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NOTICE FAILURE REVISITED: EVIDENCE ON THE USE OF VIRTUAL PATENT MARKING

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ABSTRACT

One source of uncertainty in the patent system relates to the difficulty in identifying products that are protected with a patent. This paper studies the adoption by U.S. patentees of “virtual patent marking,” namely the online provision of constructive notice to the public that an article is patented. It proposes a simple model of the decision to adopt patent marking and empirically examines factors that affect adoption. Data suggest that about 12 percent of patent holders overall provide virtual marking information (and perhaps about 25 percent of commercially active assignees). Econometric analysis suggests that the most discriminant factor of the adoption of virtual marking is the size of the patent portfolio. The likelihood of adoption increases with portfolio size, consistent with evidence that firms with a larger patent portfolio are more likely to be infringed.

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Introduction

Certainty over patent rights is essential for the efficient functioning of the patent system and markets for technology, as well as for the development of follow-on innovations (Farrell & Shapiro 2008; Gans, Hsu, & Stern 2008). Yet, patent rights are plagued with uncertainty. A first source of uncertainty concerns uncertainty about the *validity* of such rights. It arises because the Patent and Trademark Office (PTO) issues patents that are likely to be invalidated in court if they are challenged (Lemley & Shapiro 2005; de Rassenfosse, Jaffe & Webster 2016). This issue has attracted a lot of attention from law and economics scholars under the heading "patent quality." A second source of uncertainty relates to failure regarding *notice of property,* which arises because of the intangible nature of such rights (Menell & Meurer 2013).

The notice failure of patents is usually understood as arising from failure to delineate clearly the scope of the claimed invention (Bessen & Meurer 2008; Burk & Lemley 2009; Rawls 2104). Patentees fear disclosing technical information in the patent document (Cohen, Nelson & Walsh 2000) and may have incentives to purposefully obscure patent claims (Risch 2007). Combined with the fact that a patent is first and foremost a legal document, patent claims may be particularly difficult to decipher for scientists and engineers.

In a general sense, notice of property relates to notice of "who owns what." This suggests, in fact, three causes of notice failure. A first cause relates to failure to identify the ultimate owner of a patent (the "who"), which may not be necessarily the assignee. Identification of ownership is further complicated in case of reassignment because recording of assignment at the PTO is not mandatory. A second cause relates to failure to identify the "what" in the technology space, i.e., what scholars usually refer to when discussing notice failure. The last cause, which is the focus of the present paper, relates to failure to identify whether a product is protected by one or several patents—the "what" in the product space. Indeed, the link between a commercial product and the patents protecting it is far from obvious. Even if inventions were clearly described in patent documents, which they are not, one still needs to identify which inventions underlie a given product.

Section 287(a) of 35 U.S.C. (so-called "marking statute") encourages patentees to provide constructive notice to the public that an article is patented. The 2011 Leahy-Smith America Invents Act (AIA) added a new method of marking to the statute. It allowed patentees to affix the word "patent" or "pat." on the article along with a URL of a web page that associates the patented article with the patent number(s)—this practice is known as "virtual patent marking." The marking statute serves three related purposes. It helps to avoid innocent infringement, it encourages patentees to give public notice that the article is patented, and it aides the public to identify whether an article is patented.[1] In theory, virtual patent marking provides an effective solution to the third cause of notice failure. It avoids retooling manufacturing processes in case patent coverage changes and offers more room for providing the information—a full web page vs. fine prints on a physical product.

Scholarly literature on patent marking has focused primarily on false marking, especially pre-AIA (Grant 2004; Winston 2009; Cotter 2010: Deutsch 2010; Crudo 2011). Scholars have also discussed the notice statute (McKeon 1996; Siegel 1999) and have proposed changes to the marking statute (Voelzke 1995), notably concerning software patents (Oppedahl 1995; Lindholm 2004).

As far as I can ascertain, no study discusses the adoption of virtual marking by assignees. Yet, the first step towards understanding the effectiveness of marking is to provide an answer to the first-order question of its adoption rate. A recent report by the PTO discusses several legal and technical aspects regarding virtual marking and hints that it is not widely adopted (USPTO 2014), calling for more scrutiny.

This paper proposes a theory and an empirical analysis of patent marking adoption. The theory articulates both the costs and benefits of virtual patent marking for innovators. The empirical part provides first-of-its-kind estimate of the adoption rate of virtual marking and studies factors that account for the likelihood of adoption. I manually searched for virtual-marking information for a sample of 200 randomly drawn assignees with at least one active patent on January 1st, 2017. I found that about 12 percent of assignees provide virtual marking information. Next, I enriched the sample with information from 100 additional assignees that provide such information. Using regression models that correct for oversampling, I found three factors that are associated with systematic variation in adoption rate. The likelihood of adoption increases with the size of the patent portfolio and is greater for assignees headquartered in the United States. It also seems to be greater for younger firms. These findings are consistent with the theory.

The rest of the paper is organized as follows. Next section sets out the policy rationale for patent marking. The paper then proposes a model of the firm's decision to mark in order to better understand the mechanisms at play. It then presents the empirical setup and data, and discusses econometric results. It concludes by deriving implications from the findings.

The policy problem

Patents, like other intangible assets, are subject to notice failure, that is, failure to identify whether a party (and which one) owns a specific asset. A firm that has

[1] See *Artic Cat v. Bombardier Recreational Products* 2017-1475 (Fed. Circ. 2018).

independently developed an invention and wants to exploit it commercially first needs to make sure that no one else has claimed the invention. It needs to search for the invention and the owner—without even knowing whether they exist—which is costly. These search costs are a burden on technological progress.

Unless the firm performs a diligent patent search, it has no guarantee that the technology is free to use. With the increasing number of patents in the United States and elsewhere, performing a freedom-to-operate search becomes increasingly costly—diverting resources away from inventive activities. As a solution to ever-increasing search costs, some firms "outsource" this task to the PTO by filing patent applications and waiting for the examination report. This practice puts further strain on the PTO and aggravates the backlog, which also harms welfare (Palangkaraya et al. 2008). On the other hand, firms that neglect to search or perform a poor search expose themselves to litigation risk. Some authors have argued along this line that the notice failure is behind the surge in patent litigation (Bessen & Meurer 2008). This may reduce welfare by distorting R&D incentives. In practice, firms seek to strike the right balance between minimizing search cost and litigation risk.[2]

From a policy viewpoint, measures that ease notice of property improve welfare and are thus desirable. Patent marking goes some way towards addressing one cause of notice failure. It increases transparency in the patent system by providing constructive notice to the public that an article is patented. Whereas the policy rationale for promoting marking is clear, the private incentives for adopting marking are less clear. Next section presents a model of the decision to mark products.

A theory of patent marking

Let us consider a firm with sales level S and costs C. It has an exogenous probability p to be infringed and to incur an opportunity loss L (corresponding to lost sales). The firm goes to court if expected damages D exceed litigation costs C_l, which occurs with probability $t \equiv P(D - C_l) > 0$. I define net gains from going to court as $\overline{D} = D - C_l$. Thus, the expected profit in the absence of marking is given by:

$$E[\pi] = S - C - pL + pt\overline{D}$$

If the firm relies on marking, it enjoys an increase in sales by a factor $\delta > 0$ but incurs costs of marking of C' (both parameters are discussed below). If the firm's patent is infringed and the firm goes to court, it incurs litigation costs C_l but obtains damages $D_m > D$. Damages in case of marking exceed damages in the absence of marking because marking allows the firm to recover damages that occurred prior to

[2] Notice failure is also costly for the patent owner. Infringers may convince the court of inadvertent infringement, which reduces damages awarded.

filing the lawsuit.[3] The firm goes to court if the net payoffs are positive, which occurs with probability $t_m \equiv P(D_m - C_l) > 0$. It follows that $t_m > t$: if infringed, a firm that practices virtual marking is more likely to go to court because it can expect higher damages, all else equal. Damages vary widely but can be in the millions of dollars in some prominent cases. I define net gains from going to court with marking as $\bar{D}_m = D_m - C_l$. Thus, the expected profit with marking is given by:

$$E[\pi_m] = (1 + \delta)S - C - C' - pL + pt_m\bar{D}_m$$

The profit-maximizing firm marks its products if the expected value from marking is greater than 0, that is,

$$E[M] = E[\pi_m] - E[\pi] = \delta S - C' + p(t_m\bar{D}_m - t\bar{D}) > 0$$

The first term of the value function, δS, is the sales premium associated with marking. Conveying to customers the information that a product is patented may lead to more sales or may allow the firm to charge higher prices for its products. I am not aware of consumer behavior research that validates this claim. However, such evidence exists in the case of branded products and trademarks (*e.g.*, Farquhar 1989; Cheng, Clarke & Heymann 1990; Bower & Turner 2001), and the signaling role of patents has been documented in other contexts, especially for startups (Long 2002; Haeussler, Harhoff & Mueller 2014; de Rassenfosse & Fischer 2016). If a "marking premium" exists, it is likely to be small tough.

The second term, C', captures the cost of marking, which has operational, legal, and strategic components. The operational cost of marking is the cost associated with identifying patent-product correspondence and providing the information to the public. Casual discussions undertaken with various heads of intellectual property departments lead me to believe that not all firms are actually able to trace with certainty which patents cover which of their products. With virtual marking, the operational cost of marking involves mainly manpower and it is reasonable to expect that it increases with the number of products on sale. Next, the legal cost of marking is the cost associated with falsely marking products. Any person who has suffered a competitive injury as a result of false marking may file a civil action in order to seek damages, which can amount to up to $500 per falsely marked item.[4] Finally, the strategic cost of marking is the cost of revealing the importance of some patents to competitors. Sometimes, opacity regarding the patent-product correspondence creates uncertainty for competitors that benefit the invention owner more than disclosing information to the public. The business model of Heyman Capital, which was short-

[3] See, *e.g.*, *Rembrandt Wireless v. Samsung* 2016-1729 (Fed. Circ. 2017) for a recent case.
[4] The meaning of competitive injury is discussed in *Sukamar v. Nautilus Inc.* 2014-1205 (Fed. Circ. 2015) and includes attempted entry into the market.

selling the stocks of drug companies whose patents were being challenged, effectively illustrates the risk of signaling important patents (Neill 2015).

The last term, $p(t_m\overline{D}_m - t\overline{D})$, captures the expected difference in net gains associated with marking in case of litigation. The probability of infringement $p > 0$ and $\overline{D}_m > \overline{D}$ (and consequently $t_m > t$), such that the term is strictly positive. It might be small, however, since the probability of infringement is small and litigation is costly.[5] Note that p is assumed to be exogenous to marking. Should p be endogenous to marking, it would be smaller in the case of marking than in the absence of marking. Indeed, marking is likely to reduce not only inadvertent infringement but also willful infringement through increased damages for would-be infringers.

I now briefly discuss how the AIA, which allowed virtual marking, changed the incentives to mark. The largest impact of virtual marking has been a lowering of the costs of marking C'. The AIA lowered both the operational costs and the legal costs. A major hurdle to physical marking was the costs associated with retooling production lines in case of a change in patent status. With virtual marking, no retooling is necessary if the URL printed on the product is stable. The AIA has also led to a lowering of the legal cost by limiting actors who can file a civil action from any person (pre-AIA) to any person who has suffered a competitive injury (post-AIA). This change significantly lowered the risk of being sued by eliminating "predatory litigators," composed of experienced litigation teams that systematically tracked false marking with a view of claiming damages (Winston 2009). Finally, the AIA has also enabled producers of virtual goods (such as software distributed online) to use marking. Thus, overall, it seems fair to assume that the prevalence of marking is greater in a post-AIA world than before.

Empirical setup and data

Econometric framework

The unit of analysis (*i*) is an assignee and the outcome variable m_i is a dummy that takes value 1 if the assignee uses virtual marking and 0 otherwise. I estimate the following latent variable regression model:

$$m_i^* = \boldsymbol{X_i}\boldsymbol{\gamma} + \varepsilon_i$$

where $m_i = 1$ if $m_i^* > 0$ and 0 otherwise, and ε_i is the error term. The vector $\boldsymbol{X_i}$ contains demographic variables, patent-based variables, product-based variables, as well as a measure of the online presence of the assignee. Elements of $\boldsymbol{X_i}$ are explained further below. I used three regression models namely OLS, probit and logit.

[5] Lemley and Shapiro (2005) estimate that a mere 0.1 percent of patents are litigated to trial.

Sampling strategy

The identification of companies that use virtual marking is a challenging task. I have adopted the following search strategy. I have selected at random from the PTO database 200 assignees that have at least one active patent on January 1st, 2017 (excluding universities and public research organizations). Since the empirical analysis is performed at the assignee level (and not at the patent level), I ensured that every assignee had the same chance of being drawn, independently of the number of patents it owns. Next, to ensure that the sample contains a sufficient number of assignees that use virtual marking, I searched the Internet for 100 virtual patent marking web pages. Casual observation led me to believe that a large number of webmarking pages contain the following sentence:

> "The following [company name] products are protected by patents in the U.S.A. and elsewhere. This web page is intended to provide notice under 35 U.S.C. § 287(a)."

Consequently, I performed a Google search with the keywords [*35 287 following patent product*] and selected companies that appeared first in the search results.

Overall, the sample used for the empirical analysis contains a list of 300 assignees: 200 are drawn from the PTO database (and may or may not have a virtual marking web page) and 100 are drawn from a web search (and always have a virtual marking web page). These assignees jointly hold 38,809 active patents. The regression models will account for the sampling strategy by implementing sampling weights.

Covariates

The multivariate analysis exploits four types of data: demographic data, patent-based data, data related to the online presence of the assignee, and product-based data. The sources for the data are provided in the next section.

I used five variables capturing demographic dimensions.

- Variable *age* is defined as the number of years since the foundation year of the firm.
- Variable *size* is the number of employees. If the exact number of employees is unknown, the company is assigned to one of the following categories: 1, 1–5, 1–10, 11–50, 51–200, 201–500, 501–1000 employees. There is no category for assignees with 1000+ employees because the number of employees for large assignees is always known, at least approximately.
- Dummy variable *private* takes the value 1 if the assignee is a private company and 0 if it is a publicly listed company (or its parent).

- Dummy variable *US* takes value 1 if the assignee is incorporated in the United States and 0 otherwise.
- Every assignee is allocated to one main industry.

I used two variables capturing features of the patent portfolio and one variable capturing the online presence of the assignee.

- The variable *portfolio size* captures the number of active U.S. patents held by the assignee as of January 1st, 2017.
- The variable *portfolio age* captures the average age of the portfolio, in years. Patent age is computed as the number of years between filing year and year 2017.
- The variable *traffic rank* measures the popularity of the assignee's website in terms of traffic. It captures bias potentially introduced with the selection of first results returned by the Google search.

Finally, I collected two variables that capture features of the product offering of the assignee.

- The categorical variable *number of products* contains an estimate of the number of products the firm sells. It ranges from 0 (no product or unknown) to 4 according to a logarithmic scale (1 = 1–10 products, 2 = 11–100 products, 3 = 101–1000 products and 4 = 1000+ products).[6]
- The dummy variable *intangible* takes value 1 if the products are intangible (e.g., services or software) and 0 otherwise.

Data sources

Information on assignees and their products was collected manually from online sources as well as from the PTO's PatentsView database.[7]

Regarding demographic data, I searched for the homepage and the LinkedIn.com page of the assignee in order to recover information such as foundation year, country of headquarters and number of employees. Each assignee is allocated to one industry, following the LinkedIn industry nomenclatures (which contains 147 entries). When the assignee was not present on LinkedIn I allocated the assignee manually (allowing for an unknown industry). When I could not recover specific information, I performed an additional web search on crunchbase.com, Bloomberg.com, Facebook.com and other ad-hoc web resources.

[6] A firm that marks its products may not necessarily mark all its patented products. Sometimes, only products in a certain product line or exploiting a specific technology are marked.
[7] Available at http://www.patentsview.org/download/

Regarding patent-based data, I used tables from the PTO's PatentsView database to compute the number of active patents as well as the average age of the patent portfolio.

Finally, data on the online presence of the assignee come from Alexa.com, a subsidiary of Amazon.com. The algorithm according to which Alexa calculates traffic ranking is based on the amount of traffic recorded over a period of three months from users that have the Alexa toolbar installed.

Results

Descriptive statistics

A first figure of interest is the proportion of the 200 randomly drawn assignees that provides virtual marking information. About 12 percent of assignees provide virtual marking information, which translates into a 95-percent confidence interval that ranges between 8.6 and 17.9 percent. Extrapolating this figure to the roughly 150,000 unique assignees with an active patent at the PTO suggests that there might be about 18,000 assignees that report virtual marking information. However, this figure is likely to be an inflated estimate. Although the disambiguation of assignee names at the PTO has significantly improved in recent years, it is not perfect yet. This leads to an over-estimation of the number of unique assignees. Besides, even if disambiguation were perfect, ownership structure would further reduce the number of "ultimate" assignees. Therefore, a wild guess would be that 5,000 to 10,000 of ultimate patent owners report virtual patent marking information.

Table 1 presents descriptive statistics of the main variables. The average assignee in the sample was established 36 years ago. It is a fairly large privately-owned U.S. company, employing more than 4,000 people. It has a portfolio reaching 129 active U.S. patents that were filed about 5 years ago. Traffic rank indicates the popularity of the website, and lower figures mean greater popularity.

Note that information on age is missing for 3 assignees and information on size for 15 assignees. Traffic rank is missing for 80 assignees, either because no website was found (32 cases) or because no traffic data exist (48 cases)—indicating that the website receives particularly little traffic. To maximize the number of observations I fill missing values with the mean of the variable and I create a dummy that takes value 1 if the original information was missing. (However, the econometric results are robust to the exclusion of assignees with missing information.)

Table 1. Descriptive statistics

Variable name	Min	Mean	Max	Std. Dev.	Missing
age	2	35.83	247	36.93	3
size	1	4,113.75	390,000	23,672.26	15
private	0	0.71	1	-	0
US	0	0.65	1	-	0
portfolio size	1	129.36	8674	664.21	0
portfolio age	.03	4.90	15.68	3.60	0
traffic rank	195	3,190,922	19,965,764	3,777,873	80

Notes: N = 300.
Descriptive statistics are not weighted by sampling probability.

The variables exhibit some correlation, as Table 2 shows. Older firms are larger and also have a larger and older patent portfolio as well as a website that attracts more traffic.

Table 2. Correlation coefficients

	age	size	private	US	portfolio size	portfolio age
age	1.00					
size	0.57*	1.00				
private	-0.29*	-0.52*	1.00			
US	-0.13	-0.16*	0.16*	1.0		
portfolio size	0.36*	0.60*	-0.43*	-0.01	1.00	
portfolio age	0.35*	0.29*	-0.18*	-0.01	0.24*	1.00
traffic rank	-0.20*	-0.52*	0.45*	0.04	-0.53*	-0.02

Notes: N = 300.
* $p < 0.01$
Natural logarithm of all variables used except for variables private and US.

Regarding product characteristics, about 23 percent of products are classified as "intangible" and the proportion is roughly the same between firms that use/do not use patent marking (not reported). Table 3 presents the distribution of the number of products sold by assignees. The major difference between VPM assignees and non-VPM assignees seems to lie in the fact that many non-VPM assignees simply do not sell products (or the number of products was unknown).[8]

Table 3. Distribution of product number, by use of virtual marking

Number of products	VPM assignees (*N*)	Non-VPM assignees (*N*)	Total (*N*)
None or unknown	11	64	75
1 to 10	38	53	91
11 to 100	55	37	92
101 to 1000	18	18	36
More than 1000	3	3	6
Total	*125*	*175*	*300*

[8] It would seem surprising that eleven VPM assignees sell no or an unknown number of products. However, further analysis shows that seven of these cases relate to assignees that sell intangible products for which one cannot easily estimate the number of products (not reported).

Assignees in the sample with virtual marking web pages are frequently found in the medical devices industry (Table 4), for which patents are known to provide effective protection against imitation (Cohen, Nelson & Walsh 2000; Graham et al. 2009). Other commonly found industries include electronics ('consumer electronics' and 'electrical/electronic manufacturing'), machinery ('machinery' and 'mechanical or industrial engineering'), and consumer goods (including 'sporting goods').

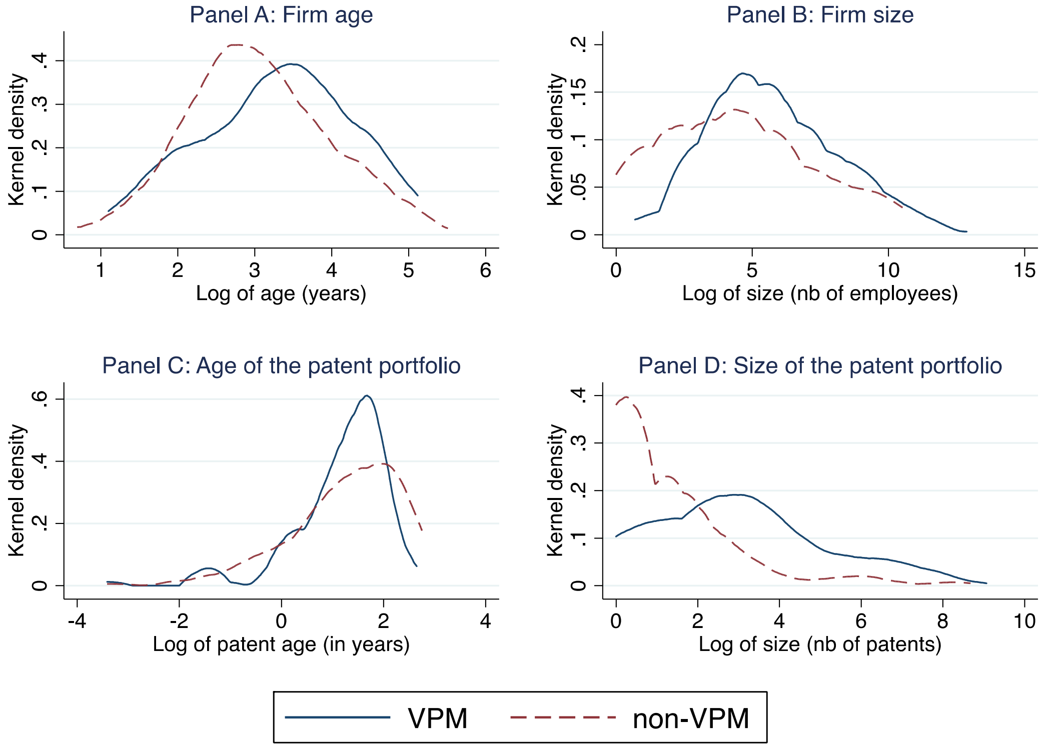
Table 4. Industries with most virtual-marking assignees in the sample

Industry	N
Medical Devices	19
Consumer Electronics	11
Electrical/Electronic Manufacturing	10
Sporting Goods	8
Machinery	7
Mechanical or Industrial Engineering	6
Consumer Goods	6

Notes: Industries with more than five virtual-marking assignees reported.
Industry is unknown for seven assignees.

Figure 1 depicts the distribution of key variables for assignees that provide virtual marking information and for assignees that do not. The natural logarithm of variables is used to account for their skewed distribution. Panels A and B show that assignees that provide virtual marking information are slightly older and larger than assignees that do not provide the information. They also have a larger patent portfolio (Panel D). The bumps in the distributions in Panel B are due to the categorical classification used when the actual number of employees was not available.

Figure 1. Distribution of key variables



Notes: Kernel density estimates.
VPM stands for Virtual Patent Marking and contains the group of assignees that have a VPM web page (conversely for non-VPM).

The next section proposes a multivariate analysis of the factors associated with the use of virtual marking.

Econometric results

Table 5 reports baseline results obtained using three regression models, namely OLS in columns (1) and (4), probit in columns (2) and (5) and logit in columns (3) and (6). Results presented in columns (1)–(3) do not control for industry fixed effects whereas results in columns (4)–(6) do. All models give roughly similar results and I discuss them jointly.

Firms headquartered in the United States are significantly more likely to use virtual marking. Across specifications, assignees with headquarters in the United States are between 12 and 16 percentage points more likely to provide virtual marking information. Younger firms seem to be also somewhat more likely to mark their products. Other demographic characteristics (*size*, *private*) are not significantly correlated with the likelihood of using virtual marking.

Regarding patent-based indicators, the size of the patent portfolio is associated with a higher likelihood of providing virtual marking information. Figure 2, based on the results presented in column (4), indicates that assignees with a portfolio lower than 20 patents (ln *portfolio size* of 3) have a probability of using virtual marking lower than 40 percent. However, assignees with a portfolio in excess of 400 patents (ln *portfolio size* of 6) are quite likely to mark their products. Bear in mind that these probabilities are estimated holding other covariates at the mean and, therefore, should not be taken at face value.

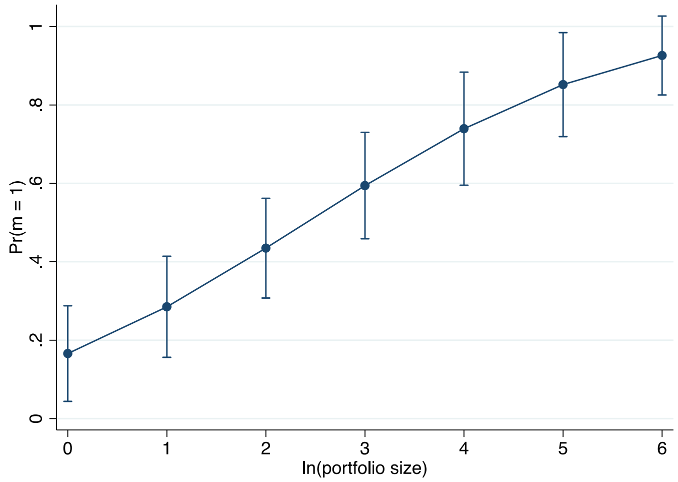
There is no evidence that assignees with a more recent patent portfolio have a higher likelihood of providing the information. Website frequentation is not correlated with the use of virtual marking. No clear pattern emerges regarding the size of the product portfolio. Firms that sell intangible products are not more likely to use virtual marking than firms that sell physical products.

Table 5. Baseline regression results

	(1)	(2)	(3)	(4)	(5)	(6)
Regression model:	OLS	Probit	Logit	OLS	Probit	Logit
ln(age)	-0.03	-0.02*	-0.03*	-0.02	-0.03*	-0.03**
	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
ln(size)	0.00	0.00	0.00	-0.00	-0.00	-0.00
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
private	0.05	0.04	0.04	0.05	0.04	0.03
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.02)
US	0.16***	0.11***	0.12***	0.16***	0.13***	0.13***
	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
ln(portfolio size)	0.05***	0.04***	0.05***	0.05***	0.04***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln(portfolio age)	-0.02	-0.01	-0.02	-0.02	-0.01	-0.02
	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
ln(traffic rank)	0.00	0.00	-0.00	-0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of products (baseline: 0 or unknown)						
1 to 10 products	0.07	0.07	0.08	0.08	0.07	0.07
	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
11 to 100 products	0.11**	0.10**	0.11**	0.13**	0.12**	0.12**
	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
101 to 1000 products	0.04	0.03	0.03	0.07	0.06	0.07
	(0.07)	(0.06)	(0.07)	(0.07)	(0.06)	(0.06)
1000+ products	0.08	0.13**	0.12**	0.10	0.14**	0.15**
	(0.09)	(0.06)	(0.06)	(0.09)	(0.06)	(0.06)
(jointly = 0, p-value)	0.16	0.08	0.09	0.10	0.02	0.02
Intangible product	0.00	0.01	0.01	0.03	0.04	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Industry effects	No	No	No	Yes	Yes	Yes
(jointly = 0, p-value)				0.53	0.04	0.00
Observations	300	300	300	300	300	300
R^2	0.44	0.46	0.48	0.46	0.51	0.53

Notes: The dependent variable takes value 1 if the assignee has a virtual patent marking section on its website and 0 otherwise.
Probability weights of finding an assignee reporting virtual patent marking of 12 percent used
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Marginal effects and pseudo-R^2 reported in columns (2)–(3) and (5)–(6).
The regression control for dummy variables that capture whether the original information on size or traffic rank was missing (not reported). Constant term included in columns (1) and (4).

Figure 2. Marginal effects at means for various portfolio sizes



Notes: Estimates performed on the random sample of 200 assignees, using population-wide coefficients presented in column (5) of Table 5.

Robustness checks

This section discusses two issues concerning the representativeness of the baseline results. First, the sample used for the analysis is reasonably large, but one may still question the sensitivity of the results to sample size. Table 6 reports estimates obtained on sub-samples split randomly by company names. The rationale for this test is that large variations in coefficients across sub-samples would cast doubt on the validity of the baseline results. Column (1) presents the baseline results from column (4) of Table 5 for comparison purposes. Column (2) presents estimates obtained on the group of assignees with a name starting with a letter comprised in the A–M range whereas column (3) reports estimates obtained on the group of assignees with a name starting with a letter comprised in the N–Z range. The coefficient associated with the patent portfolio size is stable between groups. This finding increases confidence that the baseline result is representative of the population. The coefficient associated with the U.S. dummy varies quite dramatically but remains positive and statistically significant. The coefficient associated with the age of the company is not significantly different from zero.

Next, columns (4) and (5) provide a test of the sensitivity of the sampling weights used. The baseline results assume an over-sampling of marking assignees relative to non-marking assignees by a factor of 12. Varying the oversampling to factors of 14 or 10 only slightly alters the magnitude of the coefficients. This finding provide confidence in the conclusion that the marginal effects recovered can be extrapolated to the population.

Table 6. Robustness checks

	(1) ALL	(2) A-M	(3) N-Z	(4) 14%	(5) 10%
ln(age)	-0.02	-0.04	0.00	-0.02	-0.02
	(0.02)	(0.03)	(0.04)	(0.02)	(0.02)
ln(size)	-0.00	-0.01	0.00	-0.00	-0.00
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
private	0.05	0.07	0.06	0.05	0.06
	(0.04)	(0.05)	(0.06)	(0.03)	(0.04)
US	0.16***	0.10*	0.26***	0.15***	0.18***
	(0.04)	(0.05)	(0.07)	(0.04)	(0.04)
ln(portfolio size)	0.05***	0.04**	0.07***	0.04***	0.05***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
ln(portfolio age)	-0.02	0.01	-0.09***	-0.02	-0.02
	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
ln(traffic rank)	-0.00	-0.02	0.02	-0.00	-0.00
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Number of products (baseline: 0 or unknown)					
1 to 10 products	0.08	0.06	0.04	0.08	0.07
	(0.06)	(0.08)	(0.08)	(0.06)	(0.06)
11 to 100 products	0.13**	0.11	0.16*	0.13**	0.14**
	(0.06)	(0.07)	(0.09)	(0.05)	(0.06)
101 to 1000 products	0.07	0.12	0.10	0.07	0.07
	(0.07)	(0.11)	(0.12)	(0.07)	(0.08)
1000+ products	0.10	0.03	0.90***	0.10	0.10
	(0.09)	(0.10)	(0.25)	(0.09)	(0.10)
(jointly = 0, p-value)	0.10	0.31	0.00	0.11	0.10
Intangible product	0.03	-0.00	0.10	0.03	0.03
	(0.03)	(0.06)	(0.06)	(0.03)	(0.04)
Industry effects	Yes	Yes	Yes	Yes	Yes
(jointly = 0, p-value)	0.53	0.00	0.20	0.55	0.51
Observations	300	150	150	300	300
R-squared	0.46	0.54	0.48	0.45	0.47

Notes: The dependent variable takes value 1 if the assignee has a virtual patent marking section on its website and 0 otherwise.
OLS regression model. The regression control for dummy variables that capture whether the original information on size and traffic rank was missing (not reported). Constant term included.
Probability weights of finding an assignee reporting virtual patent marking of 12 percent used in columns (1)–(3), 14 percent in column (4) and 10 percent in column (5).
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Discussion

This paper provides an in-depth overview of the use of virtual patent marking by assignees at the PTO. The findings can be summarized as follows.

First, I find that about 12 percent of assignees use virtual marking. A guesstimate suggests that this number would translate into 5,000–10,000 ultimate patent owners. Assuming that about half of assignees actually commercialize products (Giuri et al. 2007; Webster and Jensen 2011), the 12 percent figure would translate into about 25 percent adoption rate of virtual patent marking in the relevant population.

Second, the empirical analysis uncovers factors associated with the adoption of virtual marking. Medical devices firms form the largest group in the sample but marking is used across the board, including in low-tech industries such as furniture and real estate. The most robust findings are that assignees are significantly more likely to use virtual marking if they have a large patent portfolio and are headquartered in the United States. There is qualified evidence that younger firms are more likely to adopt virtual marking.

These findings are consistent with theoretical intuition. Regarding the positive effect of patent portfolio size, Hall & Ziedonis (2007) and Bessen & Meurer (2013) provide empirical evidence that patentees with a larger portfolio have a higher probability of being involved in patent litigation as enforcers. Thus, they have also greater incentives to mark. The finding that younger firms seem to be more likely to mark their products could be explained by the fact that they get more signaling benefits from marking than more established firms. These benefits may not only relate to marketing aspects. They may also concern potential funders such as venture capitalists (Haeussler, Harhoff & Mueller 2014; de Rassenfosse & Fischer 2016).

Regarding the country of headquarters, the fact that U.S. assignees are more likely to mark than foreign assignees may suggest that patent marking is predominantly a U.S. phenomenon. Patent marking may not be as important in foreign jurisdictions as in the United States, and foreign assignees may simply be less familiar with it. In Europe, for instance, the European Patent Convention does not require marking. It is also silent about the implications of marking and leaves this to national (patent and competition) laws. The United Kingdom seems to be an exception, with “webmarking” having been recently introduced with the UK Intellectual Property Act 2014.

Finally, I take the opportunity of this article to reflect on some limits of the current marking statute with a view of proposing improvements. First, patent marking applies only to product patents (see, *e.g.*, Markarian, 1997). Extending it to include method patents would further increase transparency in the patent system, as previously argued by Jacobsen (2008) and Sharkey (2014).

Second, there is a case for the government or industry associations to promote a technical standard for reporting notices of patent use and an adequate infrastructure for storing and publicizing them (see also McCaffrey 2011). Currently, there lacks a clear guidance as to how patents and products are to be “associated” (USPTO 2014) and virtual patent marks are consequently delivered in a variety of ways and formats. Furthermore, virtual patent marks are scattered across the Internet, hosted on assignees' web sites that may be temporarily unavailable. Defendants could use such elements in court to argue against proper marking. Recent advances in distributed computing (*i.e.*, blockchain technology) could be exploited to address these deficiencies. In particular, a distributed ledger, which contains information that is available to all—and verifiable by all—at any time, could be implemented. Such as system would link uniform product codes with patent numbers in a standardized format. It would remove uncertainty related to the misreporting of product-patent correspondence and to the (un)availability of the information at a given point in time. It would also enable a patent-based search of marked items. This would reinforce the transparency objective pursued by the marking statute.

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