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Patent assertion entities and patent ownership transparency: strategic recording of patent transactions at the USPTO

Valerio STERZI

Univ. Bordeaux, CNRS, GREThA, UMR 5113, F-33600 Pessac, France

GREThA UMR CNRS 5113
Université de Bordeaux
Avenue Léon Duguit
33608 Pessac – France
Tel : +33 (0)5.56.84.25.75
http://gretha.u-bordeaux.fr/

LAREFI
Université de Bordeaux
Avenue Léon Duguit
33608 Pessac – France
Tel : +33 (0)5.56.84.25.37
http://larefi.u-bordeaux.fr/

Abstract

Many PAEs hide behind dozens of unknown subsidiaries or shell companies with obscure ownership. Meanwhile, the United States Patent and Trademark Office (USPTO), like many other patent offices, does not impose a strict time period for recording the change of ownership of a patent, allowing the holder to gain an advantage by controlling the timing of its ownership disclosure. In this paper we analyze recording lags in patent transactions (defined as the time lag from the execution of the patent assignment to USPTO recording) and show that PAEs strategically notify the patent office of the transaction as a function of their litigation strategies. In particular, OLS estimates suggest that for every ten days that separate the date of the start of the litigation from the execution of the patent transaction, PAEs delay the recordation of the transaction by almost four days (while the lag is about two days when the assignee is a product company). Longer recording lags are especially,associated with transactions related to patents transferred to PAEs in the ICT sector, that are litigated in the District Court in the Eastern District of Texas and that are acquired by PAEs through unknown subsidiaries.

Keywords: Non-practicing entities, Patent trolls, Patent litigation, Patent ownership transparency

JEL: O31, O34, D23

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1 Introduction

The sharp increase in patent applications worldwide over the last 30 years is indicative of how many economies have become increasingly dependent on intellectual property (IP). In both Europe and the US, IP is today a pervasive presence in society, while intangible assets (primarily, patents and trade secrets) are the most important components of firms' market value, representing 84% of US stock market capitalization (S&P 500) in 2015, rising from 68% in 1995 and from just 32% in 1985 (Elsten and Hill, 2017).

In recent years, a new line of business which consists in exploiting and monetizing patents has emerged. Various IP markets have seen this shift to monetization, where patents that would ordinarily not have provided any return are now being reconstituted and monetized (Feldman, 2012*b*) and several product-producing companies have recently refocused their business strategy and moved one step closer to the IP monetization business, which is becoming an important source of revenue (Osenga, 2014).[1] Pénin (2012) describes this phenomenon as a "radical hijacking of the primary role of patents", and finds this shift in patent usage paradoxical, as "patents were designed to prevent infringements" whereas now they are being used "precisely in order to be infringed".

Among the entities that profit most from the monetization of patent assets, patent assertion entities (PAEs) have emerged as key players. PAEs are actors that file or acquire patents from a variety of sources and use them primarily to obtain license fees and revenue by asserting them against alleged infringers. Sometimes also referred to by the derogatory term "patent trolls", PAEs do not manufacture, distribute or sell products. Rather, by enforcing patents, PAEs often target manufacturers that allegedly use the patented technology, as the power to exclude is particularly lucrative when it is exercised against those that are already engaged in the market (and who have much to lose if they are unable to continue operating).

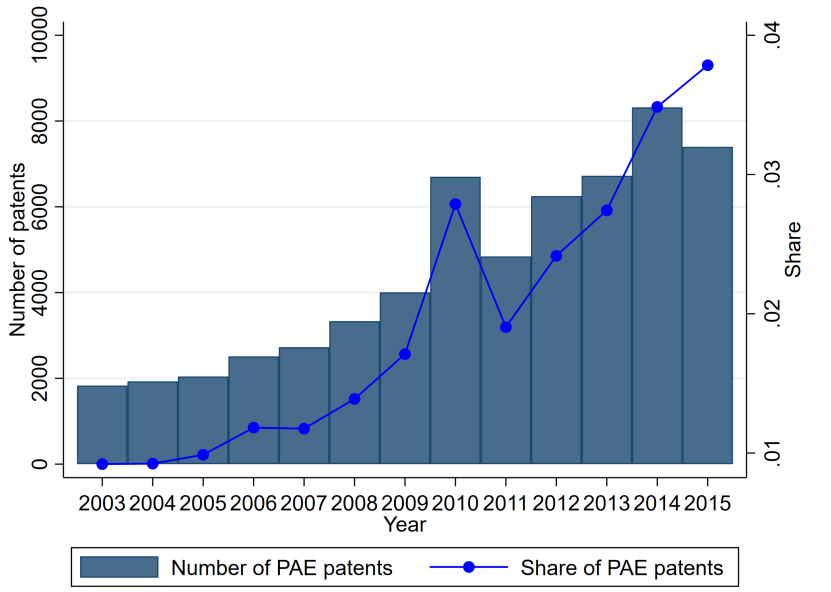
Over the past decade, the patent system has indeed witnessed a soaring number of litigation cases initiated by PAEs, and a recent study has estimated that the PAE business in the United States is worth about $30 billion in settlements and licensing fees per year (Bessen and Meurer, 2013). A widespread opinion among scholars and practitioners is that the PAE phenomenon should be a cause of concern for policymakers and stakeholders (Cohen et al., 2016; Lemley and Feldman, 2016), or may even be "the most significant problem facing the patent system today" (Lemley, 2006).

Since the end of the 2000s, PAEs have become an important actor in the US patent system. As

[1] For example, Technicolor, a company based in France that provides services and products for the communication, media and entertainment industries, initiated several patent infringement suits in Germany and France in 2017 against Samsung Electronics and, more recently, has sold its patent licensing business to InterDigital, a US wireless technology firm specialized in generating revenues by licensing and asserting patents. Among others, Blackberry, Ericsson and Nokia are examples of early market leaders that have recently embraced monetization as their core business and become supporters of privateer-style patent asserrtion entities (PAEs). These companies often operate through satellites (for example, Avanci, Unwired Planet, PanOptis in the case of Ericsson; Core Wireless and Vringo/FORM Holding for Nokia) and engage in patent stacking.

evidence, and drawn from the original data used in the present paper, Figure 1 shows the number of patents filed and acquired by PAEs at the USPTO between 2003 and 2015. During the second half of the 2000s, PAEs filed or acquired more than 2,000 patents per year, with this figure reaching more than 5,000 since 2010. In relative terms, the contribution of PAEs to patent filings and acquisitions increased sharply from the early 2000s onwards, reaching the remarkable peak of 3.5% in 2014.

Figure 1: Presence of PAEs at the USPTO



Notes: The number of patents sums both filed and acquired US granted patents. The year refers to the the execution date of the patent assignment. Source: own work, based on the US Patent Assignement Database (2017). The list of names of PAEs (and their subsidiaries) is provided by Darts-IP (See Section 3 of the paper).

Although significant, these figures should be considered as minimum estimates, since the list of names of PAEs and their subsidiaries used in the analysis (provided by Darts-IP and presented in Section 3) may be incomplete due to the frequent use by PAEs of unknown subsidiaries and shell companies to acquire and hold patents.

It is well known that by accumulating patents through unknown subsidiaries, PAEs are in fact seeking to benefit from the lack of transparency of the patent ecosystem, making it difficult to conclude who actually owns a particular patent and whether it is a patent for which target firms already have a license (Feldman, 2014; Morton and Shapiro, 2013; Sterzi et al., 2020). However, what is less known is that PAEs may also take advantage of the fact that the registration of transfers of patent ownership is often not mandatory and the legitimacy of the transaction is not directly conditional upon the registration of the change of ownership (Gorbatyuk and Kovács, 2019). This allows PAEs (and in general any patent holders)

to remain hidden while launching campaigns, be it for the acquisition of qualified positions in specific corporations or for launching a set of IP litigation actions.

In this paper, we show how pervasive this phenomenon is, by providing new evidence based on recordation lags between stated execution dates and the recording of patent transactions at the USPTO (Graham et al., 2018). Although a timely recordation should occur within three months,[2] we show that patent holders, and in particular PAEs, strategically decide to record the patent assignment at the patent office as a function of their litigation strategies. In particular, our estimates suggest that for every ten days that separate the date of litigation from the date of execution of the patent transaction, PAEs delay the recordation of the transaction by almost four days (while this lag is about two days when the assignee is a product company).

The rest of the paper is organized as follows. In Section 2, we explore the principal causes of notice failure in the patent system, paying particular attention to the problems associated with the transparency of patent ownership. In Section 3 we present the data, and in Section 4 we discuss the main hypotheses and outline the preliminary evidence. In Section 5 we propose an empirical strategy to study the relationship between recording lags in patent transactions and patent litigation, and present the main results. Finally, Section 6 concludes.

2 Notice failure in the patent system

Patents are key to innovation in that as they serve a dual role. On the one hand, they grant exclusivity for a specified time period to inventors who can demonstrate they have created something novel. In so doing, they provide a strong monetary incentive to innovate: patent protection can thus foster innovation by increasing the opportunities an inventor has to bring new products to the market. On the other hand, by encouraging inventors to disclose their inventions to the public, patents further benefit innovation and subsequent innovators by disseminating technical information. This *notice* function enables more efficient investment in innovation by stimulating further innovation, reducing pointless duplicate innovative efforts and limiting wasteful litigation.

In today's knowledge based-economy the skills needed to develop inventions have become increasingly separated from the skills needed to commercialize them (Arora et al., 2001). The globalization of markets and the increasing complexity of technologies often require more than one firm to successfully introduce an innovation into the market. For this reason, since the beginning of the 20th century, many small- and medium-sized enterprises have made a profitable business as specialist suppliers of technology to larger manufacturing firms, with the consequence that many patents that would not have been used in the past

[2] 35 U.S.C. 261 (2015).

are now being separated out from the underlying products and transferred in the form of tradable rights (Jeruss et al., 2012; Feldman, 2014; Feldman and Ewing, 2012).

In real estate markets, notice does not pose a serious problem for property development: land boundaries are recorded in publicly accessible and state-administered record offices. Since landowners can usually find out who their neighbors are, potential investors can buy the rights before making an investment and thus avoid trespassing (Menell and Meurer, 2013). In intangible asset markets, however, notice is very much an issue: the scope of patents is not clear, they are often written in vague language, and companies cannot easily find them and understand their claims. Moreover, these information gaps are further exacerbated by the inadequate disclosure of information about who ultimately holds the rights to the patent. However, implicit to the structure of the patent system is the concept that someone wishing to license a patent can identify those who hold the necessary rights: indeed, identifying those that have a financial interest in the patent is a small but essential step in guaranteeing the communication of adequate knowledge to the players in the field (Feldman, 2014).

The patent system is predicated on notice and it applies a form of strict liability to those who would trespass (Feldman, 2014). Operating firms that make, use, or sell a product protected by a patent are liable for patent infringement, regardless of whether they independently invented it or had any direct knowledge of the patented invention. Indeed, operating firms are supposed to conduct broad patent clearances and, subsequently, license all the intellectual property rights they need to develop their products or associated inventions. However, because of the vast number of active patents, the unclear patent boundaries and the patent market's lack of transparency, such patent clearances are burdensome, discouraging firms from searching for and reading relevant patents (Macdonald, 2004; Menell and Meurer, 2013; Le Bas and Pénin, 2014); and small firms with limited resources may not be able to conduct due diligence. Problems of hidden patent ownership arise largely in the shadow of litigation (Anderson, 2015). Once a patent has been acquired, patent holders may hide the patent away until its use by the alleged infringer becomes widespread. Such a situation is most likely when the parties lack the necessary patent ownership information to evaluate the litigation risk effectively (Menell and Meurer, 2013), thereby enabling patent holders to generate rewards often unrelated to any contribution made.

2.1 Patent ownership transparency

An effective patent notice would require (at least) the potential licensee (or buyer) of the patented invention to easily identify those holding the necessary rights. However, this is often not the case, mainly for two reasons. First, patent owners, PAEs in particular, set up shell companies and unknown subsidiaries to hide patent ownership. Second, they are not required to give prompt notification of a change in patent ownership to patent offices.

It is a fact that patent offices generally impose rules that require the original applicant to provide accurate patent ownership information when the original application is filed. Non-compliance brings negative consequences, such as the refusal of a patent. However, after filing, the rights can be transferred to another party and there is no limit on the number of times that the ownership of a patent can change. Depending on the patent office, these changes may not have to be registered or, if they are, their registration may be delayed, with the implication that the information as to who currently owns the patent available to the public may be incorrect.

At the USPTO, the "original applicant is presumed to be the owner of an application for an original patent, and any patent that may issue therefrom, unless there is an assignment".[3] The USPTO allows agents to record assignments of patents in order to maintain a complete history of claimed interests in a patent and to provide notice pertaining to the ownership of a patent to third parties (Graham et al., 2018).

Even though, under a patent statute, failure to record an assignment at the USPTO renders it null and void against any subsequent purchaser or mortgagee (Graham et al., 2018), the recording of an entire or partial patent assignment at the USPTO is not mandatory, as there is no express legal requirement for parties to disclose assignments. In particular, the patent statute does not impose a fixed period for registration but it does require filers to register within three months of the execution date, or before the next assignment, in order to secure protection against subsequent purchasers (Graham et al., 2018). Despite this requirement, patent transactions are recorded, on average, 192 days after the execution date, a time period that also appears to be increasing over time and exceeds 1 year in about 10% of cases.[4]

For this reason, commentators have raised concerns that current requirements for the registration of a change of patent ownership, as imposed by the USPTO, are insufficient. As Gorbatyuk and Kovács (2019) point out, the USPTO itself has acknowledged the limitations of the current system of rules for recording ownership change as "[...] the USPTO simply puts the information on the public record and does not verify the validity of the information. Recordation is a ministerial function – the USPTO neither makes a determination of the legality of the transaction nor the right of the submitting party to take the action".[5]

3 Data sources and sample construction

We conduct our analysis on an original database of US utility patent transfers we produce by merging five main data sources. The first source of information is the US Patent Assignment Database (2017 version), which we use to track patent transfers in the US by exploiting the information contained in the

[3] 37 CFR 3.73(a) (2015). Quotation from (Graham et al., 2018).

[4] These statistics are based on our calculation from the US Patent Assignment Database (2017) and consider only patent reassignments (i.e., they do not consider first filings and employer assignments).

[5] See http://assignment.uspto.gov.

'assignment' data file (Graham et al., 2018). More precisely, first we apply semantic algorithms to clean and standardize assignee names appearing in the database.[6] Second, we select the 'assignment of assignor's interest' conveyance among the several types of conveyance reported in the file, and for each isolated record, we then look at the different 'assignees' appearing in the patent history. After standardizing and harmonizing assignee and assignor names, we rebuild the ownership tree attached to each patent recorded in the original assignment database. Third, we further clean patent changes of ownership by comparing assignee names in the patent history and then deleting false patent transfers.

As a second source of information, we use the Ecoom-Eurostat-EPO-Patstat (EEE-PAT) database (Callaert et al., 2011) in order to allocate US patent holders from the US Patent Assignment Database to one of the following sectors: *private business enterprises*, *individuals*, *universities*, *government and non-profit organizations*, and *hospitals*. In doing so, patent assignee names from PAD are assigned to specific sectors when a similarity between the assignee name and a name on our list from EEE-PAT is found. Whenever a correspondence is not found, we perform an automatic search for keywords in the assignee name to allocate the unassigned entities to a unique sector.[7]. Once first filings and employer assignments are excluded, *private business enterprises* represent about 93.5% of assignments in the period covered by the analysis (between 2003 and 2015) , *universities* (3.8%), *government and non-profit organizations* (1.6%), *individuals* (1.0%) and, finally, *hospitals* (0.1%).

The third source of information is the Darts-IP database (`https://www.darts-ip.com`), from which we retrieve an extensive list of PAEs, together with their subsidiaries, which appear as plaintiffs (or, less frequently, defendants) in litigation actions in the United States or in Europe. After a few changes have been made to the list,[8] the final list of PAEs consists of 546 main groups and 1,815 firms that we match to the list of patent assignees from PAD. [9] Table A1 shows the list of top PAE groups by patent portfolio size over the period 2003-2015. It is worth noting that the networks of identified subsidiaries of PAEs do not include those that are used to acquire and file patents but that never appear as plaintiffs (or defendants) in courts, with the implication that the real contribution of PAEs to the patent market is underestimated. The bias can be particularly large for Intellectual Ventures which, according to various specialized IP companies and blogs[10], has a network of more than two thousand subsidiaries [11]. Despite this limitation, we identify 57,528 granted US utility patents filed or acquired in the years between 2003 and 2015, corresponding to about 2.3% of all patents.

[6] The matching is carried out by constructing a matching score (the Levenshtein distance or edit distance) between strings. We thank Gianluca Tarasconi for his help `https://rawpatentdata.blogspot.com/`.

[7] For example, we use the business entities code to individuate private business enterprises, and keywords like "school"or "university" to identify *universities*.

[8] We make few changes to the list provided by Darts-IP: we exclude two organizations that we consider as product companies, Abbott Laboratories and Rockstar, and three university technology transfer offices, Virginia Tech Intellectual Property, Wisconsin Alumni Research Foundation, Cornell Research Foundation.

[9] In so doing, we use a combination of the functions *SPEDIS* and *FUNCTION* in SAS to compare name similarity

[10] See `https://www.plainsite.org/tags/intellectual-ventures-shell-companies.`

[11] when these subsidiaries are included in the list of PAEs, the patent portfolio of Intellectual Ventures exceeds 30,000 patents

The fourth source of information is the OECD Patent Quality Indicators (Squicciarini et al., 2013) database that we use to collect information on patent characteristics (such as the technological field, the filing date, the number of forward citations, patent originality, patent generality, family size, the number of backward citations, and the number of claims) that may correlate with the recording lags and that we use as control variables in the econometric analysis.

Finally, the fifth source of information is the USPTO Patent Litigation dataset (2019 version), containing complete patent litigation data on district court cases filed in US district courts from January 1, 2003, to December 31, 2016, for a total of over 55,000 cases (Marco et al., 2017). By matching the USPTO Patent Litigation Dataset to PAD, we find 22,111 utility patents that were filed or acquired and recorded in the years between 2003 and 2015 and then litigated, of which 18,627 (84%) concern patent infringement cases.

4 Main hypothesis and preliminary evidence

By limiting the analysis to the years 2003-2015, our database contains in total 2,511,537 US granted utility patents, of which 57,528 show at least one PAE in their patent history. By considering only reassignments (i.e., by excluding first filings and patents transferred from inventing employees to their employer assignees), the database contains 505,709 patents, of which 27,927 have at least one PAE among their assignees, for a total of 693,399 transactions (each patent may be transferred more than once during its patent term). For each patent assignment, we observe the date of execution and the date of recordation. The average *recording lag*, defined as the difference between these two dates, is 233 days across the whole database (28-day median) and 211 if we consider only reassignments (37-day median). Interestingly, in this latter case, PAEs show the lowest recording lags (124 days) (see Table 1). PAEs thus record patent transactions in a more timely fashion, since they use the patents externally and need to prove patent ownership during the patent lawsuits. Finally, Figures A1a and A1b in the Appendix show that the recording lags appear to be increasing over time in the whole database (as shown by Graham et al. (2018)), but that they are stable if we consider only reassignments.

In general, long recording lags may suggest "*inattention, time spans of no foreseeable transaction activity, or abandonment of the property altogether*" (Graham et al., 2018), but can also suggest a deliberate strategy among patent holders to obfuscate patent ownership. In fact, since recording an assignment of the assignor's interest in patents provides *legal notice* to the third party, patent holders may strategically decide to delay the recordation of the patent transaction until they decide to enforce the patent in courts. This practice is explicitly recognized by actors in the patent ecosystem. At the FTC Workshop on patent assertion entities held in 2012, a representative of Intellectual Ventures argued as follows: "*We spend a lot of money and a lot of effort figuring out where to invest. And we don't feel like tipping our hands on*

Table 1: Average recording lags (in days) at the USPTO by type of assignee (2003-2015)

Type of assignee	**Average lag (st. dev)** *All assignments*	**Average lag (st. dev)** *Reassignments*
PAE	290.2 (826.0)	124.3 (358.3)
Private business enterprise	229.1 (652.5)	214.8 (594.5)
Government and public research organizations	234.6 (672.9)	190.9 (657.6)
Hospitals	581.1 (1154.7)	260.6 (810.3)
University	292.7 (745.7)	238.8 (656.5)
Individual	239.5 (1399.1)	241.4 (2192.2)
Total	233.1 (671.8)	211.7 (639.7)

Notes: The table shows the average number of days from the execution date of the patent assignment to the USPTO recording. The nature of conveyance is "patent assignment". "Reassignments" exclude first filings and employer assignments. Source: own work, based on data from PAD (2017). The list of PAE names is provided by Darts-IP.

our investment policies and our investment intentions to our competitors. Warren Buffett doesn't tell people where he's investing until he's forced to when he's practically ready to take over a company. Disney doesn't tell people when it[']s buying swamp land in Florida that, hey, we're planning to put a theme park over there" (quotation from Feldman (2014)).

Economic theory suggests that PAEs may keep the contents of their portfolios secret because secrecy is more profitable than transparency. First, since the accused infringers cannot clearly determine all of the parties involved in the patent, nor identify other parties that may have been targeted, their bargaining power is undermined (Morton and Shapiro, 2013). Second, by making competitors unaware of the true extent of their assets, PAEs can easily avoid pre-emptive actions (such as Inter-Partes and Post-Grant Review) by any adversaries. Third, when patent defendants are small players with low IP management skills, they may settle and make multiple payments to what is essentially the same entity (Morton and Shapiro, 2013; Feldman, 2012*a*, 2014). Feldman (2012*a*) refers to this strategy as "unbundling": "*[...]* an entity takes a group of related patents, separates them out, and transfers different ones to different monetizers. As a result, a product company must face multiple demands from different assertion entities. [...] Unbundling allows the entity that originally divided the group to magnify its return, either by retaining rights to a share of the profits or simply by virtue of the fact that the sale price of each decoupled patent reflects its settlement value" (pag. 263).

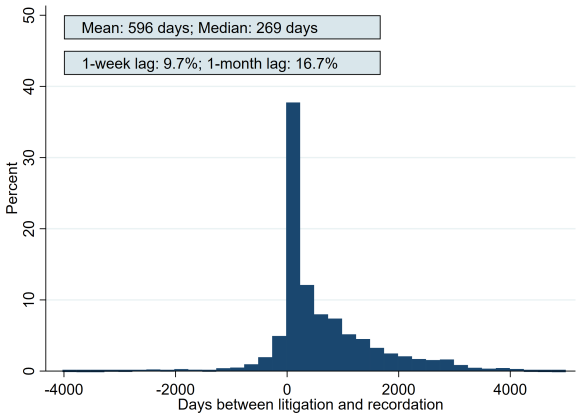
We thus expect that some PAEs (in particular those that *opportunistically* assert their patents against unwilling or potential infringers) might strategically decide to record the transaction as late as possible, that is, only when they are forced to do so, which often coincides with the moment at which they start to litigate. We thus expect to observe a correlation between the time at which PAEs decide to record the transaction and when they eventually decide to litigate the patent in courts.

Preliminary evidence points in this direction. By restricting the analysis to patents acquired and subsequently litigated in infringement actions by the patent buyer, Figures 2a and 2b show the number

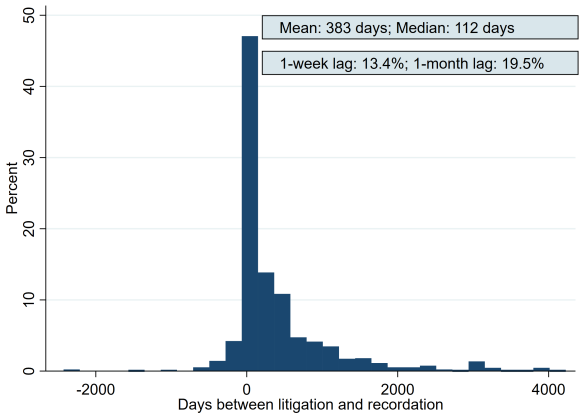
of days separating the litigation date from the recordation date of patent acquisition for both *private business enterprises* and PAEs. What does clearly emerge from the figures is that, in both cases, a large share of reassignments are recorded around the date on which the patent holder files the lawsuit. In addition, figures also show that PAEs record patent transactions at the USPTO significantly closer to the date on which they start to litigate: in the seven days preceding the litigation date, PAEs record 13.4% of transactions, while *private business enterprises* record 9.7%. Moreover, on average, *private business enterprises* record patent transactions 269 days before the litigation date, and PAEs only 112 days.

Figure 2: Number of days between litigation and recording date - First filings and employer assignments excluded

(a) Type of assignee: private business enterprises



(b) Type of assignee: PAE



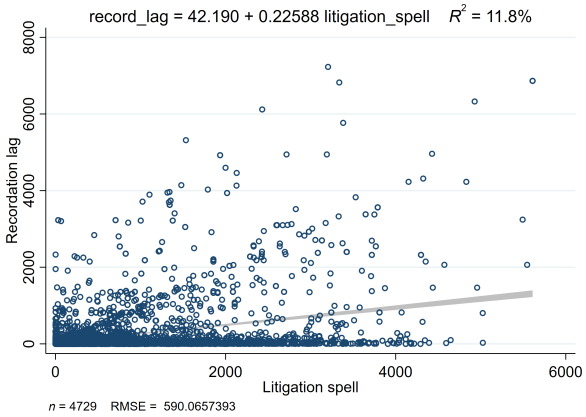
Notes: The figures show the number of days that separate the litigation date (infringement action) from the recordation date of the transaction at the USPTO. First filings and employer assignments are excluded. Only patents transferred to assignees that subsequently litigated the patent are considered. Only infringement actions are considered. Negative values mean that litigation started before the recordation of the change of ownership at the USPTO. Nature of conveyance: "patent assignment". Source: PAD (2017) for patent transfer and USPTO Patent Litigation Dataset (2019) for litigation data. The list of PAE names is provided by Darts-IP.

Similar findings are also confirmed by Figures 3a and 3b, which show the correlation between recording lags (i.e., the time lag from the execution date of the patent reassignment to USPTO recording) and litigation spells (defined as the difference between the execution date of the patent reassignment and the date on which the patent holder filed the patent infringement lawsuit). In particular, Figures 3a and 3b show the actual combinations of recording lags and litigation spells for patent transactions, where patent assignees are, respectively, *private business enterprises* and PAEs. The figures show that for each additional day separating the patent transaction date from the litigation date, *private business enterprises* delay the recordation by about 0.23 days, while PAE do so by about 0.40 days, and that 40.0% of the variation in recording lags is explained by a variation in litigation spells when the patent assignee is a

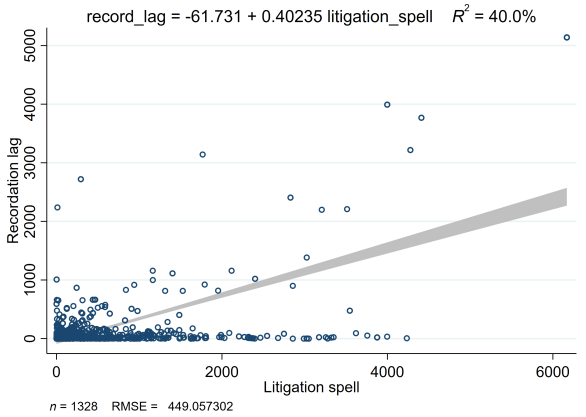
PAE, while only 11.8% when the patent assignee is a *private business enterprises*.

Figure 3: Recording lag (days between recordation and execution date) and litigation spell (number of days between first litigation date and execution date)

(a) Type of assignee: private business enterprises



(b) Type of assignee: PAE



Notes: Recording lag is defined as the difference (in days) between the recordation date and the execution date of the transaction. Nature of conveyance: "patent assignment". Litigation spell is defined as the difference (in days) between the (first) litigation date and the execution date of the transaction. First filings and employer assignments are excluded. Only patents litigated by the assignee(s) after the transaction are considered. Only infringement actions are considered. Source: PAD (2017) for patent transfers and USPTO Patent Litigation Dataset (2019) for litigation data. The list of PAE names is provided by Darts-IP.

5 Empirical Analysis

5.1 Econometric specifications

Preliminary evidence based on simple bivariate models may provide biased estimates if omitted patent and assignee characteristics are correlated with recording lags. We thus estimate a multivariate regression model using OLS to control for patent and assignee characteristics.

In the following, we restrict the analysis to patent reassignments only (i.e., we exclude from the analysis first filings and employer assignments) and to transactions where the assignee patent buyer is either a *private business enterprise* or a PAE.

Our baseline empirical specification is a linear model where the outcome ($Record - lag_i$) is the number of days from the execution date of the patent transaction to the USPTO recording. For each patent transaction i, we estimate the following model:

$$Record - lag_i = \beta_0 + \beta_1 * PAE_i + \beta_2 * LitPost_i + \beta_3 * LitPost_i * LitSpell_i + \\ + \beta_4 * LitPost_i * LitSpell_i * PAE_i + X * \gamma + \delta_t + \eta_f + \epsilon_i. \quad (1)$$

where PAE is an indicator equal to one indicating whether the patent buyer is a PAE, $LitPost$ indicates whether the patent will be litigated (in a patent infringement suit) by the patent assignee after the transaction, and $LitSpell$ indicates the number of days between the execution date of the patent transaction and the first litigation date. The matrix X controls for assignee and patent characteristics, such as: the patent portfolio of the assignee at the time of the transaction, the age of the patent, the number of forward citations, patent originality and the generality of the patent, the size of the patent family, the number of backward citations and the number of claims. Finally, the recording year effects $\delta(t)$ control for common trends, and $\eta(f)$ for technological fields (we use the 35-class WIPO classification). The models are estimated by OLS, but count models (Poisson) provide very similar results (which are shown in the Appendix in Table A2). Table 2 shows the summary statistics of the main variables where the unit of observation is the patent transaction.

Table 2: Summary statistics

	Obs.	Mean	St. Dev.	Min.	Max.
Recording lag	661675	212.3	644.7	0	79972
PAE	661675	0.05	0.21	0	1
LitPost	661675	0.009	0.096	0	1
LitSpell (only litigated patents)	6102	763.9	954.8	0	6168
LitPost x PAE	661675	0.002	0.044	0	1
LitPost x LitSpell	661675	7.0	117.2	0	6168
LitPost x LitSpell x PAE	661675	1.1	47.1	0	6168

Notes: Summary statistics are based on the sample used for model (1) in Table 3. Recordation years: 2003-2015. Assignee: private business enterprise or PAE. First filings and employer transfers are excluded.

5.2 Main results

Multivariate results are shown in Table 3 and, overall, confirm the findings of the univariate regressions shown in Figure 3a and 3b. All models include recordation year and technological field (WIPO 35 classes) fixed effects, as well as other controls for patent and assignee characteristics mentioned in Equation 1.

Our main results are as follows. First, by controlling for observable patent and assignee characteristics, PAEs do not show anymore longer recording lags than other *private business enterprises*. Second, transactions related to patents that will be used by the buyer in future future infringement actions (*LitPost*) exhibit recording lags that significantly differ from transactions related to patents that will be not used for litigation purposes. Third, recordation lags increase with litigation spells (*LitSpell*): patents that will be litigated by the patent buyer after the transaction display shorter recording lags if these patents are litigated soon (i.e., when the *LitSpell* is short), while transactions related to patents characterized by long litigation spells are recorded significantly later than other patent transactions, reflecting the motivation to provide timely notice to the court. In particular, transactions related to patents that will be litigated by the patent holder after 689 days (555 days if the patent holder is a PAE) since the transaction date display longer recordin lags than other transactions. Fourth, the correlation between the recording lags and litigation spells is much greater for PAEs: a one-day difference between the stated execution date and the first litigation date is associated with an increase in recording lag of about 0.20 days if the patent buyer is a *private business companies* and 0.36 days if the patent buyer is a PAE.

Figure 4 plots the predicted recording lags of transactions related to patents that will be litigated based on model 4 (Table 3), by litigation spell for both *private business enterprises* and PAEs. For patents litigated more than one year after the patent transaction execution date, we observe that PAEs record the transaction later than *private business enterprises* and this difference increases over time. In particular, patents asserted three years after the execution date of the patent acquisition (i.e., corresponding to a *Litigation spell* of about 1000 days) are recorded, on average, one year after the execution date if the patent assignee is a PAE and 259 days if the patent assignee is a *private business enterprises*.

All in all, these results show that, when patents are acquired for litigation purposes, the market is unaware of the real patent owner for a significant period of time, especially when the patent is transferred to a PAE. Results are robust to the exclusion of patents transferred to Intellectual Ventures and Wilan, the two largest PAEs in terms of the number of patents (see Table A3 in the Appendix) and to the inclusion of first filings and employer assignments in the analysis (see Table A4 in the Appendix).

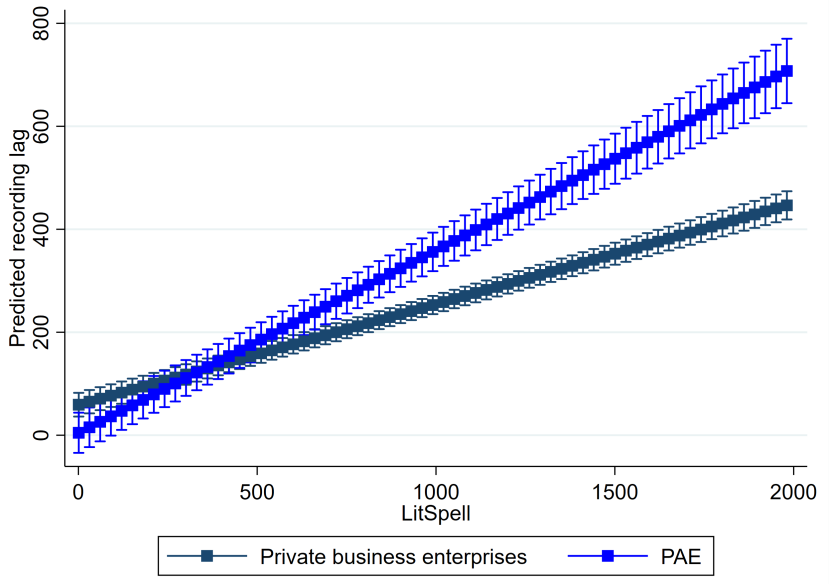
Finally, for robustness, we also apply matching techniques to further control for the characteristics of the transferred patents: in particular, we randomly match each patent transaction where the assignee is a PAE to a randomly chosen patent transaction where the assignee is a *private business enterprises*, imposing the condition that the two transactions are related to patents filed and transferred in the same year and belonging to the same technological field. The analysis, presented in the Appendix in Table A5, shows results which are in line with those presented in Table 3.

Table 3: Baseline models for recording lags - OLS models

	(1)	(2)	(3)	(4)
PAE	7.815	7.152	8.229	7.725
	(5.689)	(5.631)	(5.655)	(5.664)
LitPost		19.62**	26.05***	-134.9***
		(8.094)	(9.215)	(12.51)
LitPost x PAE			-31.10*	-62.40***
			(18.11)	(24.01)
LitPost x LitSpell				0.196***
				(0.0187)
LitPost x LitSpell x PAE				0.159***
				(0.0559)
Constant	355.1***	355.1***	355.0***	353.1***
	(17.05)	(17.05)	(17.05)	(17.09)
Observations	661675	661675	661675	661675
Adjusted R^2	0.083	0.083	0.083	0.084

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. All regressions contain recordation year and technological field (WIPO 35 classes), as well as the following assignee and patent characteristics: patent portfolio size, patent age at the time of the transfer, number of forward citations, patent originality, patent generality, family size, number of backward citations, number of claims. Dependent variable: Recording lag (in days). The reference case for the variable "PAE" is the private business enterprise. Recordation years: 2003-2015.

Figure 4: Predicted recording lags by litigation spell



Notes: The figure plots the predicted recording lags based on model 4, Table 3, by litigation spell for both private business enterprises and PAEs. Only patents acquired and later litigated by the patent assignee are considered.

5.3 Opportunistic litigation

5.3.1 ICT sector

Since the uses of patents significantly differ across technological fields and industries (Orsenigo et al., 2010), we would also expect significant differences in the recording lags of patent transactions. In particular, since the Information and Communications Technology (ICT) sector is the most prone to notice failure (Menell and Meurer, 2013) and to opportunistic patent litigation (Bessen et al., 2008) - due to a mix of factors, like the complexity of the technology, the large number of patents filed and the fast obsolescence of the technology (Pénin and Neicu, 2018) -, we would expect longer recording lags when transactions concern ICT patents are that are acquired for litigation purposes, especially when the patent buyer is a PAE.

We thus re-estimate Equation (1) by including, as interaction term, a variable (ICT_i), which equals one if the patent covers a technology in the ICT sector.[12] In particular, for each patent transaction i we estimate the following augmented version of Equation 1:

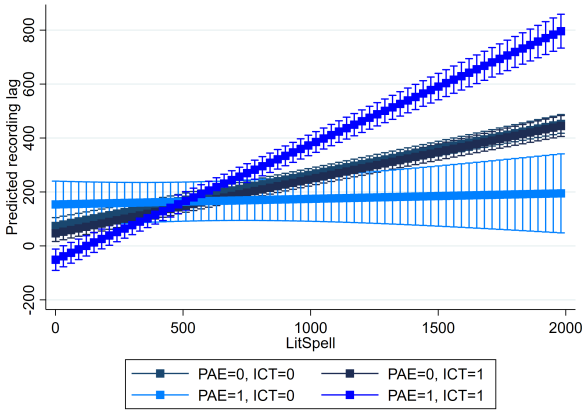
$$\begin{aligned} Record-lag_i = \beta_0 + \beta_1 * PAE_i + \beta_2 * LitPost_i + \beta_3 * LitPost_i * LitSpell_i + \\ +\beta_4 * LitPost_i * LitSpell_i * PAE_i + \beta_5 * LitPost_i * ICT_i + \beta_6 * LitPost_i * PAE_i * ICT_i + \\ +\beta_7 * LitPost_i * LitSpell_i * PAE_i * ICT_i + X * \gamma + \delta_t + \eta_f + \epsilon_i. \end{aligned} \tag{2}$$

Figure 5a shows the predicted recording lags by litigation spell for both *private business enterprises* and PAEs for transactions, and for both ICT and non-ICT sectors, based on OLS estimates shown in Table A6 in the Appendix. As expected, litigation and recordation dates are closest when the assignee is a PAE (with respect to a *private business enterprise*) and when the patent covers a technology in the ICT sector (with respect non-ICT). In particular, patents transferred to and subsequently litigated by PAEs three years after the execution date (i.e., corresponding to a litigation spell of about 1000 days) are recorded, on average, 398 days after the execution date if the patent is in the ICT sector, and 175 days after otherwise. If the patent is transferred to a *private business enterprise*, the predicted recording lags are 258 days in the ICT sector, and 275 days otherwise (but the difference is not significant).

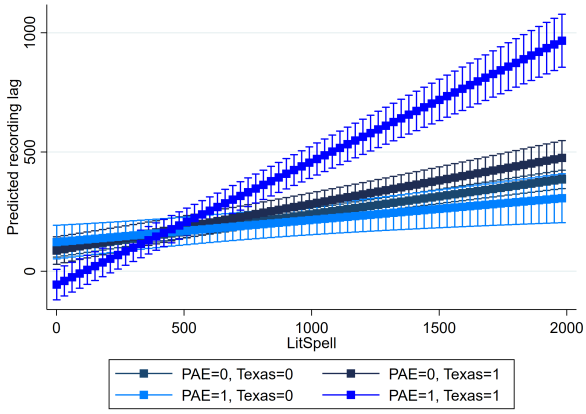
[12] The ICT sector includes the following technological fields (WIPO 2011 IPC-Technology concordance): 1. Electrical machinery, apparatus, energy; 2. Audio-visual technology; 3. Telecommunications; 4. Digital communication; 5. Basic communication processes; 6. Computer technology; 7. IT methods for management; 8. Semiconductors.

Figure 5: Predicted recording lags by litigation spell: sectoral and court differences

(a) ICT vs. other sectors



(b) Texas vs. other courts



Notes: The figure plots the predicted recording lags based on model 4, Table 3, by litigation spell for both private business enterprises and PAEs. Only patents acquired and later litigated by the patent assignee are considered. The ICT sector includes the following technological fields (WIPO 2011 IPC-Technology concordance): 1. Electrical machinery, apparatus, energy; 2. Audio-visual technology; 3. Telecommunications; 4. Digital communication; 5. Basic communication processes; 6. Computer technology; 7. IT methods for management; 8. Semiconductors. Low-tech includes all the other sectors.

5.3.2 Litigation in Texas

According to the US Patent Venue Statute, 28 U.S.C. § 1400(b), "[a]ny civil action for patent infringement may be brought in the judicial district where the defendant resides, or where the defendant has committed acts of infringement and has a regular and established place of business". [13] However, until the 2017 TC Heartland Supreme Court decision (Bagheri, 2018), the concept of residence has been commonly interpreted in a broad sense, as the new general venue law, 28 U.S.C. § 1391, includes not only the state of incorporation but "any judicial district in which it is incorporated or licensed to do business or is doing business".[14], with the consequence that patent holders had some flexibility in deciding where to suit alleged infringers (Snyder, 2017).

The Eastern District Court of Texas is well known for its handling of large numbers of patent cases initiated by PAEs for patent infringement, regardless of the location of the parties being sued. In the period 2003-2015, about 46% of patents transferred and subsequently litigated by PAEs were asserted in the Eastern District Court of Texas, whereas the analogous figure is 19% for *private business enterprises*.

The choice of initiating patent infringement cases in the Eastern District Court of Texas stems from a combination of factors, of which the plaintiff-friendly local administrative rules and the comparatively predictable assignment of judges to individual cases are among the most important (Cohen et al., 2017). Moreover, the choice of initiating a lawsuit in this district is also seen as an opportunistic strategy,

[13] Act of June 25,1948, ch. 646, § 14oo(b), 62 Stat. 935, 936 (codified at 28 U.S.C. § 1 4oo(b) (2012)).
[14] § 1391(c), 62 Stat. at 935.

especially because some of the patent holders only pretend to have activities in an area that is not a major innovation center (Cohen et al., 2016).

Indeed, although not all PAEs that litigate their patents in the Eastern District Court of Texas operate opportunistically and despite the fact that forum shopping and self-differentiation by district courts can be seen as legitimate legal practices (Algero, 1999), it is reasonable to assume that patent litigation brought by PAEs in East Texas is on average more opportunistic than patent litigation in other districts. In this court, we would also expect PAEs to be more inclined to strategically record their patent transactions only when necessary, that is, closer to the litigation date.

As before, we re-estimate Equation (1) by including, as interaction term, a variable ($Texas_i$), which equals one if the patent is asserted in the Eastern District Court of Texas. Our baseline empirical specification is a thus linear model where the outcome ($Record - lag_i$) is the number of days between the recording and the execution date of the patent transaction i. For each patent transaction i we estimate the following augmented version of Equation 1:

$$\begin{aligned} Record - lag_i = \beta_0 + \beta_1 * PAE_i + \beta_2 * LitPost_i + \beta_3 * LitPost_i * LitSpell_i + \\ +\beta_4 * LitPost_i * LitSpell_i * PAE_i + \beta_5 * LitPost_i * Texas_i + \beta_6 * LitPost_i * PAE_i * Texas_i + \\ +\beta_7 * LitPost_i * LitSpell_i * PAE_i * Texas_i + X * \gamma + \delta_t + \eta_f + \varphi_c + \epsilon_i. \end{aligned} \tag{3}$$

Figure 5b shows the predicted recording lags for litigated patents, by litigation spell for both *private business enterprises* and PAEs, and by court (Eastern District Court of Texas vs. other courts).[15] As expected, litigation and recordation dates are the closest when (i) the assignee is a PAE and (ii) the patent is asserted in the Eastern District Court of Texas. In particular, patents transferred to and then asserted 1000 days after the execution date by PAEs are recorded, on average, with a lag of 486 days if the patent is subsequently litigated in the Eastern District Court of Texas, and 220 days if it is asserted in another court. If the patent is transferred to a *private business enterprise*, the predicted recording lags are respectively 293 and 247 days.

5.4 The use of unknown subsidiaries

When PAEs want to keep secret the patent acquisition, they can also create shell companies and unknown subsidiaries to hold and, eventually, assert their assets. This tactic can increase the costs of negotiating licenses for technology adopters, making it difficult for them to identify the actual owner of the patents they need (Morton and Shapiro, 2013). This phenomenon is well known to the point that in the press

[15] OLS estimates are shown in the Appendix in Table A6, column 2.

release accompanying the 2013 Executive Action, the White House [16] discusses it openly: "Patent trolls often set up shell companies to hide their activities and enable their abusive litigation and extraction of settlements. This tactic prevents those facing litigation from knowing the full extent of the patents that their adversaries hold when negotiating settlements, or even knowing connections between multiple trolls" (House, 2013).

If the use of shell companies and the delay of the recordation of the patent transaction are part of the same strategy to obfuscate patent ownership, we would expect that PAE *unknown subsidiaries* are associated to longer recording lags than PAE known subsidiaries or parent companies.

We use the list of PAEs provided by Darts-IP and combine it with data on USPTO from PAD (2017) in order to assess to which extent PAEs make use of subsidiaries when they acquire (or file) patents. The list provided by Darts-IP contains 546 groups and 1,815 firms. Among the PAEs that make a large use of different firms to hold patents, Acacia Research Group results to be linked to 209 different entities and Intellectual Ventures to 144 entities. Sometimes PAEs make use of subsidiaries that have a name that recall the name of the main group (parent company). This is, for example, the case of some subsidiaries used by Intellectual Ventures such as *Intellectual Ventures Fund* or *Intellectual Ventures Holding* - both followed by a different number to distinguish one from the other - or the case of some subsidiaries of Acacia Research Group, such as *Acacia Patent Acquisition* or *Acacia Technologies Group*. However, in other circumstances, PAEs make use of subsidiaries with names that are very different from the names of the parent company, with the (possible) intent of holding patents without informing PAE's competitors and potential targets of the PAE patent acquisition strategy.

We thus identify and distinguish subsidiaries that have not a clear link to the PAE group, and we define them *unknown subsidiaries*. In doing so, we use fuzzy matching programming techniques that determine the likelihood of two words (the name of the PAE acquiring the patent and the name of the PAE group) matching, expressed as the asymmetric spelling distance between the two words. [17] Among a total of 1,815 entities, we identify 1,029 *unknown subsidiaries* with names that significantly differ from the PAE parent company name.

We thus match the list of PAEs and their known and *unknown subsidiaries* to entities from PAD (Version 2017) that appear as assignees of US utility granted patents acquired in the years between 2003 and 2015 and we find that 18,421 patents are transferred to PAE *unknown subsidiaries*, corresponding to about 65.5% of all transferred patents. Moreover, we notice that some PAEs (often with few patents) either never make use of make only use of *unknown subsidiaries*. We thus exclude these cases from the

[16] Press Release, The White House Office of the Press Sec'y, Fact Sheet: White House Task Force on High-Tech Patent Issues (June 4, 2013), http://www.whitehouse.gov/the-press-office/2013/06/04/fact-sheet-white-house-taskforce-high-tech-patent-issues.

[17] we use the functions "SPEDIS" and "RESULT" in SAS Software; to be considered as a unknown subsidiary, the entity should have a SPEDIS value greater than 20 and RESULT below |5|.

analysis and we end up with a sample of 16,060 patents acquired by thirty seven PAEs, of which 10,881 are patents acquired through their *unknown subsidiaries*.

In order to study whether PAE *unknown subsidiaries* show longer recording lags compared to known subsidiaries and PAE parent companies, we estimate the following model:

$$Record - lag_i = \beta_0 + \beta_1 * Unknown_Subsidiary + \beta_2 * PatentPortfolioSize + X * \gamma + \delta_t + \eta_f + \epsilon_i. \quad (4)$$

where $UnknownSubsidiary$ is an indicator equal to one for patents that are transferred to PAE *unknown subsidiaries*, and $PatentPortfolioSize$ indicates the number of patent transferred to the single firm of the PAE group in the period 1990-2017. Larger entities are supposed to be more visible to the market participants, and thus are expected to register faster patent transactions at the patent office. The matrix X controls for patent characteristics, such as: the age of the patent, the number of forward citations, patent originality and the generality of the patent, the size of the patent family, the number of backward citations and the number of claims. Finally, the recording year effects $\delta(t)$ control for common trends, and $\eta(f)$ for technological fields (we use the 35-class WIPO classification). In column (3) we also control for PAE main group fixed effects.

The models are estimated by OLS, and the results are shown in Table 4). In all specifications, transactions involving PAE *unknown subsidiaries* are recorded at the USPTO significantly later than those involving known subsidiaries or PAE parent companies. In particular, when we control for fixed effects at the PAE group (column 3), *unknown subsidiaries* notify the USPTO of the transaction about 50 days later than known subsidiaries or PAE parent companies. Finally, the size of the entity involved in the transaction also matters: larger PAE entities are found to register faster patent transactions at the USPTO than entities with small patent portfolios

Table 4: Recording lags by PAE unknown subsidiaries

	(1)	(2)	(3)
Unknown Subsidiary	17.95**	17.97**	50.27***
	(8.532)	(8.638)	(9.780)
Patent portfolio size		-0.00861	-0.0206***
		(0.00711)	(0.00641)
Constant	158.1***	161.4***	159.0***
	(22.93)	(22.71)	(26.11)
Observations	15227	15224	15224
Adjusted R^2	0.118	0.118	0.167
PAE fixed effects	No	No	Yes

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. All regressions contain recordation year and technological field (WIPO 35 classes), as well as the following patent characteristics: patent age at the time of the transfer, number of forward citations, patent originality, patent generality, family size, number of backward citations, number of claims. Dependent variable: Recording lag (in days). The reference case for the variable "Unknown Subsidiary " is the known subsidiary or the parent company. Recordation years: 2003-2015.

6 Conclusions

Several PAEs hide behind dozens of shell companies with obscure ownership. Meanwhile, national patent offices, including the USPTO, do not impose a strict time period for recording the change of ownership of a patent, allowing the holder to gain an advantage by controlling the timing of its ownership disclosure. No time pressure is in fact placed on patent buyers to register the transaction, so that recordation may be done only when it is absolutely necessary.

In our paper we analyze recording lags (defined as the time from execution date to recordation date at the patent office) in patent transactions at the USPTO and show that PAEs strategically record their transactions as a function of their litigation strategies. OLS estimates suggest that a one-day difference between the stated execution date of the patent transaction and the litigation date is associated, on average, with a delay in the recordation of about 0.20 days if the patent buyer is a private business enterprise and 0.36 days if the patent buyer is a PAE. Moreover, strategic recordation by PAEs is found to be particularly significant in the ICT sector, where the fuzzy boundaries of patents lead to more opportunistic patent litigation (Bessen et al., 2008), when the transferred patent is litigated in the Eastern District Court of Texas, famously home to opportunistic litigations (Cohen et al., 2016), and when the

transfer involve unknown subsidiaries of PAEs.

Our results provide evidence of the fact that overall, notice function is poorly served, since the information available to the public as to who currently owns the patent may often be incorrect, especially if the transfer concerns patents that will be used for monetization purposes. This implies that patent holders (and PAEs in particular) that acquire patents for future monetization cannot be recognized as the owner of the acquired patent for a significant period of time.

A further implication of our evidence is that the presence of PAEs in the patent market is actually underestimated. This is not only because PAEs make use of shell companies and unknown subsidiaries to hold patent assets, but also because they can avoid registering the patent transaction at the patent office. In fact, it is possible that some patents that we believe are still in the hands of the original inventors have in fact been transferred without revealing the transactions to the market.

One last remark concerns the policy implications of our work. We believe that patent offices should be endowed with substantive rule-making authority (Masur, 2011) and should play a central role in patent policy. Patent offices should be required to make patent ownership information more readily available, to help track formal changes of property, and to implement legislative initiatives to facilitate patent clearance and limit ex-post licensing and litigation. To make patent ownership information more transparent, patent offices should require patent owners to update information on ownership even after patent prosecution, when a patent is not explicitly under review. To conclude, the patent market should be considered an integral part of the same system that examines and grants the patent rights, while today it escapes its control.

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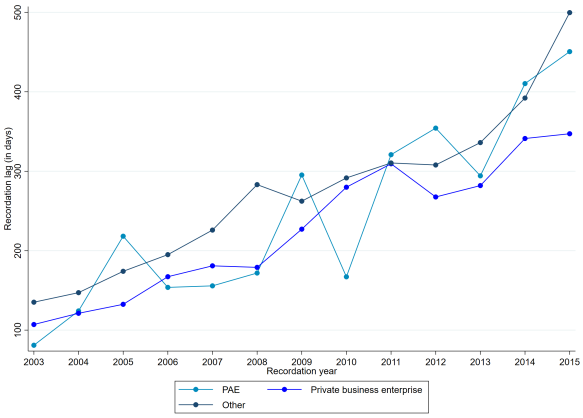
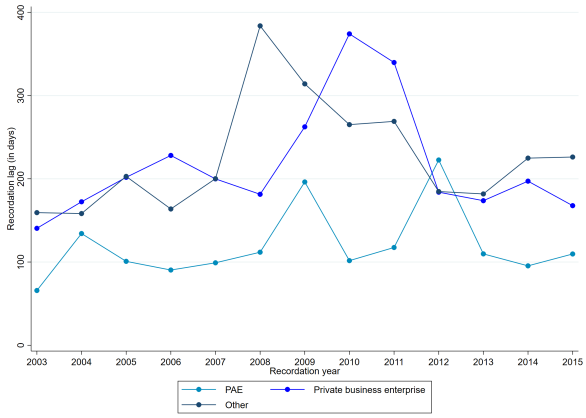
Appendix

Figure A1: Recording lag at the USPTO

(a) All assignments



(b) Reassignments



Notes: Recording lag is defined as the difference (in days) between the recordation date and the execution date of the patent assignment (transaction). Nature of conveyance: "patent assignment". US granted patents. Reassignments do not include first filings and employer assignments. Recordation years: 2003-2015. Source: own elaboration based on US Patent Assignment Database (2017). The list of PAE names is provided by Darts-IP. The category "Other" includes *individuals*, *universities*, *hospitals*, and *public and non-profit organizations*.

Table A1: TOP 10 PAEs by patent portfolio size (acquired patents)

PAE Group	Acquired patents	Total patents
INTELLECTUAL VENTURES	7115	11436
QUARTERHILL WILAN	4741	7862
PANOPTIS HOLDINGS	1883	2129
ROUND ROCK RESEARCH	1805	3664
ACACIA	1553	2292
CONVERSANT	1141	2031
IP BRIDGE	974	1185
INTELLECTUAL DISCOVERY	859	965
XPERI	832	2035
PENDRELL	542	664

Notes: The table shows the top PAEs by patent portfolio size over the period 2003-2015. Source: own elaboration based on US Patent Assignment Database (2017). The list of PAEs and their subsidiaries is provided by Darts-IP.

Table A2: Robustness check. Models for recording lags - Poisson models

	(1)	(2)	(3)	(4)
Recording lag				
PAE	-0.191***	-0.191***	-0.185***	-0.185***
	(0.0168)	(0.0168)	(0.0169)	(0.0169)
LitPost		-0.0124	0.0116	-0.758***
		(0.0374)	(0.0398)	(0.0473)
LitPost x PAE			-0.150	-0.342***
			(0.112)	(0.0893)
LitPost x LitSpell				0.000620***
				(0.0000226)
LitPost x LitSpell x PAE				0.000109***
				(0.0000276)
Constant	5.235***	5.235***	5.235***	5.227***
	(0.0276)	(0.0277)	(0.0277)	(0.0276)
Observations	661675	661675	661675	661675

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. All regressions contain recordation year and technological field (WIPO 35 classes), as well as the following assignee and patent characteristics: patent portfolio size, patent age at the time of the transfer, number of forward citations, patent originality, patent generality, family size, number of backward citations, number of claims. Dependent variable: Recording lag (in days). The reference case for the variable "PAE" is the private business enterprise. Recordation years: 2003-2015.

Table A3: Robustness check. Reassignments to Intellectual Ventures and Wilan excluded - OLS models

	(1)	(2)	(3)	(4)
PAE	27.66***	26.82***	29.42***	28.81***
	(6.950)	(6.877)	(6.975)	(6.985)
LitPost		16.39**	25.94***	-134.5***
		(8.219)	(9.222)	(12.54)
LitPost x PAE			-50.67***	-94.03***
			(19.64)	(24.59)
LitPost x LitSpell				0.195***
				(0.0187)
LitPost x LitSpell x PAE				0.175***
				(0.0566)
Constant	357.7***	357.7***	357.6***	355.6***
	(17.27)	(17.27)	(17.27)	(17.30)
Observations	649880	649880	649880	649880
Adjusted R^2	0.083	0.083	0.083	0.084

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. This table is the analogous of Table 3 with the difference that patents transactions recorded by Intellectual Ventures and Wilan are excluded. All regressions contain recordation year and technological field (WIPO 35 classes), as well as the following assignee and patent characteristics: patent portfolio size, patent age at the time of the transfer, number of forward citations, patent originality, patent generality, family size, number of backward citations, number of claims. Dependent variable: Recording lag (in days). The reference case for the variable "PAE" is the private business enterprise. Recordation years: 2003-2015.

Table A4: Robustness check. Models for recording lags including first filings and employer assignments - OLS models

	(1)	(2)	(3)	(4)
PAE	243.4***	236.7***	240.8***	239.6***
	(4.342)	(4.331)	(4.366)	(4.374)
LitPost		248.7***	267.0***	-309.8***
		(8.494)	(9.023)	(13.87)
LitPost x PAE			-131.7***	-134.9***
			(25.66)	(20.18)
LitPost x LitSpell				0.396***
				(0.0116)
LitPost x LitSpell x PAE				0.133***
				(0.0211)
Constant	59.46***	59.50***	59.37***	57.42***
	(2.564)	(2.564)	(2.564)	(2.570)
Observations	2727561	2727561	2727561	2727561
Adjusted R^2	0.159	0.160	0.160	0.164

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. All regressions contain recordation year and technological field (WIPO 35 classes), as well as the following assignee and patent characteristics: patent portfolio size, patent age at the time of the transfer, number of forward citations, patent originality, patent generality, family size, number of backward citations, number of claims. Dependent variable: Recording lag (in days). The reference case for the variable "PAE" is the private business enterprise. Recordation years: 2003-2015.

Table A5: Robustness check. Models for recording lags - Conditional OLS models

	(1)	(2)	(3)	(4)
PAE	23.26***	23.44***	23.25***	23.37***
	(3.160)	(3.150)	(3.179)	(3.179)
LitPost		-5.285	-15.84	-64.73***
		(13.56)	(18.41)	(22.38)
LitPost x PAE			12.83	-144.8***
			(24.05)	(29.83)
LitPost x LitSpell				0.107*
				(0.0583)
LitPost x LitSpell x PAE				0.275***
				(0.0770)
Constant	144.3***	144.4***	144.4***	120.2***
	(11.41)	(11.41)	(11.41)	(12.75)
Observations	62975	62975	62975	62975
Adjusted R^2	0.081	0.081	0.081	0.097

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. All regressions contain recordation year and technological field (WIPO 35 classes), as well as the following assignee and patent characteristics: patent portfolio size, patent age at the time of the transfer, number of forward citations, patent originality, patent generality, family size, number of backward citations, number of claims. Dependent variable: Recording lag (in days). The reference case for the variable "PAE" is the private business enterprise. Recordation years: 2003-2015. In these models, patents transferred to PAEs are matched to patents transferred to private business enterprises by imposing to share the same execution year, the same technological field (WIPO 35 classes) and the same age at the time of the execution date.

Table A6: Sectoral and court differences

	(ICT)	(Texas)
PAE	-7.288***	-92.41***
	(2.686)	(18.71)
LitPost	-149.9***	-315.5***
	(16.50)	(17.57)
LitPost x ICT	8.821	
	(23.15)	
LitPost x Texas		16.89
		(28.52)
LitPost x PAE	87.36***	117.3***
	(21.42)	(32.21)
LitPost x PAE x ICT	-178.2***	
	(34.46)	
LitPost x PAE x Texas		-169.2***
		(41.92)
LitPost x LitSpell	0.191***	0.149***
	(0.0245)	(0.0201)
LitPost x LitSpell x ICT	0.00978	
	(0.0376)	
LitPost x LitSpell x Texas		0.0488
		(0.0426)
LitPost x LitSpell x PAE	-0.170***	-0.0544
	(0.0320)	(0.0464)
LitPost x LitSpell x PAE x ICT	0.398***	
	(0.0703)	
LitPost x LitSpell x PAE x Texas		0.373***
		(0.0740)
Constant	311.8***	688.8***
	(4.611)	(48.25)
Observations	636565	15414

Notes: Robust standard errors in parentheses *<0.1, **<0.05; ***<0.01. The table presents the OLS estimates of Equation 2 in Column 1 (ICT) and Equation 3 in Column 2 (Texas).

GREThA UMR CNRS 5113
Université de Bordeaux
Avenue Léon Duguit
33608 Pessac – France
Tel : +33 (0)5.56.84.25.75
http://gretha.u-bordeaux.fr/

LAREFI
Université de Bordeaux
Avenue Léon Duguit
33608 Pessac – France
Tel : +33 (0)5.56.84.25.37
http://larefi.u-bordeaux.fr/

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