing and new knowledge. 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”.² 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)³. 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). 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

² 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

³ . Other key papers in this area include Arrow, 1962; Stephan, 1996; Almeida and Kogut, 1999; Klepper and Sleeper, 2005

benefit of geographic proximity is greater for inventors who are not socially close. Similar studies have been done by other researchers. Breschi and Lissoni (2009) find that after controlling for inventors' mobility and for the resulting co-invention network, the residual effect of spatial proximity on knowledge diffusion is greatly reduced. Agrawal et al. (2006) report that knowledge flows to an inventor's prior location is 50% greater than if they had never lived there. Other relevant papers include Singh (2005)⁴ and Singh and Agrawal (2009).

The theory literature on multinationals has long studied the effects of cross border mobility of employees. Edstrom and Galbraith (1977) document that the mobility 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 tasks⁵. 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 individuals, employed at a subsidiary and who had previous direct contact with the headquarters⁶.

Given this literature and given that local inventors in emerging market R&D centers of multinationals 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.

⁴ Singh (2005) documents that knowledge flow between two inventors from the same region is 66% more likely than that between two inventors from different regions. Likewise, all else being equal, knowledge flow between two inventors is three times as likely within than between firms. However, once interpersonal ties have been controlled for, there is a 17% decrease in the effect of geographic co location on probability of knowledge flow, and a 12% decrease in the effect of being within the same firm on the probability of knowledge flow

⁵ 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.

⁶ 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"

However this literature has not explored a second possible effect of mobility on knowledge creation – the fact that mobile inventors could act as resource brokers, especially for firms where resource allocation is centralized at the headquarters or other specific global locations. Local inventors in distant locations of firms face constraints in 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 ideas⁷. 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 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

⁷ 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).

and attention of top management⁸. A related paper is by Birkinshaw (1997) who analyzes the antecedents of “internal market” initiatives within multinationals⁹. This stream of work also benefits from the internal capital markets theory literature, notably Gertner, Scharfstein and Stein (1994) and Stein (1997)¹⁰. Given this literature, I hypothesize that travel to the headquarters could help local inventors define, broker and influence the process of seeking resources for their knowledge creation ideas.

In summary, I hypothesize that travel to the headquarters by local inventors could be related to either or both a knowledge seeking or resource seeking motive. I then use the empirical setting and the micro data to test the validity of either or both of these hypotheses.

3. Empirical specifications and construction of the dataset

3.1. Setup

In my empirical work, I follow the established tradition in the economics literature of empirical work within inside firms. Lazear (1992) and Baker, Gibbs and Holmstrom (1994) are key prime examples of this tradition and both of their studies focus on a single firm¹¹. 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 insider’s understanding of the knowledge creation process at this MNC subsidiary. TechMNC is a Fortune 50 technology company that started its Indian

⁸ A recent paper on issue selling is by Dutton et al. (2002)

⁹ An “internal market initiative” needs high parent-sub communication, strong proven resources (credibility) and a geocentric perspective in the parent company. In terms of process, an internal market initiative needs also needs high internal selling

¹⁰ 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.

¹¹ 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).

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.e. Indians who had worked at the U.S. headquarters and were now returning to work at the Indian R&D center. I was able to conduct structured interviews with the set of top managers at TechMNC's India R&D center and with a sample of mid and entry level 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. All patents filed at the Indian R&D center are U.S. patents and though the patent filing cost was relatively moderate, there was a significant investment of inventor hide time and funds in the pre-patenting stage when an initial idea was converted to a patentable idea. Local inventors needed funding from a product manager at TechMNC's U.S. headquarters to fund their hide time and the resources needed for the pre-patent development phase. In many cases, funding for an idea came from outside the product group that the local inventor belonged to.

In the second step I hand-collected data on employment, travel and 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 next.

3.2. Setting up the Empirical Questions

The theoretical arguments presented in Section 2 leads to the following empirical questions: whether short term travel to the headquarters leads to higher rates of patenting and whether travel to the headquarters helps local inventors access distant knowledge and/or distant resources. 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.

Structured interviews also suggest that frequent travel to the headquarters is a mechanism used by employees to socialize their patentable ideas with the headquarters based product managers. Given this, I test whether employees who travel frequently to the headquarters exhibit

higher patenting rates. However, this analysis is subject to concerns around endogeneity and selection. Using the guidelines prescribed by Ichniowski and Shaw (2006), I collect personal data on specific individuals to try and account for endogeneity and selection. The following subsection summarizes my identification strategy.

3.3. Does traveling to the headquarters lead to higher patenting?

The theoretical framework and structured interviews suggest that it is possible for local inventors to secure headquarter budget for patent filings by traveling frequently to the headquarters. Traveling to the headquarters might create opportunities for local employees to socialize their patentable ideas with headquarter sponsors and this might lead to a higher probability of securing funds.

Similarly, traveling to the headquarters or other global R&D locations might facilitate access to knowledge/inventor ties. However, a simple regression test where patenting is the dependent variable and the number of trips to the headquarters is the independent variable is beset with endogeneity issues, even if it controls for tenure, organizational group, job title and whether or not the inventor has a returnee manager. It is for example conceivable that higher ability inventors travel more frequently to the headquarters and independent of their travel, file higher number of patents.

To try and account for this possible endogeneity, I employ the following identification strategy: I identify inventors at the subsidiary R&D center of TechMNC who got married or had children in the calendar years of 2006 and 2007. Having children or getting married could be conceived as a ‘shock’ that constrains travel to the headquarters or other global locations in the short term. Interviews with HR executives at TechMNC reveal that the biggest short term constraints that such employees faced were related to (i) Getting visas for their children and spouses, which has a lead time of several months and (ii) Getting the kids and spouses covered by short-term health insurance while in the U.S. This was in addition to increased family commitments in having a child or getting married. Over the long term however, these issues get sorted out.

For my identification strategy, I conceive employees who got married or had children as being ‘treated’ with a random personal reason constraining short term travel to the headquarters. I then using propensity scores based matching techniques to identify their nearest ‘control’

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individual(s) among the group that is able to travel. I then compare the short term patenting rates of the treated and control individuals to identify whether travel to the headquarters has a positive effect on the propensity of patenting. I also conduct a series of robustness checks as indicated in Section 4.4.

3.4. Testing the ‘resource seeking’ and ‘knowledge sharing’ hypotheses

In Section 2, I had outlined two possible hypotheses for why cross border mobility could lead to higher patenting. The first hypothesis was related to a ‘knowledge seeking’ explanation, where by mobility leads to bridging of distant contexts and distant inventor ties. The second hypothesis was related to ‘resource seeking’ where returnees and headquarter travel facilitates 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 tests to validate either or both the hypotheses: I check for whether only travel to the U.S. headquarters leads to higher patenting (resource seeking hypothesis) or whether travel to all global R&D locations, including the U.S. leads to higher patenting. If I find that travel to all global locations including the U.S. led to higher patenting, I would be able to conclude that the knowledge seeking hypothesis was validated but would not be able to additionally say anything about the resource seeking hypothesis being validated. Figure 1 outlines this identification strategy.

[FIGURE 1 ABOUT HERE]

3.5. Preparing the dataset

As part of my fieldwork within TechMNC, I collected data on employment records, travel records, patenting, ethnic/college/home-state ties 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. The travel data for example was a listing of 2,593 travel records which listed airport codes of

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source and destination airports, travel dates and person name. I had to physically match employee names from this data with names on the employment records, accounting for misspellings, abbreviations, etc. I had to also infer travel destination names from the airport codes.

Table 1a summarizes employment and personal records of inventors and summary statistics related to travel and patenting are 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 variable relates to how frequently the inventor travels to the headquarters (here I use both a count measure: *num_trips_HQ* and a dummy variable, *has_traveled*).

The main control variables relate to tenure, whether or not the inventor is a returnee, whether or not the manager of the employee is a returnee, organizational group and job title. I control for tenure as inventors with higher tenure could have better access to individuals with knowledge and/or funds at other global locations. I control for organizational group as employees in certain organizational groups could have a higher propensity to file patents. I control for returnee status of the employee and the manager of the employee to account for the fact that being a returnee or having a returnee manager can facilitate access to individuals with either or both knowledge and resources at other global locations. 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. In robustness checks, I consider additional control variables such as patenting by the manager of the inventor. This is related to the fact that patenting could be a team exercise where employees contribute complementary skills – managers with prior patents contributing their knowledge of the legal process of filing a patent and local inventors contributing their technology skills.

[TABLES 1a AND 1b ABOUT HERE]

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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 ties – college ties, ethnic ties and home-state ties. To identify these ties, for each inventor, I collected information on their membership within ‘virtual communities’. Employees at TechMNC can voluntarily join virtual communities online¹². 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 then 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 ties between individual inventors and their managers and create 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 1c¹³.

[TABLE 1c ABOUT HERE]

4. Results

4.1. Summary trends

Figure 2 plots the fraction of inventors who file a patent for different organizational groups. Here I consider the effect of the key independent variable in question – whether or not the local inventor travels to the headquarters. As the graphic indicates, among local inventors, there is

¹² These virtual communities are similar to Facebook communities, however these are specific to TechMNC and reside on the company intranet.

¹³ Details on the virtual communities and the coding rules are available with the author.

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wide variance in the fraction of inventors who file a patent. For local inventors who travel to the headquarters, the fraction of inventors who file a patent is 0.15. However, in the absence of the treatment effect, for local inventors who do not travel to the headquarters, the fraction of patenting is quite low (0.05).

[FIGURE 2 ABOUT HERE]

4.2. Does traveling to the headquarters lead to higher patenting?

Next, I estimate the effect of traveling to the headquarters on patent filings. Using the identification strategy described in Section 3.4, I consider employees who got married or had children in calendar years 2006 and 2007 as ‘treated employees’ and compare them to ‘matched controls’ among the group that is able to travel. In the base case I use nearest neighbor matching and a propensity scores methodology. Matching is done using employee tenure, group, job title, returnee status and returnee status of manager as predictors of travel to the headquarters. Results are reported in Table 2.

In rows 1-3, I report a negative and statistically significant effect on subsequent patenting due to the treatment effect. In rows 4 and 5, I separate these two effects. Having a child has a much more negative effect on subsequent patenting compared to getting married. In the section on robustness checks, I subject the overall result to a battery of tests and find these results to be consistent.

[TABLE 2 ABOUT HERE]

4.3. Testing the resource allocation hypothesis

I also test for whether mobility is related to the knowledge sharing or resource allocation hypotheses. Here I exploit the organizational design of TechMNC – that resource allocation is centralized at the U.S. headquarters, however R&D is distributed across the U.S., Europe and Asia. I test for whether travel to any of these R&D centers leads to higher patenting or whether travel to the U.S. headquarters alone leads to higher patenting. Results are reported in Tables 3-5.

Table 3 considers the effect of travel to the headquarters on patenting. Here, I control for the tenure of the employee, the organizational group the employee belongs to, whether or not the employee is a returnee, whether or not the manager of the employee is a returnee and ethnic, college and home state ties with the manager. Given that my dependent variable is patents and

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based on Wooldridge (1999), in the base case I use a weighted quasi-maximum likelihood (QML) Poisson specification and to implement the same I use the generalized linear model with the Poisson family and use the iterative reweighted least square option. As the results indicate, there is a positive and highly statistically significant relationship between travel to the headquarters and patenting. Among the control variables, having a returnee manager is also positively related to patenting. I do not find a statistically significant relationship between college, home-state, ethnic ties and patenting¹⁴. As a robustness check, I also use alternate specifications like ZINB and also use a different dependent variable (`has_filed_patent`) and the results remain robust.

[TABLE 3 ABOUT HERE]

Next, I conduct tests for whether travel to China and/or Europe leads to higher patenting. If I find a positive relation between travel to China and/or Europe and patenting, I cannot differentiate between the resource seeking and knowledge seeking hypotheses. If on the other hand, I do not find a positive and statistically significant relationship between travel to China and/or Europe and patenting, I can conclude that the resource seeking hypothesis alone is validated. This is given that I have already established a positive relation between travel to the HQ and patenting and all the resources are centralized in this case at the HQ.

Table 4 reports results for whether or not travel to China leads to higher patenting. Controlling for tenure of the employee, the organizational group she belongs to, returnee status, whether or not the manager is a returnee and ethnic, college and home-state ties between the employee and her manager, I do not find a statistically significant relation between travel to China and patenting. In fact, the coefficient of travel is negative in this case.

[TABLE 4 ABOUT HERE]

Table 5 on the other hand tests for whether or not travel to Europe leads to higher patenting. As column 1 indicates, if I do not control for travel to the headquarters, I find a positive relation between travel to Europe and patenting. But when I control for travel to the headquarters and

¹⁴ Given the large negative coefficient on common home-state ties, I exclude this variable from all the regressions in Tables 3-5 and the results remain consistent

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additional control variables (columns 2-6), I do not find a statistically significant relation between travel to Europe and patenting.

[TABLE 5 ABOUT HERE]

In summary, these results help identify the mechanism in play. Under a knowledge seeking explanation, knowledge is available at R&D locations worldwide and travel to any of these locations should lead to higher patenting. On the other hand, under a pure resource seeking explanation, Europe and China and budget neutral locations as far as patent filing funds are concerned and travel to these locations should not lead to higher patenting. Resources in this context are centralized at the headquarters and the fact that I only find a positive and statistically significant relation between travel to the HQ and patenting indicates that a resource seeking mechanism is in play in this context.

4.4. Robustness checks

Next, I subject the results to a battery of robustness checks. As a falsification strategy, in my propensity scores matching analysis, I use patents filed in 2004 and 2005, i.e. patents filed in years prior to the marriage/child bearing event as the dependent variable and find almost no difference in patents filed in 2004 and 2005 between the treated group (that got married and/or had children in 2006 or 2007) and the control group.

I also use a different measure of patenting and consider the variable *has_filed_patent_0608* (dummy set to 1 if inventor has filed one or more patents in 2006-2008) as the key dependent variable and get similar results. I also analyze if the negative effect on patenting decays over time and find that the negative effect on patenting is as high 2 years after the marriage/childbirth event as in the year of the event. This result shows that the decline in patenting is not related only to the immediate shock of a marriage/childbirth event but to other factors. I propose the inability to travel in the short term as a plausible explanation.

I replicate my results result using alternate specifications (Poisson with QML standard errors and ZINB) and using an alternate dependent variable (*has_filed_patent*) and get consistent results. Finally, as a robustness check, I also estimate the effect of traveling to the headquarters on patent filings using a propensity scores estimation method (Table A1) and my results stay consistent.

5. Discussion

In this paper, I study the effect of inventor mobility on knowledge creation and make two significant departures from prior literature. In contrast to prior studies based on large patent datasets or surveys, I use employment, travel and demographic data for 1315 inventors at an emerging market R&D center of a Fortune 50 multinational (MNC). Also, the prior literature has focused on how mobility helps inventors access distant knowledge. In contrast, I hypothesize that mobility could help distant inventors secure resources centralized at the headquarters. In doing so, I integrate two previously unrelated strands of the strategy literature – the literature on mobility and knowledge and the literature on resource allocation inside the firm.

I use hand collected micro data (employment, demographic and travel records) to understand how knowledge creation in multinationals might be related to cross border mobility of employees. In summary, I have two major findings: (i) more frequent travel to HQ by local inventors leads to higher probability of patenting (odds ratio ~ 2) and (ii) travel to the headquarters has a positive effect on patenting by the local employee, however travel to locations in Europe or China does not have this effect. This result is robust to the ‘had children or got married’ matching experiment, specification and choice of dependent variable. This suggests evidence of a resource seeking story (related to securing resources from headquarter based product teams) vis-à-vis a knowledge sharing story (given that travel to Europe and China should have integrated local inventors to global inventor networks)¹⁵. Collectively, I interpret these results as local inventors traveling directly to the headquarters to gain funding. To try and account for endogeneity and selection issues, I use knowledge of personal events (e.g. knowledge of employee marriages and childbirth) and treat either of these events as a shock that constraints travel in the short term.

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 firms across a broader set of markets¹⁶. Secondly, though there is a long tradition in the innovation literature of using patents

¹⁵ 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)

¹⁶ 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

as the measure of knowledge creation, future work should consider other plausible measures of knowledge creation¹⁷.

However, my results make several contributions to the literature. Firstly, I fill a gap in the literature by using micro data (employment, travel, patenting records and social relationship data) to study how knowledge creation in firms is related to the mobility of inventors. Prior empirical work in this mobility and knowledge literature is almost entirely based on survey data or large patent data sets. The use of micro data and the knowledge of personal events of individual inventors allow me to try and control for endogeneity and selection issues.

A key contribution is also that I find evidence that both returnees and travel to headquarters 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 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 sharing¹⁸. This effect could be salient not only for multinational firms but also for single country firms with multiple locations as long as there is resource centralization at the headquarters or other specific locations.

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

¹⁷ 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.

¹⁸ 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.

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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_manager_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.

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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.

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Table 1c - Summary Statistics of Ethnic, Home-state, College Ties between Employee-Manager

Variable	Obs	Mean	Std. Dev.	Min	Max
num_grps_social	1279	11.99	9.48	0	73
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. To identify these ties, 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.
2. 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.
3. 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
4. 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

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Table 2: Propensity Scores Matching for Employees who couldn't travel to Headquarters due to Marriage/Child Birth

#	Definition of treated sample	N	Matching algorithm	ATE estimate (outcome variable: <i>num_pat_fil_0608</i>)
1	Employees who got married or had children in 2006 or 2007	68	Nearest Neighbor (2)	-0.21
2	Employees who got married or had children in 2006 or 2007	68	Nearest Neighbor (4)	-0.21
3	Employees who got married or had children in 2006 or 2007	68	Nearest Neighbor (10)	-0.21
4	Employees who had children in 2006 or 2007	27	Nearest Neighbor (4)	-0.37
5	Employees who got married in 2006 or 2007	44	Nearest Neighbor (4)	-0.05

Notes:

1. This analyses computes the average treatment effect for individuals who couldn't travel in 2006/2007 due to random personal reasons
2. I identified the 68 individuals who couldn't travel in 2006/2007 because they got married and/or they had children. These reasons are assumed to be random personal reasons that would constrain short term travel
3. Rows 1-3 defines 'treated' individuals as employees who either got married and/or had children. Rows 4 and 5 identify the effect separately for employees who had children and employees who got married
4. Using propensity scores (nearest neighbor matching), I identified the closest 'matches' for these 67 individuals who did travel. The caliper size is 0.05
5. The following variables are used to do the matching: tenure, job title, organizational group of the employee, whether the employee is a returnee and whether the employee's manager is a returnee.
6. In the base case I do matching using the four nearest neighbors. As a robustness check, I do the matching using 2 and 10 neighbors as well.
7. The average treatment effect (ATE) is computed based on the difference in patent filings for the subsequent years (2008-2008) between treated individuals and the matched the control group (people who could travel)
8. As a robustness check, I use the bias correction formula suggested by Abadie Drukker Herr and Imbens (2004)

Table 3: Regression Results - Travel to Headquarters and Patenting

	Dependent Variable				
	(1)	(2)	(3)	(4)	(5)
	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil
num_trips_HQ	0.31*** (0.08)	0.32*** (0.07)	0.36*** (0.08)	0.29*** (0.08)	0.35*** (0.08)
employee_is_returnee	-	-0.56 (0.37)	-	-	-0.26 (0.33)
manager_is_returnee	-	-	0.47* (0.27)	-	0.57** (0.27)
manager_shares_college	-	-	-	-0.67 (0.66)	-0.40 (0.67)
manager_shares_ethnicity	-	-	-	0.49 (0.38)	0.42 (0.38)
manager_shares_homestate	-	-	-	-16.12*** (0.86)	-16.37*** (0.90)
Dummies for tenure	Yes	Yes	Yes	Yes	Yes
Dummies for org groups	Yes	Yes	Yes	Yes	Yes
N	1202	1202	1118	1078	1045

Notes:

1. Table 3 tests for whether travel to the headquarters (*num_trips_HQ*) is related to higher patenting
2. The results indicate a positive and highly statistically significant relation between travel to HQ and patenting
3. The dependent variable in the base case is number of patents filed (*num_pat_fil*)
4. I control for whether or not the employee is a returnee, whether the manager is a returnee, ethnic, college and home-state ties between the manager and the employee and for tenure and organizational group that the employee belongs to
5. In the base case, I use a weighted quasi-maximum likelihood (QML) Poisson specification. I replicate the results using a ZINB specification and using a different dependent variable (*has_filed_patent*) and get similar results
6. To implement a QML Poisson model, I use the generalized linear model with Poisson family and use the iterative reweighted least square option
7. For the tenure dummies, I drop out *tenure_less_than_1yr* as the baseline variable.
8. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level
9. Robust standard errors are in parentheses

Table 4: Regression Results - Travel to China and Patenting

	Dependent Variable				
	(1)	(2)	(3)	(4)	(5)
	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil
num_trips_China	-0.45 (0.72)	-0.48 (0.71)	-0.42 (0.75)	-0.47 (0.73)	-0.43 (0.76)
employee_is_returnee	-	-0.47 (0.40)	-	-	-0.30 (0.32)
manager_is_returnee	-	-	0.58** (0.28)	-	0.66** (0.28)
manager_shares_college	-	-	-	-0.76 (0.67)	-0.48 (0.70)
manager_shares_ethnicity	-	-	-	0.50 (0.40)	0.42 (0.41)
manager_shares_homestate	-	-	-	-16.00*** (0.86)	-16.06*** (0.88)
Dummies for tenure	Yes	Yes	Yes	Yes	Yes
Dummies for org groups	Yes	Yes	Yes	Yes	Yes
N	1202	1202	1118	1078	1045

Notes:

1. Table 4 does a falsification test for whether travel to China (*num_trips_China*) is related to higher patenting. No such relation is established
2. The dependent variable in the base case is number of patents filed (*num_pat_fil*)
3. I control for whether or not the employee is a returnee, whether the manager is a returnee, ethnic, college and home-state ties between the manager and the employee and for tenure and organizational group that the employee belongs to
4. In the base case, I use a weighted quasi-maximum likelihood (QML) Poisson specification. I replicate the results using a ZINB specification and using a different dependent variable (*has_filed_patent*) and get similar results
5. To implement a QML Poisson model, I use the generalized linear model with Poisson family and use the iterative reweighted least square option
6. For the tenure dummies, I drop out *tenure_less_than_1yr* as the baseline variable.
7. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level.
8. Robust standard errors are in parentheses

Table 5: Regression Results - Travel to Europe and Patenting

	Dependent Variable					
	(1)	(2)	(3)	(4)	(5)	(6)
	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil	num_pat_fil
num_trips_Europe	0.99*** (0.25)	0.41 (0.33)	0.37 (0.33)	0.39 (0.41)	0.51 (0.38)	0.33 (0.46)
num_trips_HQ	-	0.29*** (0.09)	0.29*** (0.08)	0.30** (0.13)	0.23** (0.11)	0.30** (0.14)
employee_is_returnee	-	-	-0.54 (0.38)	-	-	-0.25 (0.33)
manager_is_returnee	-	-	-	0.45 (0.28)	-	0.54** (0.27)
manager_shares_college	-	-	-	-	-0.65 (0.66)	-0.40 (0.67)
manager_shares_ethnicity	-	-	-	-	0.52 (0.38)	0.45 (0.39)
manager_shares_homestate	-	-	-	-	-16.10*** (0.85)	-16.32 (0.89)
Dummies for tenure	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for org groups	Yes	Yes	Yes	Yes	Yes	Yes
N	1202	1202	1202	1118	1078	1045

Notes:

1. Table 5 does a falsification test for whether travel to Europe (*num_trips_Europe*) is related to higher patenting. Controlling for travel to HQ (*num_trips_HQ*), no such relation is established
2. The dependent variable in the base case is number of patents filed (*num_pat_fil*)
3. I control for whether or not the employee is a returnee, whether the manager is a returnee, ethnic, college and home-state ties between the manager and the employee and for tenure and organizational group that the employee belongs to
4. In the base case, I use a weighted quasi-maximum likelihood (QML) Poisson specification. I replicate the results using a ZINB specification and using a different dependent variable (*has_filed_patent*) and get similar results
5. To implement a QML Poisson model, I use the generalized linear model with Poisson family and use the iterative reweighted least square option
6. For the tenure dummies, I drop out *tenure_less_than_1yr* as the baseline variable.
7. *Denotes significance at the 10-percent level; **Denotes significance at the 5-percent level; ***Denotes significance at the 1-percent level.
8. Robust standard errors are in parentheses

SEEKING RESOURCES OR SEEKING KNOWLEDGE?

Figure 1 – Identification Strategy for Validating Resource Seeking and/or Knowledge Seeking Hypotheses

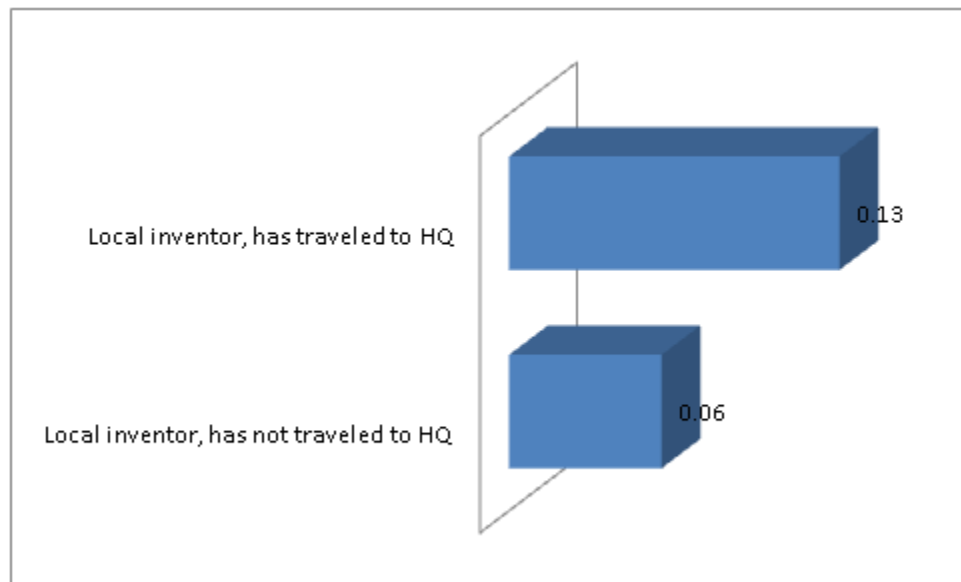
Travel to non-U.S. R&D locations in Europe and China leads to higher patenting?	Yes	Knowledge seeking hypothesis partially validated (only for non-U.S. locations)	Knowledge seeking hypothesis validated. Cannot say anything about resource seeking
	No	Neither resource or knowledge seeking hypotheses validated	Only resource seeking hypothesis validated
		No	Yes
		Travel to the U.S. HQ leads to higher patenting?	

Notes:

1. This graphic outlines my identification strategy related to testing whether mobility facilitates resource and/or knowledge seeking
2. I test for whether travel to the U.S. headquarters leads to higher patenting (horizontal axis) and/or travel to non-U.S. R&D locations in Europe and China lead to higher patenting (vertical axis)
3. The 4 possibilities are identified as follows: (i) if I find that neither travel to the U.S. or non U.S. locations leads to higher patenting, I cannot validate either of the hypotheses; (ii) Given the centralization of resources in this case at the U.S. headquarters, if I find that only travel to the U.S. leads to higher patenting, I can conclude that only the resource seeking hypothesis is validated; (iii) if I find that only travel to non-U.S. locations leads to higher patenting, I can conclude that the knowledge seeking hypothesis is validated for non-U.S. locations and (iv) if travel to both U.S. and non U.S. locations leads to higher patenting that I can conclude that the knowledge seeking hypothesis is validated but cannot say anything about resource seeking

SEEKING RESOURCES OR SEEKING KNOWLEDGE?

Figure 2 – Effect of Traveling to the Headquarters on Fraction of Employees who File a Patent



Notes:

4. This graphic compares the fraction of employees who file a patent, by different organizational groups
5. The independent variable of interest – traveling to the headquarters has a positive impact on whether or not a local inventor files a patent
6. For local inventors who travel to the headquarters, the fraction of inventors who file a patent is around 0.13. For local inventors who do not travel to the headquarters, the fraction of inventors who file a patent is around 0.06.

SEEKING RESOURCES OR SEEKING KNOWLEDGE?

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

Treatment: Employee travels abroad Outcome variable = num_pat_fil						
Matching Algorithm		ATT	SE	ATE	SE	N
Nearest neighbor (bias corrected) nnmatch command						
	M=2	0.22***	0.06	0.20***	0.06	1118
	M=4	0.19***	0.06	0.17***	0.06	1118
	M=10	0.20***	0.06	0.17***	0.06	1118
Radius matching (caliper=0.05)		0.17***	0.07	0.23	-	1089
Kernel matching						
	bw(0.2)	0.22***	0.07	0.29	-	1089
	bw(0.5)	0.24***	0.07	0.26	-	1089
	bw(0.6)	0.24***	0.06	0.26	-	1089
Local linear matching (bw=0.2)		0.18**	0.09	0.19	-	1089

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