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# How has the Mobility of Inventors been Beneficial for Developing Nations?

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**Abstract**

This paper will focus on examining the theory that states the mobility of inventors provides a channel for knowledge dissemination within industries. A United States Patent and Trademark Office (USPTO) dataset is exploited on this research in order to examine which are the factors that affect the probability of an inventor moving companies within one to four years in China. Somewhat surprisingly, the only factor that appears to have an effect on the probability of inventors moving to a different company is the patent experience that the employee has. This suggests that the inventors with the most knowledge in the industry are the ones that move about the most. Consequently, this is interpreted as evidence that these workers transmit knowledge that can be easily copied and implemented without much additional R&D effort.

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## Introduction

Companies are progressively organising their activities on a global scale. The transfer of production processes and facilities to low-wage nations is one of the most frequently seen examples of this trend. However, some business activities have aimed to avoid globalisation, since it was believed that certain activities would define the market leaders in a given industry. These core activities are R&D. Nevertheless, like most (if not all) operations of most firms and especially of the multinational enterprises, the days when R&D labs would be automatically located close to the head office, surrounded by fences and security and kept away from the general public and competition appear to be finally over. Increasingly, companies are carrying out R&D at their international branches, a development made possible by factors such as the modularisation of technologies, open innovation the availability of ICT infrastructures, the removal of trade barriers, and by the mobility of inventors or employees.

In this research paper, the focus lies mainly upon the mobility of employees or inventors, and examines how this phenomenon creates a channel of a somewhat unintended diffusion of R&D-generated knowledge. It is generally acknowledged that R&D creates positive externalities through spillovers. There are two main types of definitions of spillovers used by scholars when examining or testing this singularity. The first one is referred to as rent spillover, which is most likely to occur via the trade of intermediate inputs and capital goods (Griliches, 1992). However, the type of spillover we are going to focus on is the *knowledge* spillover. This type occurs when information is exchanged in a tacit or codified way when people meet, interact, trade or cooperate (Mohnen, 1996). Knowledge spillovers are often captured by a measure of proximity between knowledge source and recipient on the grounds that knowledge spillovers are more likely to happen when the two parties are similar or physically close to each other.

There is a desire for other parties or firms to try and gain advantage or benefit from the positive externalities being created by the spillover of information. This benefit emerges from the close proximity between the parties involved, and causes more and more firms to start clustering in a specific location, creating a 'hot spot' of knowledge. Examples like this have been seen before in places such as Silicon Valley. For this reason, it is predicted that there will be some cities in which the mobility of employees will be low *within* them but high *towards* them What this means is that individuals will be eager to mobilize in order to work *inside* the cities that enjoy high spillovers or successful business activity, but once they are working in those cities, their desire to mobilise will be lower.

This paper will address how knowledge spillover is created by the mobility of inventors or employees that bring with them their knowledge from previous employment. We argue that this knowledge brought forth is then used by the next firm that hires them to its advantage. This will be achieved by using a dataset of patent application and patent grants, which contains information about employees and inventors working for a large number of multinational and local companies. Because of time constraints, the paper will focus on China, since it is a prime example of a country that is growing rapidly in economic terms, mainly due to globalisation caused by various multinational firms making use of its great advances in technology and low-wage labour force. Moreover, this paper will also try to provide insight on how the mobilisation of employees and inventors in China has spurred the globalisation of R&D and how this has been beneficial not only for the foreign companies, but for indigenous Chinese firms as well.

The remainder of this paper is organised as follows. Section 2 briefly reviews the previous literature on the topic of employee mobility and the globalisation of R&D and discusses their common aspects. In section 3, the hypotheses and the econometric model are developed. Section 4 discusses the descriptive statistics and empirical results. Section 5 presents the baseline results and main findings and finally concluding with Section 6, which also includes this research's limitations.

# Literature Review

## Open Innovation & Globalisation of R&D

The idea of 'open innovation' was briefly mentioned in the introduction. This research paper finds it helpful to discuss the idea of open innovation since open innovation has allowed the exchange of ideas and knowledge to flow more smoothly through the channel of diffusion created by employee mobility. One of the primary objectives of this paper is to provide insight on how the mobility of inventors across firms has contributed to the globalisation of R&D and how this has been beneficial for local Chinese firms. Open innovation also has a role in knowledge spillover or knowledge expansion, and consequently contributes to the globalisation of R&D.

Firms investing in new technologies or new applications face uncertain futures. For example, when a new technology is in need of application, the innovating firm usually lacks a well-defined idea of potential target customers and how the technology can create value. How the firm can generate or capture profit only becomes clear after extensive and expensive market research, lead user interactions and investments in application technology. In this case, committing to a new venture prematurely imposes considerable risk. The innovating firm should delay irreversible investments until it has gained enough information that reduces uncertainty to a manageable level.

Closed innovation could be showcased as large and centralized R&D labs, run by large corporations receiving large amounts of funds to discover new inventions that can be used to generate profit in either the long or the short run. This worked very well for a long period of time, however, when ideas started running out, scholars such as Chebrough (2003, 2006), claimed that the internally oriented and centralised approach to R&D had become obsolete. Useful knowledge is widely disseminated and ideas must be used, or sold to other organisations. R&D is becoming increasingly expensive and returns on it are diminishing. This is due to the increase in competition in product markets and shorter product lifecycles.

Such factors encourage the idea of open innovation. Open innovation can be defined as 'the use of purpose inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively' (Chesbrough et al., 2006, p.1). An example of the positive exploitation of open innovation is the provision of funds to public research labs, such as universities, to further explore new inventions and emerging technologies. The findings of these labs are then published, and become freely available for everyone to use. Furthermore, the initial grant given to the university in order to carry out the research is likely to be less than the investment required by the firm to do so internally. These saved resources can then be put into use when finding the application of the invention, in order to create value. Another example of how open innovation can function is for firms to join a research consortium or establish research agreements with partners. Moreover, they can invest in seed capital ventures or corporate ventures, which allow firms to explore technologies or business opportunities in the first phase of the R&D process. By investing in collaborative research or taking a minority position in high-risk external ventures, investing firms learn about this opportunity and in this way decrease initial investment uncertainty.

The main benefit of open innovation besides the reduction of costs is that the knowledge is spilled for others to use. This increases the number of innovative products as well as the possibility for new start up firms to use this knowledge and generate its own ideas.

## Knowledge Spillovers

Past studies have found that there are in fact large flows of knowledge between firms when they expand to foreign nations. Singh (2007) found not only significant knowledge inflows from foreign multinational enterprises (MNE) to host country organisations, but also significant outflows back from the host country to foreign MNEs. In fact, Singh (2007) found that in technologically advanced countries such as China, knowledge outflows to foreign MNCs greatly outweigh knowledge inflows. Even in less technologically advanced countries, knowledge outflows are only slightly smaller than inflows. This suggests that knowledge spillovers are not always negative externalities. In fact, due to the opposing effects of emitting and absorbing spillover information, an efficient labour mobility outcome can be accomplished.

Singh's (2007) findings and subsequent theory are supported by Randaccio and Veugelers (2007). Their research provided a theoretical model of the trade-off that an MNE faces, between centralized and decentralised R&D. Their findings demonstrate that MNEs which expand to foreign nations are able to use the specific knowhow of the subsidiary to avoid having to adapt centrally developed innovations to local markets by using R&D decentralization. In addition, R&D subsidiaries can be used to source external knowhow which is locally available. At the same time, however, R&D internationalisation intensifies the spillover of valuable knowhow to competitors located in the foreign markets. The analysis demonstrates the importance of the intensity of competition in the local market, in determining the size of both the benefits and costs of R&D decentralisation. It shows that when R&D is undertaken abroad in association with production, the local knowledge base is not unequivocally a pulling factor attracting R&D investments by foreign MNEs, depending on the level of local competition (Randaccio and Veugelers, 2007). The paper also shows that efficiency in reverse intra-company technology transfers is a critical factor in benefiting from technology sourcing. The results thus illustrate the complementarity of efficient internal and external knowledge management systems. In addition, the model suggests that with a fall in the cost of intra-company technology transfers, relative market size loses importance as a locational factor for R&D decentralization (Randaccio and Veugelers, 2007).

Nevertheless, it is important to keep in mind that negative spillovers exist. As suggested by De Bondt and Veugelers (1991), some investment decisions made by firms in a duopolistic market are heavily influenced by the presence of spillovers. The competitive incentives towards over (or under) investment are shown to be related to the value of spillover parameters (De Bondt and Veugelers, 1991).

Some research papers even go as far as to study the actions firms take to reduce the outward flow of knowledge through markets for skilled labour. Agarwam, Ganco and Ziedonic (2009), for instance, investigated corporate reputations for toughness in patent enforcement. They conclude that a firm's litigiousness significantly reduces spillovers otherwise anticipated from departures of employee inventors, particularly when the hiring organisations are entrepreneurial ventures. This study not just shows how some firms feel threatened by spillovers, but also tries to prevent the mobility their employees in order to keep their knowledge private.

## Inventor Mobility & Spin-offs

As mentioned above, spillovers are one of the most common ways in which information or knowledge is transferred, sometimes even involuntarily. One of the main causes for spillovers happens to be the mobility of inventors. The mobility of scientists and engineers in labour markets provides a channel for knowledge dissemination within industries, (Arrow, 1692). For example Bhide (1994) found that in a survey of 100 fast-growing private companies, 71 percent of the entrepreneurial founders commercialised ideas that they had come across while working at other companies (Agarwal, Gango and Ziedonis, 2009). In a similar research, Levin, Klevorick and Nelson (1987), reported that hiring employees from rivals enabled established firms to learn about external technologies more efficiently, which increased the speed of imitation.

According to a study by Oettl and Agrawal (2008) which looked at knowledge flows resulting from the cross-border movement of investors, the inventor's new country gains from his or her arrival above and beyond the knowledge flow benefits enjoyed by the firm that recruited him: This was defined by Oettl and Agrawal (2008) as 'National Learning by Immigration'. This suggests that the entire nation will eventually gain benefit from the firm hiring a foreign inventor, who brought with him certain knowledge that was still relatively unknown to the firm and maybe the country. Through the movement of employees and their knowledge, information is able to be spread among many parties facilitating or enhancing the process of globalisation in which everyone eventually benefits. According to J. Robert Oppenheimer, 'The best way to send information is to wrap it up in a person'.

Multinational enterprises are usually the most advanced firms when it comes to R&D, as they normally possess the resources and capital required to carry it out. For this reason, we predict that their presence in a new foreign nation will lead to a positive injection into the local firms, which in turn may benefit from the knowledge which the larger companies bring with them.

Another type of employee mobility in which knowledge is able to diffuse efficiently is through spin-offs. Many of the start-up firms in an industry market are started by employees from incumbent firms using some of their former employer's technological knowhow (Franco and Filson, 2006). This has been observed in the automobile and construction industries, as well as among advertising agencies and law firms (Garvin, 1983; Phillips, 2003). This process may be seen frequently and will eventually lead to many firms using the same process as the first incumbent firm was using. The repetition of this process effectively diffuses the R&D knowledge across the industry, making all companies as efficient as the incumbent. This might seem unfair to some firms, since it might appear that they lose their competitive advantage. However, Franco and Filson (2006), claim that eventually the equilibrium is Pareto optimal because the employees 'pay' for the possibility of learning their employer's knowhow through their labour time.

It is argued that when this spin-off process occurs, the new firm will remain in close geographical proximity to the incumbent. Sometimes this happens due to the fact that the parent firm supported the spin-off: They may have seen potential profit from its creation and it is easier to control a firm that is relatively close to it than if it was further away. On other occasions, the spin-off is not supported by the parent firm but still finds it beneficial to stay in the same location. The former employee might still have some contacts in the region, and may also be more familiar with the target market. Reasons may vary, but after this happens the area starts becoming a hot spot for information and knowledge, attracting more firms and investors and therefore becoming a more lucrative business area for most employees. Moreover, inventors regularly prefer to work in larger firms, where there are generally better chances of learning and growing than in smaller firms. These larger firms tend to be the multinational corporations. In addition, larger firms usually have slack resources (resources left unused or not used efficiently), which employees or inventors can exploit. For example, empty offices that might be used for personal work, or equipment left unused (Kacperczyk, A, 2012).

## Hypothesis

Based on the literature review and theories examined, a number of hypotheses can be proposed in order to approach our research question, namely:

1) An employee is more likely to move to a different firm if he is currently working for a local Chinese firm, when compared to someone working for a multinational firm.

The first hypothesis relates to one of the final points discussed in the literature review. Past studies, such as the work of Kacperczyk, A (2012), have argued that employees exhibit a higher propensity to pursue venturing opportunities in large and mature organisations than in smaller and younger firms. Moreover, this research also suggests that employees already working for a large corporation, are more inclined to pursue better opportunities inside the established firm, than to leave and search for opportunities outside. Kacperczyk suggests large firms allow employees to grow within them, supporting the idea of *intrapreneurship*. The reasoning behind this notion states that as organisations grow older and more complex, they provide employees with more ample resources to launch internal ventures. This theory is also supported by other scholars such as Penrose (1959) that claimed an unused pool of resources inspires an impulse toward growth that motivates employees to take advantage of opportunities for intrapreneurship. These past literatures and findings suggest that employees will rather work for a large firm than a small firm, based on the opportunities that large firms offers. In addition, besides there being a higher propensity to work for a large multinationals, the opportunities that large global firms offer employees might also dissuade them from leaving the firm. For these reasons, the first hypothesis is devoted to examine these notions with regards to Chinese employees mobility, by predicting that Chinese inventors will be more likely to mobilise if they are working for a small local firm and less likely to mobilise if they are working for a large MNE.

2) An employee is less likely to move to a different firm if he is currently working in one of the three big Chinese cities (Beijing, Hong Kong or Shanghai) when compared to someone who is working outside of these three cities.

The second hypothesis is based on the aforementioned theory of 'clustering' or 'hot-spots'. This theorises that firms will tend to be in close proximity to one another in an area where a large amount of knowledge is diffused or spilled. These areas tend to be those that see large amounts of employee mobility. Therefore, the intuition behind this hypothesis is that employees or inventors would rather work for a firm located in one of the three big Chinese cities. We can expect that there will be more MNEs with larger rates of success and therefore "hot-spots" with spillovers to benefit.  This makes working in these places a more lucrative choice, with higher probabilities of personal success, or the opportunity to be recognised as a high level inventor amongst the large international firms. For this reason, an employee will be reluctant to mobilise to a different location other than these three cities.

3) An employee is less likely to move to another firm if he is currently working for a local firm located in one of the three big Chinese cities, as compared to someone working in a firm outside of these cities.

This third hypothesis has been created to test an interaction effect between the *working for a local firm* variable and *working in one of the three big Chinese cities* variable. In our first two hypotheses we will try to prove that an employee is inclined to mobilise to a different firm if the firm he is currently working for is an indigenous Chinese company. In our second hypothesis, it has been predicted that an employee will also find it appealing to mobilise if he gets an opportunity to work in one of the three big Chinese cities. However, there is a possibility that that an employee might find a job in one of the three big Chinese cities, but for a local company. If this is the case there will be a crossover between the first two hypotheses. If this is the case, it will also be necessary to investigate which factor, either the location or the type of firm, an inventor would have a higher affect on an inventor's mobility. This hypothesis predicts that employees will value the *location* of the firm more in this case than the type of firm. The reason for this may be due to the inventor not having the need to work for a MNE in order to enjoy the knowledge diffusion being spilled by them, as long as he is close enough to recognize that spilling. Hence, the eagerness to live inside the three big cities close to all the MNEs and hotspots is larger than the desire to work in a MNE located in an area far away from Shanghai, Beijing or Hong Kong.

4) An employee is more likely to move firms when he has patenting experience.

This fourth hypothesis is based on the idea that while an inventor is patenting and obtaining more working experience, he increases the level of his skills. This also means that he expects higher returns for his skills and is more prone to seek for better economic opportunities in a new place that may offer this. Another option that may affect his mobility is that firms might recruit him cause he has been recognized as an efficient employee. Moreover, an inventor with more experience might also find a way to become more valuable on his own or in a small company, rather than at a large firm that takes him for granted amongst his peers. On the other hand, there is also a possibility that an employee could be a talented inventor that has worked for years at a small local firm, and then is attracted to the possibility of working in a large multinational corporation. He can then make use of all its slack resources for his own benefit that a small local firm may fail to provide him with.

5) An inventor or employee with patenting experience is less likely to move if he is already working in one of the three big Chinese cities.

This hypothesis was designed with the purpose of testing the interaction effect between the probability of an inventor experienced in patenting moving companies, and whether or not he is working in one of the three big cities. Our first interaction hypothesis was created to observe which variable has a higher influence on the decision to move companies: the location of the firm (whether or not it was in a hotspot) or the type of firm (multinational firm or indigenous Chinese). Following this same reasoning, it would be appropriate to test whether patenting experience is valued more than the location of the firm, when it comes to an inventor deciding whether or not to move.

## Data and Methodology

This part presents the methods applied to this research and a description for the data used for the empirical analysis.

The dataset used for this research is focused on a specific group of employees, described for simplicity as patent applicants. This data comes from the United States Patent and Trademark Office (USPTO). The data entails detailed information regarding inventors such as their names, ID number, the company they work(ed) for, the location of such companies, patent application and grant dates. The dataset contains data from 2000 to 2012 containing 1,834,433 observations, an extremely large sample as it comprises a whole population of inventors. However, our research is limited just to China due to time constraints and once all the data that excludes China is dropped the number of observations falls to 65,353.

The empirical section of the research is calculated using a logit regression. Four dependent variables were created for this regression. These include 'the probability of an inventor moving to a different company within one year' (moved_company_oneyr), 'the probability of an inventor moving to a different company within two years' (moved_company_twoyr), 'the probability of an inventor moving to a different company within three years' (moved_company_threeyr) and 'the probability of an inventor moving to a different company within four years (moved_company_fouryr). Independent variables used were also created and these comprise of 'local firm' (LocalFirm), a dummy variable which takes values of either 1 or 0 if the firm in question is an indigenous Chinese firm (1) or a global international firm (0). 'Three big cities' (BigThree), a dummy variable that takes a 1 if the location of the firm is in either Beijing, Hong Kong, or Shanghai ,or a 0 if its located in any other city in China. An interaction variable between both dependent variables just discussed was formulated (called LocalFirmXBigThree) in order to test the third hypothesis. A fourth explanatory variable is stock of patents (stock_of_patents3). This is a numeric variable, which measures the number of patents that an inventor has applied for within the last 3 years. An interaction variable between stock_of_patents3 and BigThree was also created (stockofpatentsXbigthree), in order to examine the fifth hypothesis. In addition, the lag value of the variable stock_of_patents3 (stock_of_patents3_lag1) was created in order to observe the number of patents an inventor had in the year prior to the one in which he moved to a different firm. Consequently, an interaction variable between this new variable and BigThree was created (stockofpatentslagXbigthree). More independent variables include application year (AppYear), patent class/100 (dInd), and company name (AssgName). Patent class/100(dInd) indicates which patent class/category a patent belongs to. The USPTO identifies 3-digit patent classes from 002 to 987. dInd is a variable created by dividing all 3-digit numbers by 100 and classifying them into one of 0-9 categories. Application year is each year ranging from 2000 to 2012. AssgName is the company that assigned the patent the employee applied for, or in other words, the company the inventor was working for at the time of the patent application.

A logit estimation is used to run regressions using the dependent and independent variables mentioned previously. As a logit estimation is used, the magnitude of the effect of each explanatory variable on the probabilities in question is obtained using average marginal effects. For the robustness of the results, company, time and industry fixed effects are incorporated into the models.

## Descriptive statistics

This section of the research paper will be devoted to describing the database used and variables created for the regressions, in order to test the aforementioned hypotheses.

The database used comes from the USPTO, entailing detailed information regarding inventors and their work history. The database contains information from inventors from an array of countries and companies. Due to time constraints, this paper will focus solely on China. By dropping each variable that did not belong in this category the database was narrowed down to inventors located in China. As a result, the database was reduced to 65,353 observations.

The next step was to identify the multinational corporations and the local Chinese firms in the database: This was carried out by cross-referencing the companies in the database with an up-to-date Fortune 500 firms list. The firms were then coded as either "global firm" if they were one of the Fortune 500, and as "local firm" if not present in the Fortune 500 list. In the dataset there were a total of 2,898 firms located in China, from which 60 were multinational firms and the rest indigenous Chinese. From these 2,898 firms there were 1,742 inventors registered either as working, or as having had worked at some point in their careers for a multinational firm located in China.

The first hypothesis of this paper regarded the mobility rate of employees that worked for a local Chinese firm. As can be observed from Figure 1, the mobility of employees working in an indigenous Chinese firm is higher than the mobility of employees that work in a multinational corporation. Both lines share a similar pattern, although the line representing local firm employee mobility has larger fluctuations. Reasons for this may vary; the benefits of working for local firms may differ quite significantly, based on the employee/employer relationship. As the firm is smaller, the relationship between stakeholders may be more personal than in large multinationals, where more operational ceilings may exist. This may explain why there is more variation in the mobility of local firms than in multinationals. Both types of employees have an initial increase of mobility at the beginning of application year (Appyear) 2002 to 2003, and in 2003 to 2004 mobility decreases in both scenarios. However, local firm employee mobility drops. Once again, in 2004 the mobility rate increases, but is interesting to note that the local employee mobility is steeper. This could be explained through variations between indigenous Chinese firms.

Generally speaking, the mobility rate of employees working in these local firms is more than double the rate of those working in multinationals. This supports the first hypothesis.

In recent years however (2011-2012), there has been a drastic decline in the mobility of employees from both local and multinational firms. This could be a consequence of the recent global economic downturn. Uncertainty of personal financial security was high, which may have led to less risks being taken by inventors, as well as fewer job opportunities existing at companies.

To conclude the results of Figure 1, it is safe to say although both type of employees seem to follow a very similar trend, the mobility of employees working in a local firm seem to be higher than those working in multinationals. In 2002 there seemed to be a large number of openings in the job market. It could be that a large number of multinational firms arrived in China at this time, along with optimal conditions for start-up companies. Consequently, the number of firms increasing improved possibilities for new recruits, therefore enhancing inventor mobilisation.

With respect to knowledge diffusion, it may be interpreted from the results in Figure 1 that knowledge diffuses through local Chinese firms more so than multinationals. This theory is based on the fact that it is more common for local company employees to move firms. A lot of the knowledge that these firms possess becomes generalised by the movement of inventors amongst local companies. Some of the inventors that move from multinational firms to local companies bring overseas knowledge with them. This diffusion of knowledge may allude to the notion that mobility of employees working for multinational corporations appears to be lower. As mentioned in the literature review, some firms try to prevent the mobility of their employees in order to keep their knowledge private (Agarwal, Ganco and Ziedonis, 2009). Local firms are not likely to do this since the effort to hinder knowledge diffusion requires resources and extra work.

This research paper claims that the type of firm that an inventor works for could be a factor in his or her mobility. There are however other factors that should be taken into account. Scholars have referred to "hot spots", which are geographical locations in which vast amounts of information or knowledge is diffused, resulting in an enhancement of the location's efficiency and productivity. A frequently used example of this phenomenon is Silicon Valley.

The second hypothesis was formulised based on this theory. This hypothesis focuses on the fact that inventors would be less willing to move if they were working in Beijing, Shanghai or Hong Kong (Three big cities). These cities were chosen because they are well known commercial cities with a great number of multinational firms within their borders, especially when compared to other Chinese cities.

Figure 2 shows the mobility of employees working within and outside of the three big cities. What can be observed from Figure 2 is that there is a large difference in mobility rates between these two classifications. Again, both lines show similar mobility rate patterns, in that mobility of employees working in the three big cities is much higher than for those working outside of them. This does not support our second hypothesis. Reasons for this occurrence may vary but one explanation may be linked to the idea of hot spots. These three cities are economically very successful, probably offering more job opportunities than most cities in China. Therefore working inside these cities seems the more lucrative option. The number of multinational firms in these cities is higher than in others, and inventors aim to work for them (Kacperczyk, A, 2012). This can lead inventors to attempt to find work in these cities.

Moreover, hot spots not only attract inventors to their specific geographic location, but also entrepreneurs. Ambitious individuals might be attracted to the idea of using this diffused knowledge, particularly since it is condensed into one specific location. The entrepreneur might see this hotspot as a good place to start their own business, which in turn would create more job opportunities and more workers. In addition, the presence of spin-offs, also mentioned in the literature review, is also plausible. When an inventor decides to leave a firm and create a spin-off, that company is commonly situated in close proximity to the parent firm. If the inventor decided to go on his own, then the location close by the incumbent might be a familiar place for him to start his business. This particularly true if the product he intends to sell is very similar. He would have already accrued local market knowledge, and may have built up a local network on contacts. Consequently, these spin-offs would lead to an increase in the number of firms in the area, which would then lead to more jobs, increasing the path or channel for employees to mobilise.

Although in Figure 2 they are very similar, the pattern of the mobility rate of employees working outside the three big cities appears to be more stable. An explanation for this observation could be that within the three big Chinese cities, the economic or business environment is more hectic, in the sense that there are more companies being created and thus more companies going out of business. As a result, the mobilisation of employees may vary a lot more. In other cities, there might be less competition in the market, which implies that firms stay in business for longer. Consequently, there are fewer employees losing their jobs and less unemployed job seekers.  This leads to the result that the mobility of inventors in cities which are not Shanghai, Hong Kong or Beijing is more stable and suffers from fewer fluctuations.

The second hypothesis was based upon the assumption that Shanghai, Hong Kong and Beijing were the most international cities in China. What is meant by international is that these cities are home to many multinational corporations, which often bring with them international workers. In order to support this assumption, Table 1 and Table 2 which can be found below, providing the distribution of firms in Shanghai, Hong Kong and Beijing in comparison to other Chinese cities.

Table 1 shows the distribution of firms in Shanghai, Hong Kong and Beijing. According to the database, Shanghai is the city with the highest number of firms, with 598. Of these 598, 29 are multinational, and registered under the Forbes 500 list.  Therefore in Shanghai, 4.8% of the firms are considered MNEs. Beijing has a total of 523 firms within its borders, of which 20 are multinational firms. This means that 3.8% of the firms in Beijing are MNEs. Finally, Hong Kong has the least number of firms with 264. Of these 264, 8 are multinational, or 3%.

Although Hong Kong appears to have fewer firms than Shanghai and Beijing, it is on average a higher number than other cities in China. Table 2 shows seven other Chinese cities and their firms. If we look at both Tables 1 and 2 we can compare the three big cities against other 'ordinary' cities in China.

From Table 2, ShengZhen has a total of 232 firms and is the only city on the list with more than 100. From these 232, only 3 are considered multinational, resulting in a value of 1.29% as MNEs. Furthermore, three cities from the sample, Nanking, ChangChun and Daqing host no multinational firms. The total number of firms from these 7 Chinese cities is 419. Of that number, 10 are multinational firms, or 2.4%. On the other hand, when we look at both Table 1 and the total number of firms in the three big cities alone, it shows that there are 1,385 companies. From these 1,385, 57 are multinationals and thus make up 4.1% of the total of firms in Shanghai, Hong Kong and Beijing. This supports the assumption, based on the number of firms and MNEs that operate in them, that these three cities are the most international and economically successful cities in China.

Figure 1 Global and Local employee mobility

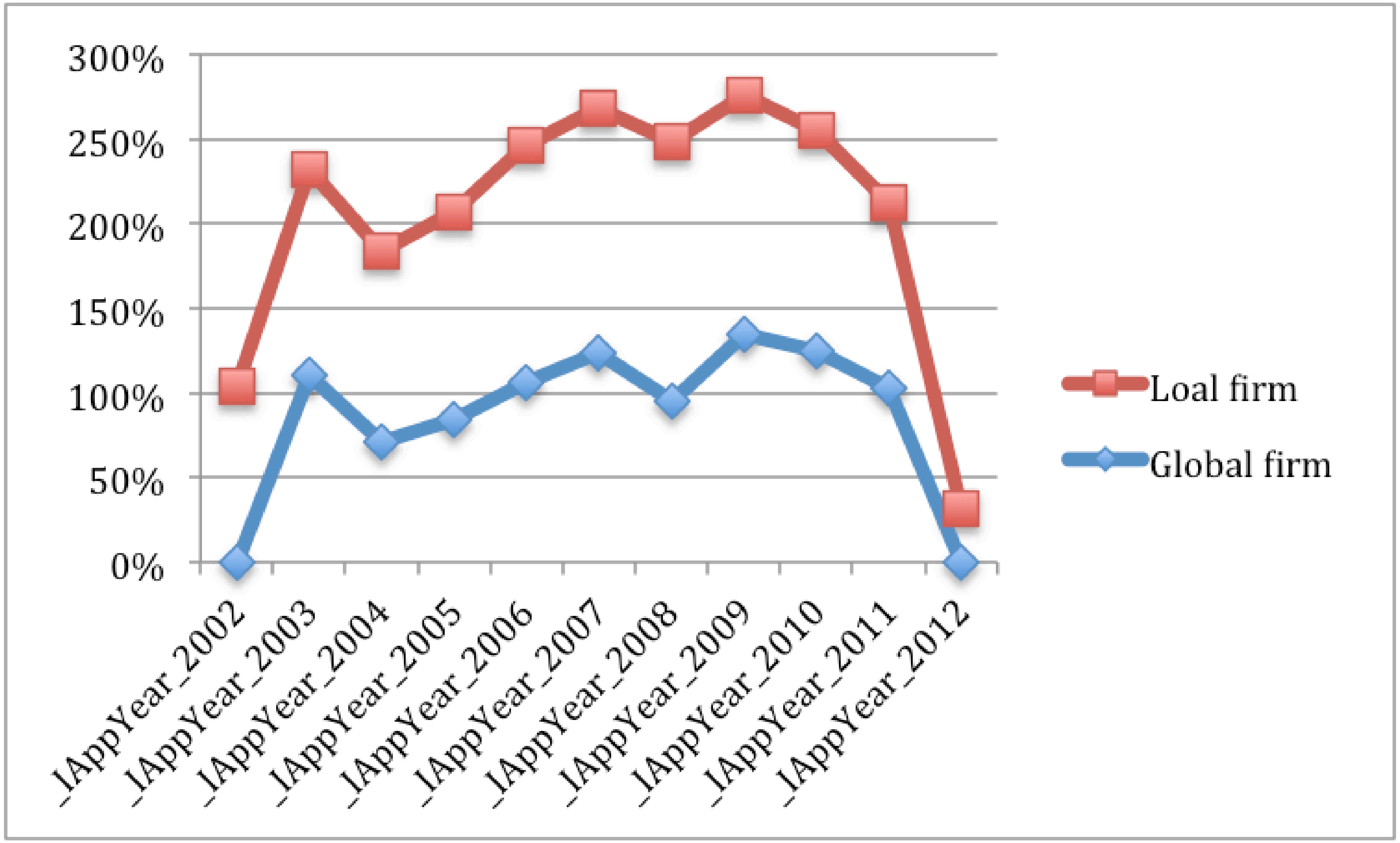

Figure 2 Mobility of Employees working in the three big cities Beijing, Shanghai and Hong Kong

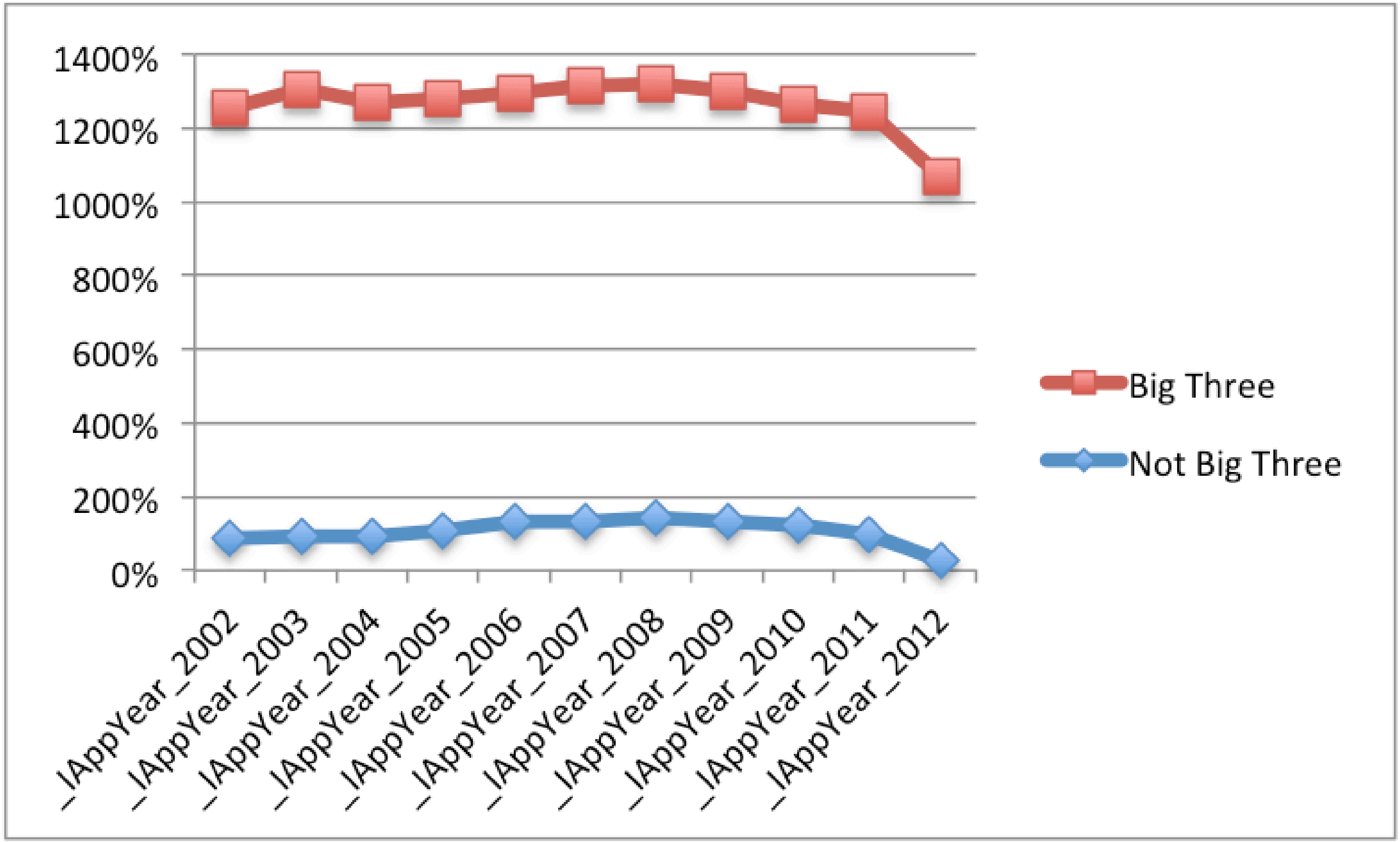

*Table1 Distribution of Firms in the Three Big Cities*

| City | Number of Firms | Number of MNEs | % |
|---|---|---|---|
| Shanghai | 598 | 29 | 4.8 |
| Beijing | 523 | 20 | 3.8 |
| Hong Kong | 264 | 8 | 3 |
| **Total** | **1385** | **57** | **4.1** |

*Table2 Distribution of Firms outside of the Three Big Cities*

| City | Number of Firms | Number of MNEs | % |
|---|---|---|---|
| Kowloon | 32 | 2 | 6.25 |
| Nanking | 3 | 0 | 0 |
| Shengzhen | 232 | 3 | 1.29 |
| Zhe-Jiang | 60 | 1 | 1.7 |
| ChangChun | 18 | 0 | 0 |
| Hang Zhou | 73 | 4 | 5.5 |
| Daqing | 1 | 0 | 0 |
| **Total** | **419** | **10** | **2.4** |

## Results

In this section of the research, the results of the logit regressions that were carried out to answer the hypothesis formulated are presented.

Table 1 below contains the results of the logit model calculating the probability of an employee moving to a different company within 1 year and within 2 years as dependent variables. Below are the coefficients and the average marginal effects for each explanatory variable.

The results show that if an employee works for a local firm instead of a multinational firm, there is a positive but insignificant coefficient on the probability that the employee will move companies within 1 year as compared to an employee who works for a multinational firm. Logit regressions only provide the sign and significance level of the coefficients. Therefore in order to obtain the magnitude of each coefficient the average marginal effects of each explanatory variable was calculated. This result however, due to its significance level, is unable to provide any proper interpretation from where to derive any conclusions. This does not support the first hypothesis, which states that an employee is more like to move companies if he is working for a local firm as compared to an employee who is working for a multinational corporation.

The same explanatory variable was examined but with a different dependent variable. The following logit model on Table 1, examines the *probability of an employee moving companies within 2 years* if he is working for a local company as compared to an employee who is working for a multinational company. The results below show a similar outcome to the previous regression. The coefficient is negative and is not significant, and the average marginal effect is remains at 0.1%. This states just as the previous model that this variable due to its significance level does not provide enough information to formulate any conclusions.

Our second explanatory variable is "*big three*", which refers to whether or not an employee is working in one of the three big Chinese cities, Shanghai, Hong Kong or Beijing. The coefficient of this variable with dependent variable *probability of moving firms within one year* appears to be negative and significant. As for the average marginal effect, it has a value of 2.8%. This states that if an employee is working in one of the three big cities, the probability of him moving to a different company within one year decreases by 2.8% as compared to someone working outside these three cities, ceteris paribus.

The effect of the same explanatory variable is examined on our second dependent variable, the *probability of an employee moving firms within two years.* It may be observed that the results vary insubstantially. Once again the coefficient appears to be negative and significant. This time however, the average marginal effect increases to 3.2%. This states that if an employee works in one of the three big cities, the probability of that employee to move to a different company within two years decreases by 3.2% as compared to someone working outside these three cities, ceteris paribus. This supports our second hypothesis which states that an employee would be less likely to move firms if he is working in one of the three big Chinese cities.

The next variable, *bigthreeXlocal*, is an interaction between the first two explanatory variables. This is done in order to test if there is an interaction effect between these two factors, the location and the type of the firm. You basically have an interaction whenever the effect of one independent variable affects the level of effect of the other. In this instance, it will be investigated whether the fact that an employee is working in a local firm which is located in the big three cities changes the initial effect shown by these two variables when tested individually.

The results show that there is a negative and significant coefficient for both the *probability of an employee moving companies within one year* and the *probability of an employee moving companies within two years.* The average marginal effect for the first regression, probability of moving within one year, has a value of 2.7%. Which states that the probability of an employee moving firms within one year, while working for a local firm located in one of the three big cities, decreases by 2.7% as compared to someone working for a local firm outside these three cities, ceteris paribus.

The average marginal effect for the second regression appears to have an increase compared to first one, showing a value of 2.8%. This means that the probability of an employee moving firms within two years, while working for a local firm located in one of the three big cities, decreases by 2.8% as compared to someone working for a local firm outside these three cities, ceteris paribus. These results support our third conclusion, which states that an inventor or employee is less likely to move firms if he is working for a local firm that is located in one of the three big Chinese cities.

The fourth hypothesis will be tested by using stock of patents as an explanatory variable with the same two dependent variables. The hypothesis states that an inventor or employee with patenting experience will be more likely to move firms. Our results show the variable is positive and significant in both models. This is interpreted as the probability of moving within one or two years to a different country increases when the inventor is experienced in patenting. Regarding the magnitude of this variable on our dependant variable, in our first model the average marginal effect has a value of 0.5%. Stating that the probability of an inventor moving firms within one year increases by 0.5% by every patent that he obtains, ceteris paribus. On the second model, the average marginal effect has a value of 0.6%, which likewise states that the probability of an inventor moving firms within two years increases by 0.6% by every patent that he or she obtains, ceteris paribus. These results support the fourth hypothesis.

Finally, to test our fifth and last hypothesis an interaction variable between stock of patents and big three was created. The aim of this interaction effect is to examine how an inventor with patenting experience would react to the probability of moving to a different firm once the location factor is implemented into the equation. By itself, an experienced inventor seemed to be highly probable to become mobile. However, it will be interesting to investigate if an inventor would consider a firm's location to be more important than his patenting experience when it comes to make a decision regarding his mobility.

On the first regression, the new interaction variable appears to have a positive and significant coefficient. This means that an inventor is still likely to move if he has a lot of patenting experience even when taking into account the firm's location. The magnitude of this coefficient is of 0.8%. This means that the probability of an inventor to move within one year increases by 0.8% by every patent that he obtains regardless of whether he is working in one of the three big Chinese cities, ceteris paribus.

The second regression appears to show the same results as the first one, even with the same magnitude. Therefore, the probability of an inventor moving companies within two years increases by 0.8% by every patent that he obtains regardless of whether he is working in one of the three big Chinese cities, ceteris paribus. This does not support the fifth hypothesis that predicted an inventor or employee with patenting experience is less likely to move if he is already working in one of the three big Chinese cities.

Table 2 is a continuation of the first two regressions. It takes the next step of the research by examining the probability of movement regarding inventors with the same explanatory variables but into two further years.

The first model's dependant variable is *the probability of an inventor moving within three years* while the second model of Table 2 examines the *probability of an inventor moving firms within four years*. The results appear to be quite similar to those in Table 1. The significance and sign of the coefficients of every explanatory variable show the same pattern as before. *Local Firm* is negative and still insignificant, *Big Three* and *BigThreeXLocalFirm* are negative and significant, and both *stock of patents* and its interaction effect with *Big Three (stockofpatentsXbigthree)* appear to still have a positive and significant coefficient.

The magnitudes of every coefficient however appear to have increased. *Big Three* increased from 3.2% to 3.6%, while *BigThreeXLocalFirm* increased from 2.8% to 3.2%. *Stock of patents* stays stable on 0.6% but *stockofpatentsXbigthree* increased from 0.7% to 0.8%. On the fourth year however, all of them remained stable with the exception of *Big Three*, which curiously fell to 3.5%. This suggests that the significance or sign of the correlation of the dependant variable remains constant through time. But on the other hand, the magnitude of their effect on the probability of an employee moving firms is altered at the end of every year. The magnitudes showed an increase by every additional year up until the fourth year where all of them with the exception of *Big Three* went stable.

Table 3 shows the correlation of all the variables used from the dataset to run the regressions. The results show that stock of patents has the highest correlation with the dependent variables (*moved company, moved company within one year, moved company within two years, moved company within three years and moved company within four years*) than any other variable in the Table and by quite a significant amount. For example, the correlation *of stock of patents* with dependent variable *moved company in four years* is of 0.127. On the other hand, the correlation of *Local Firm* on the same variable is only -0.005. This suggests a loop of causality between the dependent variables and *stock of patents* may exist. This could lead to endogeneity. In other words, the probability to observe high mobility on inventors with a lot of patenting experience could appear to be high because on the database, the inventors with the most patents are the ones that have been moving the most. Therefore, possibly causing the results to be biased. In order to fix this issue another variable was created which is the lag of *stock of patents*. This allows the regressions to be run taking into account the stock of patents each inventor had in the year prior to the one in which they moved; reducing the causality problem.

Tables 4 and 5 show the regressions using as dependant variables probability of moving within 1, 2, 3 and 4 years using same explanatory variables as the regressions on Table 1 and 2. The only exception is that *stock of patents* has been replaced by *stock of patents lag* and also replaced in the interaction variable with *Big Three*.

*Local Firm* appears to show no changes with again a negative and insignificant coefficient, therefore providing no information from where to deduce any conclusions. *Big Three* remains negative and significant but its magnitude has increased by a significant amount. On the first model in Table 1 *Big Three* had a magnitude of 2.8%. With the inclusion of *stock of patents lag*, its magnitude increased to 6.3%. Stating that the probability for an employee to move firms within one year, while working for a local firm located in one of the three big cities, decreases by 6.3% as compared to someone working for a local firm outside the three big cities, ceteris paribus. This changes nothing regarding the second hypothesis since it is again supported. This variable's sign and significance level remains unchanged in the rest of the regressions of Tables 4 and 5. However, besides an increase in its magnitude in year 2 to 6.4%, the magnitude starts decreasing in years 3 and 4, first to 5.6% and finally to 5.3%. This suggests that the impact this variable has on the probability of an inventor moving companies decreases with time.

Another curious change from the previous regressions is that *BigThreeXLocalFirm* went from being negative and significant, to insignificant once *stock of patents* was replaced by its *stock of patents lag*. This does not support our third hypothesis since its significance level does not allow for any conclusion to be formulated.

Furthermore, the new variable *stock of patents lag* has a positive and significant coefficient. Which means it has a positive correlation to the probability of an inventor moving companies within 1 to 4 years. In addition, the magnitude of this coefficient remains stable at 0.3%. This states that the probability of an inventor moving companies within 1 to 4 years increases by 0.3% by every patent he had the year before prior to his move, ceteris paribus.

The interaction variable between *stock of patents* and *Big Three* has been replaced by an interaction between *stock of patents lag* and *Big Three (stockofpatentslagXbigthree*). This variable also has a positive and significant effect on the probability of an inventor moving. Similarly to *stock of patents lag*, its magnitude remains stable through out the years but at a higher intensity with 0.8%. Stating that the probability of an inventor moving companies within 1 to 4 years increases by 0.8% by every patent he had the year before prior to his move, regardless of the location of the firm, ceteris paribus.

In order to make these results even more accurate its important to control for other factors that may affect an inventor's decision of moving firms. These control variables include: company fixed effects, time fixed effects and industry fixed effects. After adding these control variables to the regressions, it becomes clear that they do have an effect on the rest of the explanatory variables. Table 6 shows six models with dependant variable, *probability of an inventor moving within 1 year.* The first five shows with every explanatory variable independently. This is done in order to observe their individual effect on the dependant variable. Model 6, calculates the regression with all the explanatory variables included in order to observe how they affect each other, after control variables are present. Finally, the rest of the dependent variables probability of inventor moving company within 2, 3 and 4 years are shown in Table 7, calculated with all the explanatory variables in each model.

*Local Firm* remains unchanged, negative and insignificant on Table 6 model (1). *Big Three* however, has become insignificant now that the control variables have been added. This causes our second hypothesis that had been supported in every previous regression to be rejected *BigThree*X*LocalFirm* appears to have become significant and negative. Meaning that it has a negative correlation with the dependant variable therefore an employee will be less inclined to move companies within 1 year if he is working in one of the three big Chinese cities even though he might be working for a local firm, ceteris paribus.

*Stock of patents lag* and *stockofpatentslagXbigthree* appear to be both positive and significant. Therefore the number of patents or the experience an inventor had in patenting the year before he moved firms has a positive correlation with the probability of moving firms within 1 year, ceteris paribus. This factor appears to be more important than the location of the firm, whether its inside the three big Chinese cities or not. The reason for this interpretation is that it can be observed that the interaction variable also has a positive correlation with the probability of moving companies within one 1 year. Meaning that an employee would still be probable to move firms based on his patenting experience, regardless of the location of the firm, ceteris paribus.

Model 6 shows the complete model with all the variables, including the control variables, for the *probability of an inventor moving companies within 1 year*. On this model it appears only *stock of patents lag* and *stockofpatentslagXbigthree* have a significant value. This means we cannot formulate any conclusions for this model based on any of the other variables. Table 7 shows three more models with the same regression but for the remaining dependent variables, probability of moving within 2 years (1), 3 years (2) and 4 years (3). All these models appear to have the same results as the model 6 from Table 6. Every variable has an insignificant value except for *stock of patents lag* and *stockofpatentslagXbigthree*, which have a positive and significant coefficient. This means that the experience an inventor had prior to his move has a positive correlation to the probability of moving companies, regardless of the location of the firm he was working for, ceteris paribus.

Through these regressions we can only support hypothesis 4, which state that an inventor with more patenting experience is more likely to move. Hypothesis 5 is rejected since it stated that an inventor or employee with patenting experience would be less likely to move if he works in one of the three big Chinese cities. As the model results showed, this was not the case. The rest of the hypothesis could not be tested due to the level of significance of the rest of the variables, which were incapable of providing any unbiased information that would have had enable us to reject or accept our hypotheses. Unfortunately, due to time constraints it was not possible to calculate marginal effects for these coefficients in order to obtain its magnitudes.

*Table 1. Logit regression results without with the probability of an inventor to move company within one year and within two years a dependent variable*

| VARIABLES | Moved company within one year | | Moved company within two years | |
|---|---|---|---|---|
| | Coeff | Mfx | Coeff | Mfx |
| local firm | 0.005 | 0 | -0.007 | -0.001 |
| | [0.039] | [0.003] | [0.035] | [0.003] |
| big three | -0.363** | -0.028 | -0.345** | -0.032 |
| | [0.060] | [0.005] | [0.052] | [0.005] |
| bigthreeXlocal | -0.348* | -0.027 | -0.277** | -0.028 |
| | [0.111] | [0.009] | [0.095] | [0.009] |
| stock of patents | 0.069** | 0.005 | 0.063** | 0.006 |
| | [0.003] | [0.000] | [0.010] | [0.003] |
| stockofpatentsXbigthree | 0.076** | 0.006 | 0.073** | 0.007 |
| | [0.003] | [0.001] | [0.010] | [0.001] |
| Observations | 42,151 | 42,151 | 42,151 | 42,151 |
| Industry FE | NO | NO | NO | NO |
| Company FE | NO | NO | NO | NO |
| Application Year FE | NO | NO | NO | NO |
| Log-likelihood | -12152.721 | -12152.721 | -14744.24 | -14744.24 |
| Chi Sqared | 777.52 | 777.52 | 731.11 | 731.11 |
| p value | 0 | 0 | 0 | |

Robust standard errors in brackets

** p<0.01, * p<0.05, + p<0.1

NOTE: The method of estimation is Logit without fixed-effects but with average marginal effects. The dependent variable in the first model is the probability of an inventor moving companies within 1 year, while the for the second model is the probability moving companies within 2 years. Standard errors are clustered at the inventor level.

*Table 2. Logit regression results without controls with the probability of an inventor to move company within two year and within three years a dependent variable*

| VARIABLES | moved city within three years | | Moved city within four years | |
|---|---|---|---|---|
| | Coeff | Mfx | Coeff | Mfx |
| local firm | -0.01 | -0.001 | -0.03 | -0.0043 |
| | [0.033] | [0.004] | [0.033] | [0.004] |
| big three | -0.329** | -0.036 | -0.309** | -0.035 |
| | [0.050] | [0.005] | [0.048] | [0.006] |
| bigthreeXlocal | -0.296** | -0.032 | -0.276** | -0.032 |
| | [0.091] | [0.01] | [0.089] | [0.010] |
| stock of patents | 0.058** | 0.006 | 0.055** | 0.006 |
| | [0.003] | [0.000] | [0.003] | [0.000] |
| stockofpatentsXbigthree | 0.073** | 0.008 | 0.070** | 0.008 |
| | [0.010] | [0.001] | [0.009] | [0.001] |
| Observations | 42,151 | 42,151 | 42,151 | 42,151 |
| Industry FE | NO | NO | NO | NO |
| Company FE | NO | NO | NO | NO |
| Application Year FE | NO | NO | NO | NO |
| Log-likelihood | -15848.236 | -15848.236 | -16397.566 | -16397.566 |
| Chi Sqared | 679.85 | 679.85 | 631.76 | 631.76 |
| p value | 0 | 0 | 0 | 0 |

Robust standard errors in brackets

** p<0.01, * p<0.05, + p<0.1

NOTE: The method of estimation is Logit without fixed-effects but with average marginal effects. The dependent variable in the first model is the probability of an inventor moving companies within 3 years, while the for the second model is the probability moving companies within 4 years. Standard errors are clustered at the inventor level.

*Table 3. Correlation between dataset variables*

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| stock of patents | 1 | 1 | | | | | | | | | | | |
| LocalFirm | 2 | 0.026 | 1.000 | | | | | | | | | | |
| BigThree | 3 | -0.040 | -0.093 | 1.000 | | | | | | | | | |
| LocalFirmXBigThree | 4 | -0.016 | 0.328 | 0.475 | 1.000 | | | | | | | | |
| stockofpatentsXbigthree | 5 | 0.250 | -0.032 | 0.387 | 0.193 | 1.000 | | | | | | | |
| stock of patents lag | 6 | 0.643 | 0.026 | -0.058 | -0.019 | 0.053 | 1.000 | | | | | | |
| stockofpatetnslagXbigthree | 7 | 0.065 | -0.041 | 0.528 | 0.280 | 0.683 | 0.183 | 1.000 | | | | | |
| moved company three years | 8 | 0.133 | -0.002 | -0.036 | 0.030 | 0.057 | 0.072 | 0.023 | 1.000 | | | | |
| moved company four years | 9 | 0.127 | -0.005 | -0.035 | -0.030 | 0.055 | 0.068 | 0.024 | 0.972 | 1.000 | | | |
| moved company two years | 10 | 0.158 | 0.001 | -0.034 | -0.027 | 0.063 | 0.097 | 0.028 | 0.807 | 0.784 | 1.000 | | |
| moved company one year | 11 | 0.143 | -0.001 | -0.034 | -0.027 | 0.061 | 0.079 | 0.027 | 0.941 | 0.915 | 0.858 | 1.000 | |
| moved company | 12 | 0.120 | -0.010 | -0.034 | -0.031 | 0.051 | 0.064 | 0.022 | 0.945 | 0.973 | 0.763 | 0.890 | 1 |

NOTE: table provides the correlation between all the essential variables used in the regressions.

*Table 4. Logit Regression results without controls with the probability of an inventor to move company within one year and within two years a dependent variable taking into account the lag of the stock of patents*

| VARIABLES | Moved company within one year | | Moved company within two years | |
|---|---|---|---|---|
| | Coeff | Mfx | Coeff | Mfx |
| local firm | -0.065 | -0.01 | -0.036 | -0.006 |
| | [0.061] | [0.009] | [0.057] | [0.010] |
| big three | -0.415** | -0.063 | -0.372** | -0.064 |
| | [0.100] | [0.015] | [0.093] | [0.016] |
| bigthreeXlocal | -0.28 | -0.042 | -0.175 | -0.03 |
| | [0.177] | [0.027] | [0.159] | [0.027] |
| stock of patents lag | 0.022** | 0.003 | 0.017** | 0.003 |
| | [0.003] | [0.000] | [0.003] | [0.001] |
| stockofpatentslagXbigthree | 0.050** | 0.008 | 0.048** | 0.008 |
| | [0.013] | [0.002] | [0.012] | [0.002] |
| Observations | 8,967 | 8,967 | 8,967 | 8,967 |
| Industry FE | NO | NO | NO | NO |
| Company FE | NO | NO | NO | NO |
| Application Year FE | NO | NO | NO | NO |
| Log-likelihood | -4295.0022 | -4295.0022 | -4719.3647 | -4719.3647 |
| Chi Sqared | 104.55 | 104.55 | 76.86 | 76.86 |
| p value | 0 | 0 | 0 | 0 |

Robust standard errors in brackets

** p<0.01, * p<0.05, + p<0.1

NOTE: The method of estimation is Logit without fixed-effects but with average marginal effects. The dependent variable in the first model is the probability of an inventor moving companies within 1 years, while the for the second model is the probability moving companies within 2 years. Standard errors are clustered at the inventor level. The model replaces stock of patents with stock of patents lag and stockfopatentsXbigthree with stockofpatentslagXbigthree.

*Table5. Logit Regression results without controls with the probability of an inventor to move company within two year and within three years a dependent variable taking into account the lag of the stock of patents*

| [1]VARIABLES | moved company within three year | | Moved company within four years | |
|---|---|---|---|---|
| | Coeff | Mfx | Coeff | Mfx |
| local firm | -0.023 | -0.004 | -0.005 | -0.005 |
| | [0.056] | [0.010] | [0.101] | [0.010] |
| big three | -0.318** | -0.056 | -0.053** | -0.053 |
| | [0.091] | [0.016] | [0.016] | [0.016] |
| bigthreeXlocal | -0.277 | -0.049 | -0.05 | -0.049 |
| | [0.157] | [0.028] | [0.028] | [0.028] |
| stock of patents lag | 0.015** | 0.003 | 0.003** | 0.003 |
| | [0.003] | [0.001] | [0.001] | [0.001] |
| stockofpatentslagXbigthree | 0.043** | 0.008 | 0.008** | 0.008 |
| | [0.012] | [0.002] | [0.002] | [0.002] |
| Observations | 8,967 | 8,967 | 8,967 | 8,967 |
| Industry FE | NO | NO | NO | NO |
| Company FE | NO | NO | NO | NO |
| Application Year FE | NO | NO | NO | NO |
| Log-likelihood | -4837.1563 | -4837.1563 | -4892.9177 | -4892.9177 |
| Chi Sqared | 68.03 | 68.03 | 62.33 | 62.33 |
| p value | 0 | 0 | 0 | 0 |

Robust standard errors in brackets

** p<0.01, * p<0.05, + p<0.1

NOTE: The method of estimation is Logit without fixed-effects but with average marginal effects. The dependent variable in the first model is the probability of an inventor moving companies within 3 years, while the for the second model is the probability moving companies within 4 years. Standard errors are clustered at the inventor level. The model replaces stock of patents with stock of patents lag and stockfopatentsXbigthree with stockofpatentslagXbigthree.

*Table6. Logit Regression results with controls with the probability of an inventor to move company within one year as a dependent variable*

| VARIABLES | moved company within one year | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| local firm | -0.0389 | | | | | -0.335 |
| | [0.213] | | | | | [0.372] |
| big three | | -0.123 | | | | -0.00157 |
| | | [0.128] | | | | [0.284] |
| bigthreeXlocal | | | -0.458** | | | -0.305 |
| | | | [0.205] | | | [0.396] |
| Stockofpatentslag1 | | | | 0.022* | | 0.0200** |
| | | | | [ 2.26] | | [0.009] |
| Stockofpatentslag1XBigthree | | | | | 0.050** | 0.0491** |
| | | | | | [0.023] | [0.025] |
| Observations | 4,914 | 4,914 | 4,914 | 4,914 | 4,914 | 4,914 |
| Industry FE | YES | YES | YES | YES | YES | YES |
| Company FE | YES | YES | YES | YES | YES | YES |
| Application Year FE | YES | YES | YES | YES | YES | YES |

Robust standard errors in brackets

** p<0.01, * p<0.05, + p<0.1

NOTE: The method of estimation is Logit with industry, company and time fixed-effects but without average marginal effects. The table consists of 6 models all of them with probability of inventor moving within 1 year as dependent variable. The first 5 models represent the effect of every variable individually on the dependent variable, while model 6 shows the complete regression with all the variables included. Standard errors are clustered at the inventor level

*Table7. Logit Regression results with controls with the probability of an inventor to move company within two years (1), three years (2) and four years (3) a dependent variable*

| VARIABLES | | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| local firm | -0.356 | -0.349 | -0.326 |
| | [0.323] | [0.313] | [0.312] |
| big three | 0.164 | 0.239 | 0.213 |
| | [0.267] | [0.260] | [0.257] |
| bigthreeXlocal | -0.314 | -0.525 | -0.495 |
| | [0.362] | [0.364] | [0.361] |
| Stockofpatentslag1 | 0.0161** | 0.0148** | 0.0142** |
| | [0.008] | [0.007] | [0.007] |
| Stockofpatentslag1XBigthree | 0.0442* | 0.0408* | 0.0450** |
| | [0.023] | [0.022] | [0.021] |
| Observations | 4,939 | 4,945 | 4,945 |
| Industry FE | YES | YES | YES |
| Company FE | YES | YES | YES |
| Application Year FE | YES | YES | YES |

Robust standard errors in brackets

** p<0.01, * p<0.05, + p<0.1

NOTE: The method of estimation is Logit with industry, company and time fixed-effects but without average marginal effects. The table consists of 3 models. All models include all the variables with model 1 testing probability of inventor moving within 2 years, model 2 within 3 and model 3 within 4 years. Standard errors are clustered at the inventor level.

## Conclusion

The aim of this research paper was to examine how the mobility of employees may be beneficial for local firms and its impact on the globalisation of R&D in China. The main intuition was that the mobility of inventors creates a channel for knowledge to be diffused amongst the firms. This knowledge being distributed either intentionally or through spillovers can be easily copied and implemented without much additional R&D effort. Consequently, this would lead to the knowledge involved in R&D procedures to become more generalised or as more standard. The presence of MNEs in China suggests that there has been an influx of knowledge, brought in by the international inventors working for these corporations. This occurrence could be beneficial for local firms in China, as they may well be using out-dated or inefficient methods of R&D, which could be improved through utilising new ideas or innovations brought forth by the MNEs.

The final results above show that the hypotheses 1, 2, and 3 are inconclusive due to the lack of significance level. This means that the initial theory –that inventors or employees are more likely to move if they are working for a local Chinese firm in comparison to someone working for a multinational– could not be proven through our logit regression. However, Figure 1 does support this theory to some extent, by showing that there is less mobility for the local firm employees than for the multinational ones. The multinational sector in China faces more mobility, which could suggest that employees or inventors based there strive to work for a multinational corporation. The reasons for this may vary: From the point of view of the inventor, large corporations usually allow more freedom and resources for them to carry out their own work with more ease. As opposed to working at a small firm with one only specific role. Moreover, even if the inventor is young and inexperienced, a large multinational corporation, filled with older, successful and more experience inventors might be an ideal place to start gaining experience to then venture onto something new.

It was shown in Figure 1 that local firm employees have a higher mobility level than an MNE's employee. This might support the theory that since MNE employees are already working for a large corporation, the motivation to move is lower than those working for a local firm, and therefore more movement in that sector can be seen.

In addition, large multinational corporations have settled in China in cities such as Shanghai or Hong Kong: Cities that have been historically prosperous. The results also show that inventors and employees find it lucrative to find a job located in one of these cities. The interaction effect carried out (Table 6, model 3) also shows that on average, employees value the location of the firm over whether this firm is a multinational or a local firm. A possibility is that some see this as a process: The first step is to get a job within one of these three economically successful locations, followed by the second step, to get a job in a large corporation. Either way, these results support the previous theory mentioned in the literature review regarding the hot spots or geographical locations, in which a large amount of knowledge is spread, and in turn attracts more and more talent. This results in an area of high productivity, innovation and efficiency. This theory also supports the phenomenon of globalisation of R&D, due to the many multinational firms located in these three cities, suggesting that the knowhow or knowledge going through the mobility channels is not only Asian, but most likely international.

Figure 2 shows that there is much more mobility within the three big cities than in others. This means that more employees are moving between firms located within these cities and therefore knowledge is diffused. This may support the theory by Mohnen, (1996) in which he states that employee mobility is one of the most efficient ways to transport information.

More importantly, our results suggested that the inventors with the most experience regarding patenting are the ones more likely to move within the industry. Hypothesis 4, which stated that inventors with patenting experience are more likely to move, was supported. This might provide support to the fact that the presence of multinationals in economically growing nations such as China has an advantage, due to the fact that they brought their knowledge with them through their inventors. This allowed the globalisation of R&D to be enhanced. Consequently, this made it possible for local firms to adapt to the most efficient and productive way of effectively lowering their costs and keeping up with the Forbes 500 firms. Moreover, the fifth and last hypothesis was rejected. Even though it did not transpire as predicted, the fact that this hypothesis was rejected also backs up the idea that successful international inventors have been helpful and beneficial to China. This hypothesis was tested through an interaction effect between *stock of patents lag* and *Big Three.* The fact that it still showed a positive correlation with the probability of mobility states that even the inventors with the most experience in patents are still willing and probable to move companies even if they are already working in one of the three big Chinese cities. This means that is very likely that at one point in their careers in China, inventors will end up working for a local indigenous firm. This will lead to them passing on their knowledge to local employees or managers. Consequently, enhancing the idea of the globalisation of R&D and alluding to how this has been beneficial for developing nations.

## Limitations

This research piece does not come without its limitations. The paper supports the notion that inventor mobility has enhanced the globalisation of R&D and that this has been beneficial for developing nations. However, due to time constraints, this study could only focus on China, and one must bear in mind that situations and circumstances may differ from nation to nation. The impact of multinational corporations may induce alternative outcomes in other countries when taking into account other unique factors, such as cultural differences or religion. The next step for this research area could be to investigate the impact of inventor mobility and knowledge diffusion on the globalisation of R&D on a much larger geographical location.

Moreover, an important limitation from this study is that the reasons why inventors decide to move could not be studied in depth. We assume in this study that it is due to the type of firm, the benefits that multinationals have to offer, or the firm's location. In reality these decisions are influenced by a variety of factors: wages; marital status; social connections; and the level of education, amongst others. Particularly in China, many businesses maintain family ties and value these kinds of factors more so than the type of firm or the city in which they are based.

In addition, due to time constraints and a lack of resources, the magnitude of the coefficients of the last models that contained the control variables could not be calculated. This would have specified the impact that each variable had upon the dependant variables, and would therefore have been able to identify vital explanatory variables.

Furthermore, this study does not differentiate between sectors. Some sectors might experience more mobility than others, and may also be affected more dramatically by spillovers and knowledge diffusion. This study assumes that every sector reacts similarly in terms of mobility, and that the distribution of knowledge benefits everyone on the same level. In reality, there might be different levels of effect. An improvement to this study might be to focus on different working areas, examining which sectors try to prevent or make use of spillovers. Also, the globalisation of R&D might be more beneficial for some sectors than for others. Many firms in certain sectors might embrace this generalisation of knowledge, while in other sectors their privacy and knowledge might be the only difference between making profit and loss. In addition, this study also focuses on how the presence of multinational firms has been beneficial to the host country, when in reality it may be harmful to local business. The assumption that local firms can simply use the knowledge that the MNEs bring to their home country, does not take into account other factors such as costs and any other resources necessary to implement this knowledge.

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