Creditor rights and innovation: Evidence from patent collateral

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Abstract

Using novel data recording patents pledged as collateral, I show that strong creditor rights facilitate the financing of innovation. In the United States in 2013, 40% of patenting firms had pledged their patents as collateral at some point, and these firms performed 28% of R&D and 22% of patenting. Employing the random timing of court decisions as a source of exogenous variation in creditor rights, I show that patenting companies raised more debt financing when creditor rights to patents strengthened. Consequently, investment and patenting output also increased, as did the technological diversity of the patents produced.

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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 debt. Specifically, I ask whether stronger creditor rights encourage or discourage financing and investment for innovative firms. The answer is unclear: Strong creditor rights increase collateral value and thus financing capacity (Bester (1985)), but may discourage risk-taking by allocating more bargaining power to creditors in the event of financial distress (Berkovitch et al. (1998)).

The link between creditor rights and innovation is particularly important to understand because the collateral value of intangible assets is a growing source of financing for innovative firms. To document this fact, I construct a comprehensive, hand-collected dataset of patents pledged as collateral. 16% of domestic patents produced by US corporations since 1980 have been pledged as collateral at some point, and the companies pledging them performed 28% of R&D and 22% of patenting by Compustat companies in 2013. Patent collateral is particularly common in innovative industries such as pharmaceuticals and software, in which firms often have few tangible assets but many valuable patents. These findings run counter to the conventional wisdom that innovative firms lack access to collateral due to low tangibility. Instead, they suggest that the property rights granted by patents yield important financing capacity for innovative firms.

Building on this motivation, I study how the rights of secured creditors in default affect financing and investment by patenting firms. Secured creditors find it relatively difficult to enforce collateral claims against patents compared to other asset classes, so the legal system is effectively debtor-friendly for innovative firms (Amable et al. (2010), Stevens (2005)). I ask whether changing this situation would primarily serve, ex ante, to encourage corporate innovation, by increasing collateral value and financing capacity; or rather to discourage innovation, by weakening the bargaining power of equity claimants in the event of financial distress, thus reducing their incentives to invest in risky innovation in the first place.

Answering this question is challenging. Creditor rights are not randomly assigned across borrowers, but arise endogenously out of the legal and economic environment. I address

this challenge using the random timing of court decisions that clarified the legal status of patents in the United States. Specifically, the decisions elevated the importance of state over federal law for transactions involving patents. Some states provide stronger creditor rights than others, through laws that protect the bankruptcy-remoteness of collateral held in special entities, so the decisions represented a relative strengthening of creditor rights to patent collateral for borrowers incorporated in these states.

I first show that strengthened creditor rights increased borrowing by innovative firms. Treated firms – those experiencing a strengthening of secured creditor rights to patent collateral – increased their level of long-term debt by 1.9% of total assets on average in response to a decision, representing a roughly 10% increase in long-term debt relative to the initial sample mean of 18% of total assets. This finding suggests that lenders became more optimistic about the probability and speed with which they could foreclose on pledged patents in case of distress, which increased collateral value and financing capacity for patenting firms. In turn, firms were willing to draw on that increased capacity. While this may seem natural, it was not inevitable: One might expect that innovative firms avoid borrowing when secured creditors have stronger bargaining power over firm value in distress. Alternatively, one might expect no significant effect if patents simply are not valuable collateral. Instead, my findings demonstrate that stronger creditor rights primarily and significantly increased access to finance for innovative firms.

I next show that this increased borrowing translated into increased investment, as measured by the firm's spending on research and development expense (R&D) and selling, general, and administrative expense (SG&A). Treated firms increased their annualized combined spending on these categories by 3.5% of total assets, relative to an initial mean of 49%. Both R&D and SG&A include employee compensation and expenses related to producing and protecting intellectual property, and previous research has shown that they can be interpreted as investments yielding intangible assets (see, for example, Falato et al. (2013) and Eisfeldt and Papanikolau (2013)). My result thus demonstrates that increasing the collateral value of intangibles alleviates credit constraints for firms investing through these channels. Taken together, the effects on borrowing and investment demonstrate that, when lenders were more able to seize patent collateral in default, patenting firms used the marginal credit from the increased collateral value of their patents to finance investment, and not simply to adjust their capital structures. This effect outweighed any negative effects on risk-taking or

investment incentives.

I provide supporting evidence for the above conclusions by documenting heterogeneity in the treatment effects. All effects were stronger for small firms, and for firms that maintained consistently high levels of spending on R&D and SG&A. These subsamples represent the firms that were most likely to benefit from the increased collateral value of intangible assets: Small firms are more reliant on collateral to provide financing capacity, and firms spending mainly on R&D and SG&A produce few tangible assets to employ as collateral. The concentration of effects in these subsamples thus corroborates the conclusion that the strengthening of creditor rights primarily served to foster the financing of investment by patenting firms. Additional results show that the economic effects are robust across the four decisions and across the major geographic regions in which sample firms are headquartered. This rules out concerns related to, for example, differential economic development across different regions of the country.

The increase in treated firms' investment led to a subsequent increase in innovation output, as measured by new patent applications filed with the Patent Office. Between 2001 and 2013, treated firms produced about 8% more ultimately-successful patent applications, an effect that was twice as large for small firms. The estimated magnitude is larger when reweighting patenting output to account for the right-truncation in patent application data. The new patents do not appear to have been low-impact, as the average number of citations received by treated firms' patents actually increased, though not significantly so. Interestingly, the newly-produced patents spanned more technology areas: The Herfindahl index of the firm's patenting across technology categories declined, suggesting that firms were able to pursue ideas that did not fit their existing focus, where lenders might otherwise have forced them to discard these ideas in the absence of downside protection provided by loan collateral. In sum, stronger creditor rights led to increased innovation output, not only in terms of quantity but also in terms of quality and diversity.

I next show that firms in treated states were increasingly likely to pledge their patents as collateral following the court decisions, consistent with the interpretation that the collateral value of those patents had increased. Finally, I explore an additional transmission mechanism connecting creditor rights with investment in innovation: the loosening of restrictive financial covenants that constrained firms' investment policies. When creditor rights strengthened, covenant structures loosened. As a result, the quarterly ex ante probability of violating a

loan covenant declined by roughly 2% (using the covenant strictness measure developed in Murfin (2012)). Borrowers and lenders appear to have traded off ex post and ex ante creditor rights: Collateral value substituted for the protection provided by tight covenants. Covenant violations are known to lead to reduced investment and R&D spending (Chava and Roberts (2008), Nini et al. (2009), Chava et al. (2015)), so a lower probability of violating a covenant represents real flexibility for the borrower's investment policy.

In this setting, then, the primary effect of strengthened creditor rights was to alleviate constraints on firms' financing and investment policies, allowing the funding of more and higher-quality innovative projects. These findings allay concerns that granting creditors superior bargaining power in financial distress leads to conservative investment policies ex ante. However, in contrast to my findings, several prior studies have found evidence consistent with these concerns: Acharya and Subramanian (2009), Acharya et al. (2011), and Seifert and Gonenc (2012) show that countries with stronger creditor rights exhibit less secured financing and investment by innovative firms. Their conclusions suggest that the optimal bankruptcy policy balances a desire to create credit for non-innovative industries against a desire to encourage risk-taking in innovative industries. In Section 4, I explain how differences in our institutional settings can reconcile our results, which has implications for the policy conclusions of this study.

The paper also contributes to a growing literature on collateral in innovative industries and for low-tangibility firms. Rampini and Viswanathan (2013) develop a model in which limited enforcement gives rise to collateral constraints, which in turn dictate the firm's capital structure. Amable et al. (2010) note the difficulty of enforcing a security interest against patents, and develop a model that suggests that this is an important constraint on aggregate innovation. My empirical evidence is consistent with both arguments. Loumioti (2012) uses Dealscan data to examine how asset redeployability and borrower reputation affect the use of intangible assets as collateral. I use Patent Office filings to introduce novel, comprehensive data on patent collateral, and I focus on the role of creditor rights in its effectiveness. Falato et al. (2013) and Brown et al. (2009) show that investment by research-intensive firms relies heavily on cash holdings and equity financing. My paper documents the increasing capacity of patent-backed debt to support innovation investment.

The paper is organized as follows: Section 1 describes the data sources employed and uses them to offer some motivating stylized facts. Section 2 explains the identification strategy

and the sample used in the analysis. Section 3 presents and discusses the results. Section 4 interprets the findings in the context of previous studies, and Section 5 concludes.

1 Data

I begin by constructing a novel dataset listing patents pledged as collateral in the United States since 1976. When a lender accepts a patent as collateral, it generally files a notice of that fact with the United States Patent and Trademark Office (USPTO). This provides public notice of the security interest, so that a third party cannot purchase the patent and subsequently claim ignorance of the security interest. Filing with the USPTO signifies that the lender took particular care to safeguard its interest in the patents of the borrowing firm. These records have recently been published online 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 match all possible borrowers with Compustat by name. Details of this process are in Appendix C.1. I obtain quarterly Compustat data since 2000, restrict to companies headquartered in the United States (FIC code "USA"), and exclude companies in SIC industries starting with 0 (agriculture, forestry, and fishing), 6 (finance, insurance, and real estate), or 9 (public administration). This quarterly firm panel is converted to a monthly panel by copying level variables (such as assets and debt) for each month in the fiscal quarter and dividing flow variables (such as R&D expense) evenly over each month in the quarter. I remove the acquired (in-process) component of R&D (variable RDIP in Compustat). I correct for the fact that Compustat includes R&D as a component of SG&A expense by subtracting the former back out from the latter.

I next combine this dataset with monthly firm-level data on patent applications, grants, citations, and classifications. I begin with the patent data from the NBER Patent Data Project, which currently ends in 2006, and I extend it to the present using USPTO documents available online. Firm identifiers are assigned by string comparison of the patenting company with the existing NBER identifiers, and companies are then matched with Compustat using the linking file provided by the NBER, carrying the links as of 2006 forward to subsequent years. Further details are in Appendix C.2.

Finally, I obtain financial covenant ratios wherever possible from Dealscan, matching

to Compustat using the linking file from Chava and Roberts (2008). (I gather covenants data only through 2008, when these matches end.) I augment these observations with an automated search of SEC filings for sample firms. These data are used to construct the Murfin (2012) measure of covenant strictness, which captures the probability that a firm violates a covenant over the next three months. Details are in Appendix C.3. Strictness is carried forward for each firm until the next time its covenant structure is observed. I exclude strictness observations for companies that exit Compustat within the next five years, to avoid results driven by covenants imposed when the firm is deteriorating. (In my sample, covenant strictness is a strong predictor of exit within five years.)

I remove from the sample two companies, Igene Biotechnology and Northwest Biotherapeutics, that significantly alter the descriptive figures discussed in the next section due to extreme levels of the outcome variables. I also remove 21 sample companies that reclassify large amounts of convertible redeemable stock as long-term debt in Compustat during 2003 or 2004 with the enactment of SFAS 150, since it is impossible thereafter to distinguish the equity and debt components of long-term debt. Neither of these decisions significantly affects the results of the natural experiment. See Appendix C.4 for further discussion.

1.1 Stylized facts about patent collateral

I begin with three stylized facts about patent collateral that motivate the analysis:

The first stylized fact is that the frequency of patents being pledged as collateral is growing. Figure 1a traces the increase over time in the annual number of patents pledged, to over 40,000 patents per year in recent years. This increase is shared by all six major technology classes introduced by Hall et al. (2001). Restating this growth as a proportion instead of a frequency, Figure 1b shows that about 15% of patents from a given vintage are pledged as collateral within five years of being granted, a number that has also risen steadily over the past three decades. Given this dramatic growth in the use of patents as collateral, the lack of empirical evidence on the connection between secured creditor rights and investment by patenting firms is an important gap that I aim to fill.

Table 1 documents some characteristics of patents that are employed as collateral. The first column shows that they are highly-cited. This evidence is consistent with Chava et al. (2015), who show that firms with more highly-cited patents are able to raise more debt

financing, as well as Czarnitzki et al. (2014), who show that small firms gain access to finance after producing a patent. However, the Patent Office data will allow me to distinguish the *information* value of highly-cited patents (firms producing them are likely to have profitable projects) from their *collateral* value (the patents are likely to attract buyers if the firm fails, thus providing downside protection for lenders). The same column also shows that patents are more likely to be pledged when there are more firms patenting in the same field. This is consistent with previous studies emphasizing the importance of redeployability to collateral value (Benmelech and Bergman (2009), Loumioti (2012)). The final column in the table shows that publicly-owned companies are less likely to pledge their patents, presumably because they have relatively easier access to equity capital.

The second stylized fact is that patents themselves are important collateral, and are not merely an afterthought for firms that pledge all their assets. Figure 2 displays the top ten industries, identified by 3-digit SIC code, among Compustat-matched borrowers in the sample. These are low-tangibility, research-intensive industries in which patents are particularly important assets. (Brown et al. (2009) show that seven of these ten industries account for nearly all of the growth in aggregate US R&D since the early 1990s.) Thus, the patents pledged in these deals are likely to be the key collateral involved. On a more basic level, the simple fact that a lender bothers to notify the USPTO of the pledge of patents suggests that it attaches collateral value to those patents separately from other assets pledged, and individual cases cited in the Appendix A make this point anecdotally. Finally, the empirical strategy outlined in the next section will also demonstrate that 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 impact on firm behavior in response.

The third stylized fact is that the flow of credit from these deals is economically large and directly finances investment by patenting firms. In the aggregate, Figure 4 shows that the firms in question perform a major share of research investment and patenting. Table 2 shows that, among loans that can be matched to Dealscan, the median loan is worth 29% of the firm's total assets. Figure 5 restricts to the industries identified in Figure 2 and examines the within-firm dynamics of financing and investment around the date of a patent-backed loan. Panel (a) shows that long-term debt increases substantially when a firm pledges its patents: the annual flow of long-term debt issuance and retirement increase by 10% and 5%

of firm assets respectively, for a net increase of 5%. This is not substituted by an increase in cash holdings, which in fact decrease around the loan year. Moreover, investment increases around the loan date: Panel (b) of Figure 5 shows that annual R&D and SG&A expense are substantially above the firm's mean level in the loan year, by 4.4% and 3.3% of the firm's assets respectively.

The comovement between R&D and SG&A expense is striking, suggesting that both are important forms of investment by patenting firms. The runup in their levels prior to the loan date suggests also that patent-backed debt is particularly useful for projects that were financed by internal slack during the basic-research stage, but now have advanced and require investment at greater scale before their development option expires. On the other hand, there is little change around the loan date in capital expenditures, suggesting that companies investing primarily through capital expenditures are little affected by the collateral value of their intangible assets.

The existence of a market for patent-collateralized loans is puzzling from a theoretical perspective: Patents are difficult for lenders to value or sell; they support risky firms; and they are difficult to seize in default relative to more-tangible assets like real estate or inventory. All three of these constraints are commonly cited as reasons that secured debt is not a typical source of financing for innovative firms (Hall and Lerner (2010)). 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

My goal is to examine the effect of strengthened creditor rights on financing and investment by innovative firms. This effect is difficult to identify, because creditor rights are defined by laws that arise in response to complex and unobservable factors, making it difficult to claim causality in any observed association. For example, if companies in states with stronger creditor rights borrow more heavily against their patent collateral in the cross-section, this could reflect unobserved characteristics of those states that correlate with the decision to provide the stronger creditor rights in the first place.

The development of patent-related caselaw provides an empirical setting that addresses this identification concern. A series of court decisions has elevated the importance of state law over federal law with respect to contract and property rights for patents. Some states provide stronger creditor rights than others, via pro-creditor laws that facilitate foreclosure against collateral in default. Thus, when the court decisions increased the importance of state law for patents, they increased the perceived probability that the pro-creditor laws would apply to patents, so borrowers in states with these laws experienced a relative strengthening of creditor rights to patent collateral.[1]

My approach recognizes that creditor rights are defined not only by legislatures, but also by courts. The passage of pro-creditor laws in certain states was likely endogenous to the specific conditions of those states. In contrast, the events leading to the court decisions arose in response to idiosyncratic corporate circumstances. Thus, the court decisions are more plausibly exogenous than the actions of legislatures with respect to differences across states.[2] An ideal experiment would be a court decision that directly addresses the applicability to patents of the pro-creditor laws themselves. Because no such case has arisen, the decisions studied here represent the best guidance to date on the relative importance of state and federal law for lending against patents.

This section briefly describes the empirical approach: first, the court decisions that elevated the role of state law for patents; second, the laws that make some states more pro-creditor than others; and third, the sample construction and regression specifications.

2.1 Court decisions

The four decisions turned on distinct but related legal issues. Each held, for the issue at hand, that patent law was relatively narrow and did not override state law. In particular, the decisions affirmed the primacy of the Uniform Commercial Code (UCC), a body of law

[1] The relative importance of state and federal law for patents has been an uncertain and evolving issue because courts can rule that federal law (e.g., patent law) implicitly preempts state law in certain cases. This is a major source of uncertainty about the pledgeability of patents, which in turn is an important constraint on the growth of the patent-backed loan market (Amable et al. (2010), Young (2008), Stevens (2005), McJohn (2010)). Similar issues arise with other asset classes: Copyright law, for example, has been found to preempt state law quite broadly, contrasting the trend for patents (*In re Peregrine Entertainment*).

[2] Legal scholars also advocate a focus on the development of caselaw, rather than exclusively investigating legislative actions. For example, Catan and Kahan (2014) argue that caselaw regarding poison pills has been more important to takeover probabilities than widely-studied state antitakeover laws.

enacted at the state level, for transactions involving patents. (The pro-creditor state laws, described in the next section, were implemented as amendments to the UCC.) The decisions are summarized briefly here, with a more thorough discussion provided in Appendix D.

The first decision, dated March 26, 2002, concerned the bona fide purchaser defense, which is generally governed by the UCC but is also partially addressed by the Patent Act. The outcome of an earlier case had implied a bona fide purchaser defense for patents that was much broader than the UCC approach, suggesting a departure of patent law from state common law. This decision, on appeal, discarded that precedent, reversing the outcome of this case. The court emphasized the importance of the UCC, and in particular that of North Carolina (the relevant jurisdiction), in reaching its decision.

The second decision, dated May 30, 2003, included two separate findings that both limited the scope of federal patent law in preempting state law. First, the court held that a state UCC filing is sufficient to perfect a security interest in a patent, and USPTO filing is not required (adopting the position of the Ninth Circuit in a previous case). That is, the Patent Office's registry is not a replacement for state-level filing systems.[3] Second, the court rejected a novel argument that patent law implicitly redefines a limited sale as a license. The court's reasoning on both subjects echoes the previous case: despite their federal regulation, patents are not exceptional assets in property or contract law.

The third decision, dated May 15, 2007, included three relevant rulings. First, the court disallowed an attempt to foreclose against patent collateral through Patent Office documents that ignored certain requirements of California's UCC. Second, it held that a state UCC filing is necessary for perfection of a security interest, complementing the previous rulings that a state filing is sufficient. Third, it held, contrary to a creditor's argument, that Patent Office documents do not create the ability to perfect by possession (that is, by possession of the documents) that would obviate the UCC's requirement to register the security interest at all.

The fourth decision, dated August 20, 2009, further addressed foreclosure. A lender foreclosed on a patent portfolio through a bankruptcy auction, as required by Massachusetts's

[3] To perfect a security interest, the UCC requires a publicly-available filing with the Secretary of State for the state in which the collateral is located. An unperfected security interest is avoidable by the estate in bankruptcy. However, certain asset classes are exceptions to the UCC rules due to conflicting federal laws: For copyrights, a security interest is properly perfected by filing with the federal Copyright Office, and similar issues arise with railroads and aircraft.

UCC. The validity of the lender's title was later challenged because it had not filed a transfer statement with the USPTO. The court held that foreclosure under the UCC and the assignment system created by the Patent Act are independent methods of transfering patents, with the validity of the former unaffected by the existence of the latter. The court also noted the public policy benefits of harmonizing patents with state property law, thus increasing their pledgeability.

2.2 Pro-creditor state laws

The court decisions represented a relative strengthening of creditor rights to patents for some companies due to a set of pro-creditor laws enacted in some states. These laws allow borrowers to "sell" collateral to a special-purpose entity, where, in bankruptcy, it will be deemed not property of the borrower, and thus not subject to the automatic stay (since the separate entity need not file for bankruptcy). They were enacted as amendments to the UCC, and are the only significant non-uniformity in states' secured lending law (Janger (2003)). Their language is remarkably blunt; the full text of Delaware's law is reproduced as Appendix E, and the wording varies little from state to state.

The autonomy provided by these laws does not exist in other states, where bankruptcy judges may rule that the sale of collateral is not a "true sale" but rather a disguised financing. The best-known case on true sale and securitization, *Paloian v LaSalle*, illustrates the difficulty this creates: The "securitization" was a $25 million secured revolving loan, and the bankruptcy has gone through multiple hearings to date to determine whether the borrower successfully separated the collateral from its balance sheet. A 2013 opinion suggests that the pro-creditor laws could have aided the creditor (but they do not exist in Illinois, the relevant jurisdiction). With these laws present in certain states, the intuitive effect of the court decisions was to increase the expected speed and reliability with which secured lenders in those states could foreclose on patent collateral in bankruptcy.[4]

Table 3 lists the states that have passed the laws, along with the first full year in which each was in effect (the enactment date of each bill is not available). Anecdotal evidence

[4] Borrowers must opt in to this greater degree of creditor protection, but creditors can likely force borrowers to add this protection to their contracts as the firms near financial distress. In other words, under incomplete contracts, when stronger creditor rights are available, they are also effectively mandatory, a point made by the model of Berkovitch et al. (1998) among others.

suggests that the laws have not dramatically altered the securitization business (Lipson (2004)), but my paper is, to my knowledge, the first to study their effect. Patenting firms, the focus of my study, are plausibly more credit-constrained and likely to respond to such laws than the firms that account for the biggest securitization deals. Moreover, as suggested by Kieff and Paredes (2004), the laws may be particularly important for patent collateral, for which a lengthy bankruptcy proceeding is both likely and costly.

3 Natural experiment: Specifications and results

3.1 Specification and sample

I first investigate effects on long-term debt levels and investment within a two-year window around each court decision. A difference-in-difference specification for each event (court decision) involves restricting to a window around that date and regressing outcome variables on the firm-month panel, with firm and time fixed effects, and interaction terms to capture the treatment effects. I average the effects of the four events by running this regression in event time, similar to the approach taken in Gormley et al. (2013). My specification is thus:

$$\begin{aligned} y_{iskt} &= \gamma_{ik} + \delta \times \mathbb{1}\{post\}_{kt} \\ &\quad + \beta \times \mathbb{1}\{post\}_{kt} \times \mathbb{1}\{law\}_{sk} + \epsilon_{iskt} \end{aligned} \tag{1}$$

i indexes borrowers, $k \in \{1, 2, 3, 4\}$ indexes court decisions and their associated 48-month window, s indexes states, and $t \in \{0, 1\}$ indicates either before ($t = 0$) or after ($t = 1$) the court decision for a given window. γ_{ik} is a firm-event fixed effect, and δ is a post fixed effect, equal to one in months that follow the court decision for a given event window.

β, 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 enacted the pro-creditor law at that time (law). β thus captures the causal impact of strengthened creditor rights. Any confounding variation would have to involve a systematic change in the outcome variables for pro-creditor relative to other states around each of the decision dates, due to some factor other than the decisions themselves.

Because the treatment captured by β varies only at the level of the state of incorpora-

tion, all standard errors will be clustered at this level. This also addresses potential serial correlation in the residuals of the specification. Clustering by state of headquarters, firm, or firm-event does not qualitatively change the results.

To implement this specification, I isolate an event window extending 24 months before and after each court decision date. The sample in each window consists of firms that had received at least one patent in the ten previous years, and this cohort is fixed throughout the window. Between them, the four samples contain 3,008 unique firms, of which 72% are incorporated in states with pro-creditor laws, and are thus treated by the court decisions.[5] Table 5 presents a comparison of the treated and untreated companies across several financial variables, based on annual Compustat data from 2001, for the 2,055 companies already in the sample at the first event date. 74 sample firms are incorporated in states that enacted pro-creditor laws after the first decision date (Virginia, Nevada, and South Dakota). I drop them from any windows that would include their laws' enactment dates.

3.2 Debt financing

The first set of results demonstrates that firms increased their level of long-term debt in response to the strengthening of creditor rights to patent collateral represented by the court decisions. Table 6 summarizes the findings:

Columns (1) through (3) show that the average treatment effect of the four events (the estimate of β from Specification 1) was an increase in long-term debt equal to roughly 1.9% of total assets, relative to a mean of 18% at the start of the first event window, for an increase of over 10%. In Column (1), the specification is performed without firm fixed effects. Column (2) and all subsequent columns add them, with little change in the coefficient of interest. Columns (2) and (3) also show that clustering by state of location instead of state of incorporation makes no difference in the inference, as is also true for all subsequent results in the paper. These results are evidence of an increase in credit supply – lenders were more willing to provide credit to patenting firms when they were more confident in their ability to seize patent collateral in distress. Equally important, it is evidence that the managers of these firms were willing to take on leverage when it was available. The increased risk of

[5] The high fraction of treatment is due to Delaware's law, which also yields substantial variation in the physical location of treated companies. Appendix D explains why the state of incorporation is the relevant state for determining treatment status.

distress, and resulting potential loss of core assets or even liquidation, did not deter them from accessing their increased financing capacity.

Columns (4) and (5) explore heterogeneity in the sample to show where the treatment effect was concentrated. Column (4) interacts all explanatory variables with an indicator for the firm being "small," meaning that it had less than \$150m in total assets at the beginning of the event window (a definition maintained throughout the remainder of the paper). The estimated treatment effect for a firm in the small-firm subsample was an increase in long-term debt equal to 3.7% of the firm's total assets, twice the average effect across the whole sample and economically and statistically much larger than the effect for firms above the \$150m cutoff. Given that the mean value of total assets in the "small" subsample was \$50m, the cumulative effect in response to all four events for a small, treated firm is estimated at \$7.4 million marginal debt financing, compared to an average of \$5.5m in debt outstanding for this subsample as of 2001.

Column (5) explores another source of heterogeneity, the level of the firm's prior investment (combined R&D and SG&A as a fraction of total assets). Firms that maintained consistently high levels of investment should be particularly responsive to fluctuations in the availability of external finance. Indeed, this seems to be the case: Treated sample firms that were in the top decile of investment during the two years prior to a court decision increased their long-term debt level by 7.8% of total assets in response to the decision, much larger than the effect for the overall sample. This result suggests that the marginal credit supply was important for financing investment and was not simply accessed to hold additional cash. The results in the next section will test this prediction explicitly.

Finally, it is important to demonstrate that the treatment effect was localized around the event date, rather than capturing a differential trend developing between treated and untreated firms. Figure 6a demonstrates that this was the case. To construct the figure, I repeat Specification (1), but I replace the time indicators with a full set of quarterly dummies in event time. The resulting treatment effects, along with two-standard-error bands, are plotted in Figure 6a. Leading up to a court decision, debt levels followed the same path for both treated and untreated firms. Only afterward, over a period of roughly 12 months, did the treated subsample diverge, attaining a maximum of over 2% higher long-term debt as a fraction of total assets.

3.3 Investment

The previous section demonstrated that firms raised financing in response to a strengthening of creditor rights to patent collateral. This section shows that the marginal credit flowed to investment. Table 7 repeats the analysis from Table 6, with investment as the dependent variable (as before, investment means combined R&D and SG&A spending).

The average monthly effect on investment was 0.3% of the firm's total assets, for an annualized treatment effect of 3.6% of total assets. As before, Column (2) demonstrates the effect was concentrated in the smallest half of the sample, so that the average treated firm starting with $150m or less in total assets increased investment by $4.3 million in response to one of the four events on average, or $17.2 million cumulatively. Moreover, Column (3) shows again that the effect was significantly larger for firms in the top decile of investment prior to the treatment.

Columns (4) and (5) repeat this last specification, but separate out the two components of investment: Column (4) examines R&D spending, with an indicator for the firm being in the top decile of R&D, and Column (5) does the same for SG&A. The same general story holds in both cases: There was a positive treatment effect on both forms of investment throughout the sample, with a greater effect for firms that were in the top decile for that form of investment (although the differences are not statistically significant in these two columns). The effects on SG&A were generally stronger, although both were large: An average high-R&D firm increased its annual R&D spending by about 7.5% of total assets, and a high-SG&A firm increased annual SG&A by about 21% of total assets (although this last result is not statistically significant). For comparison, the average sample firm spent 13% and 37% of firm assets on R&D and SG&A respectively in 2001.

Finally, Figure 6b demonstrates, as was the case with long-term debt, that this treatment effect did not evolve as a differential trend between the two subsamples of firms. Leading up to the event date, there was no relative increase in treated firms' investment, but afterwards there was a gradual increase until their investment plateaued at a higher level. (One might also have been concerned that the effects in this and the previous section were driven more by the denominator of the outcome variables – total assets – than by their numerators. Figures 6a and 6b show that this was not the case, since the dynamics of the treatment effects are not closely correlated from month to month.)

Overall, the results so far provide compelling evidence that a strengthening of creditor

rights to patent collateral provided patenting firms with increased access to capital, which was then allocated towards increasing the scale of investment. These findings suggest that credit rationing is a more important factor than the bargaining power of creditors for the investment decisions of innovative firms: Even though the strengthening of creditor rights increased the bargaining power of creditors in default, potentially reducing the gains to residual claimants of any risky investments, sample firms were still increasingly likely to fund those investments, because they also had greater financing capacity thanks to increased patent collateral value.

To complete the narrative, I next demonstrate effects on several outcome variables that responded more gradually: the production of new patent applications, the creation of new collateral claims against patents, and the strictness of financial covenants written into the debt contracts backed by patent collateral.

3.4 Specification and sample for longer-horizon results

The remaining variables of interest are unlikely to respond strongly within the two-year window described above. For example, increased investment is not likely to yield new patents immediately after the strengthening of creditor rights. This makes estimating effects in event time problematic, since the long windows involved would overlap heavily. Instead, I construct treated and untreated cohorts in 2001 (before the first event date) and track them through to the present, calculating cumulative treatment effects β_y by year with the following specification:

$$y_{isy} = \gamma_i + \delta_y + \beta_y \times \mathbb{1}\{law\}_s + \epsilon_{isy} \tag{2}$$

Here, $\mathbb{1}\{law\}_s$ is an indicator for being incorporated in a state with a pro-creditor law as of January 2002. Year 2001 observations are absorbed into the firm fixed effect, and the year-specific coefficients β_y capture the cumulative treatment effect on the outcome variable of interest. In estimating this regression, I drop the 74 sample firms incorporated in states that enacted laws after 2002.

One concern with longer-horizon results is that firms may change their states of incorporation during the sample period. However, a scan of SEC filings for a random subset of

sample firms does not turn any examples of this occurring. The more fundamental drawback, but ultimately an unavoidable one, is that I can only use one long time series in this set of results, rather than identifying high-frequency effects of the four separate events as before.

3.5 Patenting output

The preceding results have shown that a strengthening of creditor rights to patent collateral increased access to finance and investment in R&D for patenting firms. This section shows that, in turn, small patenting firms also increased the volume and diversity of their output of new patent applications.

I measure the cumulative number of ultimately-successful patent applications filed by each sample firm from 2001 through each subsequent month.[6] New patent applications are timed to the month that they are received by the USPTO. In Table 8, I regress cumulative applications on year indicators and interactions with treatment status as in Specification (2). To address the well-known issues with overdispersion in patenting data (the outsized influence of a relatively small number of firms that file tremendous numbers of patents), I measure cumulative patenting in logs in Columns (1) and (2).

Column (1) demonstrates that firms incorporated in pro-creditor states exhibited an increase in patenting activity relative to untreated firms, reaching an 8% differential by 2013. However, the effect is statistically insignificant across the full sample. Column (2) shows that the effect is twice as large, and now highly significant, for firms with less than $150m in total assets, the same cutoff used in the prior tables. By 2013, these firms had produced 15% more patents than untreated firms. Small firms in the sample produced 34 patents on average from 2001-2013 (conditional on producing at least one), so the treatment effect corresponds with an additional 5 applications filed by treated firms.

As an alternative to the log transformation, in Column (3) I scale cumulative patenting by the firm's prior patenting activity, measured as the number of patent grants received in the ten years to 2001. This measure addresses the overdispersion issue by scaling naturally with firm size (where size is proxied by patenting volume), analogous to the way financial variables are commonly scaled by book assets or sales. Where the log transformation required

[6] Patents are typically held by the inventor until granted by the USPTO, at which point they are transferred to the corporation. Therefore, it is difficult to measure unsuccessful patent applications at the firm level.

dropping firms that did not patent from 2001-2013, this requires dropping those that did not patent from 1991-2000. Finally, in Column (4), I simply use the raw number of applications as the outcome variable, ignoring concerns about skewness in the patenting data. However, in this column I still drop firms that did not patent from 1991-2000 to avoid the influence of the large number of firms that never patent at all.

The three approaches yield comparable results: Column (3) reports an effect of 1.468 new applications per prior patent. The average small firm in the sample produced 3.72 patents from 1991-2000, so the estimated marginal output is 5.46 new patents. Column (4) yields an OLS estimate of 6.3 marginal patents produced by 2013 among treated firms relative to untreated firms. Altogether, the treatment effect is somewhere on the order of 5 to 6 patent applications per firm across all three approaches.

This estimate understates the true magnitude of the effect, because I cannot match patent applications with firms until they are granted by the USPTO. There is typically a delay of several years between the filing of the application and the granting of the patent. As a result, for recent years a large fraction of applications from both treated and untreated firms is unobserved, mechanically biasing the treatment coefficient towards zero. Indeed, the estimated treatment effect in Column (4) actually declines during the last few sample years. This problem is identical to the widely-recognized right-truncation problem with patent citations (see Hall et al. (2001)).

As a simple way to address this issue, I calculate for each vintage the ratio of aggregate applications to applications that have since been granted, using the statistics published by the USPTO. This ratio hovers around 2 in the 1980s and 1990s, then climbs steadily to 10 by 2011 and 22 by 2012. I divide this ratio by the historical average of 2, thus obtaining an imputed ratio for each vintage of eventually-successful applications to already-successful applications, and assume that this aggregate ratio also holds for each firm. One way to microfound this approach is to assume that every patent follows the same stochastic approval process after being filed with the USPTO. When I multiply the patent application counts by this inflation factor and repeat the specification from Column (4), the estimated cumulative treatment effect rises to 7.5 applications by 2012 and is increasing throughout the sample period. Figure 7 shows the evolution of this treatment effect over time (comparing just the sample means of treated and untreated firms).

Column (5) demonstrates that treated firms not only filed more patents, but also filed

patents in more technology areas. "Technology areas" refers to the 37 patenting technology subcategories developed in Hall et al. (2001). For the subsample of small firms, I calculate the Herfindahl index each year of the firm's entire patent stock across these technology areas. Conditional on filing patents in a given month, this value declines by more than .02 by 2013. For context, the mean and median Herfindahl index at 2001 were both roughly 0.5 for small firms, suggesting that they split their prior patenting output evenly between two categories. These firms filed 34 patents on average from 2001-2013 (conditional on filing one). If this was also their patenting volume from 1991-2000, and if two of the new patents were in a technology category that was new to the firm, then the Herfindahl index of the firm's patenting would decline by roughly the amount estimated.

This finding is striking, because it suggests that not only the volume but also the type of innovation produced by patenting firms responded to a strengthening of creditor rights. A potential mechanism for this finding is that firms are better able to assume the risk of branching out into a new area when lenders have greater protection in bankruptcy, because lenders require less evidence of short-term financial strength. I will offer evidence on this mechanism in Section 3.7 when examining the strictness of financial covenants.[7]

Finally, a common concern with patenting studies is that not all patents are equally important. In this context, one might be concerned that firms produced meaningless patents simply to take advantage of the greater legal significance of intellectual property rights when creditor rights strengthened, hoping that lenders would accept the worthless new patents as collateral either through naivety or simply as a potential tool for litigation. To provide some evidence on this concern, in Column (6) the dependent variable is the average number of citations received by a firm's monthly patenting output within the next five years. Citations are a commonly-used proxy for the impact or social value of a patent, as they indicate that others are building on its contribution. Far from decreasing in impact, the patents produced by small firms seemed if anything to receive more citations, although the result is volatile and not statistically significant. (The right-truncation problem is even more severe for citation counts than it was for application counts, since not only the cited but also the citing patent

[7] This view assumes that patenting in a new area increases both risk and return for the patenting firm. One might instead believe that patenting diversity reflects a desire to *decrease* firm risk by diversifying cash flows across fields. However, patenting in a new area requires significant upfront investment, delay, and uncertainty before any diversification benefits would be realized. This means that the decision to branch out carries more risk than focusing on existing business, not less.

must be published before the citation can be observed.)

A related concern is that firms were not actually producing valuable innovation in greater volume, but rather were more likely to label a given valuable idea with a patent application (instead of leaving it as a trade secret, for example). This likely accounts for at least part of the treatment effect on patenting output. However, it is unlikely to account for all of it, for two reasons. First, the full treatment effect appeared gradually. If the only consequence of the decisions was an increased incentive to label ideas with patents, that incentive increased discretely at each event date and should not have required years to manifest fully. Second, the previous section showed that investment also increased in response to the greater collateral value of patents. It seems likely that the gradual growth in patenting output was driven largely by this increased investment.

3.6 Use of patents as collateral

The previous sections have demonstrated that patents became more effective collateral when they were more pledgeable, allowing patenting firms to raise more debt financing, invest the proceeds, and ultimately produce more patents. This section will demonstrate a natural corollary: Firms that had not previously pledged their patents as collateral were increasingly likely to do so in response to their increased pledgeability.

To demonstrate this, the outcome variable in this section is an indicator for whether a firm has ever been observed to pledge its patents as collateral. The growth of this variable over time reflects firms "entering" the patent-backed loan market by pledging their patents as collateral for the first time. Columns (1) and (2) of Table 9 report regressions similar to the previous section on patenting output, but with this "has pledged" indicator as the outcome variable. The main effects of each successive year in Column (1) capture the aggregate growth of patent collateral depicted by Figure 4. However, the trend was more pronounced for treated than untreated firms, as captured by the interaction coefficients. As with the patenting outcomes, this effect was larger among small firms, as is demonstrated by Column (2). By 2013, small, treated firms were 3.8% more likely to have pledged their patents as collateral than untreated firms.

3.7 Covenant strictness

In this section, I demonstrate that the financing effects of creditor rights involved not only the presence and amount of credit, but also its terms. In particular, I examine the restrictiveness of financial covenants written into the debt contracts of patenting firms.

Columns (3) through (5) of Table 9 report the results of regressions with covenant strictness as the outcome variable. Relatively few firms exhibit strictness values in multiple years, so these specifications are performed without firm fixed effects. Columns (4) and (5) add fixed effects for state of incorporation and state of location to account for as much unobserved heterogeneity as possible. All columns show that the strengthening of creditor rights had significant, negative effects on covenant strictness. The cumulative estimated effect by 2007 is about 2% in Column (3). This reflects a 2% decrease in the quarterly ex-ante probability of violating a covenant. For a sense of magnitude, the average quarterly probability of covenant violation in the sample is 17%. The result is summarized in Figure 8, which plots the mean observed strictness level for treated and untreated firms: Treated firms initially received stricter contracts, but this disparity disappeared after the first two events.

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. Nini et al. (2009) and Chava et al. (2015) 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 in Table 9 represented significantly increased investment flexibility for the firms in my sample.

(My results cannot disentangle how much of the decrease in covenant strictness was due to the increased collateral value of a given patent portfolio, and how much was due to the increased probability of its being pledged as collateral. Either of these channels is consistent with the interpretation offered here.)

3.8 Additional findings

Tables 11 and 12 show that the positive average effects on financing and investment were not simply isolated to one event, but rather resulted from four consistent, positive coefficients for the four events, although the relatively small cross-section at any one point in time prevents

each individual effect from being statistically significant. One might have expected that the second, third, and fourth decisions only served to reinforce, and thus should have weaker effects than, the first one. However, the a priori ranking of their magnitudes is not clear. As described in Section 2.1, the four were not redundant to each other, so each plausibly released new information.

Table 10 shows that the estimated effects on financing and investment were not restricted to firms in any particular geographic region. The table partitions firms by the first digit of the zip code of their corporate headquarters and estimates the treatment effects separately for each of these regions. This comparison is possible because treatment (that is, being subject to a pro-creditor state law on the date a court decision occurs) is based on the firm's state of incorporation, not its state of headquarters, and each geographic region includes some firms incorporated in treated states and some in untreated states. One observes economically meaningful effects across all the most common regions in the sample (although the small sample sizes involved mean the estimated effects are not always statistically significant). Thus, the findings of the paper are not driven by regional differences between treated and untreated firms.

4 Interpreting the findings

Previous empirical studies of creditor rights and innovation often 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.

One explanation for our disparate results may come from the institutional differences between the United States and the countries driving their results. Most notably, India 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 relatively weak to begin with. Furthermore, since one 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 (2014), 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 resulted in increased access to finance, as well as greater financial flexibility through loosened loan covenants. The mechanism for these effects was an increase in patent pledgeability, which made 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 invested more in research and subsequently produced more patents, and these new patents were highly-cited and spanned a wider range of technology categories.

My findings demonstrate that intangible collateral can have significant economic value. On the other hand, legal uncertainty about the status of patent collateral is a major issue for participants in this market. Clarification of legal issues led 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. The collateral value of patents should be taken into account in policy debates over the optimal strength of intellectual prop-

erty rights, since these assets would have no collateral value without those rights. Finally, as innovative firms increasingly gain access to collateralized financing, this could decrease their reliance on equity funding, potentially providing a channel for the financing of innovation that is not dependent on fluctuations in the availability of venture capital or the conditions of IPO markets.

References

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

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

Bruno Amable, Jean-Bernard Chatelain, and Kirsten Ralf. Patents as Collateral. *Journal of Economic Dynamics and Control*, 2010.

Cynthia A Baker, Richard M Newman, and Douglas M Rutherford. Uniform commercial code. In Jason H P Kravitt, editor, *Securitization of Financial Assets*. Wolters Kluwer, New York, 2013.

Efraim Benmelech and Nittai K. Bergman. Collateral Pricing. *Journal of Financial Economics*, 2009.

Elazar Berkovitch, Ronen Israel, and Jaime F. Zender. The Design of Bankruptcy Law: A Case for Management Bias in Bankruptcy Reorganization. *The Journal of Financial and Quantitative Analysis*, 1998.

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.

Emiliano Catan and Marcel Kahan. The law and finance of anti-takeover statutes. *NYU School of Law Working Paper*, 2014.

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, 2015.

Dirk Czarnitzki, Bronwyn Hall, and Hanna Hottenrott. Patents as Quality Signals? The Implications for Financing Constraints on R&D. *NBER Working Paper*, 2014.

Andrea Eisfeldt and Dimitris Papanikolau. Organization Capital and the Cross-Section of Expected Returns. *Journal of Finance*, 2013.

Antonio Falato, Dalida Kadyrzhanova, and Jae Sim. Rising Intangible Capital, Shrinking Debt Capacity, and the Corporate Savings Glut. Working paper, University of Maryland, 2013.

Llewellyn Joseph Gibbons. Stop Mucking Up Copyright Law: A Proposal for a Federal Common Law of Contract. *Rutgers Law Journal*, 2004.

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.

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.

Jonathan Lipson. Secrets and Liens: The End of Notice in Commercial Finance Law. *Emory Bankruptcy Developments Journal*, 2004.

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

Stephen McJohn. Top Tens in 2010: Patent and Trademark Cases. *Northwestern Journal of Technology and Intellectual Property*, 2010.

Peter Menell. Bankruptcy Treatment of Intellectual Property Assets: An Economic Analysis. *Berkeley Technology Law Journal*, 2007.

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, 2014.

Adriano Rampini and S. Viswanathan. Collateral and Capital Structure. *Journal of Financial Economics*, 2013.

Jerome Rosenstock. *Transferring Invention Rights: Effective and Enforceable Contracts.* Aspen Publishers, 2005.

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.

Ernest 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. 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.

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.

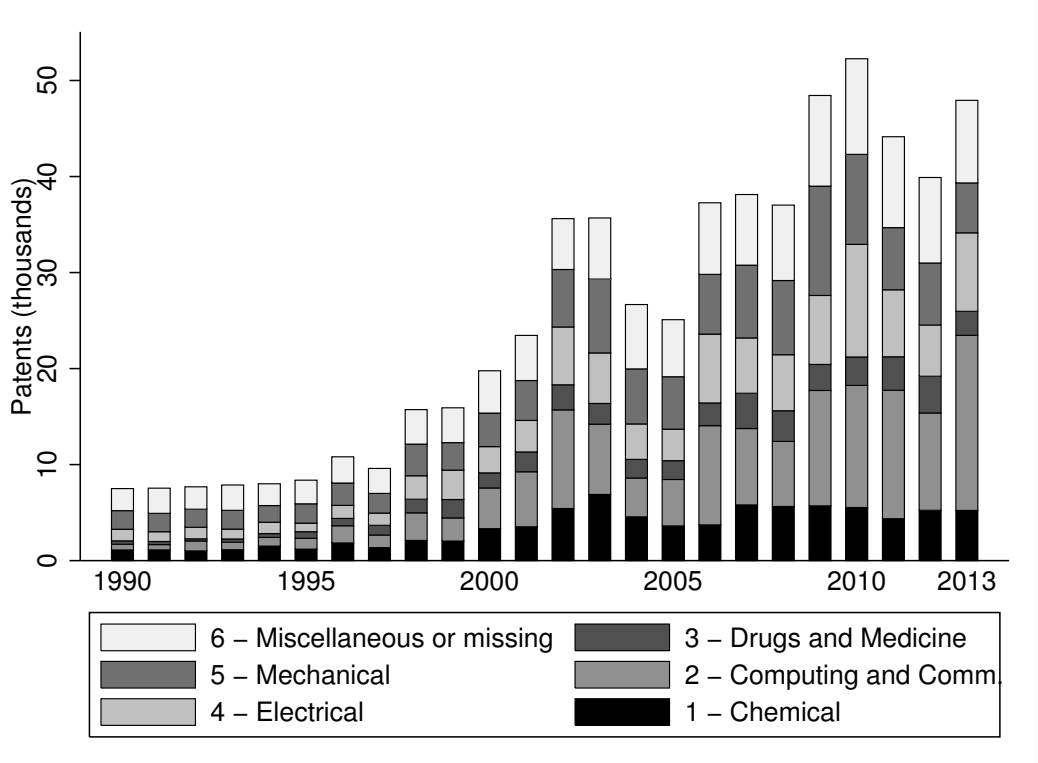
1. The following defined terms are hereby added to Section 1.1 of the Agreement:

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

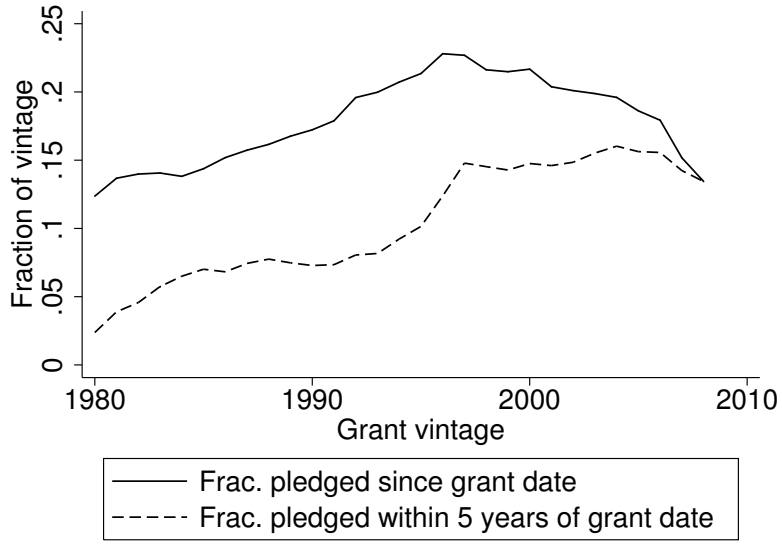
"Intellectual Property Collateral" means all of Borrower's right, title, and interest in and to the following:

(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, 1990-2013. The six patenting categories are taken from Hall et al. (2001).



(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.

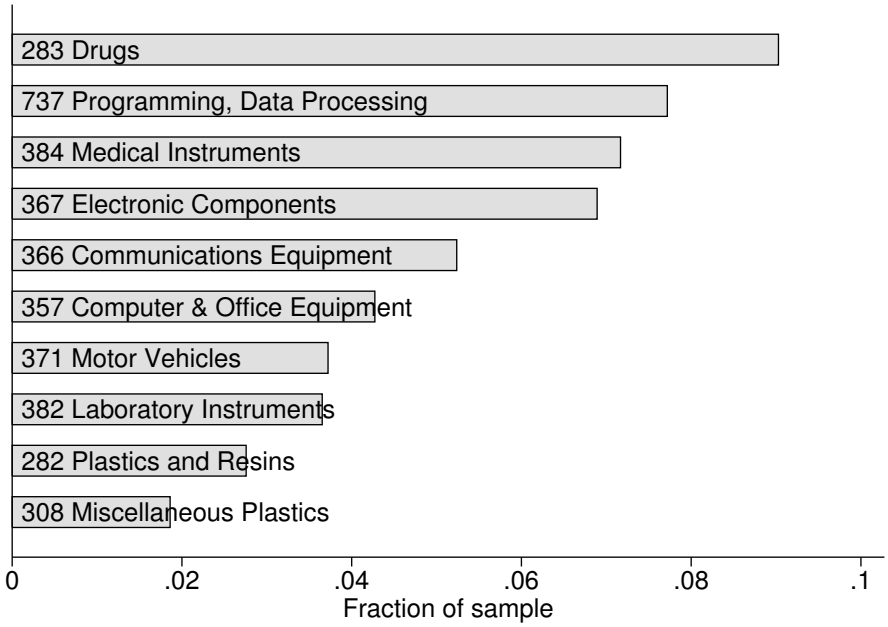


Figure 2: Top ten SIC industries of Compustat firms pledging patents as collateral since 2000. Brown et al. (2009) show that seven of these ten industries account for nearly all of the growth in aggregate R&D over the last twenty years.

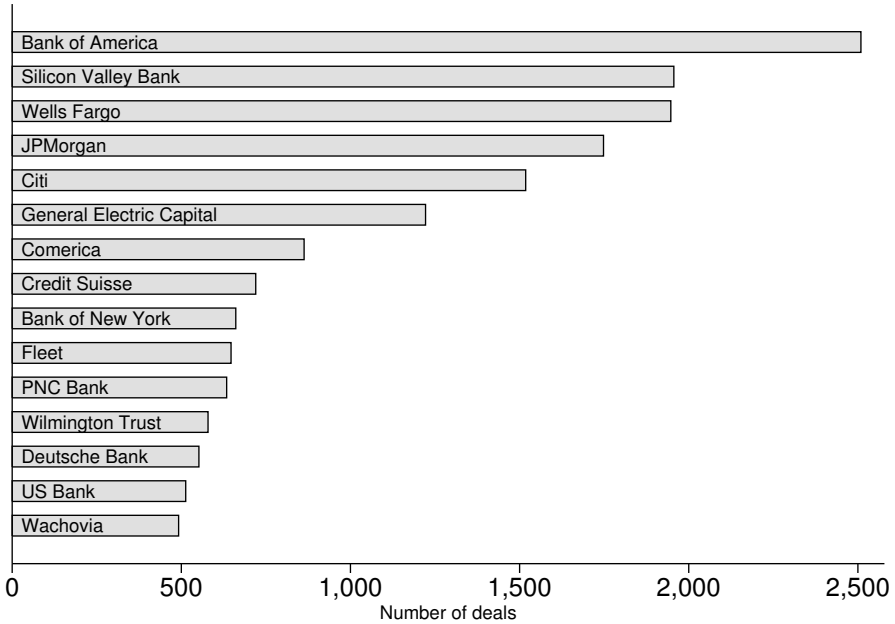
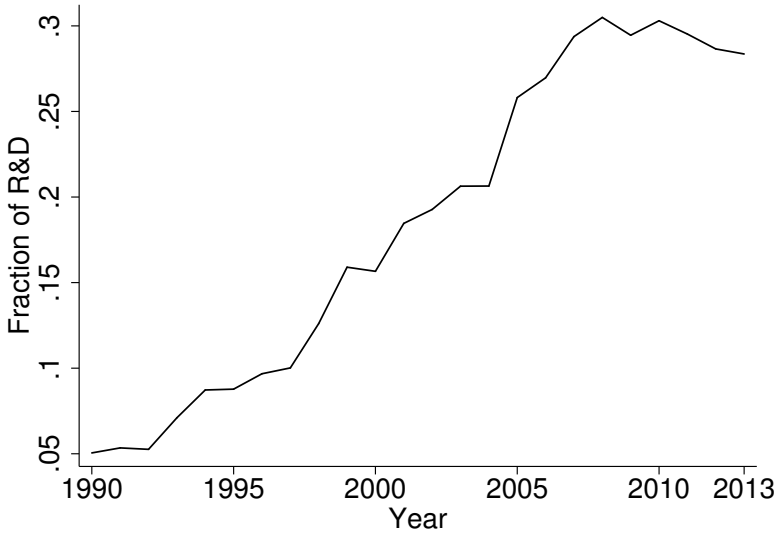
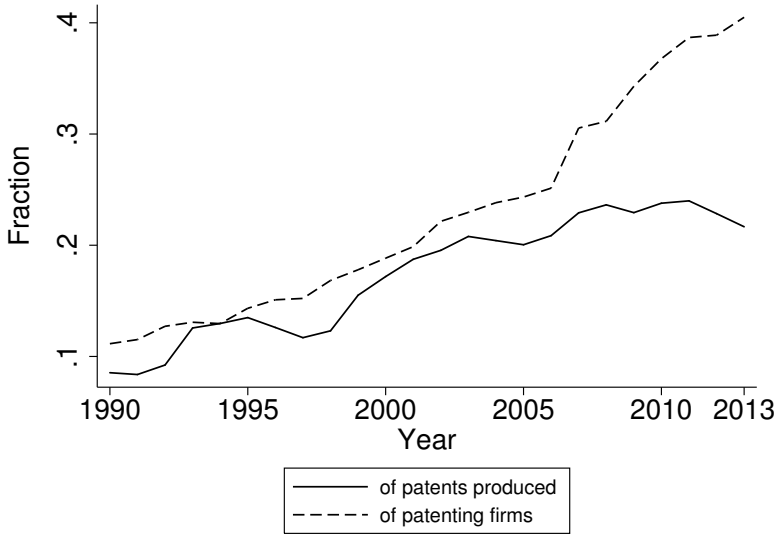


Figure 3: Top fifteen lenders against patent collateral, by total number of deals in the sample since 1976 (not restricted to Compustat borrowers). Note that the historical data includes several entities that no longer exist.

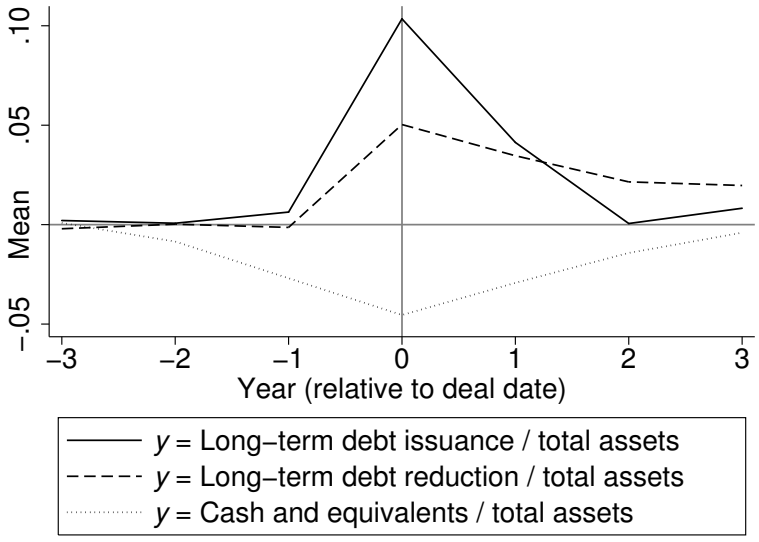


(a) Fraction of Compustat R&D performed by companies that have pledged their patents as collateral at some point in the past.

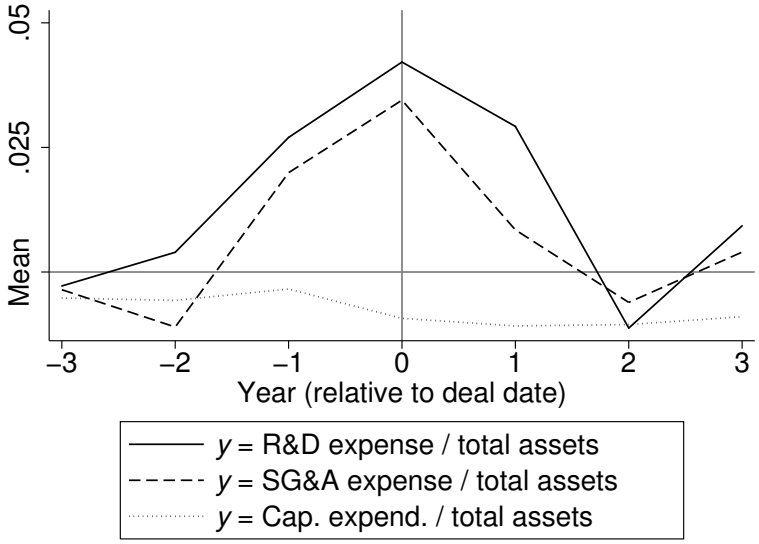


(b) Fraction of Compustat patenting performed by companies that have pledged their patents as collateral at some point in the past.

Figure 4: Importance of firms that borrow against patents to aggregate research investment and output.



(a) Financing activity. The outcome variables are Compustat items DLTIS (issuance of long-term debt), DLTR (reduction in long-term debt), and CHE (cash and short-term investments), each scaled by AT (total assets).



(b) Investment activity. The outcome variables are Compustat items XRD (research and development expense), XSGA (selling, general, and administrative expense), and CAPX (capital expenditures), all scaled by AT (total assets).

Figure 5: Dynamics of financing and investment around pledges of patent collateral. To construct each figure, I obtain annual Compustat data from 1980-2013 for the top ten SIC industries in which companies pledge patents as collateral (see Figure 2). The outcome variables in each panel are regressed on a firm fixed effect plus distributed lags of time to pledge events appearing in the USPTO data: $y_{it} = \alpha_i + \sum_{\tau=-3}^{3} \beta_\tau Pledge_{t-\tau} + \epsilon_{it}$. The figure plots the coefficients β_τ from this specification, so that "Mean" represents the firm-level mean in Compustat.

	(1) Pledge	(2) Pledge	(3) Pledge	(4) Pledge	(5) Pledge
Ln(Citations)	0.0137***				0.0127***
	(0.000289)				(0.000323)
Ln(Patenting firms)	0.0186***				0.00769***
	(0.000538)				(0.000566)
Originality		0.0138***			
		(0.00132)			
Generality			0.0461***		
			(0.00131)		
Technology area:					
Drugs/Med				*omitted*	*omitted*
Chemical				0.00489***	0.0248***
				(0.00147)	(0.00150)
Comp/Comm				0.0197***	0.0367***
				(0.00137)	(0.00139)
Electrical				0.00427***	0.0257***
				(0.00141)	(0.00142)
Mechanical				0.0706***	0.0827***
				(0.00149)	(0.00151)
Miscellanous				0.0580***	0.0627***
				(0.00148)	(0.00151)
Public company					-0.0577***
					(0.000735)
2012 - Grant Year					0.0110***
					(0.000197)
(2012 - Grant Year)^2					-0.000382***
					(0.00000573)
Constant	0.186***	0.187***	0.187***	0.161***	0.125***
	(0.000355)	(0.000355)	(0.000355)	(0.00117)	(0.00185)
Obs.	1206154	1206154	1206154	1206154	1206154
R^2	0.00285	0.0000912	0.00103	0.00453	0.0172

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 US patents granted from 1980 to 2012, and the outcome variable is an indicator for whether the patent has ever been pledged as collateral. *Ln(Patenting firms)* is the log number of distinct firms that have filed a patent in this patent's technology category *Public company* is an indicator for whether the firm that originally produced that patent can be matched with a Compustat firm. (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. The first four explanatory variables listed are demeaned.

Variable	Median	Mean	SD	N
Number of patents pledged	8.00	54.33	386.64	787
Deal amount (millions)	100.00	335.11	847.50	787
Maturity (years)	4.00	3.93	1.96	761
Firm total assets (millions)	347.69	2362.10	18502.91	748
Deal amount / firm assets	0.29	0.34	0.27	748
All-in drawn spread (bps)	250.00	274.01	137.56	556

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

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

Table 3: States and enactment dates of anti-recharacterization (pro-creditor) laws. Ohio and North Carolina passed similar laws, but restricted their applicability to FDIC-insured bank borrowers, so they are excluded from the treated group.

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 4: Court decisions used in my identification strategy.

	Untreated	Treated	$p-val$
Assets - Total	2897.26	2712.19	0.77
Sales/Turnover (Net)	2288.25	2010.27	0.51
Property, Plant and Equipment - Total (Net)	994.87	822.26	0.39
Total Debt	834.14	847.12	0.96
Long-Term Debt	669.70	664.11	0.98
Research and Development Expense	72.92	80.00	0.71
Capital Expenditures	148.41	154.45	0.88
Selling, General and Administrative Expense	431.36	326.31	0.11
Total Debt / Total Assets	0.26	0.26	0.88
Long-Term Debt / Total Assets	0.18	0.18	0.98
(R&D + SG&A) / Total Assets	0.50	0.49	0.82
R&D Expense / Total Assets	0.11	0.13	0.22
SG&A Expense / Total Assets	0.39	0.36	0.32
Number of firms	703	1353	

Table 5: Comparison of treated and untreated companies included in the natural experiment. Treated companies are those incorporated in states with pro-creditor laws. Financial data are from annual Compustat in January 2001. 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)	(2)	(3)	(4)	(5)
Treated	0.0172				
	(0.0138)				
After decision date	-0.00799*	-0.00766*	-0.00766**	-0.00998**	-0.00715**
	(0.00416)	(0.00415)	(0.00331)	(0.00376)	(0.00326)
Treated, after decision date	0.0189***	0.0189***	0.0189***	0.00525	0.0122*
	(0.00647)	(0.00654)	(0.00637)	(0.00386)	(0.00629)
Small, after decision date				0.00576	
				(0.00890)	
Treated, small, after				0.0320**	
				(0.0153)	
High-investment, after					-0.00630
					(0.0232)
Treated, high-investment, after					0.0656**
					(0.0256)
Firm FE	No	Yes	Yes	Yes	Yes
Cluster	State inc.	State loc.	State inc.	State inc.	State inc.
Obs.	333235	333235	333235	333235	333235

Standard errors in parentheses

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

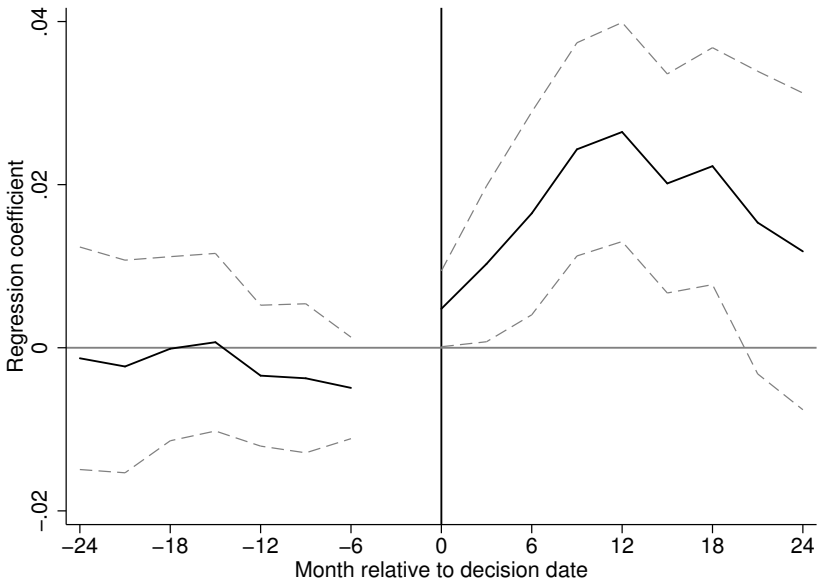
Table 6: Regression analysis of debt financing around the court decision dates. The coefficients are from Specification (1). The dependent variable is long-term debt scaled by total assets. "Small" is firms with $150m or less of total assets as of the beginning of the event window. "High-investment" is firms in the top decile of combined R&D and SG&A as a fraction of total assets as of two years before the event date.

	(1) Investment	(2) Investment	(3) Investment	(4) R&D	(5) SG&A
After decision date	-0.00188	-0.000192*	0.000499**	0.0000691	0.000684***
	(0.00117)	(0.000108)	(0.000211)	(0.000113)	(0.000191)
Treated, after decision date	0.00297**	0.0000590	0.00106***	0.000416***	0.000873**
	(0.00141)	(0.000110)	(0.000301)	(0.000116)	(0.000365)
Small, after decision date		-0.00419			
		(0.00263)			
Treated, small, after		0.00709**			
		(0.00317)			
High-investment, after			-0.0294**		
			(0.0127)		
Treated, high-investment, after			0.0249*		
			(0.0139)		
High-R&D, after				-0.0130***	
				(0.00333)	
Treated, high-R&D, after				0.00587*	
				(0.00337)	
High-SG&A, after					-0.0183*
					(0.0103)
Treated, high-SG&A, after					0.0170
					(0.0118)
Firm FE	Yes	Yes	Yes	Yes	Yes
Cluster	State inc.	State inc.	State inc.	State inc.	State inc.
Obs.	333235	333235	333235	333235	333235

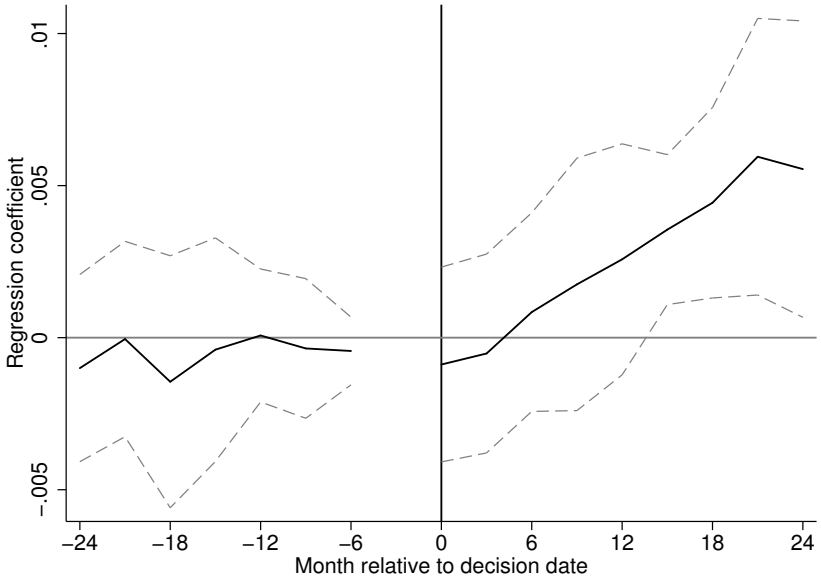
Standard errors in parentheses

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

Table 7: Regression analysis of investment by sample firms around the decision dates. The coefficients are from Specification (1). The Investment outcome variable is combined monthly R&D and SG&A expense. "Small" is firms with $150m or less of total assets as of the beginning of the event window. "High-investment" is firms in the top decile of combined R&D and SG&A as a fraction of total assets as of two years before the event date, and analogous definitions are used for the high-R&D and high-SG&A indicators. All outcome variables are scaled by the firm's total assets.



(a) The dependent variable is long-term debt as a fraction of total assets.



(b) The dependent variable is monthly investment (combined R&D and SG&A) as a fraction of firm total assets.

Figure 6: Average effects of the four court decisions, graphed in event time, where $t = 0$ is the date of the court decision. The specifications are as in Column (2) of Tables 6 and 7, but with a full set of quarterly event-time dummies included in place of the post-period indicator.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Apps)	Ln(Apps)	Apps/Patents	Apps	Herf.	Avg Cites
2002	0.847***	0.533***	0.271***	1.373***	-0.0120***	-0.522*
2003	1.273***	0.879***	0.575***	2.654***	-0.0252***	-1.285***
2004	1.523***	1.068***	0.848***	3.619***	-0.0387***	-2.179*
2005	1.695***	1.215***	1.103***	4.376***	-0.0484***	-2.214**
2006	1.804***	1.317***	1.250***	5.106***	-0.0494***	-3.993***
2007	1.903***	1.395***	1.352***	5.930***	-0.0547***	-5.421***
2008	1.986***	1.450***	1.326***	6.216***	-0.0608***	-6.962***
2009	2.058***	1.522***	1.343***	6.822***	-0.0666***	-6.619***
2010	2.115***	1.582***	1.477***	7.695***	-0.0723***	-7.667***
2011	2.160***	1.623***	1.538***	8.325***	-0.0740***	-8.623**
2012	2.192***	1.660***	1.591***	8.756***	-0.0762***	-10.87**
2013	2.203***	1.675***	1.710***	9.553***	-0.0788***	-6.359***
Treated, 2002	0.0178	0.0900**	0.167**	1.439***	-0.0115**	0.0508
Treated, 2003	0.00415	0.0969**	0.275	2.243***	-0.0158***	0.349
Treated, 2004	0.00749	0.132***	0.374	3.097***	-0.0167***	-0.0604
Treated, 2005	0.0126	0.143***	0.471	3.998***	-0.0224***	-0.627
Treated, 2006	0.0346	0.142**	0.591	4.804***	-0.0294***	0.0246
Treated, 2007	0.0427	0.148**	0.632*	5.388***	-0.0321***	1.419
Treated, 2008	0.0454	0.160**	0.794***	6.082***	-0.0285***	2.437
Treated, 2009	0.0573	0.151**	0.959***	6.179***	-0.0243**	1.711
Treated, 2010	0.0670	0.143**	1.131***	6.645***	-0.0219*	2.770
Treated, 2011	0.0730	0.146*	1.265***	6.961***	-0.0220*	3.905
Treated, 2012	0.0768	0.140*	1.396***	6.534***	-0.0242*	6.135
Treated, 2013	0.0775	0.139*	1.467***	6.347***	-0.0234	1.428
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	All	Small	Small	Small	Small	Small
Cluster	State inc.	State inc.	State inc.	State inc.	State inc.	State inc.
Obs.	208207	74530	74280	74280	107328	7319

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

Table 8: Long-run impact on treated firms' patenting output. The coefficients are from Specification (2), where the outcome variable is listed at the top of each column. "Apps" is the firm's cumulative number of patent applications since 2001, and "Patents" is the firm's stock of patents produced from 1991-2000. "Avg. Cites" is the average number of citations received by a cohort of patents filed in a given month. "Concentration" is the Herfindahl index of the firm's stock of patents produced across the two-digit technology subcategories identified in Hall et al. (2001). "Small" is the subset of firms with less than $150m in total assets.

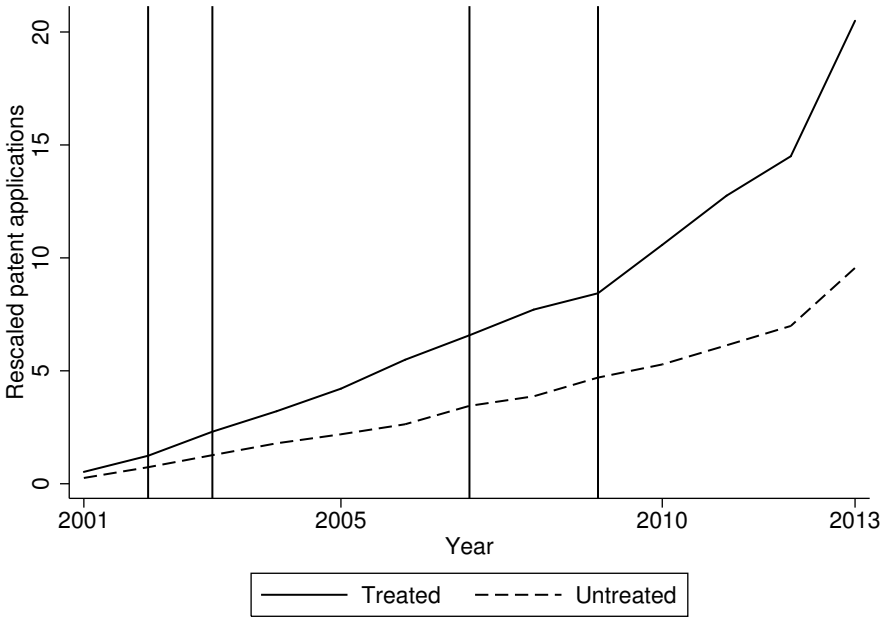


Figure 7: Patenting output for treated and untreated firms. Rescaled patent applications are firm-level cumulative counts of new patent applications filed with the Patent Office since 2001, multiplied by an inflation factor that takes into account the fraction of applications from each year that have yet to be granted (see discusion in Section 3.5). The figure plots the firm-level average of this variable for treated and untreated companies, with vertical lines showing the years of court decisions.

	(1)	(2)	(3)	(4)	(5)
	Has pledged	Has pledged	Strictness	Strictness	Strictness
2002	0.0141***	0.0112***	0.0157**	0.0152**	0.0152**
2003	0.0247***	0.0175***	0.0272***	0.0266***	0.0263***
2004	0.0304***	0.0218***	0.0307***	0.0302***	0.0293***
2005	0.0387***	0.0301***	0.0214**	0.0211**	0.0191**
2006	0.0453***	0.0366***	0.0158*	0.0154*	0.0136
2007	0.0541***	0.0402***	0.0128	0.0125	0.0105
2008	0.0619***	0.0454***	0.00672	0.00640	0.00404
2009	0.0697***	0.0429***			
2010	0.0797***	0.0489***			
2011	0.0808***	0.0549***			
2012	0.0833***	0.0603***			
2013	0.0881***	0.0632***			
Treated, 2002	-0.00156	-0.000541	-0.00995	-0.0100	-0.00949
Treated, 2003	-0.000446	0.00334	-0.0145*	-0.0147*	-0.0137*
Treated, 2004	0.00352	0.00820*	-0.0163**	-0.0176**	-0.0152*
Treated, 2005	0.00594	0.00940*	-0.0187**	-0.0203**	-0.0166*
Treated, 2006	0.00954	0.0101*	-0.0232**	-0.0246***	-0.0210**
Treated, 2007	0.0103	0.0150**	-0.0248***	-0.0260***	-0.0226**
Treated, 2008	0.0142*	0.0229**	-0.0205**	-0.0213**	-0.0179*
Treated, 2009	0.0150	0.0349***			
Treated, 2010	0.0119	0.0329***			
Treated, 2011	0.0175*	0.0332***			
Treated, 2012	0.0244**	0.0341***			
Treated, 2013	0.0264**	0.0387***			
Treated			0.0260***	0.0259**	
Intercept	0.0737***	0.0615***	0.151***	0.152***	0.169***
Fixed effect	Firm	Firm	None	State loc.	State inc.
Sample	All	Small	All	All	All
Cluster	State inc.	State inc.	State inc.	State inc.	State inc.
Obs.	602422	259321	127791	127791	127791

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

Table 9: Regression results on patent collateral usage and loan covenant strictness. The coefficients are from Specification (2), where the outcome variable is listed at the top of each column. In Columns 1 and 2, the outcome variable is an indicator for whether the firm has ever pledged its patents as collateral in the USPTO data. Column 2 restricts to firms that have less than $150m in total assets as of 2001. In Columns 3 through 5, the outcome variable is the covenant strictness measure developed in Murfin (2012). Columns 4 and 5 add fixed effects for state of headquarters and of incorporation, respectively.

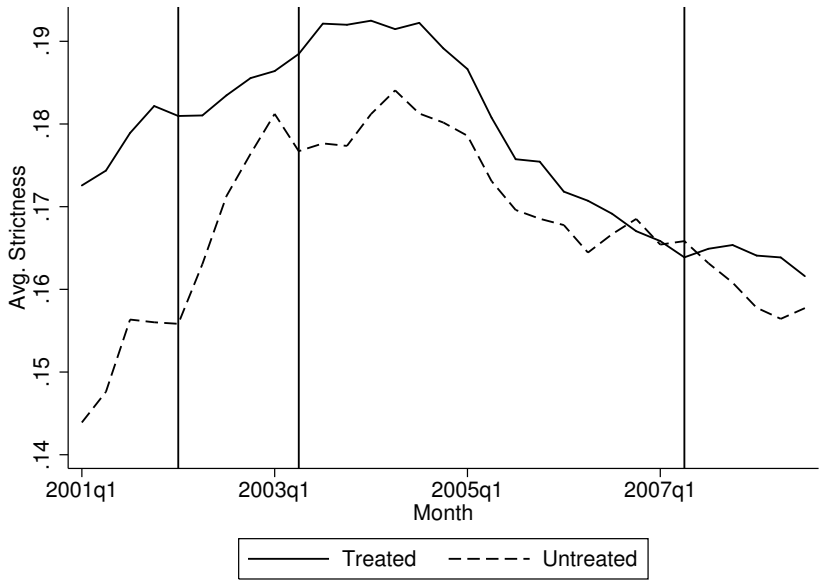


Figure 8: Average strictness of loan covenants in the treated and untreated samples. The initial disparity between the groups disappears after the first two decision dates, coinciding with both the increased use of patent collateral and the increased value of that collateral.

	(1)	(2)	(3)	(4)
After decision date	-0.0158**	-0.00944	0.00597	-0.0103
	(0.00654)	(0.0110)	(0.00572)	(0.00660)
Treated, after decision date	0.00755	0.0188*	0.0126*	0.0348
	(0.00728)	(0.0110)	(0.00667)	(0.0225)
Firm FE	Yes	Yes	Yes	Yes
Sample	Event 1	Event 2	Event 3	Event 4
Cluster	State inc.	State inc.	State inc.	State inc.
Obs.	84394	84708	86337	77796

Standard errors in parentheses

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

Table 11: Separate effects of each court decision on debt financing. The outcome variable is the firm's level of long-term debt divided by total assets.

	(1)	(2)	(3)	(4)
After decision date	-0.00268**	-0.00159	-0.00147	-0.00168
	(0.00128)	(0.00252)	(0.00102)	(0.00136)
Treated, after decision date	0.00107	0.00468*	0.00261	0.00337**
	(0.00128)	(0.00254)	(0.00295)	(0.00137)
Firm FE	Yes	Yes	Yes	Yes
Sample	Event 1	Event 2	Event 3	Event 4
Cluster	State inc.	State inc.	State inc.	State inc.
Obs.	84394	84708	86337	77796

Standard errors in parentheses

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

Table 12: Separate effects of each court decision on investment. The outcome variable is the sum of monthly R&D and SG&A expense, divided by total assets.

	(1)	(2)	(3)	(4)	(5)
After decision date	-0.00568	-0.0117	-0.0138***	0.00648	-0.0275
	(0.00487)	(0.0181)	(0.00234)	(0.0183)	(0.0170)
Treated, after decision date	0.0164***	0.0356*	0.0124***	0.0360	0.0345*
	(0.00520)	(0.0181)	(0.00275)	(0.0210)	(0.0172)
Firm FE	Yes	Yes	Yes	Yes	Yes
Sample	9 - CA,WA,OR	0 - MA,NJ,CT	1 - NY,PA,DE	8 - CO,AZ,UT	6 - IL,KS,MO
Cluster	State inc.	State inc.	State inc.	State inc.	State inc.
Obs.	88826	51674	38129	16330	22786

Standard errors in parentheses

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

(A) The outcome variable is long-term debt scaled by total assets.

	(1)	(2)	(3)	(4)	(5)
After decision date	-0.00370***	-0.00204	-0.00732	-0.00198*	-0.00370*
	(0.00125)	(0.00176)	(0.00853)	(0.000970)	(0.00206)
Treated, after decision date	0.00424***	0.00246	0.00882	0.00346**	0.00375*
	(0.00126)	(0.00176)	(0.00854)	(0.00159)	(0.00207)
Firm FE	Yes	Yes	Yes	Yes	Yes
Sample	9 - CA,WA,OR	0 - MA,NJ,CT	1 - NY,PA,DE	8 - CO,AZ,UT	6 - IL,KS,MO
Cluster	State inc.	State inc.	State inc.	State inc.	State inc.
Obs.	88826	51674	38129	16330	22786

Standard errors in parentheses

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

(B) The outcome variable is monthly investment (combined R&D and SG&A expense) scaled by total assets.

Table 10: Regression analysis of debt financing (Panel A) and monthly investment (Panel B) around the court decision dates, separately by the first digit of the zip code of the firm's state of headquarters, for the largest regions in the sample. For each one-digit zip code, the column lists the three most common states in the sample. The coefficients are from Specification (1).

C Data appendix

C.1 Patent collateral data

The Assignments dataset provides a patent number and date for each pledge of patents as collateral, as well as names of the secured party and the pledging firm. I match the latter to NBER firm identifiers, then use the NBER linking file to match these identifiers to Compustat, carrying forward the most recent set of matches to years since 2006.

Assigning the pledging companies to NBER identifiers is a complex task, as the name of the pledging company is often different from that of the original patenting company due to M&A activity, name changes, holding patents in subsidiaries or holding companies, or sales or other transfers of the patents. My approach is as follows: The Assignments data includes the entire chain of title to each patent, from its initial grant to the inventor, then its assignment to the patenting company, and subsequently through any future assignments and collateral pledges. At each point in this chain, I attempt to match the name of the current or new owner with a name listed in the NBER data. My name matching algorithm is described in Appendix C.2 below. Having performed this matching, for any pledge events that could not be matched manually, I refer to the most recent assignment or grant in that patent's chain and fill in the acquiring company from that event, if it was matched. If the previous assignment was not matched, I leave the identifier missing.

Even with this approach, problems can arise when a small company includes in its collateral portfolio limited rights to a patent that it is merely licensing from a larger corporation. For example, in August 2002, Matrics Inc pledged nine patents that it owned to Comerica Bank, but also included patent number 6198937, owned by Motorola. To avoid coding Motorola as a patent pledger in this case, I require a firm to pledge at least 2% of its existing patent stock in order to record a pledge event (patents are usually pledged in bundles, and most often as entire portfolios). This procedure leaves me with 2,208 firm-events of Compustat firms pledging patents as collateral since 1990. This approach guarantees accuracy, but at the cost of screening out over half of firm-months that appear to pledge patents, resulting in conservative estimates of the prevalence of patenting activity.

C.2 Patenting by firms since 2006

The Google Patents data contain both granted patents and pending applications, but the company producing the patent cannot be observed until the patent is granted, at which point the inventor transfers it to the corporation. Thus, I restrict to patents that have actually been granted by the Patent Office, and I manually match the company name to a list of all NBER firm identifiers for US-headquartered companies that have been assigned at least five patents as of year-end 2006 (this restriction is necessary to keep the processing time manageable).

To match the company names, I take the first 30 characters of each name, eliminate some of the most common corporate words, and calculate a distance between two company names by sequentially calculating the commonly-used Levenshtein distance between each word in the two names, dividing each distance by the maximum length of the two words (so that the penalty is per fraction of letters wrong, not number) and then dividing again by the square of the word's position in the company name (so that it is relatively more important to match the first few words of a company's name).

I am able to match 59% of domestic corporate patents granted since 2007 with firm identifiers (for comparison, 76% of domestic corporate patents granted prior to 2007 are assigned firm identifiers in the NBER data), Extensive hand checking has turned up no mistaken matches. Figure 9 displays the fraction of patents reported by the USPTO that are accounted for in the NBER and in my data, dated by grant year in Panel (a) and by application year in Panel (b).

The data also include application dates, allowing me to time the applications by quarter, where most patent datasets contain only the application year. Finally, citation pairs are also available for all granted patents through the present, allowing me to construct the citation counts received by a patent within any horizon of its grant date.

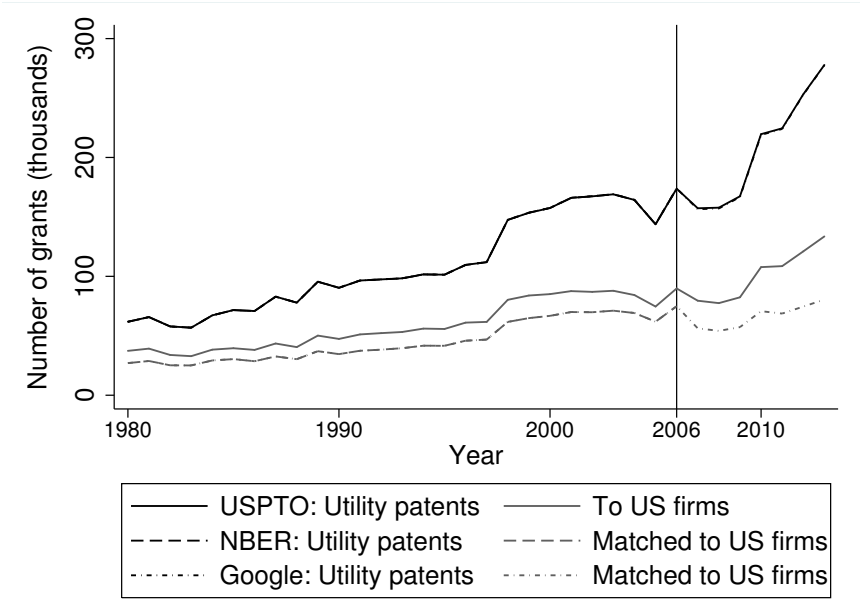
C.3 Covenant strictness

The covenants used in my analysis are: leverage ratio, fixed charges coverage ratio, current ratio, interest coverage ratio, debt service coverage ratio, debt ratio.

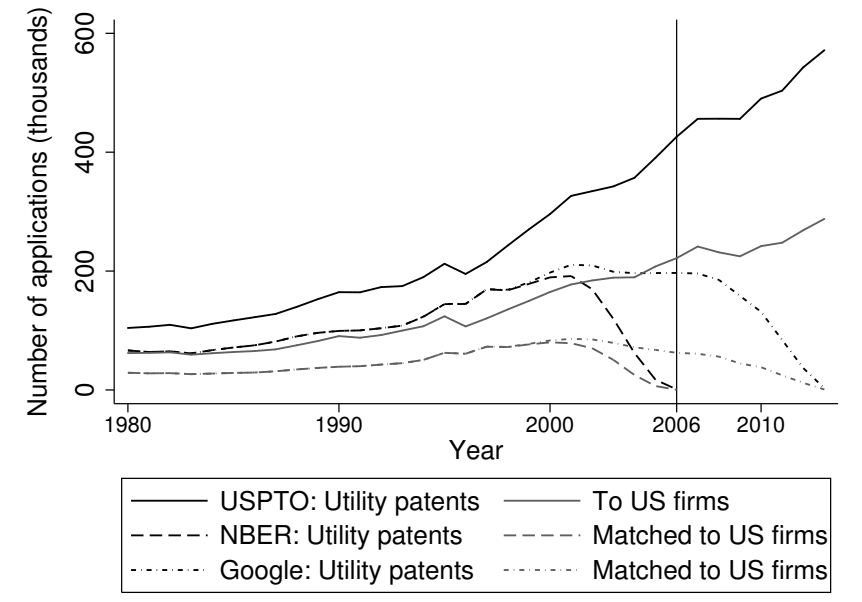
C.3.1 Performance measure definitions

I follow the definitions presented in Murfin (2012) for all variables. A few additional definitions are necessary:

> **Debt service**: the rolling four-quarter sum of quarterly interest expense and quarterly debt reduction (the first difference of dltry, or zero if this value is negative). Definition taken from the LSTA Handbook of Loan Syndications and Trading, page 304.
>
> **Debt service coverage ratio**: Ratio of rolling four-quarter sum of EBITDA to debt service. Definition taken from LSTA Handbook page 303.
>
> **Leverage ratio**: the ratio of total debt to total debt plus net worth. Taken from the most common definition encountered in a sample of loan documents.
>
> **Debt ratio**: Total debt over the rolling four-quarter sum of EBITDA. Definition taken from LSTA Handbook page 309.



(a) Timed by grant year.



(b) Timed by application year.

Figure 9: Summary of aggregate and firm-matched patenting data. Solid black lines are the total utility patent grants (Panel (a)) or applications (Panel (b)) reported by the USPTO. Lighter solid lines are the number from US companies only. Dashed lines are the aggregate figures from NBER data, which end in 2006, and dotted lines are the figures from the combined NBER and Google Patents data.

C.3.2 Leverage and debt ratio covenant definitions

The definitions of leverage ratio and debt ratio can vary across institutional settings. Checking observations individually suggests that Dealscan codes these two according to the content of the covenant, not its label, and maintains the definitions provided by the LSTA (in which a leverage ratio is the ratio of total liabilities to tangible net worth, while a debt ratio is the ratio of debt to the rolling sum of EBITDA). Meanwhile, extensive reading through the loan documents in the sample indicates that, in over 90% of observations, leverage ratio and debt ratio both refer to the LSTA's definition of a debt ratio. My approach is to take the Dealscan values to be consistent with the LSTA definitions, and then to code all observations of either covenant in the EDGAR data as an LSTA debt ratio (dropping 21 observations from the EDGAR data that list both a leverage and a debt ratio).

C.3.3 Other notes

The results reported in Murfin (2012) calculate the covariance matrices of changes in covenant levels separately for each year and for 1-digit SIC code. However, the paper notes that the results are little affected if the industries are pooled instead. For simplicity and to maximize the number of observations used to calculate each covariance matrix, I take the latter approach.

C.4 Compustat calculations

- **Total assets** = rolling eight-quarter average of **atq**
- **Long-term debt** = **dlttq**
  - SFAS 150, enacted during 2003, caused Compustat to reclassify redeemable preferred stock as long-term debt for some firms, leading to inconsistency in the definition of long-term debt across sample years. There seems to be no way to recover the non-stock portion of long-term debt for these firms thereafter. I drop any sample firms that, during calendar year 2003 or 2004, exhibit a positive amount of redeemable preferred stock in one quarter (**pstkrq**) that drops to zero in the next quarter, accompanied by an increase in long-term debt of an equal or greater amount (21 firms total).
- **R&D expense** = **xrdq** + **rdipq**
  - Variable **rdipq** is coded in Compustat as a negative number, so adding it to **xrdq** removes the acquired in-process component of R&D expenditure.

  - Additional observations on acquired in-process R&D are merged from annual Compustat and subtracted from the quarter with the largest R&D expense in the firm's fiscal year.
  - For firms that report R&D only at year-end, I divide year-end R&D evenly over all four quarters.

- **SG&A expense** = **xsgaq** - (**xrdq** + **rdipq**)
  - The final subtracted term is necessary because Compustat adjusts most companies' reported SG&A expense by adding in the value of R&D for the same period.

D Legal appendix

D.1 *Rhone-Poulenc Agro v DeKalb Genetics Corp.*

The first decision ("Rhone Poulenc II") was a reversal of two previous decisions ("Heidelberg Harris" and "Rhone Poulenc I"). The specific issue in all three was the bona fide purchaser defense, which for most assets is codified by state law (the Uniform Commercial Code, or UCC). An example of the bona fide purchaser defense is the following: Suppose party A owns a car, promises it to B, but then sells it to C, who is unaware of that promise. B cannot reclaim the car from C, because C is a "bona fide purchaser," unaware of any wrongdoing by Abe at the time of purchase.

In Heidelberg Harris, the defendant claimed that as a *licensee*, it was protected from a claim of patent infringement by the bona fide purchaser defense (arguing that it had "purchased" the right to use the patent, unaware that the licensor was acting fraudulently). The plaintiff never disputed that a licensee could make this argument, so the court allowed it. However, the argument was inconsistent with the approach of the UCC, which requires transfer of title for the bona fide purchaser defense to apply.

Rhone Poulenc I revisited this issue: The defendant here made the same argument and cited Heidelberg Harris. This time, the plaintiff challenged the idea that a mere licensee could claim the bona fide purchaser defense, but the court found itself bound by the Heidelberg Harris precedent, and thus forced to rule against the plaintiff. This court also articulated more clearly the implication of that precedent: the creation of a distinct, federal bona fide purchaser defense for patents, with an approach very different from that of the UCC. The decision quickly attracted commentary as an example of a growing trend towards federal law preempting state law (see Ziff (2002), especially footnote 28). However, the plaintiff filed an en banc appeal, allowing the court to set aside the precedent and reconsider the issue.

The appeals decision (the event that I employ) was delivered in Rhone Poulenc II. This time, the court rejected the argument that a patent licensee can claim the bona fide purchaser defense. It reasoned from the approach of the UCC, which traditionally requires a transfer

of title for this defense to apply, and emphasized repeatedly that North Carolina law makes this requirement explicit. (In contrast, the 2001 decision stated that "it was irrelevant if [North Carolina law] did not recognize such a defense.") The previous outcome was reversed and the plaintiff was able to sue for infringement.

In the bigger picture, the court signaled that patents should, as much as possible, be subject to the same property and contract law as other asset classes. The decision is often cited for the phrase "the interpretation of contracts for rights under patents is generally governed by state law" (see, for example, Gibbons (2004), Rosenstock (2005), and Young (2008)).

D.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 first held that patent law does not recharacterize limited or conditional transfers of patents as licenses instead of sales. It then held that state filing procedures are sufficient to perfect a security interest in a patent, and that the Patent Act was not intended to supersede these procedures.

The first of the two holdings arose because of a patent sale in which 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. Building on that case, the court held that patent law did not relabel this transaction as a sale.

This issue is particularly relevant for patent-backed lending, because transfers of collateral to an SPV also involve the retention of such patent rights, so that the original owner of the patents can continue to manage them. The retention of these rights increases the probability that the transfer of the collateral is not ultimately respected as a sale. The pro-creditor laws in certain states provide blanket protection against this outcome, and they are more likely to be effective for patents in light of this decision that patent law does not overrule them.[8]

The second ruling, concerning perfection of security interests in patents, adopted the position of the Ninth Circuit Court in a 1999 case. The two cases are generally cited alongside each other (see, for example, Menell (2007) and Baker et al. (2013)). Both cases contrast their conclusion with copyrights, for which the Copyright Act explicitly overrides state filing

[8]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." And later: "Notably, Delaware has attempted to mitigate the legal risk surrounding securitizations by adopting the 'Asset-Backed Securities Facilitation Act,' which, by characterizing what constitutes a true sale under Delaware law, attempts to shore up an SPE's standing as a bankruptcy-remote entity."

systems for perfection of security interests, and mention similar issues concerning railroads and airplanes.

D.3 *Joseph Braunstein v Gateway Management Services (In Re: Coldwave Systems, LLC)*

This decision was made on May 15, 2007 by the Bankruptcy Court for the District of Massachusetts. It first disallowed an attempt to foreclose on patent collateral via the Patent Office registry due to noncompliance with California UCC. It next held that a state filing is necessary for perfection of a security interest, even if the Patent Office is notified of that interest. It finally held that a security interest cannot be perfected simply by possession of Patent Office transfer statements, which would preclude the need for filing the interest at all.

The chain of events began when the borrower pledged its patents as collateral, then defaulted on its loan payments. The lender notified the borrower and the USPTO that it was confiscating the patents, and believed thereafter that the patents were its property. The borrower never responded, and subsequently it filed for bankruptcy. The court ruled that the lender did not legally own the patents, because the borrower had never explicitly agreed to settle the debt by relinquishing them, as is required under California UCC.

Next, the lender claimed that it had, at least, a perfected security interest in the patents, which should allow it to reclaim them even after the bankruptcy filing. As evidence, the lender showed that it had notified the Patent Office of its security interest at the time of the loan (but it did not file with the state). The court recognized that this case was a novel situation, the reverse of existing precedents in which the lenders had filed with the state but not with the USPTO. It followed the same logic to conclude that the Patent Office filing was ineffective for perfection: Patent law was not intended to replace state law with respect to commercial lending.

Finally, the lender argued that filing was unnecessary, because it had perfected its security interest by taking possession of the patents, as evidenced by the transfer statement it had filed with the Patent Office. The judge disallowed this too, reasoning that actual possession is impossible for an intangible asset, leaving state filing as the only method of perfection, and further elevating the perceived importance of state law for transactions involving patents.

McJohn (2010):

> Patent law is federal law. Commercial law is generally state law, governed by various states' adoption of the Uniform Commercial Code. Where the two bodies of law overlap, there can be uncertainty as to which governs [...] The creditor [in this case] creatively, if vainly, argued that it need not file, because it had possession of the patent certificate, just as a pawnshop perfects by possession of

the jewelry in its safe. *Coldwave* reflects a great uncertainty in the intersection between commercial law and intellectual property.

D.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 following UCC procedures was sufficient to transfer ownership, even though the transfer was not filed with the USPTO. A district court had assumed that this was the case, but acknowledged that there was room for disagreement on the issue, and certified an appeal, resulting in this decision.

The patents were originally granted to TradeAccess, a Massachusetts company which later changed its name to Ozro. Ozro pledged them to Silicon Valley Bank and to a venture fund. Ozro 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 they did not file transfer documents with the USPTO. Subsequently, the founder of TradeAccess started a new company, Sky Technologies, which acquired the patents from the lenders once more.

When Sky sued SAP for patent infringement, SAP alleged that the lenders had never truly acquired the patents in foreclosure because they had not notified the Patent Office. The Patent Act requires a filing with the Patent Office for any assignment of a patent. However, the court distinguished the "assignments" of the Patent Act from foreclosure in bankruptcy, holding that both were valid means of transfering title. Thus, patent law should imply no exceptions to the typical legal regime for secured lending.

This is perhaps the most direct of the four cases in articulating a state-law regime for secured lending involving patents. The court specifically mentioned policy desirability of its decision:

> First, if foreclosure on security interests secured by patent collateral could not transfer ownership to the secured creditor, a large number of patent titles presently subject to security interests may be invalidated. Any secured creditor who maintained an interest in patent collateral would be in danger of losing its rights in such collateral. Second, by restricting transfer of patent ownership only to assignments, the value of patents could significantly diminish because patent owners would be limited in their ability to use patents as collateral or pledged security.

See also McJohn (2010):

> Intellectual property is the subject of many finance transactions, from loans to joint ventures to securitization and beyond. The simple and clear approach taken by Sky Technologies (treating intellectual property like any collateral) will facilitate those transactions.

D.5 Other notes about the court decisions.

Such decisions are often the result of appeals, and are themselves appealed. I focus on the date of the final decision in the case, consistent with the dates used when these decisions are cited. That is, I ignore appeals that were not heard by the higher court.

All four decisions were from federal courts, not state courts (two by bankruptcy courts and two by the Federal Circuit court of appeals).

The delays between the triggering events and the ultimate decision ranged from three to five years, making it unlikely that the timing of the court decisions correlates with time-varying conditions affecting treated firms differently from untreated firms.

The state of incorporation, not the state of location, determines treatment status:

- Under Revised Article 9 of the Uniform Commercial Code (effective as of July 2001), the state law defining ownership of collateral in bankruptcy is the state in which the debtor is located, and the location of a corporate debtor is defined as its state of corporation.
- Under old Article 9, the relevant state was the state in which the collateral was located. Even then, courts typically located of intangible assets with the debtor's location, so the two regimes had the same effect for patent collateral.
- Loan parties can choose the state law governing some aspects of their contracts, but cannot choose the state law that governs ownership of collateral in bankruptcy. This was established in 1998 in *In re Eagle Enterprises* by the United States Bankruptcy Court for the Eastern District of Pennsylvania, and upheld on appeal by the district court the next year. The loan parties in this case had agreed to use German law to govern a loan secured by trucks located in Pennsylvania. (Germany has no automatic stay protection in bankruptcy, among other creditor-friendly provisions.) The court had no problem with the international aspect of the contract, but held that the ability to select governing laws could not extend to issues of ownership in bankruptcy. It reasoned that the bankruptcy estate, a separate entity from the loan parties themselves, would have been adversely affected by such an ability (which was of course the point), and it had not had the opportunity to object when the contract was signed (as it did not yet exist). Thus, loan parties are not allowed to contract around the provisions of their states' laws for the division of assets in bankruptcy. I thank Steve Weise for referring me to this decision.

D.6 Citations to court decisions

- **Rhone-Poulenc II**: *Rhone-Poulenc Agro v Dekalb Genetics*, decided by the United States Court of Appeals for the Federal Circuit, March 26, 2002 (en banc rehearing of Rhone-Poulenc I). Available online.
- **Pasteurized Eggs**: *In re Pasteurized Eggs Corporation*, decided by the United States Bankruptcy Court for the District of New Hampshire, May 30, 2003. Available online.
- **Coldwave Systems**: *In re Coldwave Systems LLC*, decided by the United States Bankruptcy Court for the District of Massachusetts, May 15, 2007. Available online.
- **Sky Tech**: *Sky Technologies, LLC v SAP AG and SAP America*, decided by the United States Court of Appeals for the Federal Circuit (on appeal from the United States District Court for the Eastern District of Texas), August 20, 2009. Available online.

E Delaware Asset-Backed Securities Facilitation Act

§ 2701A Title.

This chapter may be referred to as the "Asset-Backed Securities Facilitation Act."

§ 2702A Intent.

It is intended by the General Assembly that the term "securitization transaction" shall be construed broadly.

§ 2703A Securitization transaction.

(a) Notwithstanding any other provision of law, including, but not limited to, §9-506 of this title, "Debtor's right to redeem collateral," as said section existed prior to July 1, 2001, and §9-623 of the title, "Right to redeem collateral," which became effective July 1, 2001, to the extent set forth in the transaction documents relating to a securitization transaction:

(1) Any property, assets or rights purported to be transferred, in whole or in part, in the securitization transaction shall be deemed to be no longer be the property, assets or rights of the transferor;

(2) A transferor in the securitization transaction, its creditors or, in any insolvency proceeding with respect to the transferor or the transferor's property, a bankruptcy trustee, receiver, debtor, debtor in possession or similar person, to the extent the issue is governed by Delaware law, shall have no rights, legal

or equitable, whatsoever to reacquire, reclaim, recover, repudiate, disaffirm, redeem or recharacterize as property of the transferor any property, assets or rights purported to be transferred, in whole or in part, by the transferor; and

(3) In the event of a bankruptcy, receivership or other insolvency proceeding with respect to the transferor or the transferor's property, to the extent the issue is governed by Delaware law, such property, assets and rights shall not be deemed to be part of the transferor's property, assets, rights or estate.

(b) Nothing contained in this chapter shall be deemed to require any securitization transaction to be treated as a sale for federal or state tax purposes or to preclude the treatment of any securitization transaction as debt for federal or state tax purposes or to change any applicable laws relating to the perfection and priority of security or ownership interests of persons other than the transferor, hypothetical lien creditor or, in the event of a bankruptcy, receivership or other insolvency proceeding with respect to the transferor or its property, a bankruptcy trustee, receiver, debtor, debtor in possession or similar person.

It is not the purpose of this chapter to change the tax treatment of securitizations that take place pursuant to this chapter.