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Colocation and Geographic Proximity in Markets for Technology

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Abstract

We study the effects of geographic proximity on the decision of firms to license technology from one of the top Academic Medical Centers in the world. We use a unique dataset that allows us to observe both licenses that are concluded – "deals done" and license negotiations that fail – "deals not done." Using patents filed after 1981 and observed until 2011, we find that proximity and collocation both influence positively the decision to license a patent. Because all of our firms have considered and done due diligence on the patent of their interest, we can eliminate "search costs" as the explanation for this finding. We consider instead the informal reputation and quality verification opportunity that colocation provides as well as the physical costs of transferring tacit knowledge.

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Abstract

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1. Introduction

Transactions in markets for technology have significantly increased during the last two decades (Arora et al. 2001, Sheehan et al. 2004; Robbins, 2006; Cantwell, 2007). The rapid development of the information and technology sector as well as the life sciences industry, global competition, the breadth of knowledge needed to develop the complex technologies that today's customers demand have made it imperative for companies to not just rely on in-house R&D but also on external sources of knowledge. Similarly, new sources of private and public funding have enabled the development of new technologies by public institutions or start-up companies focused on innovation only and not able to or interested in product development. As a consequence, the volume of technology licensing and the importance of markets for technology have both increased remarkably (Zuniga and Guellec, 2009; Kamiyama, 2006). Nowadays, licensing represents one of the most important options available to transfer technology (Anand & Khanna, 2000b; Arora & Fosfuri, 2003). In fact, in several industries licensing has become an integral part of firms' strategy to appropriate value from innovation (Gans & Stern, 2003).

Consequently, licensing has attracted increasing attention in the management literature. In this area, research has mainly focused on analyzing the strategic determinants of licensing decisions (Gans et al., 2008; Gambardella et al., 2007; Kani and Motohashi, 2012; Bianchi et al., 2011; Cockburn et al., 2010; Kim and Vonortas, 2006; Fosfuri, 2006), on quantifying the number and total value of transactions in markets for technology (Arora et al. 2001; Sheehan et al. 2004; OECD,2006; Robbins, 2006; Athreye and Cantwell; 2007), on modeling the optimal licensing payment form (Katz and Shapiro, 1985; Gallini, 1984; Gallini and Winter, 1985; Kamien and Tauman, 1986; Rockett,1990; Bousquet et al. 1998; Vishwasrao, 2007) and on studying the relationship between licensing-in and firm performance (Zahra, 1996b; Jones et al., 2001;Rothaermel et al., 2006; Cassiman and Veugelers, 2006; Tsai and Wang, 2007).

Previous research has not studied extensively the effect of geographic distance between seller and buyer on the propensity to sign licenses. One explanation is the lack of uniform licensing data: licensing agreements are confidential and it is not compulsory for companies to report licensing revenues as a separate item on the income statement. Licenses available to researchers are those publicly announced by companies and such announcements are selective and subject to strategic consideration by the firm. (Gans, Hsu and Stern, 2008). Furthermore, considerations of technology buyers and overall the demand side of the markets for technology remain largely unexplored as data on licensees or potential licensees is also lacking (see for exceptions Ali and Cockburn, 2012; and Zhang et al., 2015).

In this paper we analyze the demand side of markets for technologies. Specifically, we are interested in how geographical distance influences the decision of firms to license new technology. To do so we use a dataset which contains all the agreements signed by an Academic Medical Center technology licensing office for their patented inventions between 1981 and 2011. Our data is unique in that it contains agreements that are successful licenses – "deals done" as well as agreements that were attempted licenses - "deals not done." These deals not done include confidentiality agreements that interested firms signed in order to do due diligence on the technology and option agreements that did not result in licenses. By not selecting on successful licenses, we effectively have a "control group."

The remainder of this paper is organized as follows. Section 2 presents the literature review and hypotheses development. Section 3 describes the data, variables and methodology. Section 4 reports the results and Section 5 concludes with a discussion of the results and their managerial implications.

2. Literature Review and Hypotheses Development.

2.1 Markets for Technology and Licensing

Over the last decades a new way to manage R&D innovations has emerged. With strong competition in the product market, shorter product life cycles, and robust growth in information and communication technologies, companies cannot produce everything by themselves (Zuniga and Guellec, 2009). Increasingly, they must trust networks, new entrants, and technology-based firms if they want to remain efficient and competitive. In the pharmaceutical industry, technology discontinuity has required incumbent firms to use licensing to access new knowledge and technology (Sosa, 2011). Licensing agreements thus have increased in importance and volume, to become the most important method for commercializing and diffusing new technologies outside the firm (Anand and Khanna, 2000; Hagedoorn, 2002; Somaya et al. 2010).

Despite this surge in popularity, establishing a licensing agreement is not an easy task. As Razgaitis (2004) shows, 75% of the companies that want to license out their technology could not find licensees. In the same line, Gambardella et al. (2007) finds that 11 % of firms' patents are licensed and 7% of firm patents are available for licensing but remain unlicensed – that is almost 40% of patents available for licensing remain unlicensed. Patenting companies also acknowledge that they would like to license out more but that it is difficult to achieve a successful licensing agreement (Zuniga & Guellec, 2009). According to Ali and Cockburn (2012), once licensing negotiations have begun, only 48% of negotiations result in a contract. This is not surprising as markets for technology are characterized by high search costs, asymmetric information between parties, difficulties in describing and valuing the technology, uncertainty about the validity and applicability of the traded technology, uncertainty about IPR protection, the risk of opportunistic behavior by licensees and the difficulty of monitoring and coordination (Gans, Hsu and Stern, 2008; Anton and Yao, 1994; Arora, A., Fosfuri, A., and A. Gambardella, 2001). Thus it is reasonable to expect that parties do not take this decision quickly and there are multiple determinants of the final decision to license.

2. The Geography of Innovation

The economic geography literature has studied the importance of location for innovation and has emphasized its importance, especially for high technology firms. Even in an era of high speed communication, cheap and efficient transportation and few border barriers, physical location seems to still be a source of competitive advantage (Porter, 1998). The main reasons for co-location with other firms in the same industry and the emergence of industrial clusters, that have been advanced include knowledge spillovers, knowledge embedded in and only available within formal and informal networks and scientific communities and the concentration of human and financial capital (Gittelman, 2007; Gittelman, Cantwell and Alcacer, 2008; Audrestch and Stephan, 1996; Marshall, 1890; Stuart and Sorenson, 2003)

Already in 1890, in an attempt to answer why firms belonging to the same industry are often geographically close to each other Marshall pointed out that "cities have ideas in the air" and defined spillovers as "unintended transmission of knowledge that occurs among individuals and organizations, as opposed to the conscious sharing and exchange of knowledge". The existence of these spillovers, has been proposed as an explanation for the geographical concentration of companies that belong to the same industry (Griliches, 1998). Measuring spillovers has been an important but challenging task in the innovation literature. As Paul Krugman (1991: p.53) argues: "knowledge flows…are invisible; they leave no paper trail by which they may be measured and tracked". Most research has used patent data and patent citations among firms to estimate the movement of "ideas in the air" i.e. spillovers (Griliches, 1998; Scherer, 1982, 1984; Jaffe, 1986). Only recently has research tried to disentangle spillovers that occur due to invisible knowledge flows from knowledge that flows that occur through formal licenses (Mowery and Ziedonis, 2015).

2.3 The Importance of Geographical Proximity in Markets for Technology

Our study is designed to explore and understand the flow of ideas from one research institution to firms through licensing. While licensing represents a formal way of technology transfer it does automatically imply that its success will be independent of geographic proximity.

Physical proximity to the institution where research originated may influence licensing in two ways. First, firms collocated with the licensor may be able to learn about the licensing opportunity faster through their formal and informal networks – i.e. proximity can facilitate search (Gittelman et. al., 2008). Second, firms that are closer to the licensor may be able to verify the quality of the knowledge and technology and prevent opportunistic behavior on the part of the licensee and finally, proximity may aid the transfer tacit knowledge and know-how more easily as they get easier and more in person access to the inventor(s) – i.e. proximity may facilitate transfer and expectations and ease of transfer.

In the current version of this paper we are not able to explore the influence of proximity on the ability of firms to find an invention because all of the firms in our dataset that have signed an agreement have in effect found the invention that they are considering. In this paper, we will focus solely on the other aspects of the firms' strategic considerations – the ability to verify the quality of and transfer knowledge and the importance of geographical proximity.

One of the most vexing problems in markets for technology is verifying the quality of the knowledge that is being sold. Markets for technology are characterized by asymmetric information between parties, difficulties describing and valuing the focal technology, and uncertainty about the validity and applicability of the traded technology (Arora & Gambardella, 2010). With university technologies that are early stage as in our case, the problems are worsened. Collocation, however, can aid in this process. First of all, collocated partners are more likely to share a common social network and verify through informal means the reputation of the inventor and the quality of the invention. Furthermore, both parties can expect that opportunistic behavior will be inhibited as it will have effects on their future reputation. In their paper, Gans, Hsu and Stern (2008) find that the effect of formal intellectual property rights on the likelihood of completing a license are less important if the contracting parties are collocated.

Hypothesis 1: Collocation of the licensor and a firm is more likely to result in a license.

Another reason why proximity may influence the decision of a firm to sign a license would be the expected transfer costs of the technology. While the licensing contracts involve the right to use the patent, often more is required to continue to develop the technology. As Agarwal (2006) shows, inventor involvement with the firm post-licensing is essential for successful technology transfer. Such involvement may involve consulting as in the above case or the ability of firm employees to work in the labs of the scientists to understand the relevant techniques. In our case, inventions are very early stage and firms that license sometimes sign sponsored research agreements and continue to work with the inventor in developing the invention. Geographical proximity will certainly aid in this process as it will lower transfer costs. In expectation of this, we believe that the firm is more likely to sign a license on the technology it is considering.

Based on the reasoning above we propose the following hypothesis:

Hypothesis 2: A shorter geographical distance between the firm and the AMC is more likely to lead to a license.

A paper by Gittelman, Cantwell and Alcacer (2008) has considered the above arguments and tested similar hypotheses. However, they deal with selected licenses of drug molecules among biotech and pharmaceutical firms and only observe concluded licenses that have been publicly disclosed by the firms. In our case, we observe all instances of firms who have shown a threshold level of interest in a technology at our AMC by signing a confidentiality agreement - i.e. both “deals done” and “deals not done.” This allows us to focus only on the decision to license rather than conflating search and ability. In fact, they do note that a Heckman selection model shows that their data does indeed suffer from selection bias that they attempt to correct. Their Heckman first stage regression attempts to determine the characteristics that make it more likely for a drug to be ever licensed. Our data includes all 48 patents that have been considered for licensing but never licensed, about 25% of all patents that have agreements associated with them.

3. Data

3.1 Research Setting and AMC data

Our patent and licensing data comes a large Academic Medical Center (AMC) with over half a billion US dollars in research funding per year. Our sample of 285 patents and their associated 307 agreements includes only those patents that are assigned exclusively to our AMC and exclude patents that are co-owned with other institutions or are the result of research that was sponsored by firms. Under US patent law each co-assignee can use or license the patent separately without the permission of our institution and as such, we cannot be sure that we observe all licenses by such firms. In the case of sponsored research, the sponsoring firm usually gets either an automatic license or the right of first refusal to the patent and there is concern that the research direction may reflect the interests of each sponsor and as such not be comparable to our remaining patents. The oldest patent in our dataset was filed in 1981 and we observe our patents and record all relevant licenses until February 2011.

All AMC employees sign as contract that requires them, to disclose to the TLO any invention conceived or developed while employed at the institution or with funds administered through the AMC and assign it all to the intellectual property (IPR). The TLO manages patent prosecution and licensing of the respective inventions. Income from patents (above costs) is distributed in the following way – 25% split between the inventors, 25% to the inventors' lab, 25% to inventors' department and 25% to the hospital.

Once a patent is filed with the USPTO, the TLO markets it to potential licensees through direct correspondence. Non-confidential innovation summaries are made publicly available through the web. Interested parties can also find information through inventors' research publications, conference presentations. Some inventors also use their industry contacts to reach potentially interested firms. Unfortunately, we do not have data on the marketing activities of inventors or the TLO.

If interested in a technology, firms can choose to sign a confidentiality agreement (CDA) and gain access to in-depth information about the invention including IPR protection strategy and the patent application. CDAs do not require the payment of a fee and do not provide rights to the use of the patents and concurrent CDAs with multiple firms for the same invention are not uncommon. Some firms then choose to sign an option for an exclusive license which means that another firm will not be allowed to license the same invention during the time of the option. For such consideration firms pay an option fee and usually, but not always, assume the costs of patent prosecution during that time. Other firms may choose to sign an exclusive or non-exclusive license without signing an option agreement. Usually, licenses require the payment of a license fee, patent cost reimbursement (including maintenance fees), milestone fees and royalty payments and requirements for continual product development.

Our data includes all the agreements signed for a specific patent. Agreements that involve licenses are considered “deals done” and agreements that do not result in licenses are considered “deals not done.” In total we have 600 agreements-patent pairs as some patents involve multiple agreements and some agreements include multiple patents.

Our licensor has a mandate to work for the common good and try to achieve licenses and bring products to patients to cure disease. Its mission is to save and improve lives rather than maximize profits. Furthermore, the AMC does not have the ability to bring products to market by itself. As a result, the inability to reach a mutually agreeable Price with an interested company is rarely, if ever, a reason for “deals not done”. Usually, it is because the potential licensee concludes from their research that they are no longer interested in the technology for reasons other than price. Qualitative data in the case files, which are carefully read, such as comments by officers about why the potential licensee may not have returned for a license after signing a CDA never list price as the reason. License terms are quite standard based on the technology type but negotiation and variation are possible.

4.2 Geographical distance

Data on closest geographical location of each company was collected for the year in which the agreement was signed. Sources included company 10K statements accessed through Edgar on the sec.gov website. Usually, but not always, 10K statements include a list of all firm properties with their location. Additional sources included Annual reports, financial news websites such as Bloomberg.com for small companies, research publications and books. If no other source was available, we used company patents filed in the respective year. Occasionally, it was not possible to find the location(s) of the company in the respective year. This happened usually for companies that were very large with multiple locations or for small ones that are not active anymore and had no patents available. In those cases, the geographic location is missing. We imputed location for firms that were very small and that had one location only over a number of years close to the year of agreement but no source documenting the location for that specific year.

Once the geographical locations were found, we calculated physical distance from our AMC using the Haversine formula. For our models, we divided the distance by 1000 for better readability of results. Additionally, we created categorical variables to indicate whether the firm was located within the same state or within the same country. In all our calculations, the closest location of the firm was used. While not all locations are involved in R&D activities, it is not always possible to distinguish the specific firm activities associated with the locations. Furthermore, if distance does indeed have a negative effect on the probability of concluding a license, our estimates of such an effect would be conservative.

4.3 Control Variables

We use the average number of forward citations per year to control for the importance and commercial potential of a patent (Trajtenberg, 1990). The number of unique four digit IPC codes (Lerner, 1994) and number of references made to prior patents are used to proxy for patent scope. A patent that belongs to fewer patent classes is expected to be less broad. If a patent cites a prior patent, it means that its claims are delimited by the prior art. The more citations a patent makes to other patents, the more incremental it is considered and the more developed and crowded the technological space to which it belongs.

Conversely, inventions with fewer backward citations have been called more pioneering. Patent citations can be included by the patent filer or the examiner. Previous research has shown that patent scope is related to patent valuations and licensing outcomes (Lerner, 1994; Gambardella et. al., 2007; Decheneaux et al., 2008). Cohort variables are also included for each decade since 1980 depending on the priority date of the patent. Shorter cohort periods are not used due to small sample size.

Each patent was manually coded for whether the invention was a medical device by reading through the patent claims and abstract. If a patent would have required an approval by the FDA as a device in order to be used in the market, then it would be classified as a medical device. A variable for the experience of the lead inventor is defined as the number of patents invention disclosures that this inventor has previously made at this specific technology licensing office (TLO). It is a proxy for the inventor's experience in innovating, navigating the patenting and licensing process and perhaps for the strength of his research portfolio. Firms can view it as a signal for the invention's quality and perhaps the strength of IP rights in this specific area which can further be correlated with commercialization potential.

For each firm that has signed an agreement we use the total count of filed firm patents at time of agreement as a control variable. Another variable, the firm's R&D age is calculated based on the difference between the year in which the agreement was signed and the year in which the firm filed its first patent.

4. Results

4.1 Summary Statistics

Table 1 presents some summary statistics from our data. We note that of our 600 patent agreement pairs only 572 have information on locations and distance and of those, 22% are located within the same state as our licensee, Massachusetts and 90% of the firms have at least one location in the US at the time of signing the agreement. Firms are located on average 1600 miles from the AMC with some firms just 2 miles away and the furthest firm almost 17000 miles away. Graph 1 shows a histogram of distance (measured in '000 miles). We observe that the majority of the firms are located relatively close to the licensee. We also observe a spike around 4000 miles. These two observations reflect the fact the existence of two other clusters of pharmaceutical research in the US – the Research Triangle in the North East and the Bay Area in California.

Our summary table also shows that about 15% of our patents would fall in the medical device category. The average patent has 3.2 unique 4 digit IPC codes, 10.7 backward cites and 0.8 forward cites per year up to the time of the agreement. The average patent is its inventor's 7th patent. We also observe that 92% of our patents were disclosed and filed before 2001. Similarly the average firm has about 1600 patents but many firms have 0. In fact, 176 (of 600) of the patent-agreement pairs are associated with firms that have no patents, usually very early stage start-ups. Note that the above results are based on observations that are patent-agreement pairs. In our dataset we have 285 patents and 307 agreements giving us 600 patent-agreement pairs. We exclude from our analyses the 285 patents in our dataset that have no agreements (CDAs, options, licenses).

Table 2 presents our results. We would like to emphasize that this is a very early draft of our paper and for that reason, robustness tests and additional analyses are missing but will be available before a presentation in June in case our paper be accepted.

We run a simple logit model with a categorical dependent variable that is equal to 1 if the agreement was a license i.e. "deal done" and equal to 0 if the agreement was not a license but was instead just an exploratory CDA or option. Licenses can be exclusive, non-exclusive, co-exclusive or sublicenses. Of our 307 agreements, 148 or 48% are deals. Of the 600 patent-agreement pairs, 307 (a coincidence) are license-patent pairs (51%) a slightly larger number indicating that agreements that are licenses have slightly more patents than agreements that do not result in licenses.

Model 0 includes only our control variables. Of note is the quantitatively and statistically significant value of the forward cites per year variable indicating that, in agreement with previous literature, inventions with more forward citations are more likely to be licensed. We also note that patents disclosed and patented in the 1980s and 1990s have a higher chance of being licensed compared to those disclosed in the 2000. This is not surprising as these patents have been available for licensing for a longer amount of time than those patented in the omitted decade. We also see that firm variables, as well as other patent variables do not seem to significantly influence the likelihood of licensing.

Model 1 is a logit model only of our variable of interest, geographical distance, and shows that distance is negatively related to the probability of a deal. Our result is highly significant. In Model 2 we add patent level variables such as scope, forward and backward cites and whether the patent protects a medical device. In Model 3 we add inventor level variables – lead inventor experience as well as cohort variables. Model 4 add the firm variables. We note that in all of these models our distance result is strong and statistically significant.

Model 5 and 6 test whether co-location in the same state or in the same country increase the likelihood of success. We recall that only 22% of our agreements are with firms within the state but note that the likelihood of license is stronger if the firm is co-located in the same state. Our country results are stronger indicating that if the firm has an office (but not necessarily headquarters) located within the same country, the likelihood of a license similarly increases.

5. Discussion and Limitations

5.1. The Importance of Distance and Colocation

Our results show that when it comes to licensing, distance is important. We find that the closer firms are located to the licensor, the more likely they are to license a patent that they have looked at. In fact, for observations where the firm is no more than 1000 miles away from the AMC (i.e. on the East Coast), 56% are licenses. For firms that are located further between 1000 and 5000 (mostly the West Coast of the US), the rate of licensing drops to 47% and for firms further away than that, the rate of licensing drops to 32%. This is consistent with our theory that larger distances limit the ability to transfer technology. Being located at a larger distance impedes frequent face-to-face interactions between the inventors and the firm. If firm scientists were to get access to tacit knowledge by working in the inventor lab, it would require that they either relocate or travel frequently. Joint work, through sponsored research agreements would also become costlier as some knowledge is difficult to transfer. Inventors' motivation to engage with the firm may also depend on the time and travel costs imposed on them in the transfer of tacit knowledge (Agarwal, A., 2006).

As distance increases, it also becomes harder to find reliable informal information about the quality, the character and commitment of the inventors. In the local community, it is easier to find friends, co-workers and acquaintances who have interacted with the inventor and can ascertain her reputation and status. While hard information found in patents and publications may be important, soft information may be more valuable when difficult technology transfer is attempted and co-working and large financial investments are involved (Gans et. al, 2008). Our results show that indeed, firms in the local community, as measured by location in the same state, are more likely to license.

Finally, firms located in the same country are more likely to sign a license as well. In this case, while the local community and reputation issues may not be as important. However, legal issues associated with technology and commercialization are much easier to deal within the same country. This could also be a consideration in this case. It is important, however, to not over interpret that result as only about 10% of our observations are with firms that have no US locations.

It is important to note that the results that we observe are not due to higher search costs for more distant firms. While that may be a significant issue in why firms in general do not license technologies that are geographically distant, we remind our readers that all of the firms in our dataset have looked and done due diligence on the focal patent.

5.2. Conclusion and Limitations

Our study exploits a unique dataset of all the firms that show up to look at and do due diligence on patents available for licensing at one of the top AMCs in the world. We find that even eliminating the concerns over the limitations on search that geographical distance poses, firms' licensing decisions depend on their proximity to the inventor.

One of the most important limitations of our study is that our data comes from an Academic Medical Center. This may impact generalizability as licensing between firms may be different and the importance of geographical proximity may be larger or smaller in such cases.

In its current form, our study is very early stage and further robustness checks are needed to confirm our results under different controls.

Finally, 90% of our patents are first filed before 2000. The connectedness of the world is increasing by the hour. Although we don't expect them to differ substantially, our results may be different in this decade and the impact of geography may be different as social networks expand and surpass geographical boundaries and as reputation and trust can be verified and monitored more easily through formal and social media.

Table 1: Summary Statistics of Main Variables, (each obs is a patent/agreement pair)

Variable	Obs	Mean	Std. Dev.	Min	Max
License	600	0.51167	0.50028	0	1
Firm Located in Same Country	572	0.90559	0.29265	0	1
Firm Located in Same State	572	0.22378	0.41714	0	1
Patent Scope	600	3.23667	2.42497	1	19
Count of Backward Cites	600	10.6983	10.3502	0	54
Forward Cites per Year	600	0.79092	1.39913	0	18.9102
Device	600	0.14833	0.35573	0	1
Lead Inventor Experience	600	7.505	4.80852	1	25
1980s Patent	600	0.31333	0.46424	0	1
1990s Patent	600	0.61167	0.48778	0	1
Number of Firm Patents (000)	600	1.57698	3.56911	0	16.392
Firm R&D Age in Years	600	13.5847	13.3139	0	46.1766

Graph 1: Histogram of Distance (in '000 mi)

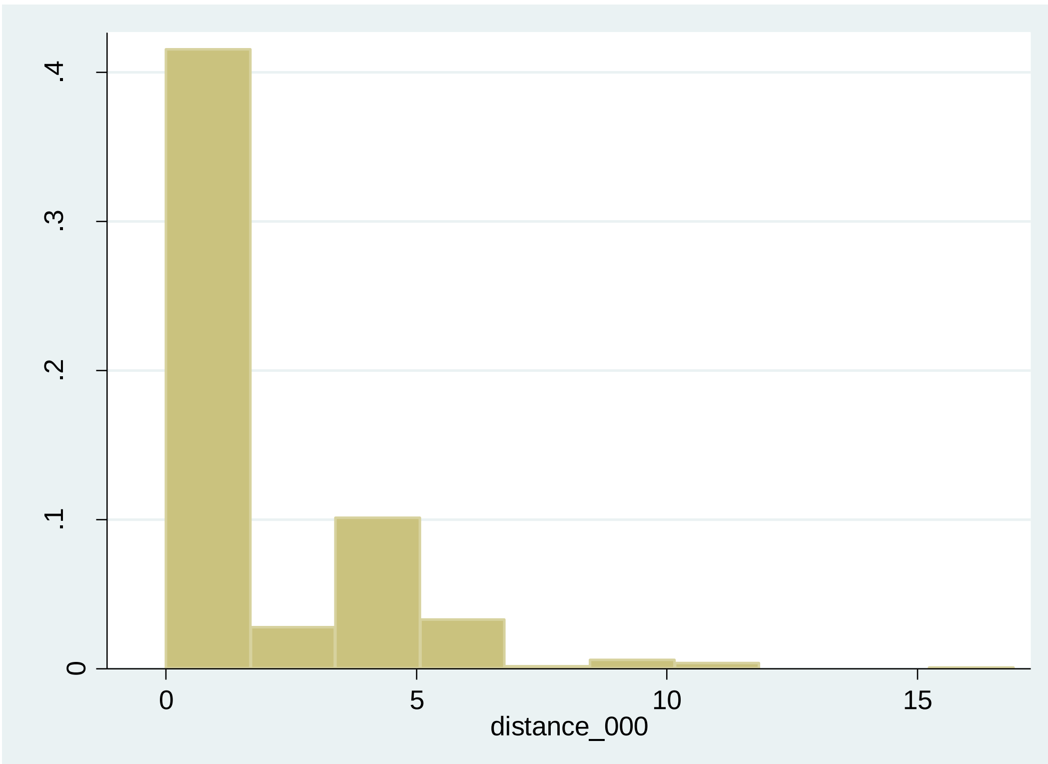

Table 2: The Effect of Distance and Colocation on Licensing

Dependent Variable: Deal, Clustered by Invention Disclosure

	0	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	deal	deal	deal	deal	deal	deal	deal
Distance (in '000mi)		-0.153**	-0.171***	-0.180***	-0.138**		
		(0.061)	(0.063)	(0.065)	(0.066)		
Firm Located within State	0.014					0.639*	
	(0.073)					(0.337)	
Firm Located within Country	-0.004						1.003**
	(0.016)						(0.497)
Patent Scope	0.351***		0.060	0.066	0.028	0.019	0.028
	(0.135)		(0.063)	(0.071)	(0.075)	(0.072)	(0.074)
Patent Backward Cites	-0.140		-0.010	-0.010	-0.011	-0.009	-0.010
	(0.515)		(0.015)	(0.018)	(0.017)	(0.016)	(0.017)
Patent Forward Cites/Yr	-0.014		0.379***	0.309**	0.340**	0.357***	0.354***
	(0.032)		(0.143)	(0.136)	(0.133)	(0.132)	(0.131)
Device	2.052***		-0.141	-0.072	-0.017	-0.059	-0.028
	(0.580)		(0.476)	(0.535)	(0.547)	(0.531)	(0.536)
Lead Inventor Experience	1.522***			-0.013	-0.010	-0.010	-0.012
	(0.504)			(0.032)	(0.032)	(0.031)	(0.033)
1980s patent	0.069			1.876***	1.958***	2.049***	1.853***
	(0.060)			(0.631)	(0.614)	(0.600)	(0.618)
1990s patent	0.019			1.556***	1.543***	1.523***	1.557***
	(0.014)			(0.536)	(0.537)	(0.531)	(0.533)
Num of Firm Patents ('000)					0.056	0.081	0.062
					(0.058)	(0.063)	(0.059)
Firm R&D Age					0.012	0.018	0.013
					(0.015)	(0.015)	(0.015)
Constant	-2.028***	0.325*	0.005	-1.423**	-1.693***	-2.192***	-2.830***
	(0.597)	(0.196)	(0.341)	(0.583)	(0.610)	(0.616)	(0.737)
Observations	600	572	572	572	572	572	572

Robust standard errors in parentheses

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

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