# Creditor rights and innovation: Evidence from patent collateral

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**Abstract**

I construct a novel dataset of patent collateral portfolios and use it to show that stronger creditor rights facilitate the financing of innovation. I begin by showing that (1) secured debt is an important source of financing for innovation, and (2) patents are an important form of collateral supporting this financing. Since 2003, 49% of public-sector R&D is performed by companies that have patent-secured loans. Using the random timing of court decisions that strengthened the effectiveness of state property law for patents, and variation across states in the ease of seizing loan collateral, I show that patents are more likely to be pledged when it is easier to seize them as collateral. Debt issuance, R&D investment, and patenting output also increase in response, and the increased patenting output receives more citations on average. Analysis of the debt contracts reveals that covenants and collateral act as substitutes: When creditor rights strengthen, covenants loosen, granting firms more flexibility to invest in risky projects.

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# Introduction

Innovation is critical to economic growth, but its financing is inhibited by problems of moral hazard and adverse selection. These frictions lead to credit rationing, increased costs of capital, and an inefficient level of innovation (Hall and Lerner (2010)). I examine a contracting mechanism that mitigates these frictions: the use of patent portfolios as collateral for secured credit. Specifically, I ask whether stronger creditor rights – defined as an increased ability to seize collateral in bankruptcy – encourage or discourage financing and investment for innovative firms. The answer is unclear: Stronger creditor rights increase collateral value (Bester (1985)), but may discourage risk-taking by promoting the inefficient liquidation of underperforming firms (Aghion et al. (1992)). The linkage between creditor rights and innovation is particularly important to understand because secured debt is a growing means of financing innovative firms.

The fact that secured debt finances innovation runs counter to conventional wisdom that intangible assets – the main source of value for many innovative firms – are not pledgeable. I document this new finding by constructing a comprehensive, hand-collected dataset of patent collateral portfolios in the United States. Companies with patent-backed debt perform 49% of public-sector R&D and 41% of patenting since 2003. Of the aggregate stock of patents, 16% have been pledged as collateral at some point. Borrowers range from young companies to some of the largest firms in the world, and the role of patent collateral is particularly important in innovative industries such as pharmaceuticals and software, in which firms often have few tangible assets but many valuable patents.

With these findings as motivation, I turn to the main question of this study: How do the rights of secured creditors in default affect financing and innovation for research-intensive firms? Patent collateral is subject to several unique legal issues relative to other asset classes, which effectively creates a distinct set of creditor rights for innovative firms relative to other firms. In particular, it is relatively difficult to enforce collateral claims against patents in default compared to other asset classes (Stevens (2005)). As a result, the legal system is relatively debtor-friendly for innovative firms, raising the question whether such an arrangement is an optimal manner to encourage corporate innovation. This is the motivation behind my study: I ask whether stronger creditor rights in default encourage or discourage financing and innovation for research-intensive firms.

Answering this question is empirically challenging. Creditor rights are not randomly assigned to firms, but rather are a response to economic conditions and political economy concerns that directly affect the allocation of credit and innovative activity. I address this challenge using the random timing of four court decisions that have addressed property rights to patents under United States law. Specifically, each case addressed a potential conflict between state and federal law with respect to patent property rights, and each

ruling relied on state law to reach its verdict. Some states provide stronger creditor rights than others, so these verdicts generate plausibly exogenous within-firm increases in creditor rights to patent collateral for some firms relative to other firms. Moreover, the events only affected property rights to patents, and not to any other asset class, allowing me to isolate the economic importance of patent collateral separately from any other assets pledged simultaneously.

In the year following a strengthening of creditor rights to patent collateral, affected firms exhibit a 1.40% relative increase in the probability of pledging patents as loan collateral. Their annual issuance of long-term debt increases by 1.76% of firm total assets. These findings demonstrate that weak ex ante creditor rights constrain access to collateral for innovative firms: When creditor rights strengthen, these firms are more likely to collateralize their patents, and they raise more financing. While this finding may seem natural, it is not obvious. One might expect that innovative firms avoid putting patents at risk of foreclosure, as they are often the firm's core assets. Alternatively, one might expect no significant effect if other constraints on the use of patents as collateral (such as the difficulty of valuation, or the general risk of financing innovative firms) outweigh the significance of weak creditor rights. Therefore, it is important to establish the positive impact of stronger creditor rights on secured financing before examining other outcomes.

Along with the increase in collateral usage and debt issuance, firms experiencing a strengthening of creditor rights to patent collateral exhibit a 1.75% relative increase in R&D expenditure as a fraction of total assets. This finding establishes that research investment by innovative firms is credit constrained, and that increased access to collateral via strengthened creditor rights alleviates this constraint. Over a subsequent four-year horizon, intensively-patenting firms (those that already own 20 patents or more) produce 31 more new patents on average relative to firms that do not experience a strengthening of creditor rights. This effect on innovation output is even stronger when patents are weighted by forward citations to account for variability in the economic value of patents. Interestingly, the newly-produced patents also span more technology areas: about one in five firms responds by patenting in a new technology area, a large increase given that most sample firms only patent in one or two areas. In sum, stronger creditor rights lead to increases in innovation output, not only in terms of quantity but also in terms of quality and diversity.

Analysis of the terms of debt contracts in the sample reveals a novel tradeoff underlying the increase in innovation investment and output for some firms: When creditor rights strengthen, financial covenants loosen. The ex ante annual probability of violating a loan covenant declines by 5.0% for firms experiencing a strengthening of creditor rights relative to the rest of the sample. This effect is concentrated among firms patenting in the areas of chemicals, pharmaceuticals, drugs, and medicines. Borrowers and lenders in these industries trade off ex post and ex ante creditor rights – in other words, collateral

value substitutes for the protection provided by tight covenants. A lower probability of violating a covenant represents real operating flexibility, because covenant violations are known to lead to reduced investment and R&D spending (Chava and Roberts (2008), Nini et al. (2009), Chava et al. (2013)).

To provide further evidence for my interpretation of the results, I investigate heterogeneity in the effects of stronger creditor rights based on the size of the firm's patent portfolio. If the strengthening of creditor rights affects firms by increasing the collateral value of their patents, then one would expect a stronger effect for firms that own more patents, and indeed this is the case. The relative increase in the probability of pledging patents is 4.00% greater for a firm in the top third of the distribution of patent portfolio size (20 patents) than a firm below this threshold. Likewise, the increase in patenting output is almost entirely concentrated in this group. This interaction effect is weaker or absent when firms are sorted on total assets or sales instead of patent portfolio size. In other words, patent portfolio size is not simply an empirical proxy for other factors, such as agency problems or access to capital markets, that are associated with typical measures of firm size.

Interestingly, sample firms with relatively few patents (fewer than 20) exhibit small but statistically significant decreases in patenting output, despite exhibiting increased debt issuance and looser financial covenants. This finding reflects an interaction between firms: Those with large patent portfolios are able to raise more financing than those with small portfolios, as described above, and they subsequently acquire external assets and employees in significant numbers. Consequently, small-portfolio firms in industries with many large-portfolio competitors experience a negative effect of strengthened creditor rights on patenting output through a crowding-out effect. Conversely, for small-portfolio firms with no large-portfolio competitors, the effect is significantly positive. In other words, the benefits of strengthened creditor rights accrue disproportionately to firms with larger patent portfolios and thus more collateral, ultimately putting their small-portfolio competitors at a disadvantage. Nevertheless, the aggregate effect on patenting is positive, because firms with fewer than 20 patents account for less than 15% of patenting output.

In sum, I find a positive effect of stronger creditor rights on corporate innovation. Credit rationing and restrictive covenants are both mitigated by stronger creditor rights, allowing investment in more and riskier innovation. The conclusions for theory and policy are several. First, innovative firms have access to a supply of valuable collateral – their patents – that has not been fully appreciated in prior studies. This is true despite the difficulty of valuing a patent and the risk involved in lending to innovative firms. Second, the strength of creditor rights in default is a critical determinant of the effectiveness of this collateral. Third, access to collateral is of first-order importance to the financing of innovation. Policies or technologies that increase the effectiveness of intangible assets as collateral have dramatic consequences for the quantity, quality, and diversity of innovation

output in the economy.

Several previous studies examining the linkage between creditor rights and innovation have reached the opposite conclusion to mine: Acharya and Subramanian (2009), Acharya et al. (2011), and Seifert and Gonenc (2012) show that countries with stronger creditor rights, or that have recently strengthened creditor rights, exhibit smaller volumes of secured debt in innovative industries, less patenting, more corporate conservatism, slower firm- and industry-level asset growth rates, and lower R&D spending. Vig (2013) shows similar effects on secured debt volume, asset growth, and cash hoarding in response to a strengthening of creditor rights in India. Hsu et al. (2013) argue that credit-market development, in contrast to equity-market development, has a negative causal impact on innovation output. Their findings suggest that the conservative preferences of secured creditors lead to less risk-taking in legal regimes where those creditors receive more control rights. In Section 4, I explain how differences in our institutional settings can explain our disparate results.

The remainder of the paper is organized as follows: Section 1 describes my data sources and uses them to offer some motivating stylized facts. Section 2 explains my identification strategy, empirical specifications, and the sample used in the analysis. Section 3 presents and discusses the results. Section 4 explains my findings in the context of previous studies, and Section 5 concludes.

# 1 Data

I begin by constructing a novel dataset listing all patents pledged as collateral for secured loans since 1976. When a lender accepts a security interest in a patent, it files a notice of that interest with the United States Patent and Trademark Office (USPTO) to prevent unauthorized subsequent sales. These USPTO records have subsequently been published as flat files through the Google Patents project. From these files, I assemble a dataset containing the date, patent number, borrower name, and lender name for each pledge of patents as collateral for a loan.

I combine this data with USPTO data on patent applications, grants, transfers, citations, and classifications. I begin with the NBER patent dataset originally introduced by Hall et al. (2001), which currently ends in 2006, and I extend it to the present using USPTO documents, matching company names with the 2006-vintage company identifiers provided by the NBER. (This extension is necessary because two of the events used in my identification strategy occur after 2006.) For patents granted since 2006, I am currently able to match 65% reliably with firm identifiers, compared with a match rate of 85% for the NBER data from 1976-2006. I restrict to patents that have actually been granted by the Patent Office, since this is when the company name is observed.

Where possible, companies are matched with accounting data in Compustat, using the

company identifiers provided by the NBER Patent Data Project. For these companies, I also obtain all loans recorded in the Dealscan database, matching them to Compustat using the linkfile developed in Chava and Roberts (2008). I augment this sample by performing an automated search of SEC filings on the EDGAR system. My algorithm identifies loan origination and amendment documents, extracting their dates and their effects on covenant thresholds. I focus on the the five most common financial covenants in Dealscan,[1] and I use these to construct the Murfin (2012) measure of covenant strictness, which captures the probability that a firm violates one of its covenants within the next three months.

## 1.1 Stylized facts about patent collateral

I first use the data to document three stylized facts about the market for patent-backed loans that motivate my analysis:

First, patent-backed financing is common and growing. Figure 1a in the Appendix traces the increase over time in the frequency of this financing, from a negligible number of patents pledged in 1980 to roughly 36,000 per year recently. Figure 1b shows that roughly 15% of patents from a typical vintage are pledged as collateral within five years of being granted, a number that has also risen steadily. Given this rapid growth, the lack of research on the collateral value of patents is an important gap that I aim to fill. Table 1 examines the cross-sectional determinants of pledging a patent as loan collateral in a descriptive regression framework: Highly-cited patents in fields with more competitors (and thus potential buyers) are more likely to be pledged. Lenders are frequently banks but may also be venture funds or other non-bank lenders.

Figure 1 here.

Table 1 here.

Second, the flow of credit from these deals is economically large and directly finances research. Figure 2 shows that, for Compustat-listed borrowers, debt issuance and R&D expense both increase substantially as a proportion of total assets (6% and 4% respectively) when a firm borrows against its patents. Relatively few of the loans can be matched to Dealscan, but for those that can, Table 2 shows that the median ratio of loan value to firm total assets is 27%, comparable to the median of 27.7% for secured loans generally. These facts demonstrate that there are many economically large transactions in which patents are at least a portion of the collateral portfolio. Moreover, the firms that borrow against patents perform a major share of aggregate investment in innovation: Figure 3 demonstrates that between half of domestic patenting and public-sector R&D

[1] Interest coverage ratio, leverage ratio, debt service coverage ratio, fixed charges coverage ratio, and current ratio.

by US firms is performed by companies that have pledged patents as collateral within the previous three years (a typical maturity for a patent-backed loan).

Figure 2 here.

Table 2 here.

Figure 3 here.

Third, patents themselves are often an economically important source of collateral value, and are not merely an afterthought for high-tangibility firms that pledge all their assets simultaneously. This is important if my study is to inform innovation policy, because many innovative firms have few tangible assets to pledge. At the industry level, the most common 3-digit SIC codes of Compustat firms pledging patents as collateral are all low-tangibility, R&D-intensive industries. Figure 4 displays the distribution of the top ten industries in the sample.[2] At the firm level, the firms that pledge patents as collateral within these industries are not a high-tangibility subsample. To show this, in Table 3 I construct the firm-level tangibility measure used in Berger et al. (1996) and Almeida and Campello (2007) and compare it for firms that do and do not pledge patents as collateral. Firms that pledge patents as collateral are not significantly higher-tangibility, even within the low-tangibility industries where this activity is most common.

Figure 4 here.

Table 3 here.

Individual examples also illustrate that patent collateral can be valuable in its own right. For example, Insite Vision, a developer of optical pharmaceuticals, raised $6 million of debt financing in 2005 (more than the total assets reported on its balance sheet) by pledging its patent portfolio as collateral. The money financed clinical trials, and the company warned investors that restrictive debt covenants or lack of access to debt finance might inhibit future product development. In another example, Scientific Learning, an educational software company, added patent collateral to a loan portfolio after deteriorating financially and violating a loan covenant. The lender simultaneously reduced the amount of the loan, but presumably the additional collateral kept the consequences from being worse. These cases and others are described in the Appendix, and the accounting and legal literature provide further examples (see, for example, Loumioti (2012)).

Finally, my empirical strategy will also address the issue of whether patent collateral is economically valuable, because the events that I study affect creditor rights for patent collateral alone. If patents are not valuable collateral, I would expect to see no large

[2]Brown et al. (2009) show that these industries account for nearly all of the growth in aggregate US R&D expense since the early 1990s.

impact on firm behavior in response. Thus, my findings will offer evidence on the economic importance of patent collateral to innovation financing and investment.

The existence of a market for patent-collateralized loans is puzzling from a theoretical perspective: Patents support risky firms; they are difficult for lenders to value or sell; and they are difficult to seize in default relative to tangible assets. All three of these constraints are commonly stated as reasons that secured debt is not typical for innovative firms (Hall and Lerner (2010); Stevens (2005)). In the remainder of the paper, I examine the third of these factors – the weakness of creditor rights in default – and I demonstrate that a strengthening of creditor rights has significant effects on financing and investment in innovation, suggesting that this can be a valuable target for policies attempting to increase access to finance for innovative firms.

# 2 Identification strategy

Patent collateral claims are not perfectly enforced in bankruptcy. This increases the probability of the borrower retaining its patents in default, while impeding secured lending in the first place by weakening the lender's remedies, contributing to the assumption in many studies that intangible assets cannot be used as loan collateral. This imperfection in the contract space for patent-backed financing provides both the motivation and the identification strategy behind my study.

The key legal issue on which I focus is the conflict between state and federal law governing ownership claims to patents. Property claims and security interests are governed by state law for most asset classes, but the Patent Act also defines property rights to patents, and the scope of this language in preempting state laws has been the subject of an evolving caselaw. For example, as of the late 1990s it was expected that the Patent Act might nullify state-level filing systems for the perfection of security interests in patents (see Stevens (2005) for a discussion). This was already the case with copyrights, which are similarly created by the federal Copyright Act, as well as for railroads and aircraft, which are regulated at the federal level.[3]

Four court decisions over the last ten years have addressed unique circumstances in which the critical issue was the extent of the property rights created by the Patent Act. The first and last involved patent infringement claims, while the others were bankruptcy cases involving patent collateral. In each case, the court employed a narrow interpretation of the implications of patent law, thus increasing the relative importance of state laws in defining property rights to patents. I argue that these events increased creditor rights to patents for some states relative to others, because some states provide stronger creditor rights than others. This is the basic mechanism behind my identification strategy.

[3] *In re: Peregrine Entertainment, Ltd.*; *In re: Cybernetic Services, Inc.*

Before describing these cases, I first explain how creditor rights vary across states. First, I describe the automatic stay feature of the bankruptcy code, which limits creditor rights. Second, I describe variation in the strength of the automatic stay across states. Finally, I explain the court cases, which amplified the magnitude of this variation for patent collateral.

## 2.1 Avoiding the automatic stay

The most common measure of creditor rights is the presence or absence of automatic stay protection in bankruptcy (see, for example, La Porta et al. (1997)). Beginning from the moment of a bankruptcy filing, the automatic stay requires the judge's approval before a secured creditor can claim the firm's assets. Even if the creditor succeeds in doing so, the automatic stay creates substantial delay in acquiring the collateral. Aside from being costly in its own right, this delay damages the recovery value of the collateral, as no one has sufficient incentives to maintain this value in the meantime. Kieff and Paredes (2004) note that this concern is particularly acute with patent collateral, for which maintenance includes prosecuting infringers and pursuing value-maximizing strategies like cross-licensing.

The United States imposes an automatic stay, contributing to its weak creditor rights score in empirical studies. However, many borrowers evade the automatic stay by selling their collateral to a bankruptcy-remote special-purpose entity (SPE), which remains solvent (and thus free to transfer the collateral to the lender) if the borrower files for bankruptcy. In particular, it is standard practice for innovative companies to locate their patents in special-purpose entities (Cowan and Newberry (2013)).

## 2.2 Anti-recharacterization statutes

Transfering collateral to an SPE can protect secured lenders from the automatic stay, but the success of this strategy is not certain. Bankruptcy judges have the discretion to rule that the transfer was, in economic content, closer to a financing transaction than to a true sale, a ruling known as recharacterization. Seven states have adopted anti-recharacterization statutes to limit this risk. These laws treat any collateral transfer as a true sale if it is labeled as such. This provides enhanced creditor rights for borrowers located in these states, by making it more likely that the collateral is found to be bankruptcy remote, and therefore that secured creditors evade the automatic stay.[4] Table

[4]These laws are the most important state-level non-uniformity in secured lending laws (Janger (2003)). Kieff and Paredes (2004) mention their potential benefit to patent-backed financing, which carries a high risk of recharacterization, as the original owner plays an active role in the management of the patents even after their transfer.

4 lists the states and adoption dates of the laws.[5]

It might seem natural to exploit this cross-sectional variation by regressing outcome variables of interest (secured financing and innovation output) on the presence of an anti-recharacterization law. However, this specification would suffer from an omitted variable bias, since the assignment of laws and companies to states is non-random, and is itself correlated with the outcome variables of interest (for example, if the laws were the outcome of lobbying). Moreover, this strategy would not isolate the economic importance of patent collateral as opposed to other asset classes, because the state laws applied to all asset classes equally. This means that any findings from this strategy might not generalize to firms consisting mainly of intangible assets, which are an important set of firms from the perspective of innovation investment. Instead, I exploit four court decisions that amplified the importance, for patents specifically, of this cross-sectional variation.

## 2.3 Court decisions

Each of the four decisions resolved an apparent conflict between state and federal law with respect to ownership claims in patents. This is a frequent source of uncertainty for patent collateral, because patent ownership is governed both by state property law and by federal patent law. Each decision narrowed the interpretation of patent law in defining property rights over patents, leaving more scope for state law to do so. Thus, they plausibly strengthened perceived creditor rights for firms located in states with relatively stronger creditor rights (although none of the decisions directly mention the anti-recharacterization laws described above).

Crucially, the timing of each decision was plausibly random with respect to any differential trends in my outcome variables of interest between states with and without anti-recharacterization laws. The four decisions came 53, 20, 30, and 34 months after the respective events triggering them, which in turn had a large idiosyncratic component. The lengths of these delays were driven by the argument and deliberation of each case, which is plausibly exogenous to any contemporaneous differential trends between states with and without anti-recharacterization laws. Finally, it was not known at the start of the deliberations that the conflict between state and federal law would be the deciding issue in each case.

The remainder of this section briefly explains the effect of each decision. Appendix B.1 provides more detail about their content, as well as citations to external sources discussing them.

The first decision, *Rhone-Poulenc Agro v DeKalb Genetics*, was a rehearing of a patent infringement lawsuit. Overturning the previous ruling, the Court of Appeals for

[5] Typically, the physical location of loan collateral determines the state law that will prevail in assessing property rights in bankruptcy. Since patents have no physical location, the issue is more complex, but most courts locate them in the owner's state of incorporation.

the Federal Circuit narrowed its interpretation of the Patent Act's bona fide purchaser defense to reflect more closely the principles of state common law. Specifically, the court reversed its previous decision that a non-exclusive licensee could claim the bona fide purchaser defense under patent law. It justified this with the fact that state laws typically require the acquisition of title to be considered a bona fide purchaser, and stated its desire to restrict as much as possible the preemption of state law for ownership of patents. The ruling demonstrated a strong inclination to leave state property law intact for patents wherever possible. The decision was announced on March 26, 2002.

In the second decision, *Pasteurized Eggs Corporation vs. Bon Dente Joint Venture*, the bankruptcy court in a Chapter 11 proceeding ruled that patent law does not recharacterize limited transfers of patent ownership (in which the original owner retains rights to prosecute infringers and file followup applications) as licenses instead of sales. This transaction structure also characterizes the method by which patents are transferred to an SPV, and this case was the first to challenge the validity of such a sale. The ruling also found that a state UCC filing is necessary to perfect a security interest in a patent, because the Patent Act's filing system for ownership of patents does not preempt state law with respect to perfection. (A previous case had already determined that state filing is sufficient.) The ruling was announced on May 30, 2003.

In the third decision, *Braunstein v Gateway Management*, the bankruptcy court in a Chapter 7 proceeding ruled that the Patent Act's filing system for ownership of patents cannot be used to foreclose on a patent without following the provisions of state law. A borrower had defaulted on a patent-backed loan, and the lender sent notice to the Patent Office that it was confiscating the patents under the terms of the loan, believing thereafter that it owned them. However, the court held that under state law this unilateral foreclosure would have required physical possession of the collateral, which is impossible for intangible assets. The court also re-affirmed, as with the previous decision, that perfection of a security interest requires filing with the state, not the Patent Office. The decision was announced on May 15, 2007.

In the fourth decision, *Sky Technologies LLC v SAP AG and SAP America*, the Court of Appeals for the Federal Circuit ruled that foreclosing on a patent through state procedures is sufficient to effect a transfer of ownership. That is, the Patent Act does not create any special requirements for this process. This was not a bankruptcy case, but hinged on a foreclosure that had previously occurred, the validity of which was challenged because the Patent Office had not been notified. This decision was announced on August 20, 2009.

Tables 4 and 5 here.

## 2.4 Specification

The dataset is a firm panel, with all variables observable at monthly or quarterly intervals. A typical difference-in-difference specification for one of the four events would involve restricting to a window around that event date and regressing the outcome variables of interest on this panel, with firm and time fixed effects and appropriate interaction terms to capture the treatment effects. My empirical specification is equivalent to running all four of these difference-in-difference specifications simultaneously and obtaining an average coefficient across them. To do this, I run the specification in event time, stacking event windows of consistent length for each of the four events centered at that event date, an approach taken by Gormley et al. (2013) among others. My event windows are one year long, except when examining patenting outcomes, in which case the windows are lengthened to four years to allow for the delay of developing a new project.

I also collapse the time series before and after each event into one firm-level observation, aggregating the outcome variables within each firm-window, so that each firm-event time series consists of only two observations, a before and an after. This transformation is suggested by Bertrand et al. (2004) and Angrist and Pischke (2009) as a simple way to address potential serial correlation in firm-level residuals.

My general specification is thus:

$$\begin{aligned} y_{ikt} = \alpha &+ \gamma_{ik} + \delta_{kt} \\ &+ \beta_k \times \mathbb{1}\{post\}_{kt} \times \mathbb{1}\{law\}_{ks} \\ &+ \epsilon_{ikt} \end{aligned} \tag{1}$$

$i$ indexes borrowers, $k \in \{1, 2, 3\}$ indexes court decisions, $s$ indexes states, and $t \in \{0, 1\}$ indexes before and after windows for each decision. My tests will employ various outcome variables $y_{ikt}$, but the right hand side of the equation (and the sample of firms) will remain constant. $\gamma_{ik}$ is a firm-event fixed effect: It can vary between different decisions $k$, but it stays constant before and after a given decision. That is, the effect of any unobserved heterogeneity can change between event windows as long as it remains constant at the firm level within a given window. $\delta_{kt}$ absorbs time-series variation, taking on six different values. $\beta_k$, the coefficient on the interaction term, is the key variable of interest. The interaction term for court decision $k$ turns on after the corresponding decision is announced (*post*) in states that have anti-recharacterization laws at that time (*law*). $\beta_k$ thus captures the causal impact of strengthened creditor rights.

I fix the sample of firms at the beginning of each event and hold it constant, to avoid concerns about unobserved entry into the sample after the event window begins. Because the treatment captured by $\beta_k$ varies only at the state-event level, all standard errors will be clustered at this level.

## 2.5 Sample companies

For each event, my sample consists of all Compustat firms that have received at least one patent in the prior ten years in any of four patent technology categories. The categories I consider are Chemical, Computing and Communications, Drugs and Medicine, and Electronics (codes 1 through 4 of the technology categories originally introduced by Hall et al. (2001)). I exclude Mechanical and Miscellaneous patents (codes 5 and 6). Companies patenting primarily in the Mechanical category tend to be fairly high-tangibility and not as reliant on patent collateral, and those in Miscellaneous represent a broad range of industries that often are not primarily innovative (such as Furniture, Apparels, or Receptacles).

I restrict to firms that can be matched with NBER and Compustat identifiers. I remove companies headquartered outside the United States, and companies with SIC codes beginning with 9 (government entities) or 6 (financial companies). Finally, I exclude the top ten companies by patent portfolio size. This does not qualitatively affect my results, as these companies do not significantly respond to the natural experiment (and are not likely to be credit constrained), but it leaves treated and untreated subsamples that are more comparable than they otherwise would be, since the top patenting companies are disproportionately located in Delaware and are in the right tail of many observable firm characteristics. The companies removed are IBM, Micron Technology, Hewlett-Packard, Intel, Motorola, Microsoft, Lucent Technologies, Texas Instruments, Kodak, and Sun Microsystems. Results are not significantly affected if five or twenty companies are removed instead of ten.

The sample restrictions leave me with 1,952 unique sample companies, of which 73% are either incorporated, headquartered, or produce patents in states with anti-recharacterization statutes. I code all these companies as being treated by the court decisions. (The high fraction of treatment is due to Delaware's law, which also yields a great deal of variation in the physical location of treated companies.) Table 6 presents a comparison of the treated and untreated companies across several financial variables. I retain one observation for each sample company before and after each event (see previous section), resulting in a dataset of 10,628 firm-observations. Using my combined Dealscan and EDGAR data, I am able to observe covenant strictness levels for 4,982 of these firm-observations (carrying forward strictness levels for observations in which it is not observed to change).

Table 6 here.

# 3 Results

## 3.1 Collateral usage

I first investigate how the usage of secured debt responds to a strengthening of creditor rights. The dependent variable is an indicator for whether a company pledges patents as loan collateral within a twelve-month window around each court decision.

Table 7 here.

Figure 5 here.

The results of the estimation are reported in Table 7. The average effect of a strengthening of creditor rights, reported in Column (1) of Panel (a), is a 1.40% increase in the probability that a company pledges its patents as collateral in the year following the event. This increase in the probability of borrowing is accompanied by an increase in the amount borrowed: In Column (2), the outcome variable is Compustat's annual long-term debt issuance variable for the fiscal years before and after the shock occurs. Long-term debt issuance increases by 1.76% of the firm's total assets on average. This can capture both the creation of new credit agreements and increased borrowing under existing agreements. In sum, patenting firms become more likely to borrow against their patents when the patents become more pledgeable as collateral, and they receive more credit as well. It may seem unsurprising that the usage of patent-backed debt increases when patents become more pledgeable, but this finding is a necessary first condition for an investigation of how creditor rights affect innovation, and is not trivial in light of previous research (see Section 4).

To address concerns about differential trends between the treated and untreated groups, Panel (a) of Figure 5 interacts the probability of pledging patents as loan collateral with monthly indicators to show that the treatment effect appears at the event dates, not as a pre-trend. The figure restricts to firms with at least 20 patents, which is the subsample in which the effects are mostly clustered (see Section 3.4 below). Panel (b) of Table 7 separates firms by their primary patenting area out of the four technology areas that I consider (Chemical, Computing, Drugs/Medicine, and Electronics). Firms in all four areas are consistently more likely to pledge their patents as loan collateral in response to a strengthening of creditor rights, although the decreased sample size and power makes these results not individually statistically significant. Table 8 does the same for the debt issuance variable, and Tables 16 and 17 examine the effects across the most common states in which sample companies are located (for which the identifying variation comes from the company's state of incorporation).

Table 8 here.

Having established the positive effect of increased creditor rights on secured financing, I turn next to an examination of the real effects on firm activities. In particular, I will focus on measures of the firm's investment in innovation.

## 3.2 Research investment and patenting output

I first examine the effect of stronger creditor rights on investment in R&D. I repeat the previous specification, but replace the outcome variable with the firm's annual R&D expense scaled by its total assets. Column (3) of Table 7 reports the result. On average, R&D expense increases by 1.75% of the firm's total assets for a firm experiencing a strengthening of creditor rights relative to one that does not. This finding demonstrates that the marginal credit supply is channeled towards research, so that stronger creditor rights translate into real effects on innovation output. One implication is that investment in innovation faces financing constraints, consistent with previous studies that focus, for example, on investment sensitivities to cash flows (Brown et al. (2009)). Table 9 shows that all four technology areas exhibit increases in R&D expense, although the effect is not economically significant for firms that primarily patent in the Computing category.

Table 9 here.

The positive effect on R&D expenditures within a one-year window translates into subsequent production of innovation. To show this, I measure innovation through the patenting output of sample firms during a four-year window after each event. I obtain all new patent applications filed by sample companies subsequent to the event dates, restricting to those that were ultimately granted so that I can observe the company name. For the third and fourth events, this also requires the new patent-firm matches that I create after 2006. I time the new patents to the date that the application is received by the Patent Office, and I examine the number of these applications, the citations they receive, and the technology categories that they represent.

Table 10 here.

In Panel (a) of Table 10, I repeat the main specification. In Column (1) the outcome variable is the number of new applications filed by the firm. Columns (2) and (3) decompose this effect along the extensive and intensive margin (the outcome variables are, respectively, an indicator for filing an application, and the number of applications conditional on filing).

Firms subject to a strengthening of creditor rights increased their patenting output, with little effect on the extensive margin in Column (2) (the probability of patenting) but an economically large effect on the intensive margin in Column (3) (the number of patents filed, conditional on filing at some point in the window). However, these average effects

across the sample of firms are not statistically significant. Panel (b) demonstrates that the findings are particularly concentrated, and become statistically significant, among firms that have large patent portfolios. The panel repeats all the above specifications, but restricts to the subsample of firms that own 20 or more patents as of the event date. This subset represents roughly one-third of sample firms, but they are the most economically important from the perspective of innovation, accounting for 95% of the existing patent stock in the sample and 87% of new applications. The effects of strengthened creditor rights on patenting output become statistically significant for this subsample, and the effect on the extensive margin of patenting in Column (2) becomes slightly positive, though still insignificant. This heterogeneity will be explored further in Section 3.4.

Panel (b) of Figure 5 displays how this treatment effect evolves over time, using the number of new patents produced as the outcome variable. As with Panel (a), the figure restricts to firms with at least 20 patents, as there is a negligible effect on the outcome variable for the rest of the sample. There is no trend separating the two groups before the event date, but instead a gradually increasing effect over the span of several years, reflecting the lag involved in developing a new technology.

A common concern in empirical research on patenting output is that not all patents are created equal. In this setting, one might be concerned that the new patents do not represent valuable innovation, but rather an increased labeling of low-quality ideas with patent applications in the hopes of obtaining collateral value from them. In principle, this is not likely to be a concern with my results, for two reasons: First, the effect develops gradually in Figure 5, which would not be expected if firms are merely patenting existing or meaningless ideas. Second, lenders must believe that patents have value in order to lend against them. As a final way of dealing with this issue, Column (4) of Table 10 weights patents by the citations they have subsequently received from other patents, which is a common empirical approach to distinguishing between economically important and unimportant patents. The effect of strengthened creditor rights on citation-weighted patenting output in Panel (b) is about 219 for firms with at least 20 patents. The average citation count of patents produced by this subsample is 3, so the impact on citation-weighted patenting is much larger than the value that would be expected if the new patents were of marginally lower economic value. Instead, the marginal patents are more valuable, at least as measured by citation counts.

Column (4) in Panel (b) demonstrates a new finding using this subsample: Stronger creditor rights increase not only the quantity and quality but also the diversity of patenting output. To show this, I measure the number of technology categories in which a company files patents, using the 22 technology categories identified in Hall et al. (2001) (these are sub-categories of the four main categories employed throughout the analysis). The average effect is roughly one-fourth of a sub-category over the four-year window. For comparison, the median patenting firm only files in 2 such categories over a four-year

period. In other words, in response to a strengthening of creditor rights, about one in four companies files a patent application over the subsequent four years in a technology category in which it was not already present, which represents a 50% increase over the diversity of the median patenting firm's diversity in that window.

The effect on patenting diversity is noteworthy, because it shows that a strengthening of creditor rights not only allows firms to pursue new projects in their core technology areas, but also enables them to pursue research outside these areas, representing an increase in the risk of the firm's investment in innovation. One might expect that this diversity represents a decrease in firm risk, not an increase, as is often the interpretation when firms undertake diversifying acquisitions. However, the new patents in this setting are produced, not acquired, so their success could not have been forecast in advance. Even after the application date, which is the timing that I use, there would have been substantial uncertainty about the probability of the patent being granted, and the cash flows it would produce conditional on being granted. Also, the patents produced in response to the events saw an average subsequent delay of 2.85 years from the application date to the grant date, so that any diversification benefits were far in the future at the time the projects were started. Thus, it is more reasonable to interpret the increased diversity of patenting as an increase, not a decrease, in firm risk.

My findings so far demonstrate that innovative firms are more likely to employ their patents as collateral in response to strengthened creditor rights. By doing so, they are able to raise more financing, and these funds flow towards investment in research. Ultimately, they produce more patents which are of higher quality and span a broader range of technology areas. However, the allocation of credit is not the only function of financial contracts – the terms on which credit is extended also have real impacts on firm decisions. In particular, the ability to undertake risky investments is constrained by financial covenants. I therefore turn next to an examination of those terms, as captured in the structure of the financial covenants of secured debt contracts in the sample.

## 3.3 Covenant strictness

My previous findings demonstrated the effects of strengthened creditor rights on the provision of credit. In this section, I demonstrate effects on the terms of that credit. I restrict to the subsample of firms for which I observe a loan (or amendment to a loan) and its covenant structure, either from Dealscan or from my automated search of EDGAR filings, both before and after an event date. For these observations, I use the borrower's most recent data from quarterly Compustat to construct the covenant strictness measure developed in Murfin (2012), which reflects the probability that a firm violates any of its covenants over the next quarter (and thus enters technical default). I then repeat my previous specification, using as the dependent variable the measure of covenant strictness.

The result is reported in Table 11.

Table 11 here.

The increases in creditor rights have significant, negative effects on covenant strictness. On average, the ex ante probability of covenant violation and resulting control rights transfer decreases by 2.1% at a quarterly frequency for treated firms relative to untreated firms. The interpretation is that lenders accept weaker control rights when they receive greater bankruptcy protection. For a sense of the economic importance of this effect, the mean strictness measure in my sample is 16.7%, so the reported coefficient translates into a roughly 5.0% lower annual probability of a covenant violation. Chava et al. (2013) show that a single covenant violation is associated with significant decreases in both capital expenditures and R&D, so the loosening of covenant structures captured by the regression represents significant operating flexibility for the firms in my sample.

To get a sense of the strictness of the contracts in relative terms, rather than as an absolute measure, Column (2) of Table 11, Panel (a), replaces the dependent variable with an indicator for being above the cross-sectional mean contract strictness. The result, a negative effect of 3.0%, demonstrates that firms receive looser covenant structures in relative as well as absolute terms in response to a strengthening of creditor rights.

The finding that lenders and borrowers trade off creditor control rights in default against creditor control rights ex ante (in the form of loan covenants) is a novel contribution of my study. This finding demonstrates that collateral value can substitute for covenant tightness in secured lending. Given the substantial real effects of covenant tightness on firm investment as documented by many previous empirical studies, this linkage is an important one to understand in considering the connection between financing frictions and the real economy.

## 3.4 Portfolio size and interactions between firms

In Table 10, I demonstrated heterogeneity of the effects on patenting output based on the size of the firm's existing patent portfolio. In this section, I explain why that heterogeneity arises: The effect of strengthening creditor rights to patent collateral is to increase the pledgeability, and therefore the collateral value, of individual patents. Firms with larger patent portfolios therefore receive a greater shock to their stock of pledgeable assets when creditor rights strengthen.

To demonstrate this fact, in Table 12 I return to three of my key outcome variables: the probability of pledging patents as collateral, the number of applications subsequently filed, and the number of technology categories in which a firm files patents, in Columns (1), (2), and (3) respectively. The specification is modified by interacting all covariates with the log number of patents owned by the firm. The table reports only the two key coefficients

of interest. The first is the interaction term from all the previous specifications, and the second is the further interaction of this term with the firm's log number of patents. The first of these two thus captures the effect of strengthening creditor rights on a firm with only one patent (so that the log count is zero). The second reflects the marginal effect of doubling the firm's portfolio size.

Table 12 here.

In all three specifications, the new interaction coefficients are positive, and in the first two they are statistically significant, showing that the effect of increasing patent collateral value is stronger for firms with more patents, as is intuitive. Panel (b) demonstrates the same finding in a less paramatric way, dividing the firms into subsamples at the 20-patent threshold used earlier (the top third of firms by patent portfolio size). Again, the effects are much more positive for firms that have larger patent portfolios.

These findings also highlight an empirical puzzle: For firms with few patents, a strengthening of creditor rights leads to a decrease in patenting volume. The aggregate effect of the events on patenting output is still positive, as the negative effect for firms with few patents is far outweighed by the positive effect on those with many patents. Nevertheless, the finding warrants further examination. One might hypothesize, for example, that firms with small patent portfolios exhibit unique frictions or agency problems that cause them to invest more conservatively than firms with large portfolios in response to a strengthening of creditor rights. The next set of findings demonstrates that this is not the best explanation. Instead, the negative effect on patenting by small-portfolio firms reflects an externality in the form of interactions between the two subsamples.

To show this, I divide firms according to the technology category in which they file most of their patent applications, interpreting this category as the firm's market. For each such market, I compute the average log portfolio size in that market as a measure of competitor size. I restrict the sample to firms with fewer than 20 patents, as in Table 12, Panel (b), Column (3). In Table 13, I return to an examination of the effect of strengthened creditor rights on these firms' patenting output, and I investigate how this effect interacts with the size of the patent portfolios owned by the firm's competitors.

Table 13 here.

In Column (1) of Table 13, I reproduce the finding that these firms exhibited a negative average effect of strengthened creditor rights on patenting volume. In Column (2), I interact this treatment effect with the measure of competitor size. The interaction is significant and negative, but the main treatment effect (as average competitor patent portfolio size approaches zero) is positive. The interpretation is as follows: The strengthening of creditor rights benefits all firms through the provision and terms of credit, but this benefit accrues differentially depending on the amount of collateral the firm has

available. In markets where large-portfolio firms compete with small-portfolio ones, the greater benefit accruing to the former allows them to take market share from the latter. When small-portfolio firms do not have large-portfolio competitors, they exhibit the same positive effects of creditor rights as other firms.

In ongoing work, I further substantiate this interpretation by merging in data from SDC Platinum on the acquisition activity of sample firms. Preliminary results are in Tables 14 and 15. In Column (1), the outcome variable is an indicator for undertaking an acquisition. In Column (2), it is an indicator for an acquisition that brings in at least 5,000 employees. Companies experiencing a strengthening of creditor rights exhibit increased acquisition activity, both in terms of dollar value and in terms of human capital (number of employees), but only if they have large patent portfolios. The external acquisition of physical assets and human capital by large-portfolio firms provides a plausible mechanism by which their success might result in decreased production of patenting by competitors with small patent portfolios, which are presumably the targets of these acquisitions.

Tables 14 and 15 here.

### 3.4.1 Patent portfolio size and firm size

This section has shown that patent portfolio size is a significant intermediary for the effect of strengthened creditor rights on financing and innovation by research-intensive firms. However, patent portfolio size is not randomly assigned to firms, raising the possibility of an omitted variable bias – the size of a firm's patent portfolio may be correlated with some other trait that drives the results. The most obvious concern is that patent portfolio size is simply a proxy for other typical measures of firm size, such as total assets. Firm size is known to correlate with many important unobservable firm characteristics, so it would be difficult to say for sure that none of those characteristics was truly driving the results if patent portfolio size was simply another measure of firm size.

Perhaps surprisingly, this concern is not warranted. The results of this section are not replicated when firms are sorted on total assets instead of patent portfolio size: For example, Columns (1) and (4) of Table 12 demonstrate that the probability of pledging patents as loan collateral is significantly increasing in patent portfolio size, but not in total assets. Tables 15 demonstrates a similar finding for acquisition activity. Indeed, among sample firms, the correlation between log total assets and log patent portfolio size, while positive, is only 40%. For comparison, the logarithms of sales, assets, employment, and other size variables all have correlations of 80-90% in the cross-section in annual Compustat data.

Thus, the most plausible interpretation of the interactions with patent portfolio size is that they capture the strength of the collateral shock represented by the court decisions.

Firms with large patent portfolios respond to the creditor rights shocks more positively than other firms primarily because their larger collateral portfolios magnify the effects of shocks to creditor recovery values. However, these firms are not necessarily "large" along other dimensions.

# 4 Reconciling with previous studies

Previous empirical studies of creditor rights and innovation typically reach the opposite conclusions to mine. Acharya and Subramanian (2009) and Seifert and Gonenc (2012) find lower rates of patenting and usage of secured debt by innovative industries in countries that have strong creditor rights, or that have recently strengthened creditor rights. Acharya et al. (2011) demonstrate a further negative relationship between creditor rights and firms' willingness to take risks. Vig (2013) shows that firms used less secured debt, and invested more conservatively, in response to a strengthening of secured creditor rights in India.

The difference in our conclusions can likely be explained by institutional differences between the United States and the countries driving their results. Most notably, India – the setting for Vig (2013) – is a country with particularly strong creditor rights but weak enforcement of the law, receiving scores of 4/4 and 4.17/10 respectively in these categories in the original classification of La Porta et al. (1997). Similarly, the reforming countries that provide the identifying variation in Acharya and Subramanian (2009) have an average creditor-rights score of 2.9 out of 4, but an average rule-of-law score of 8.35, with two of nine countries (Indonesia and Israel) scoring below 5. The United States, by contrast, receives a score of 1 out of 4 for creditor rights – partly due to the strength of its automatic stay in bankruptcy – but receives the maximum rule-of-law score of 10.

Taken together, the results of our studies suggest that strengthened creditor rights are effective for fostering financing and innovation when they are not extremely strong to begin with. Furthermore, since an important mechanism for my results is the loosening of restrictive ex ante loan covenants, the strict enforcement of contractual contingencies in the United States may be another critical factor in my findings. This is consistent with evidence from Lerner and Schoar (2005), who show that financial contracts exhibit more state contingencies in countries with stronger legal enforcement, as well as Ponticelli (2013), who demonstrates that the effectiveness of legal reform depends on the effectiveness of its enforcement.

# 5 Conclusions

I have introduced a novel dataset on patent-collateralized debt to document the importance of patent collateral to the financing of innovation. Given this importance, I ask

whether stronger creditor rights in default increase or decrease the usage of secured finance and investment in research by patenting firms. The evidence shows that stronger creditor rights result in increased access to finance, as well as greater financial flexibility through loosened loan covenants. The mechanism for these effects is an increase in patent pledgeability, which makes patents more effective as collateral. The effect of creditor rights in default on contract covenants outside of default represents a previously-undocumented tradeoff between ex post and ex ante control rights. With increased access to credit and increased financial flexibility, firms invest more in research and subsequently produce more patents, which span a wider range of technology categories. For firms that have few patents, but that compete with firms with large patent portfolios, the strengthening of creditor rights leads to a decrease in patenting output as they are put at a competitive disadvantage compared to the large-portfolio firms. For all other firms, the effect on innovation output is positive. My findings demonstrate that intangible collateral can have significantly more economic value than previous studies have realized. On the other hand, legal uncertainty about the status of patent collateral is a major issue for participants in this market. Clarification of these issues leads to large responses in financing and innovation output for research-intensive firms, suggesting a useful focus for policymakers interested in spurring innovation and growth in the economy.

# References


Viral Acharya and Krishnamurthy Subramanian. Bankruptcy Codes and Innovation. *Review of Financial Studies*, 2009.

Viral Acharya, Rangarajan K. Sundaram, and Kose John. Cross-Country Variation in Capital Structures: The Role of Bankruptcy Codes. *Journal of Financial Intermediation*, 2009.

Viral Acharya, Yakov Amihud, and Lubomir Litov. Creditor Rights and Corporate Risk-Taking. *Journal of Financial Economics*, 2011.

Philippe Aghion, Oliver Hart, and John Moore. The Economics of Bankruptcy Reform. *Journal of Law, Economics, and Organization*, 1992.

Heitor Almeida and Murillo Campello. Financial Constraints, Asset Tangibility, and Corporate Investment. *Review of Financial Studies*, 2007.

Joshua Angrist and Jorn-Steffen Pischke. *Mostly Harmless Econometrics*. Princeton University Press, 2009.

Philip Berger, Eli Ofek, and Itzhak Swary. Investor Valuation of the Abandonment Option. *Journal of Financial Economics*, 1996.

Marianne Bertrand, Esther Duflo, and Sendhil Mullainathan. How Much Should We Trust Differences-in-Differences Estimates? *The Quarterly Journal of Economics*, 2004.

Helmut Bester. Screening vs. Rationing in Credit Markets with Imperfect Information. *American Economic Review*, 1985.

James Brown, Steven Fazzari, and Bruce Petersen. Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom. *Journal of Finance*, 2009.

Sudheer Chava and Michael Roberts. How Does Financing Impact Investment? The Role of Debt Covenants. *Journal of Finance*, 2008.

Sudheer Chava, Vikram Nanda, and Steven Chong Xiao. Lending to Innovative Firms: The Role of Lender Expertise and Control Rights. Working paper, Georgia Institute of Technology, 2013.

Mark J. Cowan and Warren Newberry, Jr. Reevaluating the Intellectual Property Holding Company. *Management Accounting Quarterly*, 2013.

Todd Gormley, David Matsa, and Todd Milbourn. CEO Compensation and Corporate Risk: Evidence from a Natural Experiment. *Journal of Accounting and Economics*, 2013.

Bronwyn Hall and Josh Lerner. Financing R&D and Innovation. *Handbook of the Economics of Innovation*, 2010.

Bronwyn Hall, Adam Jaffe, and Manuel Trajtenberg. The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools. Working paper, NBER, 2001.

Po-Hsuan Hsu, Xuan Tian, and Yan Xu. Financial Development and Innovation: Cross-country Evidence. *Journal of Financial Economics*, 2013.

Edward Janger. The Death of Secured Lending. *Cardozo Law Review*, 2003.

Scott Kieff and Troy Paredes. An Approach to Intellectual Property, Bankruptcy, and Corporate Control. *Washington University Law Review*, 2004.

Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer, and Robert Vishny. Legal Determinants of External Finance. *Journal of Finance*, 1997.

Josh Lerner and Antoinette Schoar. Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity. *Quarterly Journal of Economics*, 2005.

Maria Loumioti. The Use of Intangible Assets as Loan Collateral. Working paper, University of Southern California, 2012.

Justin Murfin. The Supply-Side Determinants of Loan Covenant Strictness. *Journal of Finance*, 2012.

Greg Nini, David Smith, and Amir Sufi. Creditor Control Rights and Firm Investment Policy. *Journal of Financial Economics*, 2009.

Jacopo Ponticelli. Court Enforcement and Productivity: Evidence from a Bankruptcy Reform in Brazil. Working paper, University of Chicago, 2013.

Raghuram Rajan and Luigi Zingales. What Do We Know About Capital Structure? Some Evidence From International Data. *Journal of Finance*, 1995.

Bruce Seifert and Halit Gonenc. Creditor Rights and R&D Expenditures. *Corporate Governance: An International Review*, 2012.

Pauline Stevens. Security Interests in Patents and Patent Applications? *Journal of Technology Law and Policy*, 2005.

Vikrant Vig. Access to Collateral and Corporate Debt Structure: Evidence from a Natural Experiment. *Journal of Finance*, 2013.

Ernst Young. Preemption and Federal Common Law. *Notre Dame Law Review*, 2008.

Elaine Ziff. The Effect of Corporate Acquisitions on the Target Company's License Rights. *The Business Lawyer*, 2002.

# A Patents as collateral

## Examples

The data include a wide range of companies and financing structures. The common thread in each deal is the importance of patent collateral.

The largest patent collateral portfolio in the sample comes from Eastman Kodak's debtor-in-possession financing with Citigroup in January 2012, a portfolio of 7,741 patents. Nearly as large is the portfolio for a loan made to Xerox in June 2002, in which it pledged 7,442 patents to a syndicate of 13 banks, with Bank One as lead arranger. The detailed documentation relating exclusively to patent collateral testifies to its importance in these deals. (An excerpt from the Xerox deal appears on the following page.) However, the most interesting events for my study are those involving borrowers with few pledgeable assets other than patents.

For example, Insite Vision, a developer of optical pharmaceuticals, has issued private placements of patent-collateralized debt several times. One example, from December 2005, raised $6 million debt financing, with Bank of New York as the collateral agent and Paramount BioCapital as the main investor. As a result, Insite reported $6.1 million of debt outstanding in 2006Q1, despite having zero sales or revenues, only $3.9 milion in cash or equivalents, and only $4.7 million in total assets. The all-asset lien included the company's portfolio of 32 pharmaceuticals patents, which were eight years old on average and have received a median of 13 citations and a mean of 18 (compared to a median of 4 and mean of 10 citations for the universe of all patents). A press release from the date of the deal closing announced that the funds would go towards clinical trials and future applications for approval of new products, and financial statements in the subsequent securities registration statement warn that restrictive debt covenants or lack of access to debt financing might interfere with the company's operations.

In another example, Scientific Learning, a developer of educational software, amended an existing secured credit agreement with Comerica Bank in August 2012 to add its portfolio of 81 patents to the collateral pool, where they had previously been explicitly excluded. The company's revenues had been declining, and it had recently violated a financial covenant. Simultaneously with the loan amendment, the lender reduced the commitment amount and tightened the covenant structure. However, the addition of patent collateral provided the lender with recovery value in default and may have prevented it from withdrawing the credit line completely, which would have seriously jeopardized the company's survival. The example demonstrates that collateral, and in particular patent collateral, can subsitute for the downside protection achieved through tight covenants or credit rationing.

PATENT SECURITY AGREEMENT

(Patents, Patent Applications and Patent Licenses)

WHEREAS, XEROX CORPORATION ("Xerox") (the "Lien Grantor") owns, or in the case of licenses is a party to, the Patent Collateral (as defined below);

WHEREAS, Xerox, the Overseas Borrowers party thereto, the Lenders party thereto, BANK ONE, NA, as Administrative Agent, Collateral Agent and LC Issuing Bank, JPMORGAN CHASE BANK, as Documentation Agent and CITIBANK, N.A., as Syndication Agent, are parties to a Credit Agreement dated as of _____, 2002 (as amended from time to time, the "Credit Agreement"); and

WHEREAS, pursuant to (i) a Guarantee and Security Agreement dated as of _____, 2002 (as amended and/or supplemented from time to time, the "Security Agreement") among Xerox, the Subsidiary Guarantors party thereto and BANK ONE, NA, as Collateral Agent for the Secured Parties referred to therein (in such capacity, together with its successors in such capacity, the "Grantee"), and (ii) certain other Domestic Security Documents (including this Patent Security Agreement), the Lien Grantor has secured certain of its obligations (the "Secured Obligations") by granting to the Grantee for the benefit of such Secured Parties a continuing security interest in personal property of the Lien Grantor, including all right, title and interest of the Lien Grantor in and to the Patent Collateral (as defined below);

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Lien Grantor grants to the Grantee for the benefit of the Secured Parties (as defined in the Security Agreement), to secure the Secured Obligations, a continuing security interest in and to all of the Lien Grantor's right, title and interest in, to and under the following (all of the following items or types of property being herein collectively referred to as the "Patent Collateral"), except to the extent (and only to the extent) prohibited by a Permitted Encumbrance (as defined in the Security Agreement), whether now owned or existing or hereafter acquired or arising:

(i) each Patent (as defined in the Security Agreement) owned by the Lien Grantor, including, without limitation, each Patent referred to in Schedule 1 hereto;

First page of a patent security agreement. Taken from credit agreement documents filed by Xerox Corporation with Form 8-K on June 21, 2002.

Notwithstanding the foregoing, the Collateral shall not include any (1) such property that (a) is nonassignable by its terms without the consent of the licensor thereof or another party (but only to the extent such prohibition on transfer is enforceable under applicable law, including, without limitation, Sections 9406 and 9408 of the Code), (b) the granting of a security interest therein is contrary to applicable law, provided that upon the cessation of any such restriction or prohibition, such property shall automatically become part of the Collateral, or (2) copyrights, patents, trademarks, servicemarks and applications therefor, now owned or hereafter acquired, or any claims for damages by way of any past, present and future infringement of any of the foregoing (collectively, the "Intellectual Property); provided however, the Collateral shall include all accounts and general intangibles that consist of rights to payment and proceeds from the sale, licensing or disposition of all or any part, or rights in, the foregoing (the "Rights to Payment"). Notwithstanding the foregoing, if a judicial authority (including a U.S. Bankruptcy Court) holds that a security interest in the underlying Intellectual Property is necessary in have a security interest in the Rights to Payment, then the Collateral shall automatically, and effective as of the Closing Date, include the Intellectual Property to the extent necessary to permit perfection of Bank's security interest in the Rights to Payment.

Excerpt from credit agreement between Scientific Learning and Comerica Bank, February 9, 2012, excluding intellectual property from the collateral portfolio.

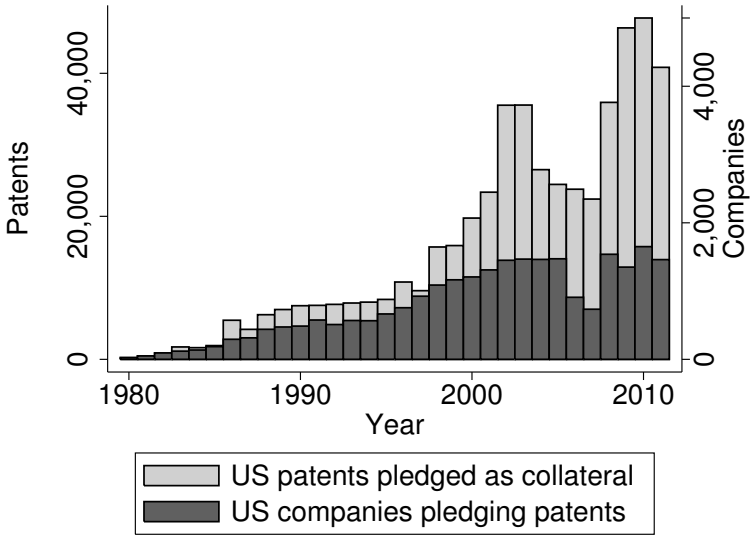
1. The following defined terms are hereby added to Section 1.1 of the Agreement:

"Bookings" means new booked sales as set forth in the forecast provided by Borrower to Bank on August 7, 2012.

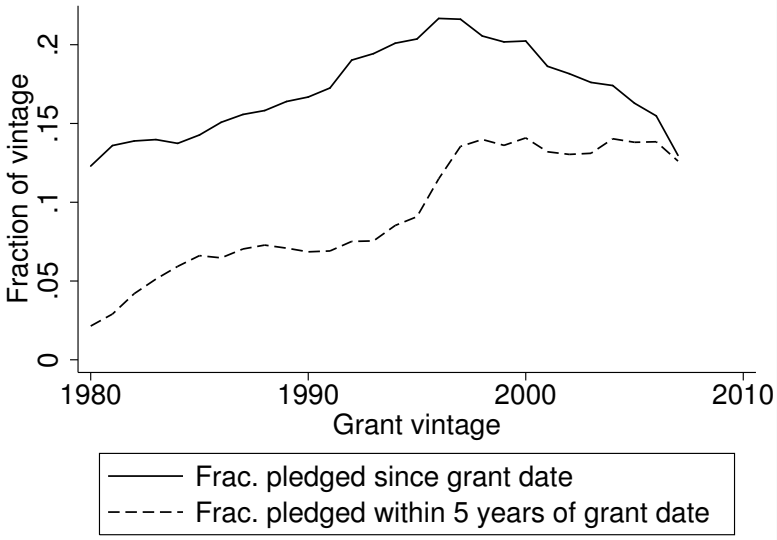
"Intellectual Property Collateral" means all of Borrower's right, title, and interest in and to the following:

(a) Copyrights, Trademarks and Patents;
(b) Any and all trade secrets, and any and all intellectual property rights in computer software and computer software products now or hereafter existing, created, acquired or held;
(c) Any and all design rights which may be available to Borrower now or hereafter existing, created, acquired or held;
(d) Any and all claims for damages by way of past, present and future infringement of any of the rights included above, with the right, but not the obligation, to sue for and collect such damages for said use or infringement of the intellectual property rights identified above;
(e) All licenses or other rights to use any of the Copyrights, Patents or Trademarks, and all license fees and royalties arising from such use to the extent permitted by such license or rights;
(f) All amendments, renewals and extensions of any of the Copyrights, Trademarks or Patents; and
(g) All proceeds and products of the foregoing, including without limitation all payments under insurance or any indemnity or warranty payable in respect of any of the foregoing.

Excerpt from an amendment to the same credit agreement, August 14, 2012, adding intellectual property to the collateral pool in response to the borrower's deterioration.




**(a)** Number of patents pledged as collateral per year, 1980-2011. The series for patents represents the entire sample. The series for companies restricts to one observation per borrower-year, for domestic companies only, using Compustat firm identifiers where possible and then NBER firm identifiers.




**(b)** Fraction of patents pledged as collateral, by grant vintage. The solid line shows the fraction of patents in each grant vintage that has since been pledged as collateral. The series begins to decrease before 2000, but this is largely an artifact of right-truncation, since the younger vintages have had less time to be pledged as collateral. To illustrate this, the dotted line shows the fraction of patents that are pledged within five years of their grant date, which is nondecreasing.

**Figure 1:** Growth in the market for patent-backed loans over time.

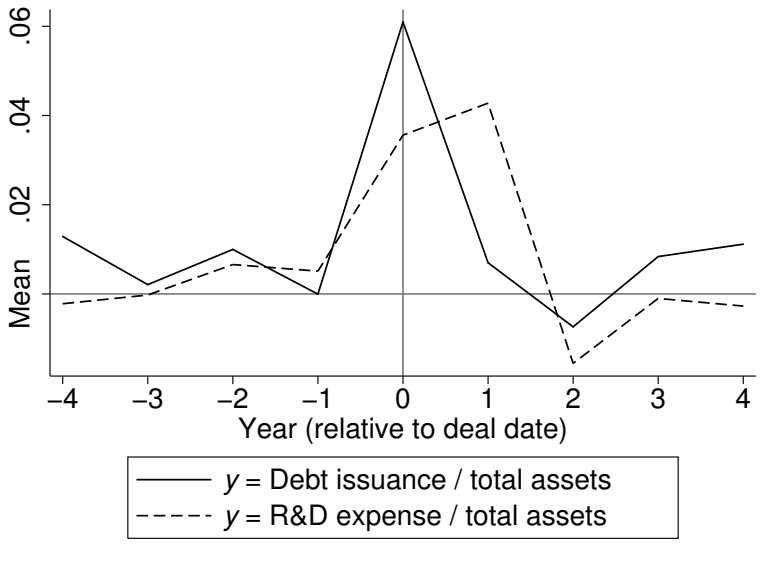
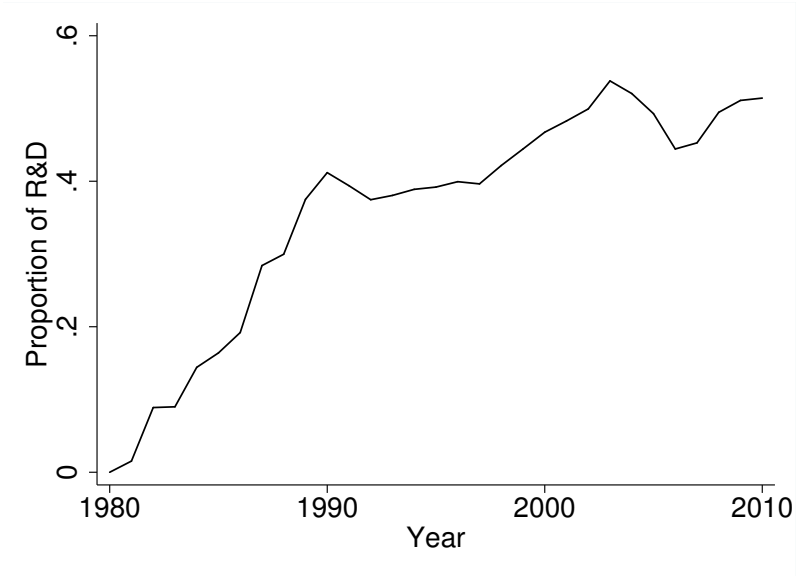
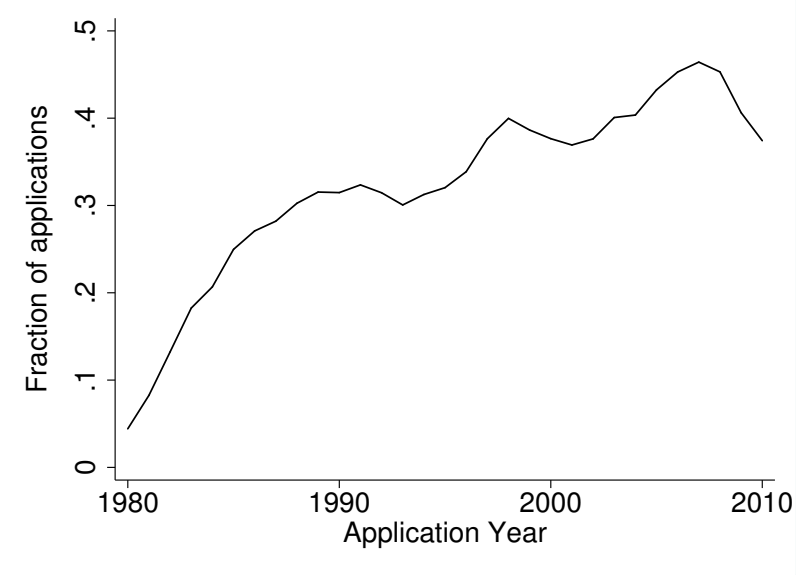



**Figure 2:** Dynamics of long-term debt issuance and research and development expense around patent-backed financing events. To construct each figure, I obtain annual Compustat data from 1980-2011 for the high-tech industries identified in Brown et al. (2009). I regress the two outcome variables (items DLTIS and XRD respectively) on a firm fixed effect plus distributed lags of time to financing events: $y_{it} = \alpha_i + \sum_{\tau=-4}^{4} \beta_\tau Pledge_{t-\tau} + \epsilon_{it}$. The figure plots the coefficients $\beta_\tau$ from this estimation. High-tech industries are drugs (SIC code 283); office and computing equipment (357); communications equipment (366); electronic components (367); scientific instruments (382); medical instruments (384); and software (737).




**(a)** Fraction of Compustat R&D performed by companies that have pledged patents as collateral within the previous three years (the typical maturity of a patent-backed loan).




**(b)** Fraction of US patent applications filed by domestic companies that have pledged patents as collateral within the previous three years (restricting to applications that were ultimately successful).

**Figure 3:** Relative importance of firms that borrow against patents to aggregate research investment and output.

| | (1) Pledge | (2) Pledge | (3) Pledge | (4) Pledge |
|---|---|---|---|---|
| Ln(Citations) | 0.0136*** | | | 0.0128*** |
| | (0.000285) | | | (0.000351) |
| Ln(Competitors) | 0.0172*** | | | 0.00654*** |
| | (0.000505) | | | (0.000532) |
| Originality | | 0.0126*** | | 0.00758*** |
| | | (0.00130) | | (0.00140) |
| Generality | | 0.0404*** | | -0.00506*** |
| | | (0.00132) | | (0.00154) |
| *Category:* | | | | |
| Drugs/Med | | | *omitted* | – |
| Chemical | | | 0.00851*** | 0.0239*** |
| | | | (0.00138) | (0.00142) |
| Comp/Comm | | | 0.0277*** | 0.0388*** |
| | | | (0.00132) | (0.00135) |
| Electrical | | | 0.0120*** | 0.0287*** |
| | | | (0.00134) | (0.00136) |
| Mechanical | | | 0.0722*** | 0.0817*** |
| | | | (0.00141) | (0.00145) |
| Miscellanous | | | 0.0627*** | 0.0651*** |
| | | | (0.00140) | (0.00144) |
| Public company | | | | -0.0500*** |
| | | | | (0.000717) |
| 2012 - Grant Year | | | | 0.0109*** |
| | | | | (0.000210) |
| (2012 - Grant Year)$^2$ | | | | -0.000347*** |
| | | | | (0.00000581) |
| Constant | 0.175*** | 0.174*** | 0.145*** | 0.0995*** |
| | (0.000345) | (0.000351) | (0.00110) | (0.00197) |
| Obs. | 1215441 | 1215441 | 1215441 | 1215441 |
| $R^2$ | 0.00283 | 0.00102 | 0.00466 | 0.0152 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 1:** Cross-sectional model of probability of a patent being pledged. The sample is all patents granted since 1980, and the outcome variable is an indicator for whether the patent has since been pledged as collateral. *Public company* is an indicator for whether the patent can be matched with a Compustat firm. *Ln(Competitors)* is the log number of distinct firms that have filed a patent in this patent's technology category (using the subcategories introduced in Hall et al. (2001)). The last two terms are a quadratic time trend to match the pattern captured by Figure 1b. All non-categorical variables except for the time trends are demeaned.

| Variable | Median | Mean | SD | N |
|---|---|---|---|---|
| Number of patents pledged | 5.00 | 43.23 | 347.96 | 975 |
| Deal amount (millions) | 100.00 | 376.32 | 950.26 | 975 |
| Firm total assets (millions) | 382.44 | 8218.98 | 45113.58 | 975 |
| Deal amount / total assets | 0.27 | 0.32 | 0.28 | 975 |
| Maturity (years) | 3.62 | 3.80 | 1.95 | 930 |
| All-in drawn spread (bps) | 250.00 | 252.22 | 140.13 | 686 |

**Table 2:** Sample information on the Dealscan-matched subsample of loans.

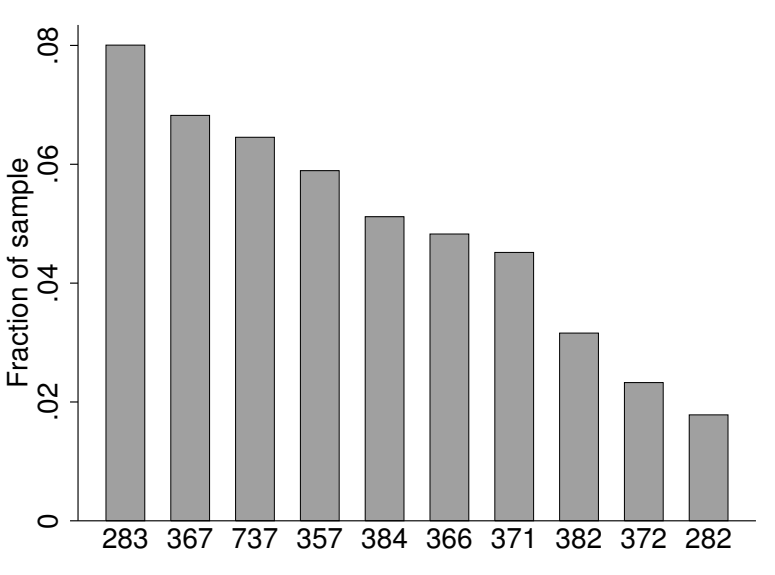



**Figure 4:** Top ten industries, by SIC codes, of Compustat-listed firms that pledge patents as collateral: Respectively, these are Drugs, Electronic Components, Computer Programming and Data Processing, Computer and Office Equipment, Medical Instruments and Supplies, Communications Equipment, Motor Vehicles, Laboratory Instruments, Aircraft and Parts, Plastics and Synthetics.

| | Do not pledge patents | Pledge patents |
|---|---|---|
| All industries: | (N = 22764) | (N = 1769) |
| Tangibility | 0.52 | 0.54 |
| Tangibility (excl. cash) | 0.35 | 0.36 |
| PP&E / Assets | 0.25 | 0.24 |
| Top 10 3-digit SIC: | (N = 4996) | (N = 841) |
| Tangibility | 0.61 | 0.57 |
| Tangibility (excl. cash) | 0.29 | 0.31 |
| PP&E / Assets | 0.16 | 0.19 |

**Table 3:** Tangibility measures for firms that do and do not pledge patents. The first is defined as in Berger et al. (1996) and Almeida and Campello (2007): $Tangibility = (0.715 * Receivables + 0.547 * Inventory + 0.535 * PP\&E + Cash)/Assets$. The second excludes cash holdings. The third is net property, plant, and equipment scaled by total assets. Data are firm-level means, calculated from annual Compustat since 1976.

| State | Year adopted |
|---|---|
| Texas | 1997 |
| Louisiana | 1997 |
| Alabama | 2001 |
| Delaware | 2002 |
| South Dakota | 2003 |
| Virginia | 2004 |
| Nevada | 2005 |

**Table 4:** States and enactment dates of anti-recharacterization laws.

| Case | Decision date |
|---|---|
| Rhone-Poulenc Agro v DeKalb Genetics Corp. | March 26, 2002 |
| Pasteurized Eggs Corporation v Bon Dente Joint Venture | May 30, 2003 |
| Braunstein v Gateway Management Services | May 15, 2007 |
| Sky Technologies LLC v SAP AG and SAP America | August 20, 2009 |

**Table 5:** Court decisions used in my identification strategy.

| Financial variables: | Untreated | Treated | $p - val$ |
|---|---|---|---|
| Patents owned in categories 1-4 | 64.34 | 51.31 | 0.30 |
| Assets - Total | 2260.12 | 2235.98 | 0.97 |
| Research and Development Expense | 52.46 | 54.90 | 0.87 |
| Capital Expenditures | 134.47 | 152.67 | 0.71 |
| Selling, General and Administrative Expense | 356.99 | 268.91 | 0.16 |
| Sales/Turnover (Net) | 1841.99 | 1849.17 | 0.99 |
| Property, Plant and Equipment - Total (Net) | 810.63 | 783.94 | 0.89 |
| Primary patenting area: | | | |
| 1 - Chemical | 23.2% | 20.8% | |
| 2 - Computing/Communications | 27.9% | 33.0% | |
| 3 - Drugs/Medicine | 24.1% | 25.3% | |
| 4 - Electronics | 24.9% | 21.0% | |
| Number of firms | 535 | 1417 | |

**Table 6:** Comparison of treated and untreated companies included in the natural experiment. Treated companies are those incorporated in states with anti-recharacterization laws. Data are from annual Compustat. The first two columns show subsample means. The last column shows the p-value from a two-sided t-test of the difference in means.

# B Natural experiment: Results

| | (1) Pledge | (2) Debt Issuance/Assets | (3) R&D/Assets |
|---|---|---|---|
| Law × After | 0.0140* | 0.0176** | 0.0175** |
| | (0.00763) | (0.00733) | (0.00800) |
| Firm-event FE | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes |
| Obs. | 10628 | 10628 | 10628 |
| Within $R^2$ | 0.00364 | 0.00482 | 0.100 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Panel (a)**

| | (1) Pledge | (2) Pledge | (3) Pledge | (4) Pledge |
|---|---|---|---|---|
| Law × After | 0.0219 | 0.0143 | 0.0119 | 0.0113 |
| | (0.0176) | (0.0148) | (0.0194) | (0.0199) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Category | Chemical | Computing | Drugs/Med | Electronics |
| Obs. | 2238 | 3320 | 2666 | 2404 |
| Within $R^2$ | 0.00673 | 0.00149 | 0.00584 | 0.0136 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Panel (b)**

**Table 7:** Effect of strengthened creditor rights on firm financing. In Column (1) of Panel (a), the dependent variable is an indicator at the firm level for pledging patents as loan collateral. The coefficients are interaction terms that turn on after each event for companies incorporated in states with anti-recharacterization laws (see Specification 1). In Column (2) of Panel (a), the dependent variable is the issuance of long-term debt as a fraction of the firm's total assets. The event windows are one year long. Panel (b) demonstrates consistent effects for firms that primarily patent in each of the four technology categories considered in my sample. Standard errors are clustered at the state level.

| | (1) Debt iss./Assets | (2) Debt iss./Assets | (3) Debt iss./Assets | (4) Debt iss./Assets |
|---|---|---|---|---|
| Law × After | 0.0119 | 0.0242** | 0.0285 | 0.00533 |
| | (0.0133) | (0.00980) | (0.0173) | (0.0115) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Category | Chemical | Computing | Drugs/Med | Electronics |
| Obs. | 2238 | 3320 | 2666 | 2404 |
| Within $R^2$ | 0.0114 | 0.00580 | 0.00962 | 0.00660 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 8:** Effect of strengthened creditor rights on debt issuance, separately for each of the four technology categories considered in my sample. Standard errors are clustered at the state level.

| | (1) R&D/Assets | (2) R&D/Assets | (3) R&D/Assets | (4) R&D/Assets |
|---|---|---|---|---|
| Law × After | 0.0103** | 0.000220 | 0.0438** | 0.0112** |
| | (0.00449) | (0.00732) | (0.0191) | (0.00443) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Category | Chemical | Computing | Drugs/Medicine | Electronics |
| Obs. | 2238 | 3320 | 2666 | 2404 |
| Within $R^2$ | 0.0410 | 0.147 | 0.159 | 0.118 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 9:** Effect of strengthened creditor rights on firm investment in R&D. The dependent variable is R&D expense as a fraction of total assets. The coefficients are interaction terms that turn on after each event for companies incorporated in states with anti-recharacterization laws (see Specification 1). The event windows are one year long. Column (1) reports the average effect across all firms, and the remaining columns demonstrate for firms that primarily patent in each of the four technology categories considered in my sample. Standard errors are clustered at the state level.

| | (1) Num. applications | (2) Extensive | (3) Intensive | (4) Num. citations |
|---|---|---|---|---|
| Law × After | 5.006 | -0.0103 | 14.32 | 26.67 |
| | (5.647) | (0.0111) | (12.50) | (37.30) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Obs. | 10628 | 10628 | 6292 | 10628 |
| Within $R^2$ | 0.0386 | 0.270 | 0.0758 | 0.0466 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Panel (a):** Full sample.

| | (1) Num. applications | (2) Ext. | (3) Int. | (4) Num. citations | (5) Categories |
|---|---|---|---|---|---|
| Law × After | 31.29$^{*}$ | 0.0119 | 45.02$^{**}$ | 218.7$^{**}$ | 0.292$^{*}$ |
| | (18.00) | (0.0238) | (18.79) | (84.34) | (0.170) |
| Firm-event FE | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes |
| Obs. | 3376 | 3376 | 2758 | 3376 | 2758 |
| Within $R^2$ | 0.118 | 0.351 | 0.139 | 0.133 | 0.361 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Panel (b):** Only firms with at least 20 patents as of the event date.

**Table 10:** Effect of strengthened creditor rights on innovation investment and output. In Column (1), the dependent variable is an indicator for whether the firm files a new patent application, capturing the extensive margin of patenting activity. In Column (2), the dependent variable is the number of applications filed by patenting firms, capturing the intensive margin. In Column (3), the dependent variable is the citation-weighted number of applications filed (equivalently, the total number of citations received by patents produced in response to the events). Finally, in Column (4) of Panel (b), the dependent variable is the number of technology categories represented by the firm's patents, and the sample is restricted to companies that actually file a patent in the event window. The event windows are four years long. The coefficients are interaction terms that turn on after each event for companies in states with anti-recharacterization laws (see Specification 1).

| | (1) Strictness | (2) Above-avg Strictness |
|---|---|---|
| Law × After | -0.0208* | -0.0303 |
| | (0.0121) | (0.0210) |
| Firm-event FE | Yes | Yes |
| Time FE | Yes | Yes |
| Obs. | 4982 | 4982 |
| Within $R^2$ | 0.307 | 0.192 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Panel (a)**

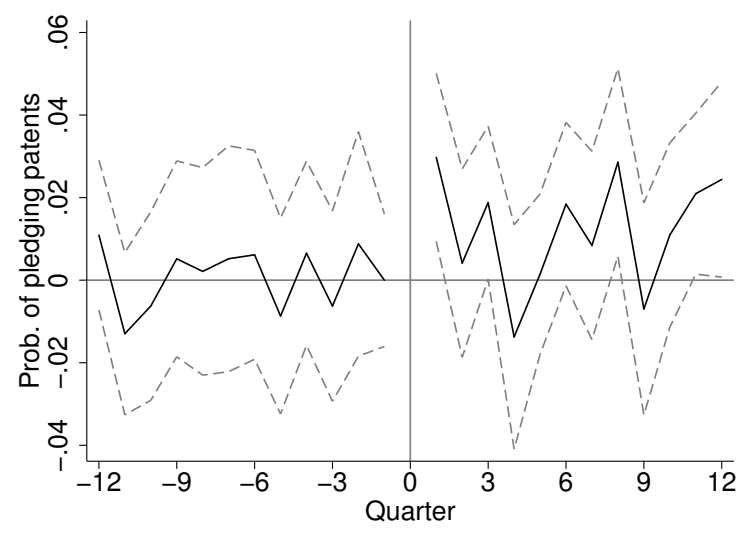
| | (1) Strictness | (2) Strictness | (3) Strictness | (4) Strictness |
|---|---|---|---|---|
| Law × After | -0.0452** | 0.0172 | -0.0731*** | 0.00927 |
| | (0.0214) | (0.0218) | (0.0210) | (0.0214) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Category | Chemical | Computing | Drugs/Med | Electronics |
| Obs. | 1280 | 1560 | 960 | 1182 |
| Within $R^2$ | 0.401 | 0.274 | 0.210 | 0.341 |

Standard errors in parentheses

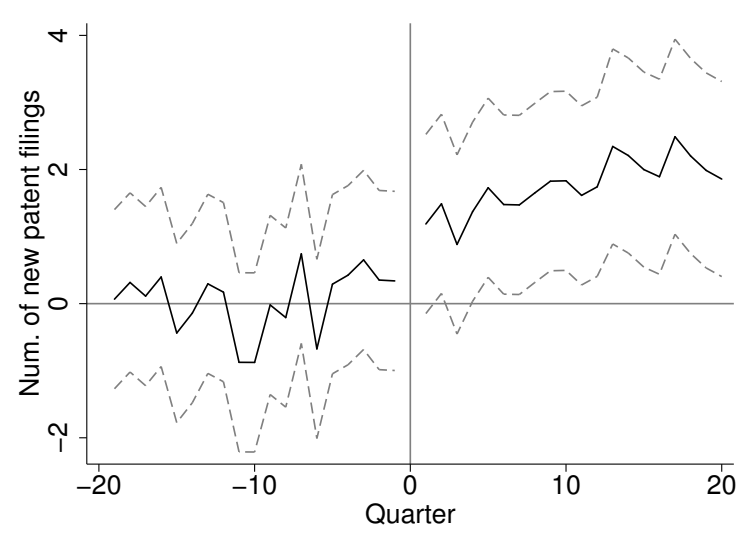
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Panel (b)**

**Table 11:** Effect of strengthened creditor rights on covenant strictness. The dependent variable is the Murfin (2012) measure of covenant strictness, except in Column (2) of Panel (a), where it is the probability of that strictness measure being above the cross-sectional mean (a relative instead of an absolute measure of strictness). The event windows are four years long. The coefficients are interaction terms that turn on after each event for companies in states with anti-recharacterization laws (see Specification 1). Panel (b) reports separate effects for the four technology classes considered in the study.




**(a)** The dependent variable is an indicator for pledging patents as collateral, measured at a quarterly frequency.




**(b)** The dependent variable is the number of patents produced (dated by application), measured at a quarterly frequency.

**Figure 5:** Natural experiment results depicted in event time. Each figure interacts the effect of being incorporated in a treated state with monthly indicator variables in event time. The figures exhibit level changes at the event date, rather than any differential trends separating the treated and untreated groups. The sample is restricted to companies owning at least 20 patents as of the beginning of the event window, as this subsample drives the positive effects (see Table 12).

| | (1) Pledge | (2) Applications | (3) Categories | (4) Pledge |
|---|---|---|---|---|
| Law × After | -0.0129 | -13.87 | -0.118 | 0.0149 |
| | (0.0149) | (9.590) | (0.180) | (0.0168) |
| Law × After × Ln(Patents) | 0.0121* | 10.35* | 0.0592 | |
| | (0.00721) | (5.746) | (0.0653) | |
| Law × After × Ln(Assets) | | | | -0.000203 |
| | | | | (0.00287) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| All interactions | Yes | Yes | Yes | Yes |
| Obs. | 10628 | 10628 | 6292 | 10628 |
| Within $R^2$ | 0.00504 | 0.216 | 0.312 | 0.00533 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Panel (a)**

| | (1) Pledge | (2) Pledge | (3) Applications | (4) Applications |
|---|---|---|---|---|
| Law × After | 0.00206 | 0.0421*** | -0.775** | 31.29* |
| | (0.00971) | (0.0139) | (0.288) | (18.00) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| # Patents | $< 20$ | $\geq 20$ | $< 20$ | $\geq 20$ |
| Obs. | 7252 | 3376 | 7252 | 3376 |
| Within $R^2$ | 0.00309 | 0.00595 | 0.0115 | 0.118 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Panel (b)**

**Table 12:** Effect of patent portfolio size. In Panel (a), the first coefficient reported is an interaction term that turns on after each event for companies in states with anti-recharacterization laws. The second coefficient further interacts the first with the logarithm of the number of patents owned by the firm. Firm fixed effects, time fixed effects, and all interaction terms are included. In the last column, the interaction is with firm total assets instead of with patent portfolio size. Panel (b) takes a less parametric approach, dividing the sample at 20 patents and reporting separate effects for the two subsamples.

| | (1)<br>Num Applications | (2)<br>Num Applications |
|---|---|---|
| Law × After | -0.775** | 2.792** |
| | (0.288) | (1.312) |
| Law × After × Avg. size | | -1.816*** |
| | | (0.648) |
| Firm-event FE | Yes | Yes |
| Time FE | Yes | Yes |
| All interactions | | Yes |
| Obs. | 7252 | 7252 |
| Within $R^2$ | 0.0115 | 0.0143 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 13:** Interactions between firms with small and large patent portfolios (using 20 patents as a cutoff). The dependent variable is the number of applications filed in a four-year window. The first coefficient reported is an interaction term that turns on after each event for companies in states with anti-recharacterization laws. The second coefficient further interacts the first with the average across all firms in the same industry of the logarithm of the number of patents owned by the firm.

| | (1) Acquire | (2) Acq. employees |
|---|---|---|
| Law × After | 0.0645*** | 0.0227* |
| | (0.0233) | (0.0128) |
| Firm-event FE | Yes | Yes |
| Time FE | Yes | Yes |
| Obs. | 3376 | 3376 |
| Within $R^2$ | 0.0117 | 0.0230 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 14:** Response of acquisition activity to a strengthening of creditor rights, restricting to firms with at least 20 patents. In Column (1), the outcome variable is an indicator for the firm's undertaking an acquisition in a two-year window around the event date. In Column (2), it is an indicator for an acquisition that brings in at least 5,000 employees.

| | (1) Acquire | (2) Acq. employees | (3) Acquire | (4) Acq. employees |
|---|---|---|---|---|
| Law × After | -0.0123 | -0.0259** | 0.0143 | -0.0162 |
| | (0.0159) | (0.0113) | (0.0291) | (0.0105) |
| Law × After × Ln(Patents) | 0.0124** | 0.0104*** | | |
| | (0.00608) | (0.00350) | | |
| Law × After × Ln(Assets) | | | 0.000192 | 0.00250 |
| | | | (0.00408) | (0.00275) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| All interactions | Yes | Yes | Yes | Yes |
| Obs. | 10628 | 10628 | 10628 | 10628 |
| Within $R^2$ | 0.00696 | 0.0167 | 0.00729 | 0.0214 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 15:** Response of acquisition activity to a strengthening of creditor rights. In Column (1), the outcome variable is an indicator for the firm's undertaking an acquisition in a two-year window around the event date. In Column (2), it is an indicator for an acquisition that brings in at least 5,000 employees. The estimates demonstrate that firms with large patent portfolios are significantly more likely to undertake such acquisitions in response to a strengthening of creditor rights; Column (3) and (4) show that this effect does not hold when the interaction is with total assets.

| | (1) Pledge | (2) Pledge | (3) Pledge | (4) Pledge |
|---|---|---|---|---|
| Law × After | 0.0505*** | 0.0189*** | 0.0851*** | 0.0299 |
| | (0.0164) | (0.00507) | (0.0184) | (0.0304) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| State of HQ | CA | MA | NY | NJ |
| Obs. | 2896 | 794 | 716 | 474 |
| Within $R^2$ | 0.00864 | 0.00367 | 0.0202 | 0.00853 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 16:** Effects on pledging probability, separately for the top states of headquarters in the sample.

| | (1) Debt iss./Assets | (2) Debt iss./Assets | (3) Debt iss./Assets | (4) Debt iss./Assets |
|---|---|---|---|---|
| Law × After | 0.0228** | 0.00714 | 0.0199 | 0.0624* |
| | (0.00850) | (0.0116) | (0.0258) | (0.0320) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| State of HQ | CA | MA | NY | NJ |
| Obs. | 2896 | 794 | 716 | 474 |
| Within $R^2$ | 0.00597 | 0.0227 | 0.0146 | 0.0327 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 17:** Effects on long-term debt issuance, separately for the top states of headquarters in the sample.

| | (1) R&D/Assets | (2) R&D/Assets | (3) R&D/Assets | (4) R&D/Assets |
|---|---|---|---|---|
| Law × After | 0.0153 | 0.0192*** | 0.0284*** | 0.0392*** |
| | (0.0233) | (0.00153) | (0.00516) | (0.00664) |
| Firm-event FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| State of HQ | CA | MA | NY | NJ |
| Obs. | 2896 | 794 | 716 | 474 |
| Within $R^2$ | 0.165 | 0.255 | 0.105 | 0.140 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table 18:** Effects on investment in R&D, separately for the top states of headquarters in the sample.

## B.1 Court decisions and implications

This section provides more detail about the four bankruptcy court decisions used in my identification strategy, and how each represented a relative increase in the perceived importance of state law for defining property rights to patents.

**Case 1: *Rhone-Poulenc Agro v DeKalb Genetics Corp.***

This decision was made on March 26, 2002 by the Court of Appeals for the Federal Circuit, reversing a previous ruling by the same court. That previous ruling, from 2001, addressed the applicability of the bona fide purchaser defense to non-exclusive patent licensees. In that ruling the court had held, first, that it was necessary to articulate a federal common law for this issue (thus overriding state law); and, second, that the court was bound to respect a prior precedent (*Heidelberg Harris, Inc v Loebach*) in determining the content of the new law, forcing it to conclude that any licensee had access to the bona fide purchaser defense. This conclusion protected the defendant against any claim of infringement. However, the plaintiff petitioned for an en banc rehearing so that the court could reconsider the latter conclusion.

The 2002 ruling (the outcome of the rehearing) was able to set aside the precedent and give the issue more nuanced consideration. In this ruling, the court emphasized the importance of overriding state law only where necessary due to explicit language in the Patent Act, and of harmonizing the resulting federal law as closely as possible with the provisions of the state-level Uniform Commercial Code. The resulting law was still federal in nature, but was based on the spirit of state common law, not the Patent Act or prior precedents in patent law. As a result, the outcome of the prior ruling was reversed on the grounds that state laws have hardly ever permitted the bona fide purchaser defense for a party that has not obtained title to the asset, such as a non-exclusive licensee. This allowed the plaintiff to sue for patent infringement.

The 2002 ruling thus demonstrated a strong inclination by the court to overrule state common law for patents only when necessary, and to respect as much as possible the provisions of state law with respect to the ownership of patents. This shift has been noticed in the legal literature: A paper published between the two rulings mentioned the first ruling as a possible indication of a trend toward a growing body of federal common law overriding state laws (Ziff (2002), footnote 28). The latter ruling, on the other hand, is often cited for its emphasis on state law (for example Young (2008), footnote 118, citing the ruling's statement that "the interpretation of contracts for rights under patents is generally governed by state law"). Thus, the decisions increased the perceived importance of state law for defining ownership of patents, which plausibly increased the effectiveness of the state-level anti-recharacterization laws for protecting patent collateral.

**Case 2: *Pasteurized Eggs Corporation v Bon Dente Joint Venture***

This decision was made on May 30, 2003 by the Bankruptcy Court for the District of New Hampshire. It held that patent law does not recharacterize limited or conditional transfers of patents as licenses instead of sales.

Borrowers must separate themselves economically from the management of assets in a special-purpose entity, or they run a greater risk of a judge consolidating the two in bankruptcy. This is a challenge when patents serve as collateral, because patents require

active management, increasing the probability that the transfer of the collateral is not ultimately respected as a sale.[6]

*Pasteurized v Bon Dente* involved a patent sale with the same structure: The seller retained the right to infringe prosecutors and file followup applications. After the buyer filed for bankruptcy, the seller argued that this transaction should be characterized as a patent license, not a sale, and therefore that the seller should be able to reclaim the patent from the bankruptcy estate.

The closest available precedent was a case involving standing to sue for patent infringement (*Waterman v Mackenzie*, 1891). Building on that case, the court held that patent law did not relabel this transaction as a sale. This left the status of such transactions to be a matter for state property law, as it is for most other asset classes, and thus plausibly increased the perceived effectiveness of state-level pro-creditor laws for protecting collateral claims to patents.

Moreover, the ruling re-emphasized that the Patent Act contains no language overruling the requirements of state law with respect to perfection of security interests. This was not a new finding, having been previously established in a 2001 case (*In re: Cybernetic Services*), but it provided additional weight to the finding, and this ruling is often cited along with *Cybernetic* in support of that doctrine.

Court documents indicate that the decision was made on May 30, 2003, but (unlike the other decisions) it was originally an unpublished decision. The decision subsequently became a reported one. Conversation with the district court indicated that they have no record of the date that this happened, but that the delay is typically a month. Therefore, I place the publication of the decision in July 2003.

### Case 3: *Joseph Braunstein v Gateway Management Services*

This decision was made on May 15, 2007 by the Bankruptcy Court for the District of Massachusetts. The issue was whether foreclosure on patents can be accomplished by filing notice with the Patent Office, without respecting the foreclosure-related requirements of state law. The patent-backed loan in this case was made in January 2003. In November 2004, the borrower defaulted on its loan payments. The lender notified the borrower and the USPTO that it was confiscating the patent collateral, and believed thereafter that the patents were its property. The borrower never responded, and subsequently it filed for bankruptcy in March 2005.

The court ruled that the lender did not legally own the patents, because the borrower had not explicitly agreed to settle the debt by signing them over, which was required under state property law. Moreover, the lender had neglected to file a financing statement with the secretary of state until within the preference period, so its security interest was unperfected. The filing with the Patent Office did nothing to perfect the security interest, since state law governs the perfection of security interests in patents, consistent with the previous case.

Finally, the lender argued that it had perfected its security interest by taking possession of the patents, even if this did not constitute ownership. Perfection can be accomplished by possession with some asset classes. However, the judge disallowed this too, because state law requires physical possession for perfection in this manner, and physical

[6] Kieff and Paredes (2004): "The more control the originator exerts over the IP SPE [...] the greater is the risk that a bankruptcy court will determine that the IP SPE is not bankruptcy remote and that the transferred IP assets are in fact part of the debtor's bankruptcy estate."

possession is impossible with intangible assets such as patents.

The ruling illustrates the challenges of creating a credible collateral claim against a patent portfolio. However, by repeatedly emphasizing the role of state law in reaching its conclusions, the ruling plausibly created a relative increase in perceived creditor rights to patents for companies incorporated in states with stronger creditor rights.

### Case 4: *Sky Technologies, LLC, v SAP AG and SAP America*

This decision was announced on August 20, 2009 by the Court of Appeals for the Third Circuit. The issue was whether a foreclosure on patents under state law is sufficient to transfer ownership, even when no notice of the transfer of ownership is filed with the Patent Office. A lower court had assumed that this was the case, but acknowledged that there was room for disagreement on the issue and invited appeal of the decision.

The dispute originated with an allegation of infringement brought by Sky Technologies against SAP. The defendants moved to dismiss on the basis that Sky did not have clear ownership of the patents involved. The patents were originally granted to TradeAccess Inc., a Massachusetts company, which later pledged them as collateral to Silicon Valley Bank (a bank specializing in patent-backed lending to high-tech firms) and to Cross Atlantic Capital Partners (a venture fund). The borrower subsequently defaulted and the lenders foreclosed on the patents, following the procedures outlined by the Massachusetts Uniform Commercial Code (staging and bidding at a public auction), but did not file transfer documents with the USPTO. Subsequently, the founder of TradeAcces started a new company, Sky Technologies, which acquired the patents from the lenders once more.

SAP and Oracle alleged that the lenders never truly acquired the patents in foreclosure because they had not notified the Patent Office of this transfer, and because the Patent Act requires a filing with the Patent Office for any assignment of a patent. The court applied a narrower understanding of the term "assignment," distinguishing them from transfers "by operation of law," of which it held that foreclosure was an example. In doing so, it reaffirmed the primacy of state law for determining property rights to patents.