ACQUIRING PATENTS IN SECRET: STRATEGIC DISCLOSURE IN MARKETS FOR TECHNOLOGY

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Abstract

Markets for technology can provide important opportunities for firms to reinforce their competitive position. However, participating in markets for technology can also reveal important information to competitors. In this paper, we study this tension by exploring the strategic disclosure of patent acquisitions and the conditions under which firms will trade the benefits of competitor deterrence for those of secrecy. We develop a model where firms choose their optimal disclosure policy based on the costs of imitation and the effectiveness of competitor deterrence. We test the predictions of the model using data on patent assignments and examining the recording lag between execution date and registration date with the USPTO. We find that the recording lag for patent assignments is lower when the buyer works on technologies closely related to those acquired and when the buyer can credibly threaten to enforce the acquired patents. Interestingly, we show that the buyer delays disclosure when the seller is a large firm, suggesting that buyers take advantage of the seller's ability to deter competitors while keeping the transaction secret. Additional analyses reveal that a) regulatory changes increasing patent disclosure, and thus lowering imitation costs, reduce the recording lag in patent assignments, and (b) an increase in the enforceability of business method and software patents reduces the recording lag for assignments including such patents.

Keywords: Markets for technology; Strategic disclosure; Patent assignments; Intellectual property rights

"Apple has quietly acquired a failed home security startup's patent portfolio, according to a new report. The tech giant bought three Lighthouse AI patents and three patent applications related to capturing video and monitoring environments for security purposes…Apple apparently bought the patents and patent applications sometime in late-2018, but the transaction wasn't revealed until recently when the U.S Patent and Trademark Office (USPTO) updated their ownership information…Apple often makes small acquisitions to buy companies or their assets that ultimately become features in other products the tech giant already sells. It's possible it could be doing the same with the Lighthouse AI patent portfolio. It's also possible that Apple has ambitions in the home security market".

Fortune Magazine, March 5th, 2019 – article by Don Reisinger

1. Introduction

Markets for technology (MFT) are an important avenue for firms to reinforce their competitive position (Arora et al. 2001, Gans et al. 2008). Firms can acquire technologies that complement their resource portfolios and deter other firms from competing (Clarkson and Toh 2010, Arora and Nandkumar 2012, Akcigit et al. 2016, Glaeser and Landsman 2021). Nevertheless, participation in such markets can simultaneously undermine firms' prospects by disclosing information to competitors. As our motivating story regarding Apple's acquisition of Lighthouse's patents indicates, technology trades provide important clues about the buyer's competitive position that could, in turn, facilitate imitation. Hence, the benefits of participating in MFT are reduced when transactions enable competitors to better understand and react to the buyer's technology investments.

The execution of a technology trade does not need to coincide with its publication though. Parties to a patent transaction can opt for confidentiality by hiding information or by opting for private markets, where they have better control over the amount of information available to competitors (Chien 2010, Ewing 2010, Love et al. 2018). Alternatively, firms can strategically delay disclosure. Buyers of patent rights can record the assignment at the US Patent and Trademark Office (USPTO) at a time of their choosing (Graham et al. 2018). But delayed recordation undermines the benefits of competitor deterrence as patents limit entry by competitors in product markets or technology areas, and reduce the probability of being targeted in patent suits (Lerner 1995, Lanjouw and Schankerman 2004, Glaeser and Landsman 2021, Conti et al. 2022). This creates an important trade-off where firms choose between foregoing the benefits of competitor deterrence for those of keeping the patent transaction secret. How do firms strategically disclose their trades in MFT?

We answer this question by developing a model of information disclosure in MFT featuring an inventor that owns a patent (or seller), an incumbent firm that can potentially buy the inventor's patent (or incumbent), and an imitator that competes with the incumbent firm (or competitor). The seller and incumbent firm are assumed to differ in their ability to enforce patent rights. In the event of a patent sale, the incumbent can choose whether to keep the transaction secret, in which case they do not reveal their plans to the competitor, or to reveal the transaction, in which case imitation is easier but the incumbent can threaten the imitator with enforcing the patent. Hence, the cost of imitation is lower with the disclosure of the patent sale, and patent deterrence, if successful, allows the buyer firm to achieve monopoly profits. This mechanism illustrates why incumbents that are at risk of imitation can reinforce their competitive position by disclosing patent ownership as compared to secrecy when their ability to enforce the newly acquired patent rights against the imitator is sufficiently high. A second mechanism is choosing secrecy. By concealing the transaction and patent ownership from the imitator, the buyer of the patent can inhibit imitation. This tactic cultivates a perception within the imitator that she risks facing litigation from the seller, thus acting as a deterrent. This mechanism captures why incumbents can choose secrecy after a technology transaction when the seller's ability to enforce patent rights against the imitator is sufficiently high.

Given this setup, we develop three predictions. First, the buyer will opt for disclosure when the reduction in the cost of imitation resulting from disclosing the transaction is small. Keeping the transaction secret is not beneficial in this case as the competitor gains little new knowledge that will enable her to imitate more successfully. So, the incumbent will strategically reveal the patent sale to take advantage of patent deterrence by raising the risk of legal action from the buyer. Second, the buyer will choose to make the patent acquisition public when her capacity to dissuade the competitor via legal action is substantial. A key benefit of disclosing the patent acquisition lies in deterring the competitor from attempting imitation. So, if deterrence is deemed credible, the incentives to disclose are amplified. Third, the buyer will keep the patent trade secret when the seller's capability to enforce patent rights is notably strong. In this case, the buyer can strategically employ secrecy. This involves leading the competitor to believe that the litigious seller retains ownership of the patent, simultaneously ensuring that the costs of imitation remain elevated.

We test the predictions of this model using data on patent assignments at the USPTO and their recording lag, that is the difference between execution date and recordation date, to gauge firms' delay in disclosing patent trades. First, we argue that the change in the cost of imitation should be lower when the buyer's technologies are closely related to those acquired. In this case, the trade provides little new information to competitors as they already know the type of technologies employed by the buyer. Consistent with this view, we find that the recording lag is shorter when the assigned patents are already cited by patents in the buying firm's portfolio. Next, we suggest that the benefits of competitor deterrence are higher for larger and more litigious firms as they can better protect their IP rights and more credibly threaten enforcement (Lerner 1995, Lanjouw and Schankerman 2001, 2004, Agarwal et al. 2009). We find evidence supporting this view as the recording lag is shorter when the buyer is more litigious and longer when the seller is a large firm. These results suggest that buyers strategically delay disclosure when they lack a reputation for enforcement and when the seller can deter competitors.

In additional analysis, we take advantage of the passage of the American Inventor's Protection Act (AIPA) in 1999 and the associated increase in patent disclosure through the publication of patent applications (Hegde and Luo 2018, Lück et al. 2020, Chondrakis et al. 2021, Beyhaghi et al. 2022). AIPA attenuated the drop in imitation costs resulting from the disclosure of patent trades involving patent applications, given that these were already available in the public domain, and should thus precipitate disclosure according to our model. Our results are consistent with this conjecture as we find that patent assignments including patent applications have a shorter recording lag after AIPA, as compared to assignments that include only granted patents. In a second test, we exploit an increase in the enforceability of business method and software patents to study its impact on the disclosure of patent transactions. In particular, we focus on *Ex parte Lundgren*, an administrative decision by the USPTO's Board of Patent Appeals and Interferences (BPAI) in 2005, that removed the 'technological arts' requirement for patent eligibility and thus increased the enforceability of business method and software patents (Cotter 2007, Thomas and DiMatteo 2007). Consistent with our model, we show that patent trades including business method or software patents were more likely to have a shorter recording lag, as compared to trades not including such patents, following *Lundgren*.

This paper contributes to the MFT and patent disclosure literatures by providing, to the best of our knowledge, the first theoretical and empirical evidence related to the strategic disclosure of technology trades.[1] The extant literature on MFT has primarily focused on information frictions

[1] For a similar trade-off in the context of trademarks, see Fink et al. (2022).

as impediments to contracting (Arora et al. 2001, Gans et al. 2008, Agrawal et al. 2015), but there is less consideration for the informational content of these transactions. Here, we complement existing work by highlighting the competitive implications of patent trades and how these can facilitate imitation, which in turn reduces the benefits from participating in MFT. The literature on patent disclosure provides key insights on the trade-off between secrecy and disclosure for new technologies (e.g. Gallini 1992, Anton and Yao 2004, Hopenhayn and Squintani 2015, Chien 2016), but has not explored the disclosure effects of changes in patent ownership. Our model and findings reveal new insights about the interplay between imitation costs, competitor deterrence, and disclosure decisions in technology markets. These results extend the patent disclosure literature and identify an additional channel through which market participants learn about firms' technology investments.

Finally, our findings have implications for the design of patent institutions (Gallini 2002, Moser 2005, Hall and Harhoff 2012). Transparency in patent ownership is a hotly contested issue. Current legislative efforts[2] in the US, for example, seek to amend the rules for disclosing patent transactions (Feldman 2014, Sterzi 2021, Gorbatyuk and Kovács 2022). The mandatory disclosure of patent trades will likely facilitate knowledge diffusion, especially for technologies that have high imitation costs and are thus more difficult to adopt. Yet, mandatory disclosure could also negatively affect the operation of MFT when buyers are worried about imitation. Policymakers should consider the benefits and costs of patent trade disclosure in their efforts to increase transparency in patent ownership while maintaining well-functioning MFT.

[2] See Pride in Patent Ownership Act: https://www.congress.gov/bill/117th-congress/senate-bill/2774/text

2. Patent Assignments and Disclosure

Patent assignments entail the transfer of rights, title, and interest in a patent or bundle of patents. Patent assignments are key for economic growth as they enable firms to generate gains from trade by matching patent sellers with buyers (Akcigit et al. 2016, Serrano 2018). Approximately 13.5% - 16% of all USPTO-granted patents are traded at least once while smaller firms are disproportionately likely to sell their patents as compared to larger firms (Serrano 2010, Figueroa and Serrano 2019). Traded patents are typically more technologically distant to the inventor and closer to the technological stock of the buyer (Akcigit et al. 2016, Kwon et al. 2022).

A peculiarity of patent assignments is that disclosure is optional (Graham et al. 2018, Gorbatyuk and Kovács 2022). While the USPTO encourages assignees to record their transactions within three months of the purchase, there is often a significant lag between the execution date and recordation date of patent assignments. The average recording lag for all patent trades is approximately 212 days during the 2003-2015 time period, and this has been relatively stable over time (Sterzi 2021). When a patent assignment is recorded with the patent office, it becomes part of the public record. This means that the details of the assignment, including the names of the seller (assignor) and buyer (assignee), the date of the assignments, and patents, are publicly available.

The disclosure of patent assignments can be detrimental to the new owner if she wishes to keep the contents of the assignment confidential. Revealing strategic information about patented technologies can compromise a buyer's competitive position. Such considerations are evident in commentaries by legal scholars and IP practitioners. For example, Chien (2010) notes that practicing companies hide information about patent transactions to avoid public scrutiny while Love et al. (2018) explain that confidentiality is valued by buyers in a transaction due to uncertainty about how competitors will interpret the transaction. In a different context, Fink et al. (2022) show that firms use 'submarine' trademarks to strategically delay the disclosure of future products. The benefits of secrecy are emphasized by Ewing (2010: 69) who explains that:

> "*Secrecy is an elemental assumption in IP transactions. Say nothing. Ever. CFOs nervously roll IP licensing expenses into the costs of goods produced to avoid any public slip. Miniature versions of actual sales documents are publicly recorded to thwart greater disclosure*".

Nevertheless, the disclosure of patent transactions can also be beneficial for the new owner of a patent because it establishes ownership and can act as a deterrent against potential imitators.[3] The recordation of the assignment can act as a deterrent against potential imitators as it signals that the new owner is serious about protecting her intellectual property rights and is willing to take action to do so.[4] This benefit of patent deterrence is highlighted by Gotts and Sher (2012) who explain that the accumulation of patents in a particular technology field can deter firms from entering the market or competing. Furthermore, when discussing Facebook's acquisition of several hundred patents from AOL and IBM in the early 2010s, Kravets (2012) notes that:

> "*Facebook likely felt exposed against Google's significantly larger and ever-expanding patent portfolio. These patent acquisitions provide Facebook with some protection as the competition between the two companies heats up*".

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[3] Although a delay in the recordation of a patent assignment has currently no penalty on the legal rights that patents confer to new owners (Feldman 2014), recording a patent assignment at the patent office in the United States provide evidence in court of *bona fide* purchase in cases where the acquired patents were subsequently sold to a different firm in good faith (Serrano 2010, Fischer and Henkel 2012).

[4] Of course, recordation with the USPTO need not coincide with the disclosure of a particular patent trade. While this is theoretically plausible, firms have strong incentives to disclose transactions by recording the assignment with the USPTO which offers a centralized, standardized, and verifiable repository of patent ownership (Hegde and Luo 2018). In the absence of this, assignees would need to rely on ad hoc communications that could be missed by competitors or firms that rely on patent records to analyze the technological landscape. This could reduce the deterrence effect of disclosure, a fact which is especially problematic during the time frame of our study, 1997-2006, when internet news sources and online news aggregators were less developed. Besides that, recording the assignment offers a permanent and easily accessible record and the cost of doing so is minimal.

This discussion suggests that the timing of recordation with the USPTO is, at least partly, a strategic decision, with firms balancing the benefits of patent deterrence resulting from disclosure with those of reduced likelihood of imitation by keeping the transaction secret.

3. A Model of Information Disclosure in Markets for Technology

We present a model to describe the relationship between an innovator that owns a patented technology (firm S), an incumbent monopolist (firm A) that has an opportunity to acquire the patented technology, and a competitor (firm B) that can potentially imitate the incumbent's acquired technology. The innovator and the incumbent monopolist differ in their ability to successfully enforce patent rights against imitators. The model has three dates. At time zero, natures chooses whether the innovator sells a patented technology to the incumbent. With probability μ the patented technology remains owned by the innovator whereas the technology is sold to the incumbent with probability $1-\mu$. The innovator and incumbent learn about the realization of nature by the end of time zero, but the competitor does not. The competitor does not know the actual identity of the innovator (seller).

At time one, if the patented technology has not been sold to the incumbent, the patent ownership and thus the legal right to enforce the patent against a potential imitator remains with the innovator. Alternatively, if the patented technology has been sold, the incumbent must decide if she registers the assignment of the patent rights in the patent office. If registered, the competitor learns both about the technology acquisition and the change of ownership over the patents because this information is disclosed. If not registered, the competitor remains uninformed about who is the actual owner of the patent rights. It is also assumed that registering an assignment allows the new owner to enforce the acquired patent rights against an imitator. Informing potential imitators of the patent coverage over the technology places them on notice that any unauthorized use of the patented invention could result in legal repercussions by the new owner. This can sometimes serve as a significant deterrent to competitors who might otherwise consider imitating the technologies (Clarkson and Toh 2010, Glaeser and Landsman 2021). The registration, however, could also compromise the incumbent's competitive position by providing strategic information to the potential imitator. Competitors can use this information to develop competing technologies more quickly and effectively. Therefore, it is important for an incumbent to carefully consider the potential consequences of revealing strategic information about an acquired technology to competitors against the potential benefits associated with deterrence.

At the beginning of time two, imitation by the competitor is determined. There are two subgames faced by the potential imitator. In the first subgame, the imitator faces an incumbent that has chosen to disclose the patented inventions by registering the assignment of the patents obtained in a technology acquisition. To capture that the incumbent can lose a key competitive advantage over its competitors, the cost of imitating the incumbent, c_A, is assumed to be zero when the patents in the transaction are disclosed but remains positive otherwise. This parameter captures the increased costs imitators face to capitalize on other firm's technologies by learning about what has not been publicly revealed through the publication of patents. To incorporate the legal consequences that competitors may face from imitating the incumbent's technologies, we assume that the incumbent will file an infringement action against an imitator, but the outcome is uncertain. The uncertainty is represented by the probability γ_A that the technology of the potential imitator infringes on the incumbent's acquired patents. In combination, the parameter γ_A captures the likelihood of an imitator facing litigation by the incumbent and being found to infringe on the incumbent's patents. If the imitator is found to have infringed on the acquired patents, a court injunction will prevent the imitator from exploiting its invention. In this case, the incumbent will generate monopoly profits π and the imitator zero profits. The alternative outcome is that the imitator's new technology does not infringe. If this is the case, the two firms will compete against each other; the imitator will generate $\theta^B\pi$ and the incumbent $\theta^A\pi$, where $\theta^B < 1, \theta^A < 1$, and $\theta^A + \theta^B < 1$.[5] If imitation does not occur, the incumbent and potential imitator profits will be π and a zero mean, random monetary component ε, respectively.

In the second subgame, the imitator is uninformed about who – innovator or incumbent – owns the patent rights. One possibility is that the incumbent is the new owner because the patented technology was sold but he chose secrecy and thus did not register the transaction in the patent office. The second possibility is that the patents are owned by the innovator because there was no technology acquisition. In an extensive form game, these two possibilities correspond to two notes within one information set. In line with the literature of dynamic games of incomplete information, we will assume that the competitor assigns belief $(1-\beta)$ to the probability that the innovator remains the patent owner conditional on no news about changes in patent ownership and β to the probability that the incumbent is the new patent owner conditional on no new news about changes in patent ownership. If there are no news about changes in patent ownership, it is assumed that the expected cost of imitating the incumbent remains positive at $c_A > 0$. For simplicity, we also assume that an incumbent that did not register an assignment will not be able to enforce the acquired patent rights and thus accommodate the imitator when imitation occurs. In this case, the incumbent and potential imitator will generate profits $\theta^A\pi$ and $\theta^B\pi$. If imitation does not occur, then the incumbent will retain monopoly profits π and the potential imitator will earn a zero mean, random monetary component ε.

[5] We focus on scenarios where the profits of the potential imitator $\theta^B\pi$ are higher than the cost of imitation *c*.

The second possibility, which occurs with probability β, corresponds to the case where the patents are still owned by the innovator because there was no patent sale to the incumbent. In this case, we assume that the expected costs of imitation are $c_S > 0$. If there is imitation and the imitator is found to infringe on the patents owned by the innovator, the imitator will generate zero profits. It is assumed that there is a probability γ_S that the imitator will face litigation and be found to infringe on the patents when the innovator is the plaintiff. [6] If the imitator's new technology does not infringe on the patents, the imitator will generate $\theta^B \pi$, where $\theta^B < 1$. Alternatively, if imitation does not occur, the potential imitator will earn a zero mean, random monetary component ε.

3.1. The Disclosure and Imitation Strategies

Disclosure and imitation strategies are derived as part of a Perfect Bayesian Equilibrium. We begin analyzing the imitation decision of the competitor. If there is registration of the patent assignment by the incumbent, imitation will occur if the competitor's payoff from imitating is higher than his outside option

$$(1-\gamma_A)\theta^B \pi \geq \varepsilon$$

Which occurs with probability

$$\Omega_D = \Omega_D(\gamma_A, \theta^B) = \Pr\{\varepsilon \leq (1-\gamma_A)\theta^B \pi\}$$

If there is no registration, and taking into consideration that the potential imitator is uninformed about who owns the patent rights when the incumbent chooses secrecy, there will be imitation if

$$\beta[(1-\gamma_S)\theta^B \pi - c_S] + (1-\beta)(\theta^B \pi - c_A) \geq \varepsilon$$

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[6] Because the potential imitator does not know the identity of the innovator (seller), the parameter γ_S should be interpreted as the expected enforceability across relevant potential innovators at risk of selling a patent to the incumbent firm.

Which occurs with probability

$$\Omega_{ND} = \Omega_{ND}(c_A, c_S, \gamma_S, \beta, \theta^B) = \Pr\{\varepsilon \leq \beta[(1-\gamma_S)\theta^B\pi - c_S] + (1-\beta)(\theta^B\pi - c_A)\}$$

The fact that disclosing patent rights through the registration of an assignment can serve as a deterrence mechanism is captured by the probabilities of imitation under disclosure (Ω_D) and no disclosure (Ω_{ND}). Registering the patent assignment reduces a rival firm's cost of imitation from c_A to zero, but it also dampens its expected proceeds from imitating by $\gamma_A\pi\theta^B$.[7] Disclosing an acquired technology by registering a patent assignment can then lower the probability of a rival firm imitating the incumbent's technology when the costs of imitation c_A are less than $\gamma_A\pi\theta^B$. This result also implies that disclosing patented inventions can be more effective to deter competitors from imitating when the likelihood of an imitator being found to infringe an acquired patent (γ_A) is higher and the costs of imitating an acquired technology (c_A) lower.

Interestingly, the probability of imitation under disclosure (Ω_D) and no disclosure (Ω_{ND}) also reveal that secrecy sometimes can also act as a deterrence mechanism. When the innovator's ability to enforce patent rights γ_s is high, an incumbent that has acquired a patented invention can strategically use secrecy to deter the rival firm from imitating by leveraging the innovator's ability to enforce patent rights. By keeping the rival uninformed about the technology acquisition, the incumbent makes the rival firm believe that there is still a positive probability that she could face litigation against a litigious innovator. Therefore, a strategy that keeps patent acquisitions secret can also act as a deterrence mechanism against potential imitators.

Next, we derive the expected payoffs of registering a patent assignment following a technology acquisition and the expected payoff of keeping the patent acquisition secret. Let the

[7] Note that the expected proceeds from imitating drop by $\gamma_A\pi\theta^B$, from $\theta^B\pi$ to $(1-\gamma_A)\theta^B\pi$, when the incumbent discloses patent rights through the registration of an assignment.

expected payoff of registering a patent transaction Π_D be $\Pi_D = \Omega_D(\gamma_A, \theta^B)(\gamma_A\pi + (1-\gamma_A)\theta^A\pi) + (1-\Omega_D(\gamma_A, \theta^B))\pi$. The first term is equal to the probability that the rival firm imitates after the acquired technology is disclosed by the incumbent multiplied by the expected payoff that the incumbent would generate when imitation occurs. The second term is equal to the probability that the rival firm does imitate following such technology disclosure multiplied by the incumbent's monopoly payoff. If instead the incumbent chooses secrecy, the expected payoff of secrecy is $\Pi_{ND} = \Omega_{ND}(c_A, c_S, \gamma_S, \beta, \theta^B)\theta^A\pi + \left(1-\Omega_{ND}(c_A, c_S, \gamma_S, \beta, \theta^B)\right)\pi$, where the first term corresponds to the probability that the rival firm imitates the acquired technology multiplied by the payoff the incumbent generates when imitation occurs, and the second term is the probability that imitation does not occur when secrecy was chosen multiplied by the incumbent's monopoly payoff. Intuitively, registering a patent assignment following a technology acquisition increases an incumbent's expected payoff by $\gamma_A\pi(1-\theta^A)$ when imitation occurs whereas the payoff remains unaffected when imitation does not occur.

Taking into consideration how disclosure influences the risk of imitation and incumbent's expected payoffs, as well as how the competitor's beliefs about patent ownership conditional on secrecy affects her imitation decision, an incumbent will register a patent assignment following a technology acquisition if the expected payoff of registering the transaction (Π_D) is higher than otherwise (Π_{ND}). When choosing to disclose an acquired technology, the incumbent will weigh an increase in the expected payoff when imitation occurs due to the enforceability of patent rights against the possibility of potentially higher risk of imitation. Similarly, the competitor will choose to imitate if, given his beliefs about patent ownership conditional on secrecy as well as the incumbent's disclosure strategy, the expected payoff of imitation is higher than otherwise not imitating. Moreover, the beliefs must be computed using Bayes' rule and be consistent with the disclosure and imitation strategies of the incumbent and competitor.

3.2. The Disclosure and Imitation Pure Strategy Perfect Bayesian Equilibrium

To solve the Perfect Bayesian Equilibrium, let us begin considering the competitor beliefs β over the possibility that the innovator remains the owner of the patent rights conditional on no news. This corresponds to the first node of the second subgame, which follows directly the link after nature determines there is no technology acquisition. Define the probability of no disclosure conditional after a technology acquisition to be Q. Applying Bayes' rule,

$$\beta = \text{Pr(Innovator has ownership|No news)} = \frac{\text{Pr (Innovator has ownership \& No news)}}{\text{Pr (No news)}}$$

$$= \frac{\mu}{\mu + (1 - \mu)Q}$$

For the no disclosure and disclosure equilibria in pure strategies to exist, it must be the case that the expected payoff the strategy holds in equilibrium is higher than the alternative. In particular, the no disclosure equilibria in pure strategies exists if the expected payoff of no disclosure is higher than the expected payoff of disclosure and the beliefs of the imitator are consistent with this strategy of the incumbent and competitor. In a no disclosure equilibrium, i.e., $Q = 1$, so given the belief's derived from Bayes' rule, $\beta = \mu$ after substituting $Q = 1$ in the above formula for the belief. That is, $\Pi_{ND}(c_A, c_S, \gamma_S, \theta^A, \theta^B, \beta = \mu) \geq \Pi_D(\gamma_A, \theta^A, \theta^B, \beta = \mu)$. It can be shown that a no disclosure equilibrium thus will exist when the expected payoff of an uninformed imitator, $\mu[(1 - \gamma_S)\theta^B\pi - c_S] + (1 - \mu)(\theta^B\pi - c_A)$, is small enough. Similarly, the disclosure equilibria, $Q = 0$, will exist when $\Pi_D(\gamma_A, \theta^A, \theta^B, \beta = 1) \geq \Pi_{ND}(c_A, c_S, \gamma_S, \theta^A, \theta^B, \beta = 1)$ where $\beta = 1$. It also can be shown that when the expected payoff of an imitator is not found to infringe on the patent when the plaintiff is the innovator, i.e., $[(1 - \gamma_S)\theta^B\pi - c_S]$, is high enough there exist a disclosure equilibrium.[8]

3.3. The Effect of the Change in the Cost of Imitation on the Disclosure of Patent Acquisitions

Acquired technologies with lower changes in the costs of imitating the incumbent (c_A) are associated with higher probability of being disclosed. When the change in the costs of imitating the incumbent are low, the probability of the incumbent being imitated is high. In such cases, disclosing the acquired technology by registering the ownership of the patent rights can sometimes be more effective than secrecy at deterring competitors from imitating. Specifically, if the probability of successfully enforcing patents against potentially infringing rivals is high enough, the benefits of disclosing the acquired technologies by registering an assignment can outweigh those of secrecy.

As the change in the cost of imitation increases, the benefits of secrecy also increase because the risk of imitation that incumbents face is now lower. To see this, we evaluate the change in the expected profit of secrecy (no disclosure) when the change in the cost of imitation c_A is higher. In our model, this corresponds to $\frac{d\Pi_{ND}}{dc_A} = \pi\theta^A\frac{d\Omega_{ND}}{dc_A} - \pi\frac{d\Omega_{ND}}{dc_A}$. Because the probability of imitation under secrecy decreases with the cost of imitation ($\frac{d\Omega_{ND}}{dc_A} < 0$), the expected profit of secrecy unambiguously increases with the change in the cost of imitation.[9] Intuitively, a larger change in the costs of imitation raise the burden that competitors face to imitate the acquired

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[8] If the proceeds of the innovator when the imitator is not found to infringe on the patents is lower than the proceeds of the imitator when patents are owned by an incumbent that does not disclose the transaction, i.e., $(1 - \gamma_S)\theta^B\pi - c_S < \theta^B\pi - c_A$, then there is no pure strategy equilibria but there is mixed strategy equilibria.

[9] Note that the expected profit of disclosure is not affected by the cost of imitation (as we assumed that the costs of imitation become zero with disclosure).

technology whereas they do not alter the incumbent's benefits of competitor deterrence. As a result, the probability of disclosure decreases with the change in the cost of imitating the incumbent.

Hypothesis 1. The likelihood of disclosing a patent acquisition by registering the assignment is decreasing with the change in the cost of imitation.

Interestingly, the incumbent's choice over disclosing acquired technologies has effects on the diffusion of technologies. The result showing a positive relationship between secrecy and the change in the cost of imitation implies that keeping trades in markets for technology secret can have deleterious effects on technology diffusion. The incumbent's choice over disclosing acquired technologies reduces the diffusion of the use of technology, especially for technologies that are costlier to be adopted in the absence of mandatory disclosure.

3.4. The effect of Patent Enforceability on the Disclosure of Patent Acquisitions

We also find a positive relationship between the probability of disclosure and the likelihood of an imitator being found to infringe on the patents of an acquired technology by the incumbent. The likelihood of an imitator being found to infringe on acquired patented inventions (γ_A) raises the benefits of competitor deterrence whereas it has no effect on the expected profit from secrecy, making secrecy less attractive for the incumbent when γ_A is higher.[10] In our model, this corresponds to showing that the expected profits of disclosing an acquired technology increase with γ_A. Because the likelihood of imitation is decreasing with γ_A (as seen by $\frac{d\Omega_D}{d\gamma_A} < 0$), the change of the expected profit from disclosing the acquired patented technologies when γ_A

[10] Consistent with our view that an incumbent's secrecy strategy does not reveal patent ownership to rival firms, our model assumed that the expected profits of secrecy are unaffected by the likelihood that an imitator will be found to infringe on an acquired technology by the incumbent (γ_A).

increases, i.e., $\frac{d\Pi_D}{d\gamma_A} = \Omega_D(1-\theta^A) + \frac{d\Omega_D}{d\gamma_A}(\gamma(1-\theta^A)-1)$, is positive. The probability of disclosure is therefore weakly positively associated with the likelihood of an imitator being found to infringe an acquired technology. This result illustrates why incumbents that are at risk of imitation can reinforce their competitive position by disclosing patent ownership as compared to secrecy when the likelihood that of an imitator being found to infringe on the incumbent's newly acquired technology is higher. This discussion leads to the following hypothesis.

Hypothesis 2. The likelihood of disclosing a patent acquisition by registering the assignment is higher when the incumbent's enforceability of the patent rights is higher (γ_A).

Moreover, we find that the likelihood of the imitator infringing on the patents when the innovator is the plaintiff is positively associated with secrecy or no disclosure. In our model, the likelihood that the imitator will be found to infringe on the patents when the innovator (potential seller) is the plaintiff ($\boldsymbol{\gamma_S}$) does not affect the expected payoff of disclosure whereas it raises the expected payoff of secrecy by decreasing the probability that the competitor will imitate ($\frac{\boldsymbol{d\Omega_{ND}}}{\boldsymbol{d\gamma_S}} < 0$). This is because keeping the potential imitator uninformed by not registering the patent acquisition manipulates the information set of the competitor in a way that puts a significant weight on the possibility that the competitor will face litigation against the potential seller.[11] This finding captures how incumbents will choose secrecy after a technology acquisition when γ_S is high, as this allows them to deter imitators through the potential seller's enforceability while at

[11] We use the term "potential seller" instead of "innovator" here to emphasize that, in the absence of disclosure, the potential imitator does not know neither the identity of the innovator nor whether the patent was sold. Therefore, as previously noted, the parameter γ_S should be interpreted as the expected enforceability across all relevant innovators at risk of selling their patents to the incumbent firm.

the same time avoiding lowering imitation costs. This discussion leads to the following hypothesis:

Hypothesis 3. The likelihood of disclosing a patent acquisition by registering the assignment is lower when the potential seller's enforceability of the patent rights is higher (γ_S).

4. Data and Methods

For our empirical analysis, we rely on the patent assignments dataset available from the USPTO (Graham et al. 2018). This records all "assignments of assignor's interest", that is changes in patent ownership, related to both patent applications and granted patents. The biggest challenge with this dataset is to identify patent trades from other types of conveyances. While it is straightforward to exclude employee-to-employer assignments or other administrative events (e.g., name corrections), there are various reasons to record assignments that do not represent a trade between two independent corporate entities. As a starting point, we matched the assignment data with Compustat and were able to identify all entries indicated as assignments, listing a Compustat firm as an assignee, and executed during the 1997-2006 time period. This resulted in 734,621 assignment records, 678,470 of which were employer assignments. From the remaining 56,151 assignments, we were able to identify genuine patent trades based on the following procedure:

1. We removed within-firm transactions (e.g., from one subsidiary to another or to headquarters) by comparing the different corporate names (or their variations) corresponding to the same corporate parent available in the NBER patent database (Hall et al. 2001).
2. We removed assignments that correspond to M&A transactions. While the patent assignments dataset flags such transactions, we relied on SDC data and were able to identify additional assignments that are the result of corporate acquisitions.

3. For all the remaining assignment records, we manually searched the assignor and assignee names to ensure that they represent transactions between two independent corporate entities. For this, we relied on Dow Jones' Factiva database, the LexisNexis directory of corporate affiliations, and other news sources. During this search we identified additional within-firm transactions, assignments corresponding to corporate acquisitions as well as acquisitions of divisions or business units. These were excluded from the sample. We also excluded cases where the assignee is a spin-off and the patents were transferred from the corporate parent.

Following this procedure, we were able to identify 3,190 patent transactions undertaken by 870 Compustat firms during the 1997-2006 time period. We drop from our sample 123 observations with missing variables. This leaves us with a final sample of 3,067 patent transactions undertaken by 804 Compustat firms during the 1997-2006 time period. A total of 12,104 patents changed ownership as a result of these trades, with almost 28% of these involving multiple patents, while 3.94 patents are sold in the average transaction. Figure 1 presents the annual trends in terms of patent trades and patents traded for our sample during the study period.

- Insert Figure 1 about here -

An important concern here is whether all patent transactions are recorded at the USPTO. While we cannot exclude the possibility that some patent acquisitions are missing from the USPTO records, prior evidence suggests that almost all assignments are eventually recorded. According to a Federal Trade Commission report (2016), 95.5% of patents acquired by patent assertion entities (PAEs) were recorded at the USPTO's assignment database. Of course, the use of patent rights differs across PAEs and practicing entities. But practicing firms should have strong incentives to eventually record patent transactions since competitor imitation costs diminish over time and they can still enjoy the benefits of enforcement and deterrence. Besides that, recording protects buyers from a later sale of the acquired patents to a different firm in good faith (Serrano 2010, Graham et al. 2018, Arora et al. 2022).

4.1. Key Variables

To test the predictions of our model, we will use *Recording lag*, defined as the difference in days from the execution of a patent trade to its registration with the USPTO, as a dependent variable. As explained before, this variable reflects a deliberate strategy among patent holders to obfuscate patent ownership (Sterzi 2021: 986), and is, therefore, an appropriate measure of delayed disclosure. It is important to note here that this approach does not directly correspond to our model which defines disclosure in binary terms. While we acknowledge this mismatch, an alternative approach where we define disclosure as a binary variable based on an arbitrary cut-off point would mask important heterogeneity in the disclosure of patent trades. Nevertheless, we undertake robustness tests with *Recording lag* defined as a dummy variable.

Next, we calculate four key independent variables that help us test the predictions of our model by proxying the drop in the cost of imitation resulting from disclosing the transaction and the likelihood of the effectiveness of deterrence – see Table 1 for all variable definitions. First, we estimate *Buyer citing*, a dummy variable equal to one when at least one of the traded patents is cited by the buyer's patents. The drop in imitation costs should be lower when the buyer cites the acquired patents given that competitors already know that the buyer is using similar technologies. So, there is little new information disclosed from the transaction and we expect a negative relationship between *Buyer citing* and *Recording lag.*

- Insert Table 1 about here -

Next, we use *Buyer litigiousness* as a proxy for the buyer's effectiveness to deter competitors. This is calculated as the natural logarithm of the sum of patent suits involving the buyer during the three years prior to the focal transaction as reported by the USPTO patent litigation dataset (Marco et al. 2017). This measure captures a firm's reputation for enforcement and propensity to fight patent suits, both of which are likely to increase the effectiveness of competitor deterrence (Lanjouw and Schankerman 2001, Bessen and Meurer 2006, Agarwal et al. 2009). To capture the seller's litigiousness, we follow a similar approach. It is important to note here that, as per our model, the seller is unknown to the imitator. So, our measure should reflect the litigiousness of the potential or representative seller. To capture this, we identify representative sellers as those firms that sold patents in year *t-1* in the buyer's technological space, defined based on the primary patent classes of the patents granted to the buyer in the past ten years prior to the focal transaction.[12] *Representative seller litigiousness* then is the average of the sum of patent suits involving all potential sellers during the three years before the focal transaction.

A second measure to proxy effective deterrence is based on firm size. Small firms struggle to enforce their IP rights as they typically lack financial or managerial resources to fight patent suits and are less likely to cooperatively resolve conflicts (Lerner 1995, Lanjouw and Schankerman 2004). We lack detailed information on sellers as not all firms are publicly traded. As an alternative, we rely on the reported firm size status at the USPTO which differentiates between large and small entities, the latter defined as those with less than 500 employees. All buyers in our sample have a large firm status, so we create *Representative large seller* as the percentage of expected sellers – defined as above – with "large entity" status at the USPTO.

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[12] Note that both measures of change in the likelihood of effective deterrence cannot be estimated for the case of buyers without granted patents. Also note that we only observe patent sales where the buyer is a Compustat firm so our measure captures average or expected seller to Compustat firms.

4.2. Control Variables

We control for several other factors that could affect the length of the registration lag. To begin with, we create *Patents assigned* to count the number of patents traded in the focal transaction. Next, we calculate *Litigated patent*, a dummy variable taking the value of one when at least one of the traded patents was litigated during the year following the execution date based on data from the LitAlert database. Patent enforcement requires registration and this often happens just before filing a patent suit, so this variable accounts for this possibility (Sterzi 2021). *Re-assignment* is a dummy variable taking the value of one when at least one of the traded patents was subsequently reassigned in a different transaction. Like in the case of litigation, recording the correct owner is a requirement for sale.

Next, we control for the quality of the acquired patent(s) using *Citations received*, i.e. the number of forward citations received by the acquired patents adjusted for truncation (Hall et al. 2001), as well as for the basicness and applicability of the acquired patents using *Generality* and *Originality*, defined as in Trajtenberg *et al.* (1997). We also control for the technological proximity between the buyer and the traded patents by calculating Jaffe's (1986) measure of angular separation between the primary patent classes of the traded patents and the buyer's ten-year patent portfolio. *Buyer patent portfolio* controls for the buyer's patenting output and is defined as the natural logarithm of the citation-weighted count of patents granted to the buyer during the ten-year period before the transaction. Lastly, we include *Sales* as a proxy for the assignee firm's size, and *R&D intensity* to account for the assignee firm's technology spending.

4.3. Empirical Methods

We follow two approaches to test the predictions of our model. First, we rely on the set of variables we describe above to proxy imitation costs and the effectiveness of competitor deterrence. We estimate the following model with $Recording\ lag_{it}$ as the outcome variable for assignment *i* undertaken by firm *j* and executed in year *t*:

$$Recording\ lag_{ijt} = \alpha + \beta' X_{ij} + A_j + B_t + C_i + \varepsilon_{ijt} \qquad (1)$$

where X_{ij} is a vector of assignment or assignee characteristics, A_j is the buyer firm fixed effects that capture time-invariant, firm-specific differences that influence disclosure, B_t is the execution year fixed effects that account for temporal patterns in the disclosure of patent trades, C_i is the primary patent (IPC) class fixed effects that account for differences in the propensity to disclose patent trades across technology areas,[13] and ε_{ijt} is the error term. We use OLS and cluster-robust standard errors at the buyer firm level but we also provide results with Poisson regression.

Of course, the approach we describe above is subject to endogeneity concerns as firm size or litigiousness could be correlated with other determinants of the decision to disclose. So, in a second approach, we look for changes in imitation costs and the effectiveness of competitor deterrence that are independent of the characteristics of the firms involved in the transaction. To do so, we take advantage of two regulatory changes that occurred during the time frame of our study.

4.3.1. American Inventor's Protection Act (AIPA). The first change we exploit is the American Inventor's Protection Act (AIPA). This reform has been studied extensively and recent scholarship has demonstrated its impact on the disclosure of information related to patented inventions (Hegde and Luo 2018, Lück et al. 2020, Chondrakis et al. 2021, Beyhaghi et al. 2022). In particular, AIPA mandated the disclosure of patent applications 18 months after their filing date for all patents filed after November 29th, 2000, changing the USPTO's longstanding

[13] When multiple patents are traded, we use the most frequent primary patent class among the traded patents.

policy of keeping patent applications secret. While there are some exceptions to the publication of applications (Graham and Hegde 2015), there is robust evidence that AIPA created a more transparent information environment through the faster disclosure of early-stage technologies.

The passage of AIPA affords us with an opportunity to test a key prediction of our model, that is how changes in imitation costs impact the disclosure of patent trades. Whereas firms had limited or no information related to patent applications pre-AIPA, this changed with the publication of patent applications and provided competitors with an improved understanding of their technological component. Hence, the AIPA information shock made the disclosure of transactions involving patent applications less consequential, as competitors were already aware of the (potentially) patentable claims in the traded applications. This reduced the benefits of delayed disclosure. In comparison, granted patents were already published so AIPA had less of an impact with regards to the disclosure of patent trades. We take advantage of this decrease in the drop in imitation costs resulting from the publication of patent trades and employ a difference-in-differences (DD) analysis. We estimate the following model:

$$Recording\ lag_{ijt} = \alpha + \beta' X_{ij} + A_j + B_t + C_i + \lambda_2 Application_i + \mu_2 PostAIPA_t + \delta_2 Application_i \times PostAIPA_t + \varepsilon_{ijt} \qquad (3)$$

where *Application* is a dummy variable taking the value of one if at least one patent application is acquired, and *PostAIPA* is a dummy variable taking the value of one when the assignment was executed after AIPA's effects took place, that is after the year 2001 when patent applications started getting published. Our key estimate of interest is δ_2 which captures the AIPA treatment. Under the assumption that the disclosure of patent trades would be comparable for assignments that include patent applications versus those that do not, the DD model allows us to identify the causal effect of a decrease in competitor imitation costs resulting from the publication of patent trades on the disclosure of patent transactions.

4.3.2. Ex parte Lundgren. *Ex parte Lundgren* was an administrative decision by the USPTO's Board of Patent Appeals and Interferences (BPAI) in 2005 that increased the enforceability of business method and software (BM&S) patents. In more detail, BM&S patents faced substantial limits to patentability, or were considered as non-patentable subject matter, until the 1990s when the USPTO and the Court of Appeals for the Federal Circuit (CAFC) affirmed their patentability in a series of decisions.[14] From the mid-1990s onwards, this regulatory shift led to an upsurge in the filing and granting of BM&S patents (Duffy 2010, Hall and MacGarvie 2010). In the early 2000s, the USPTO started imposing an additional requirement on the recitation of 'technology' in pending claims, a fact that challenged the enforceability of those patents (Messinger et al. 2006). This shift was subsequently reversed with the BPAI's *Lundgren* decision, which explicitly removed the 'technological arts' requirement for patent eligibility and increased the enforceability of BM&S patents (Cotter 2007, Thomas and DiMatteo 2007).

The *Ex parte Lundgren* decision provides us with an apt context to test a key prediction of our model. Prior to *Lundgren*, the benefits of disclosing the acquisition of BM&S patents were reduced as it was unclear if these patents could be enforced in courts. In contrast, the effectiveness of competitor deterrence, and therefore disclosure, increased post-*Lundgren*, given that buyer firms could credibly threaten enforcement of BM&S patents. We take advantage of this increase in the effectiveness of competitor deterrence and estimate the following model:

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[14] For a detailed review of the regulatory history of business method and software patents during the 1990s and early 2000s see (USPTO 2000, Hall 2003, Graham and Mowrey 2004, Duffy 2010, Hall and MacGarvie 2010). Of particular importance are the 1995 drop of the business method exception from Section 706.3(a) of the USPTO's MPEP, the 1995 *In re Beauregrad* BPAI decision, and the1998 *State Street vs. Signature Financial* CAFC decision.

$$Recording\ lag_{ijt} = \alpha + \beta' X_{ij} + A_j + B_t + C_i + \lambda_1 BM\&S\ Patent_i + \mu_1 PostLundgren_t + \delta_1 BM\&S\ Patent_i \times PostLundgren_t + \varepsilon_{ijt} \qquad (2)$$

where *BM&S patent* is a dummy variable taking the value of one if at least one of the assigned patents has a primary patent class corresponding to business method or software patents,[15] and *PostLundgren* is a dummy variable taking the value of one when the assignment was executed after *Ex parte Lundgren*, i.e. after September 30th, 2005. The coefficient δ_1 tests for changes in the recording of assignments that include BM&S patents versus those that do not. Under the assumption that the disclosure of patent trades would be comparable for assignments that include BM&S patents versus those that do not, the DD model allows us to identify the causal effect of an increase in competitor deterrence on the disclosure of patent transactions.

5. Analysis & Results

Table 2 provides summary statistics and pairwise correlations. Consistent with previous studies of patent assignments (Graham et al. 2018, Sterzi 2021), we find the lag between execution date and registration date to be 228 days on average, with a minimum of zero and a maximum of more than 10 years. A bit more than a quarter of all assignments in our sample are registered within one month following the execution date, while roughly 5% of assignments have a recording lag of almost three years. Buyer firms in our sample reflect a wide cross-section of the economy in terms of primary industry affiliation but have higher R&D intensity and patent propensity than the average Compustat firm. We have less information related to the sellers, but it is interesting to note that 9% have a small firm status at the USPTO.

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[15] 705 is the USPTO patent class corresponding to business method patents. For software patents, we rely on Graham and Mowery (Graham and Mowrey 2004) who classify as software patents those with primary patent classes (IPC) in G06F (main groups: 3, 5, 7, 9, 11, 12 13 15), G06K (main groups: 9, 15), and H04L (main group: 9).

- Insert Table 2 about here -

Table 3 presents results from the regression analysis with *Recording lag* as the dependent variable. In Model (1) the coefficient of *Buyer citing* is negative with a *p*-value of 0.09, consistent with the view that the drop in imitation costs, and therefore recording lags, are lower when the buyer works on technologies that are closely related to those acquired. The impact of *Buyer citing* is sizeable, reducing *Recording lag* by approximately 50 days, or a 21.8% decrease from the mean, when it is equal to one. In Model (2), *Buyer litigiousness* is negatively correlated with *Recording lag* with a *p*-value of 0.03. This is consistent with our conjecture that the benefits of faster disclosure are higher when the buyer is more litigious. The effect size is large, with a standard deviation increase in *Buyer litigiousness* resulting in a 97-day reduction in the *Recording lag*, equivalent to a 42.5% drop from the mean.

- Insert Table 3 about here -

In Model (3), we include *Representative seller litigiousness* and find, as expected, a positive correlation with *Recording lag*. However, the effect is not significant with a *p*-value of 0.25. In Model (4), we provide support to the proposition that the seller's ability to deter competitors will result in slower disclosure. We include *Representative large seller* and find this to be positively correlated with *Recording lag* with a *p*-value of 0.02. This is consistent with the view that buyers delay disclosure when they can take advantage of the seller's deterrence potential. The effect size is sizeable, with a standard deviation increase in *Representative large seller* increasing the recording lag by almost 57 days, or a 25% increase from the mean. Model (5) includes all variables and results remain unchanged. In the remaining Models (6) to (10) we are able to replicate our findings using Poisson regression. Overall, our results suggest that buyers have less incentives to disclose a patent trade when they acquire unrelated technologies, which likely provides more information to competitors, when they cannot credibly threaten enforcement, and when they can take advantage of the seller's ability to deter competitors.

5.1. Robustness Tests

In Table 4 we test the robustness of our findings. First, we check if our results are driven by observations with very high *Recording lag*, which might reflect cases of inactivity or abandonment of the patent rights (Graham et al. 2018). Models (1) and (2) alleviate such concerns as all our results hold when we winsorize the dependent variable at the 97.5th or 95th percentile respectively. In Model (3), we change our dependent variable and use a dummy equal to one when the assignment is recorded one year after the execution date. All our results hold.

- Insert Table 4 about here -

In Model (4), we address a potential concern with our measure of the drop in imitation costs resulting from the disclosure of patent trades. *Buyer citing* could also capture an increase in competitor deterrence, as the buyer acquires a set of overlapping patent rights. The disclosure of this trade informs over the buyer's (increased) control over a patent thicket, deterring other firms from competing as a result (Shapiro 2001, Reitzig 2004, Galasso and Schankerman 2010). To explore whether this mechanism explains our findings, we note that overlapping patent portfolios are much more likely to deter competitors in complex-technology industries, like semiconductors or electronics (Merges and Nelson 1990, Ziedonis 2004). So, if deterrence is the main mechanism driving our results, the negative effect of *Buyer citing* should be more pronounced in the case of complex-technology industries. To test this, we interact *Buyer citing* with *Complex technology* industry, a dummy variable equal to one when the primary 1-digit international patent class of the traded patent(s) is in electricity. Results do not support the deterrence mechanism, as the interaction term is positive with a *p*-value of 0.47.

In Model (5), we look into the intensive margin of buyer citations to the acquired patents and define *Buyer citing* as the (average) percentage of buyer citations received by the assigned patent(s) out of the total number of citations received. Our results remain unchanged. In Model (6), we estimate *Buyer-seller relative litigiousness* as a dummy variable equal to one when *Buyer litigiousness* is higher than *Representative Seller litigiousness*. As expected, the coefficient of *Buyer-seller relative litigiousness* is negative, with a *p*-value of 0.04. Lastly, in Model (7), we estimate *Seller litigiousness* and *Large seller* based on the actual, not the representative, seller. So, *Seller litigiousness* is the natural logarithm of the sum of patent suits involving the seller during the three years prior to the focal transaction and *Large seller* is a dummy variable equal to one when the seller has a large entity status at the USPTO. All our results hold.

5.2. Additional Analyses

A challenge of the previous analysis is that we infer the level of competitor imitation costs and the effectiveness of competitor deterrence from firm or transaction characteristics. This evidence, while informative, is susceptible to omitted variable bias as unobservable firm or technology characteristics could drive the disclosure patterns we observe for reasons unrelated to our theory. Here, we employ a different approach and take advantage of two regulatory changes that increased the level of competitor deterrence and reduced competitors' imitation costs.

5.2.1. AIPA analysis. Table 5, panel (a) presents the results from the analysis related to AIPA. As we argued before, AIPA disproportionately reduced the drop in competitor imitation costs for assignments containing patent applications, so we expect a lower recording lag for such assignments. We find support for this view in model (1) as the interaction term between *Application* and *PostAIPA* is negative with a *p*-value at 0.02. While assignments containing applications are overall more likely to face delayed disclosure by 149 days as compared to assignments containing only granted patents, this difference disappears post-AIPA. In model (2) we look more precisely at assigned patent applications and define *Application* as a dummy variable taking the value of one when at least one patent application is included in the assignment and the difference between the assignment execution date and patent application date is larger than 18 months, i.e. publishable under AIPA rules. Our results remain unchanged. Lastly, we are able to replicate our results when we winsorize the dependent variable at the 95th percentile in Model (3) and when we define *Application* as the percentage of patent applications included in the assignment in Model (4).

- Insert Table 5 and Figure 2 about here -

Of course, a key assumption for this analysis is that changes in the disclosure of patent acquisitions would have been comparable for assignments with or without patent applications in the absence of AIPA. Figure 2 plots the coefficients of individual year dummies interacted with *Application* based on Model (1). These are indistinguishable from zero, suggesting that there are no discernible differences in pre-trends across the two groups of assignments. But after AIPA, the coefficients turn negative as expected, providing us with increased confidence in the interpretation of the DD analysis.

5.2.2. Ex parte Lundgren analysis. Table 5, panel (b) presents the results from the analysis related to *Ex parte Lundgren*. In Model (1) we can see that the main effect of *BM&S Patent* is indistinguishable from zero, suggesting that the presence of business method and software patents does not influence *Recording lag* for the entire sample of assignments. However, following *Ex parte Lundgren*, we see significant differences in the disclosure of patent acquisitions. The DD estimator is negative with a *p*-value lower than 0.01, suggesting that buyers are much faster in recording their acquisitions of business method and software patents following

Ex parte Lundgren. As we argued before, this regulatory change increased the enforceability of business method and software patents, and therefore the effectiveness of competitor deterrence, making the disclosure of patent acquisitions more attractive.

The reduction in *Recording lag* is large, with the assignments of business method and software patents being recorded 322 days faster post-Lundgren on average, as compared to the pre-Lundgren period. The equivalent drop for other assignments is much smaller at approximately 27 days. This effect is partly driven by some outliers during the pre-Lundgren period. In Model (2), we winsorize the dependent variable at the 95th percentile and find smaller drops in the recording lag of business method and software patent assignments, at 227 days, between the pre- and post-Lundgren periods. In any case, such large effects are not surprising given that we moved from a period when the enforceability of business method and software patents was questioned to one where the patentability of such patents was explicitly reaffirmed by the USPTO. Our results are also consistent in Model (3) where we use a smaller time period that is centered around the Lundgren decision, i.e. 2004-2006, and in Model (4) where we define *BM&S Patent* as the percentage of business method and software patents included in the assignment.

- Insert Figure 3 about here -

Again, we look if the parallel trends assumption holds for the DD analysis.. To that effect, the evidence in Figure 3 is reassuring. The coefficients of individual year dummies interacted with *BM&S Patent*, based on Model (1), are indistinguishable from zero up until *Ex parte Lundgren*, suggesting that there are no discernible differences in pre-trends across the two groups of assignments. But after Lundgren, the coefficients turn negative as expected, providing us with increased confidence in the interpretation of the DD analysis.

6. Discussion & Conclusion

The market for patents forms a key part of MFT and allows firms to capture important gains from trade by matching buyers and sellers of intellectual property rights (Serrano 2010, Akcigit et al. 2016). While an important literature has studied the information frictions that impede the function of MFT (Arora et al. 2001, Gans et al. 2008, Arora and Gambardella 2010), the strategic behavior of firms has received less attention. Here, we focus on the decision to disclose the acquisition of patents and put forward a simple model where firms trade the benefits of competitor deterrence resulting from disclosure with those of secrecy by failing to register the transaction. The model provides us with three predictions, namely that firms will disclose patent acquisitions when the drop in competitor imitation costs is small, when the buyer's effectiveness of competitor deterrence is high, and when the seller's ability to enforce her patents is low.

Empirically, we test the predictions of this model in a sample of patent assignments from the USPTO. Our results are broadly consistent with our predictions as we find the recording lag of patent acquisitions to be shorter when the acquired technology is cited by the buyer, in which case there is little new information from the disclosure of the assignment as competitors already know that the buyer is working on similar technologies, and when the buyer firm has a reputation for enforcement, in which case competitor deterrence is likely more effective. Interestingly, we show that the recording lag is higher when the seller is a large entity and can better enforce their patents. In this case, we argue that the buyer can take advantage of the seller's ability to deter competitors without disclosing the patent sale. Lastly, we take advantage of two regulatory changes that increased the effectiveness of competitor deterrence and reduced competitors' imitation costs and find results consistent with our framework.

6.1. Implications for theory

This paper contributes to the MFT literature by highlighting the strategic implications of disclosing patent trades (Arora et al. 2001, Gans et al. 2008, Agrawal et al. 2015). Patent acquisitions provide important cues regarding a firm's technological investments and their disclosure could undermine or reinforce a firm's competitive position. Our work is, to the best of our knowledge, the first to highlight this important trade-off and identify a set of parameters influencing the decision to disclose patent acquisitions. In this way, we complement existing work by identifying disclosure as a key strategic choice that can create both costs and benefits when participating in MFT (Anton and Yao 2004, Fink et al. 2022).

Besides that, our work is important in studying the interplay between the costs of imitation and the benefits of competitor deterrence to determine disclosure in MFT. These results extend the literature on patent disclosure (e.g. Gallini 1992, Anton and Yao 2004, Hopenhayn and Squintani 2015, Chien 2016) by emphasizing the informational content of changes in patent ownership. Whereas previous work has largely focused on the trade-off between disclosing a technology and keeping it secret, our paper focuses on the decision to disclose the acquisition of technologies that are already published in the public domain. In this way, we highlight the signaling effect of technology trades and an additional channel through which market participants learn about firms' technology investments.

Lastly, our work has implications for the resource-based view of the firm, in particular strategic factor market theory (Barney 1986, Makadok and Barney 2001). This is a key component of a theory of performance heterogeneity and identifies the use of private information in resource markets as a key antecedent of competitive advantage. Here, we suggest that the act of trading itself can undermine a firm's future ability to profit if the disclosure of resource acquisitions conveys credible information about resource value to competitors. Hence, the use of private information in resource markets could simultaneously reduce their value when the trade is observable. It is key therefore to explicitly account for disclosure, and firms' scope to delay that, in order to fully understand value creation and capture in strategic factor markets.

6.2. Implications for Practice and Policy

Ensuring transparency in patent ownership is seen as a key challenge for the USPTO and other patent offices worldwide (Feldman 2014, Sterzi 2021, Gorbatyuk and Kovács 2022). Legal scholars argue that the lack of clarity regarding ultimate patent owners allows patent holders to game the system, leading to more litigation and increased transaction costs (Menell and Meurer 2013, Anderson 2015). The lack of mandatory recording for patent assignments is seen as a key, albeit not the only, contributor to this, resulting in calls to amend the current rules. For example, the USPTO initiated a public discussion in 2014 to consider the pros and cons of forcing the identification of attributable owners for patents while the Pride in Patent Ownership Act, which would mandate the disclosure of patent ownership, is currently debated in the US Congress.

Our work is relevant for this important policy question as it provides additional arguments both in favor, and against, the mandatory disclosure of patent assignments. On the one hand, forcing the disclosure of patent trades will likely facilitate knowledge diffusion as patent acquisitions provide important signals to competitors about the value of technologies and their synergy potential. This is especially important for technologies that have high imitation costs and are thus more difficult to be adopted. Hence, the economy can benefit from the faster, and more widespread, diffusion of new technologies. However, mandatory disclosure could also negatively affect the function of MFT. A key concern is that it could lead firms to reduce their reliance on MFT, as buyers may be hesitant to engage in patent trades if they believe that this will increase the likelihood of imitation by competitors. This could ultimately reduce the efficiency of MFT, leading to slower adoption of new technologies and weaker incentives to innovate. Policy makers should weigh the potential benefits as well as the costs of mandatory disclosure in their effort to increase transparency in patent ownership while maintaining well-functioning MFT.

6.3. Limitations and Future Research

Our study is subject to some limitations. First, our model naturally simplifies the cost-benefit analysis that firms face when considering the disclosure of patent acquisitions. Our intention is to keep our model tractable and emphasize the key trade-off firms face between deterrence and imitation. But we acknowledge that we shy away from the full complexity associated with the decision to disclose. For example, competitor heterogeneity, i.e. how good competitors are at imitating, or differences in market structure could foreseeably play a role in the decision to disclose. It would be interesting to explore such extensions in future work. Second, while there's good evidence that the vast majority of patent assignments are eventually recorded (FTC 2016), we cannot be sure that our analysis includes every single transaction undertaken by firms in our sample. We have no reasons to believe that this could introduce sampling bias to our analysis, but future work could look for instances where such data is available. Third, we do not consider how the disclosure of patent assignments is shaped by other technology-related disclosures, e.g. patent grants, corporate acquisitions or licensing agreements. While such questions are beyond the scope of this study, it would be interesting to explore these in future research.

In conclusion, this article provides novel theoretical and empirical evidence related to the strategic disclosure of technology trades. Notwithstanding the limitations we discuss above, our study highlights a key trade-off that firms face when acquiring patents in MFT and provides important insights about factors that shape their disclosure decisions.

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Table 1. Variable names, descriptions and data sources

Variable name	Variable description
	Key variables
Recording lag	The delay (in days) to record the patent assignment transaction starting from the execution date.
Buyer citing	A dummy variable taking the value of one when at least one traded patent is cited by the buyer's patents.
Buyer litigiousness	The natural logarithm of the sum of patent litigation cases where the buyer was involved in years *t-1* to *t-3* .
Representative seller litigiousness	First, we identify the primary patent class of all patents granted to the buyer in the ten years prior to the assignment execution date. Then, we identify patent sellers in these patent classes in year *t-1* and calculate the average sum of patent litigation cases where the sellers were involved in years *t-1* to *t-3* .
Representative large seller	First, we identify the primary patent class of all patents granted to the buyer in the ten years prior to the assignment execution date. Then we identify patent sellers in these patent classes in year *t-1* and calculate the percentage of sellers with a USPTO large entity status.
	Control variables
Patents assigned	The number of patents assigned in the transaction.
Litigated patent	A dummy variable taking the value of one when at least one assigned patent is litigated during the one-year period following the execution date.
Re-assignment	A dummy variable taking the value of one when at least one assigned is subsequently re-assigned in a different transaction.
Citations received	The average number of (forward) citations received by patents assigned in the transaction
Generality	Trajtenberg *et al.* (1997)'s measure of generality averaged across patents assigned in the transaction
Originality	Trajtenberg *et al.* (1997)'s measure of originality averaged across patents assigned in the transaction
Tech proximity	Jaffe's (1986) measure of technological proximity between the assigned patent(s) and the buyer's portfolio of patents granted during the ten year period prior to the transaction.
Buyer patent portfolio	The natural log of the citation weighted count of patents (corrected for truncation) granted to the buyer during the ten year period prior to the transaction.
Sales	The natural log of assignee sales in year *t*
R&D intensity	Asignee R&D expenses divided by sales in year *t*
	Additional variables
BM&S Patent	A dummy variable taking the value of one when at least one patent assigned in the transaction has a primary patent class corresponding to business method or software patents.
PostLundgren	A dummy variable taking the value of one when the assignment was executed after Ex parte Lundgren, i.e. after September 30th, 2005.
Application	A dummy variable taking the value of one when at least one patent application is assigned.
PostAIPA	A dummy variable taking the value of one when the assignment was executed after AIPA's effects took place, i.e. after the year 2001.

Source: USPTO, NBER, Compustat

Table 2. Descriptive statistics and pairwise correlations

	Variable	Mean	St.Dv.	Pair-wise correlations																		
				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1)	*Recording lag*	228.41	493.90	1.00																		
(2)	*Buyer citing*	0.24	0.43	0.01	1.00																	
(3)	*Buyer litigiousness*	0.60	0.98	-0.02	0.12	1.00																
(4)	*Representative seller litigiousness*	1.85	2.17	0.09	0.03	0.26	1.00															
(5)	*Representative large seller*	0.90	0.11	0.03	0.05	0.06	0.20	1.00														
(6)	*Patents assigned*	3.95	10.84	-0.01	0.26	0.04	0.02	0.02	1.00													
(7)	*Litigated patent*	0.00	0.06	-0.02	0.03	0.00	0.04	0.00	0.01	1.00												
(8)	*Re-assignment*	0.39	0.49	-0.06	0.01	-0.04	0.08	0.08	0.10	-0.01	1.00											
(9)	*Citations received*	59.58	105.53	0.02	0.18	0.08	0.06	0.08	-0.02	-0.01	0.02	1.00										
(10)	*Generality*	0.41	0.27	-0.01	0.15	0.00	-0.02	0.00	0.01	0.03	0.01	0.26	1.00									
(11)	*Originality*	0.47	0.24	-0.01	0.00	0.07	0.01	0.04	0.00	-0.04	0.03	0.13	0.16	1.00								
(12)	*Tech proximity*	0.27	0.33	0.03	0.19	0.01	-0.03	-0.02	0.01	-0.01	-0.02	0.01	-0.16	-0.12	1.00							
(13)	*Buyer patent portfolio*	9.10	2.69	0.02	0.21	0.37	0.13	0.15	0.04	-0.04	-0.02	0.14	-0.04	0.05	0.17	1.00						
(14)	*Sales*	6.68	2.83	0.04	0.16	0.40	0.24	0.12	0.11	-0.01	-0.03	0.09	0.01	0.09	-0.12	0.52	1.00					
(15)	*R&D intensity*	0.13	0.09	-0.02	-0.04	-0.09	-0.01	0.01	-0.09	-0.03	0.02	-0.02	-0.08	-0.10	0.19	0.13	-0.54	1.00				
(16)	*BM&S Patent*	0.12	0.33	0.03	0.12	0.08	0.11	0.17	0.12	-0.01	0.04	0.23	0.14	0.14	-0.06	0.13	0.09	0.03	1.00			
(17)	*PostLundgren*	0.11	0.31	-0.02	0.07	0.10	0.06	0.00	0.08	-0.02	-0.05	0.02	-0.10	0.06	0.03	0.06	0.11	-0.06	0.00	1.00		
(18)	*Application*	0.47	0.50	0.04	-0.07	0.08	0.11	0.03	0.10	-0.03	0.05	0.09	-0.27	0.13	-0.02	0.14	0.14	-0.01	0.12	0.04	1.00	
(19)	*PostAIPA*	0.60	0.49	-0.09	-0.02	0.07	-0.12	0.05	0.01	-0.08	-0.08	0.02	-0.23	0.02	0.09	0.16	-0.11	0.29	-0.02	0.28	-0.01	1.00

N = 3,067

Table 3. OLS regression models

All Models use *Recording lag* as the dependent variable. Models (1) - (5) use ordinary least squares regression and Models (6) - (10) use Poisson regression. Standard errors are clustered at the firm level and *p*-values are reported in parentheses.

	OLS					Poisson				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Buyer citing	-50.351†				-52.867†	-0.158†				-0.189*
	(0.09)				(0.08)	(0.08)				(0.02)
Buyer litigiousness		-99.340*			-81.663†		-0.416**			-0.395*
		(0.03)			(0.08)		(0.00)			(0.02)
Representative seller litigiousness			27.527		20.085			0.018		-0.008
			(0.25)		(0.40)			(0.40)		(0.72)
Representative large seller				531.345*	434.985*				1.448*	1.411†
				(0.02)	(0.02)				(0.05)	(0.06)
Patents assigned	0.152	-0.100	-0.019	-0.074	0.517	-0.001	-0.001	-0.000	-0.000	0.003
	(0.91)	(0.94)	(0.99)	(0.95)	(0.69)	(0.88)	(0.86)	(1.00)	(0.98)	(0.69)
Litigated patent	59.450	68.390	-223.663	-153.757	-153.399	0.013	0.250	-1.375	-1.387	-0.672
	(0.63)	(0.55)	(0.44)	(0.61)	(0.55)	(0.98)	(0.62)	(0.23)	(0.23)	(0.52)
Re-assignment	-55.392	-57.162	-64.597†	-61.217	-65.308†	-0.239†	-0.263†	-0.288†	-0.290*	-0.295*
	(0.12)	(0.11)	(0.09)	(0.10)	(0.10)	(0.09)	(0.05)	(0.05)	(0.05)	(0.05)
Citations received	-0.010	-0.045	0.010	-0.009	0.021	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.93)	(0.68)	(0.94)	(0.94)	(0.86)	(0.50)	(0.31)	(0.85)	(0.74)	(0.95)
Generality	25.364	13.499	25.312	19.142	42.137	0.131	0.080	0.089	0.095	0.148
	(0.57)	(0.76)	(0.53)	(0.64)	(0.29)	(0.42)	(0.61)	(0.56)	(0.54)	(0.34)
Originality	-16.431	-11.983	-14.778	-24.563	-21.883	-0.018	-0.013	0.016	-0.006	-0.021
	(0.74)	(0.80)	(0.77)	(0.64)	(0.68)	(0.90)	(0.93)	(0.92)	(0.97)	(0.89)
Tech proximity	83.473	74.159	66.198	66.946	73.954	0.212	0.209	0.130	0.131	0.145
	(0.15)	(0.19)	(0.22)	(0.21)	(0.18)	(0.14)	(0.13)	(0.41)	(0.39)	(0.33)
Buyer patent portfolio	-24.784	-5.712	-34.796	-38.586	-22.871	-0.107	-0.028	-0.120	-0.121	-0.083
	(0.30)	(0.83)	(0.40)	(0.36)	(0.59)	(0.19)	(0.79)	(0.25)	(0.28)	(0.51)
Sales	-15.682	-12.712	-51.290	-44.682	-36.335	-0.088	-0.068	-0.233	-0.227	-0.154
	(0.63)	(0.68)	(0.24)	(0.32)	(0.40)	(0.46)	(0.58)	(0.15)	(0.18)	(0.35)
R&D intensity	-389.926	-425.795	-201.343	-222.381	-267.762	-2.558	-2.075	1.154	0.429	1.358
	(0.72)	(0.70)	(0.85)	(0.83)	(0.79)	(0.41)	(0.48)	(0.70)	(0.89)	(0.64)
Constant	271.533	210.316	1125.703**	739.464†	638.583	5.821**	5.455**	7.831**	6.655**	5.951**
	(0.41)	(0.50)	(0.00)	(0.09)	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology area FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3067	3067	2488	2488	2488	3067	3067	2488	2488	2488
No of firms	804	804	547	547	547	804	804	547	547	547
(Pseudo) R^2	0.477	0.479	0.449	0.449	0.455	(0.637)	(0.641)	(0.623)	(0.625)	(0.631)

† p < 10%, * p < 5%, ** p < 1%

Table 4. Robustness tests

All models use ordinary least squares regression with *Recording lag* as the dependent variable. Standard errors are clustered at the firm level and p-values are reported in parentheses. In models (1) and (2) the top 2.5% and 5% of *Recording lag* observations are winsorized respectively, and in model (3) the dependent variable is a dummy equal to one when the recording lag is longer than one year. In Model (4) *Complex technology* is a dummy equal to one when the assigned patent's 1-digit IPC class is electricity. In model (5) *Buyer citing* is defined as the (average) percentage of buyer citations received by the assigned patent(s) out of the total number of citations received. In model (6) we calculate *Buyer-seller relative litigiousness* as a dummy variable equal to one when the buyer is more litigious than the seller. In Model (7) we estimate *Seller litigiousness* and *Small seller* based on the actual, not the expected, seller.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Buyer citing	-41.720*	-39.477*	-0.050*	-61.555†	-107.520†	-54.538†	-51.690†
	(0.03)	(0.01)	(0.05)	(0.07)	(0.08)	(0.07)	(0.08)
Buyer litigiousness	-61.785†	-51.086†	-0.101**	-79.673†	-81.276†		-98.707*
	(0.07)	(0.08)	(0.00)	(0.08)	(0.08)		(0.03)
(Representative) seller litigiousness	14.295	9.739	0.020*	20.089	20.824		-14.038
	(0.24)	(0.21)	(0.03)	(0.40)	(0.37)		(0.49)
(Representative) large seller	203.605†	168.901†	0.241†	434.294*	439.021*	517.504*	163.389**
	(0.06)	(0.08)	(0.05)	(0.02)	(0.02)	(0.01)	(0.00)
Buyer citing x Complex technology industry				39.007			
				(0.47)			
Buyer-seller relative litigiousness						-169.890*	
						(0.04)	
Patents assigned	0.561	0.361	0.000	0.444	0.062	0.514	0.269
	(0.61)	(0.64)	(0.93)	(0.74)	(0.96)	(0.70)	(0.84)
Litigated patent	-92.950	-58.439	-0.092	-157.424	-164.469	-118.705	57.742
	(0.49)	(0.57)	(0.37)	(0.55)	(0.53)	(0.65)	(0.64)
Re-assignment	-43.829	-34.263	-0.056†	-65.294†	-66.088†	-69.151†	-54.374
	(0.11)	(0.12)	(0.06)	(0.10)	(0.09)	(0.09)	(0.14)
Citations received	-0.019	-0.029	-0.000	0.019	-0.002	0.006	-0.008
	(0.85)	(0.73)	(0.45)	(0.87)	(0.99)	(0.96)	(0.94)
Generality	28.742	19.353	0.006	42.965	31.683	37.709	27.606
	(0.34)	(0.44)	(0.84)	(0.28)	(0.42)	(0.35)	(0.54)
Originality	-6.089	-8.097	0.001	-21.658	-19.756	-21.701	-16.708
	(0.88)	(0.81)	(0.97)	(0.68)	(0.70)	(0.68)	(0.73)
Tech proximity	45.945	40.881†	0.069†	72.482	68.000	69.631	82.928
	(0.13)	(0.09)	(0.06)	(0.18)	(0.20)	(0.20)	(0.15)
Buyer patent portfolio	-27.023	-24.025	-0.039	-22.882	-24.186	-21.596	-4.009
	(0.43)	(0.44)	(0.24)	(0.59)	(0.57)	(0.63)	(0.88)
Sales	-31.655	-23.996	-0.037	-36.142	-35.230	-36.100	-15.459
	(0.27)	(0.34)	(0.22)	(0.40)	(0.41)	(0.42)	(0.61)
R&D intensity	-494.118	-419.799	-0.842	-256.471	-248.489	-167.325	-471.914
	(0.38)	(0.40)	(0.22)	(0.80)	(0.81)	(0.87)	(0.66)
Constant	556.377*	450.916*	0.565†	637.414	639.423	614.073	58.752
	(0.04)	(0.04)	(0.06)	(0.11)	(0.10)	(0.15)	(0.85)
Firm FE	Yes	Yes	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology area FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2488	2488	2488	2488	2488	2488	3067
No of firms	547	547	547	547	547	547	804
R^2	0.501	0.514	0.513	0.455	0.455	0.455	0.483

† p < 10%, * p < 5%, ** p < 1%

Table 5. Additional analysis

Panel (a) - AIPA

All models use ordinary least squares regression. Models (1), (2) and (4) use *Recording lag* as the dependent variable while in Model (3) we windsorize the dependent variable at the 95th percentile. Standard errors are clustered at the firm level and *p*-values are reported in parentheses. In model (2) *Application* is a dummy variable equal to one when at least one of the patents assigned had not been granted when the transaction the difference between assignment execution date and patent application date is larger than 18 months. In model (4) *Application* is defined as the percentage of patents assigned that were not granted when the transaction took place.

	(1)	(2)	(3)	(4)
Application	148.625*	275.768**	68.521*	168.709*
	(0.02)	(0.00)	(0.02)	(0.03)
Application x PostAIPA	-185.269*	-210.270**	-85.329*	-204.982*
	(0.02)	(0.00)	(0.02)	(0.02)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Technology area FE	Yes	Yes	Yes	Yes
N	3067	3067	3067	3067
No of firms	804	804	804	804
R^2	0.481	0.492	0.536	0.482

† p < 10%, * p < 5%, ** p < 1%

Panel (b) - Ex parte Lundgren

All models use ordinary least squares regression with *Recording lag* as the dependent variable. Standard errors are clustered at the firm level and *p*-values are reported in parentheses. In models (1) to (3) *Business method & software patent* is a dummy variable equal to one when at least one business method or software patent is assigned in the transaction. In model (4) *Business method & software patent* is defined as the percentage of business method or software patents assigned in the transaction. In model (2) we windsorize the dependent variable at the 95th percentile while in model (3) we exclude transactions that took place before 2004.

	(1)	(2)	(3)	(4)
Business method & software patent	33.057	17.392	161.793	48.918
	(0.58)	(0.61)	(0.11)	(0.51)
PostLundgren	-27.498	-19.313	26.582	-30.688
	(0.77)	(0.79)	(0.84)	(0.75)
Business method & software patent x PostLundgren	-294.471**	-197.392**	-339.049*	-359.648*
	(0.01)	(0.00)	(0.05)	(0.01)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Technology area FE	Yes	Yes	Yes	Yes
N	3067	3067	767	3067
No of firms	804	804	317	804
R^2	0.478	0.535	0.650	0.478

Figure 1. Patent assignment trends, 1997-2006
This graph presents the number of unique patent trades and the number of traded patents registered with the USPTO and having a Compustat firm as the assignee during the 1997-2006 time period.

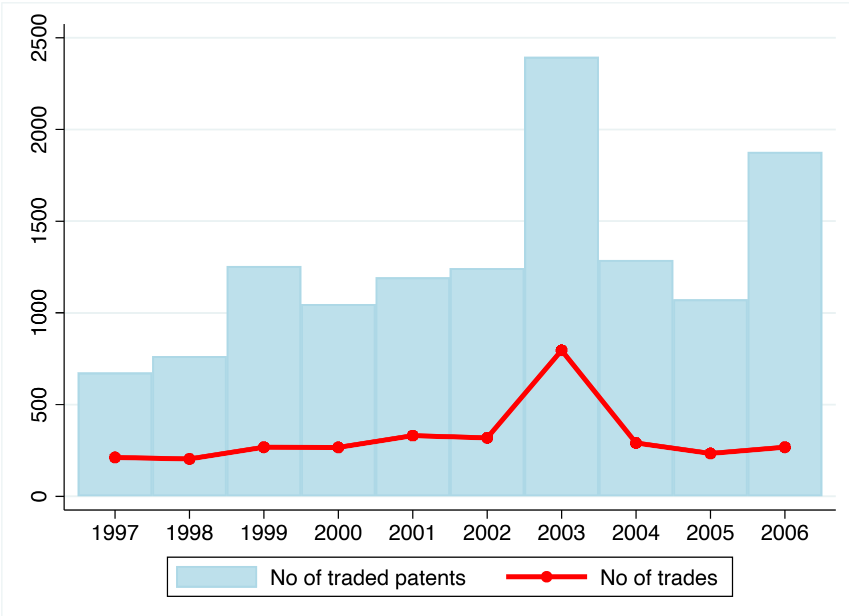

Figure 2. Effect of AIPA on recording lag, 1997-2006
This graph presents the coefficient estimates of individual year dummies interacted with *Application*. The year 2001 is the base year and thus excluded. Standard errors are clustered at the firm level and 95% confidence intervals are plotted.

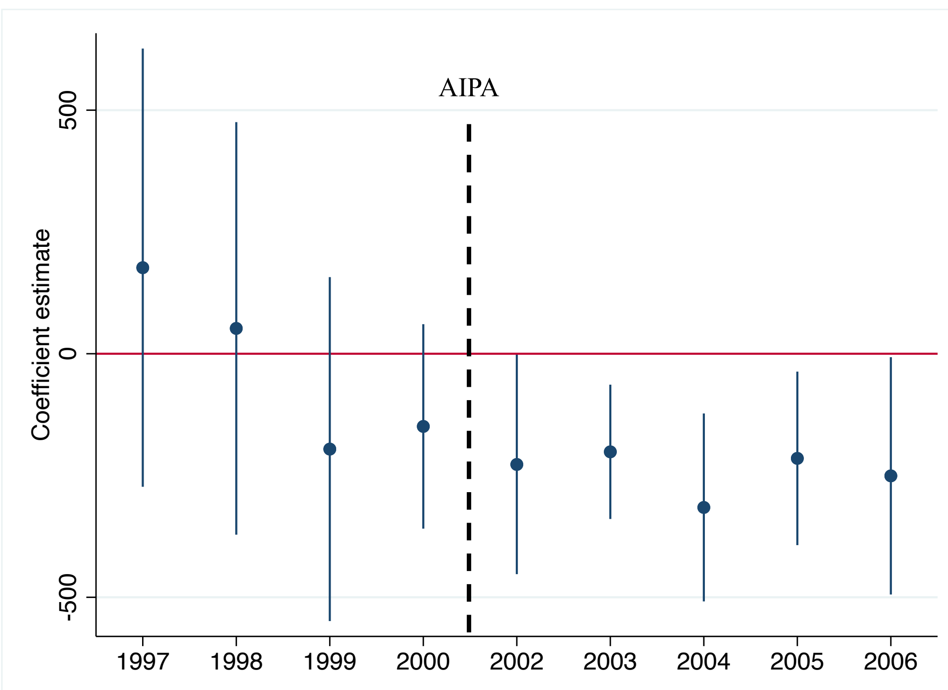

Figure 3. Effect of Ex parte Lundgren on recording lag, 1997-2006
This graph presents the coefficient estimates of individual year dummies interacted with *BM&S patent*. The year 2005Q1-Q3 is the base year and thus excluded. Standard errors are clustered at the firm level and 95% confidence intervals are plotted.