Bankruptcy Codes and Innovation[1]

Viral V. Acharya

London Business School, NYU-Stern & CEPR

Krishnamurthy Subramanian

Emory University

September 18, 2008

[1]We are grateful to Raghu Sundaram for numerous discussions since the early stage of the project, to an anonymous referee and Matt Spiegel (editor), to Mark Garmaise, Amir Sufi, Felix Oberholzer-Gee, Stefano Rossi, and Vikramaditya Khanna (discussants), and to Kenneth Ayotte, Gustavo Manso, Raghuram Rajan and Luigi Zingales, and seminar and conference participants at Annual Finance Association (AFA) Meetings 2008, Conference on Private and Public Resolution of Financial Distress at Institute of Advanced Studies, Vienna, Emory University, the Federal Reserve Board of Governors, London Business School, Mitsui Life Conference on Financing and Organizing the Firm at University of Michigan, the NBER Summer 2007 Institute on Law and Economics, Stanford University, the Summer Conference on Corporate Finance at the Indian School of Business, and U.C. Berkeley. We thank Bronwyn Hall, John Cantwell, and Grid Thoma for their detailed responses to our queries about the use of US patents to proxy international innovation, and Jon Haveman for sharing with us his SIC-ISIC concordance data. Rong Leng deserves our special thanks for her excellent research assistance. All errors remain our own. A part of this paper was completed while Viral Acharya was visiting Stanford GSB and employed full-time at London Business School. Contact author: Viral V. Acharya, New York University - Stern School of Business, 44 West 4 St., Room 9-84, New York, NY - 10012. Tel: +1 212 998 0354, Fax: +1 212 995 4256, e-mail: vacharya@stern.nyu.edu

Abstract

Bankruptcy Codes and Innovation

We argue that when bankruptcy code is creditor-friendly, excessive liquidations cause levered firms to shun innovation, whereas by promoting continuation upon failure, a debtor-friendly code induces greater innovation. We provide empirical support for this claim by employing patents as a proxy for innovation. Using time-series changes within a country and cross-country variation in creditor rights, we confirm that a creditor-friendly code leads to lower absolute level of innovation by firms as well as relatively lower innovation by firms in technologically innovative industries. When creditor rights are stronger, technologically innovative industries employ relatively less leverage and grow disproportionately slower.

JEL: G3, K2, O3, O4, O5.

Keywords: Creditor rights, R&D, Technological change, Law and finance, Entrepreneurship, Growth, Financial development.

Introduction

Existing empirical evidence indicates that legal institutions of an economy affect its financial organization and economic growth.[1] Less well understood, especially empirically, is whether legal institutions that govern financial contracts affect the nature of real investments in an economy. In this paper, we focus on one specific aspect of this overarching theme: Does the nature of bankruptcy code affect the extent of innovation in an economy?[2]

The effect of bankruptcy codes on real investments can be understood in the context of conflicts of interest arising between firmowners/equityholders and creditors at time of distress, as studied theoretically in a large body of literature starting with Gertner and Scharfstein (1991). Consider two polar cases of the bankruptcy code: First, the debtor-friendly code where equityholders retain all control rights in bankruptcy; and, second, the creditor-friendly code where all control rights are transferred to a firm's creditors. Also consider two technologies: innovative and conservative. In financial distress, the firm's existing investment may be inefficiently liquidated under the creditor-friendly code whereas it may be inefficiently continued under the debtor-friendly code. While this trade-off arises for both technologies, greater risk inherent in the innovative technology accentuates the deadweight costs arising from liquidation under the creditor-friendly code but mitigates the deadweight costs from continuation under the debtor-friendly code. Thus, a creditor-friendly code discourages ex-ante risk-taking and innovation relative to a debtor-friendly code.

Firms' investment decisions are also affected by their choice of the optimal financing mix. When the code becomes more creditor-friendly, firms unwind the inefficiencies arising from bankruptcy codes by optimally financing the innovative technology with disproportionately lower debt when compared to the conservative technology. However, there is a cost to lowering debt (for example, the foregoing of tax-shields or incentive benefits related to debt). Therefore, compared to the debtor-friendly code, under the creditor-friendly code, the firm value associated with the innovative technology is disproportionately lower than that associated with the conservative technology. We thus predict that aggregate innovation would be lower in countries where the bankruptcy code is more creditor-friendly. The mechanism for this effect yields the following difference-in-difference prediction: when the bankruptcy code becomes more creditor-friendly, the value of an optimally financed innovative firm reduces disproportionately more than that of an optimally financed conservative firm.

We provide evidence supporting this effect of bankruptcy codes on innovation using patents issued by the USPTO to US and foreign firms from 1978 to 2002, and citations to these patents, as constructed by Hall, Jaffe and Trajtenberg (2001). The "industry" level classification we employ pertains to the patent classes in this data. We measure innovation for an industry in a given year by the number of patents applied for in that year (and subsequently granted) in that industry, the number of all subsequent citations to these patents, and the number of firms filing for patents in that industry.[3] We use Djankov, McLiesh and Shleifer (2007) for information on country-level creditor rights index[4] and its within-country change.

We follow a two-fold empirical strategy. First, since creditor rights are likely to be correlated with other country level unobserved factors, we exploit country level *exogenous* changes in creditor rights to conduct difference-in-difference tests of the causal effect of creditor rights on innovation. Second, to highlight the causal mechanism, we test in the pooled cross-section whether a higher creditor rights index for a country is associated with relatively lower innovation in industries that have a higher propensity to innovate. We also use the exogenous creditor rights changes to confirm the relative effect obtained in the cross-sectional tests. To conduct these cross-sectional and time-series tests of the causal mechanism, we follow the methodology introduced by Rajan and Zingales (1998) and rank patent classes by their patenting intensity in the US.[5] Except for this ranking of industries, we exclude the patents filed by the US firms from all other analysis.

In our difference-in-difference tests, we find strong evidence that strengthening of creditor rights lowers innovation. Compared to the "control" group of counties that did not undergo a creditor rights change, the "treatment" group of countries that underwent a creditor rights increase (decrease) generated 9.7% less (10.7% more) patents, 13.3% less (15.4% more) citations to these patents, and 8.4% less (9.2% more) patenting firms. In estimating this effect, we include country and time fixed effects that are required to identify the difference-in-difference as well as fixed effects for each patent class to control for industry level unobserved factors. We also control for (i) a country's bilateral trade with the US in each of its industries using its exports and imports with the US in different years; (ii) a measure of the country's comparative advantage in an industry using the ratio of value-added of an industry in a country in a given year to the total value-added for the country that year; and (iii) the GDP per capita of the country. To control for the effect of changes in patent protection in some countries during our sample period, we re-estimate the difference-in-difference by excluding these countries and find the effect to be similar. To alleviate concerns about reverse causality, we investigate the dynamic effect of the creditor rights changes and find that the effect manifests only two years after the change.[6] Furthermore, the effect of the creditor rights change is experienced both at the *intensive* and *extensive* margins since we find similar effects using the median, average and citation weighted average number of patents.

Next, we undertake cross-sectional tests to highlight the causal mechanism for the effect of creditor rights on innovation. Since our explanatory variable here is the *interaction* between country-level creditor rights and the industry-level innovation intensity, we include country and industry fixed effects together with year fixed effects in all our specifications. We find that the coefficient of the interaction between creditor rights and innovation intensity is uniformly negative and statistically and economically significant. We show that these cross-sectional results are also robust to time-varying heterogeneity at the country level (using country by time fixed effects) and industry level (using industry by time fixed effects) as well as to effects of a country's bilateral trade with the US, its industry level comparative advantages and its GDP per capita.

Our most compelling evidence on the causal mechanism comes from the time-series tests.

Here, we conduct a third-difference test by computing a difference-in-difference estimate for the interaction of creditor rights with innovation intensity. We find that while the difference in innovation between two adjacent industries is statistically indistinguishable in countries that did not experience a creditor rights change, in countries that underwent an increase (a decrease) in creditor rights, the more innovative industry generated 10.3% less (11.5% more) patents, 56.4% less (29.3% more) citations to these patents, and 9.5% less (10.5% more) patenting firms than its adjacent less innovative industry.

Having confirmed the effect of bankruptcy codes on innovative activity, we examine the effect of bankruptcy codes on leverage choice. Due to limits on data availability, we focus on the G-7 countries and study the relationship between leverage and creditor rights. We find that when creditor rights are stronger, innovative industries take on relatively less leverage (book debt, market debt, debt inclusive of all non-equity liabilities, and debt net of cash and cash equivalents) compared to other industries. Thus, firms in innovative industries do appear to unwind the effect of stronger creditor rights by undertaking smaller quantities of debt and keeping more cash reserves.

Finally, we ask how the differential impact of bankruptcy code on innovative versus non-innovative industries impacts the growth rates of these industries? In regressions using the growth rates for each ISIC industry in a country, we find the coefficient of the interaction between creditor rights and industry-level innovation intensity to be strongly negative. This effect is also economically significant and robust to including the Rajan and Zingales (1998) measures of financial development and their interaction with external financial dependence. Note that this evidence does not rely on any data on patents other than the US data which is employed to calculate the intrinsic innovation intensity of industries, and as such is robust to concerns that patents may be an imperfect proxy for all innovation activity.

The paper proceeds as follows. Section 1 presents our empirical evidence. Section 2 discusses our innovation proxy and related literature. Section 3 concludes.

1 Empirical Evidence

1.1 Empirical Strategy

We investigate whether a more creditor friendly bankruptcy code lowers innovation in a country. To understand our test designs, consider two industries in two countries: Biotechnology and Textiles in the United States and Germany. Firms in the Biotechnology sector have a higher propensity to innovate and have riskier cash flows than firms in the Apparel industry while the German bankruptcy code is more creditor-friendly than the US bankruptcy code (Djankov, McLiesh and Shleifer, 2007). We investigate whether innovation in Germany is lower than that in the US. To this purpose, we follow a two-fold empirical strategy.

First, since creditor rights are expected to be largely collinear with other country level unobserved factors, we exploit country level *exogenous* changes in creditor rights to conduct difference-in-difference tests: the difference in the level of innovation in a country before and after the creditor rights change, compared to the same difference for countries that did not experience a creditor rights change. The difference-in-difference test provides direct evidence that stronger creditor rights lead to lower innovation.

Second, we focus on the *mechanism* that leads to this effect. We predict that the value from innovation for Biotechnology firms minus that for Apparel & Textile firms is expected to be higher in the US than in Germany. Figure 1 illustrates this interaction effect. In this figure, we plot across time the ratio of realized number of patents and citations for two innovation-intensive industries (Biotechnology and Surgery and Medical Instruments) relative to a benchmark conservative industry (Apparel & Textile) for the US vis-a-vis Germany (top two plots) and US vis-a-vis Japan (bottom two plots). Note that Japan, like Germany, also has a higher creditor rights index than the US. In each of the two innovation-intensive industries, the ratio for the US is substantially higher than that for either Germany or Japan, often by a factor of five. The factor increases in most cases over time right from 1978 (the beginning of our data and, in fact, the year the US passed the Bankruptcy Reform Act making its code even more debtor-friendly). In the econometric variant of this visual test, we examine the *interaction* of country level index of creditor rights with proxies for the Innovation Intensity of an industry. Here, we include country and industry level fixed effects to control for time-invarying unobserved heterogeneity at these levels.

We also use the creditor rights changes to re-examine the interaction effect described above. Here, we estimate a difference-in-difference for the interaction term, thus providing a third-difference test for our hypothesis.

1.2 Data and Proxies

To implement the cross-sectional and third-difference time-series tests described above, we construct a proxy for an industry's intrinsic propensity to innovate. We describe the construction of this proxy after describing our data and sample and our proxies for innovation.

To proxy for innovation, we use patents filed with the US Patent Office (USPTO) and the citations to these patents, compiled in the NBER Patents File (Hall, Jaffe and Trajtenberg, 2001). The NBER patent dataset provides among other items, annual information on patent assignee names, the number of patents, the number of citations received by each patent, the technology class of the patent and the year that the patent application is filed. The dataset covers all patents filed with the USPTO by firms from around 85 countries. We exploit the technological dimension of the data generated by *"patent classes"*. Over the years, the USPTO has developed a highly elaborate classification system for the technologies to which the patented inventions belong, consisting of about 400 patent classes. During the patent examination process, patents are assigned to detailed technologies as defined by the patent class. The USPTO performs these assignments with care to facilitate future searches of the prior work in a specific area of technology (Kortum and Lerner, 1999).

We date our patents according to the year in which they were applied for. This avoids anomalies that may be created due to lag between the date of application and the date of granting of the patent (Hall, Jaffe and Trajtenberg, 2001). Note that although we use the application year as the relevant year for our analysis, the patents appear in the database only after they are granted. Hence, we use the patents actually granted (rather than the patent applications) for our analysis.[7]

1.2.1 Proxies for Innovation

We use three broad metrics to measure innovation. The first is a simple patent count of the number of patents that were filed in a particular year in a specific patent class. As our second metric of innovative activity, we use the citations that are made to the patents in a specific patent class. Citations capture the importance and drastic nature of innovation. This proxy is motivated by the recognition that the simple count of patents does not distinguish breakthrough innovations from less significant or incremental technological discoveries.[8] Intuitively, the rationale behind using patent citations to identify important innovations is that if firms are willing to further invest in a project that is building upon a previous patent, it implies that the cited patent is influential and economically significant. In addition, patent citations tend to arrive over time, suggesting that the importance of a patent may be revealed over a period of time and may be difficult to evaluate at the time the innovation occurred. Finally, citations help control for country-level differences arising in the number of patents due to differences in the number and size of firms.

As our third measure of innovative activity, we employ the number of patenting firms in a patent class. The USPTO defines "assignee" as the entity to which a patent is assigned. A simple count of the number of assignees in a patent class in a given application year provides a measure of the number of patenting entities. Since patents may be assigned to individuals, corporations or academic departments, the USPTO classifies patents according to the type of assignees using the "assignee code". Assignee codes equal to 2 and 3 identify US non-government organizations (mostly corporations) and non-US, non-government organizations (mostly corporations) respectively. These categories account respectively for 47.2% and 31.2% of all patents filed with the USPTO.

While the number of patents, number of citations, and the number of patenting firms represent measures of aggregate innovation, we also examine average measures of innovation in a patent class. We employ the median number of patents, the simple average number of patents, and the citation weighted average number of patents applied in a patent class. Employing the aggregate measures of innovation together with these average measures enables to examine both the *extensive* and *intensive margins* of innovative activity.

Patents have long been used as an indicator of innovative activity in both micro- and macro-economic studies (Griliches, 1990). Although patents provide an imperfect measure of innovation, there is no other widely accepted method which can be applied to capture technological advances.[9] Nevertheless, we are aware that using patents has its drawbacks. Not all firms patent their innovations, because some inventions do not meet the patentability criteria and because the inventor might rely on secrecy or other means to protect its innovation. In addition, patents measure only successful innovations. To that extent, our results are subject to the same criticisms as previous studies that use patents to measure innovation (e.g., Griliches, 1990; Kortum and Lerner, 1999).

1.2.2 Proxy for Innovation Intensity

The "industry" level classification we employ pertains to the *patent classes* in the data. We identify an industry's (patent class') propensity to innovate by the number of patents filed by the median US firm in that industry. This corresponds to using the patents under USPTO assignee code "2".

The choice of the US for the ranking of industries is for several reasons. First, the US has the most populated data across various patent classes and over time. Second, the US had the most well-developed financial markets over our sample period and these have been shown to be necessary for funding of constrained but high-growth sectors (Rajan and Zingales, 1998). Last, but not the least, the US has had the most vibrant research environment in universities and the most open immigration policy for enrolling scholars in these universities.

While using the patents filed by US firms is the most natural choice for proxying innovation intensity, as a robustness check, we also employ the USPTO patents filed by Japanese firms to generate a proxy for innovation intensity.

We then make the assumption that the propensity to innovate is driven primarily by the technological characteristics of firms in that industry. This assumption can be justified along the following grounds. First, Cohen, Nelson and Walsh (1996) find in their survey of patenting across various US industries that the propensity to patent is largely driven by technological characteristics of an industry. Hence, we reason that these technological characteristics carry over to other countries. For example, the correlation in patent class ranking between the US and Germany (Japan) is 0.676 (0.618) on average in the time-series, its value ranging from a minimum of 0.63 (0.54) to a maximum of 0.76 (0.71).

Second, Hall, Jaffe and Trajtenberg (2001) find that the number of patents filed per year and the number of citations per year to these patents vary with the industry category, with Computers and Communications having the highest number of patents filed per year and the highest number of citations to these patents per year, and the more mature Mechanical industry exhibiting the lowest values on both counts. They describe the reasons for these differences as primarily technological. Cohen et al. (1996) contrast between discrete and complex technologies and argue that firms file more patents and cite each other's patent more when the technology is "complex".

While Rajan and Zingales (1998) construct a time-invariant industry level proxy for external financial dependence, our proxy for innovation intensity is *time-varying*. Hall, Jaffe and Trajtenberg (2001) show in Figure 5 of their study that there have been changes in the share of patents occupied by the different industry categories over the period 1978-2002. This is an important observation suggesting that the technological innovation intensity of industries has changed in a relative fashion over time. This point has also been stressed by Kortum and Lerner (1999) who find for example that the number of patents filed in Biotechnology and Software industries has risen considerably since the late 1970s, both absolutely and as a share of total patenting in the United States. Kortum and Lerner (1999) suggest that the principal reason for this pattern is the inter-temporal variation in the level of innovation across different industries, particularly due to the arrival of technological shocks.

1.2.3 Creditor/Debtor Friendliness of the Bankruptcy Code

We view a bankruptcy code to be more creditor friendly if the code provides more rights to creditors in bankruptcy. Our data on the cross-section and time-series of country-level index of creditor rights comes from Djankov, McLiesh and Shleifer (2007). This is a score between 0 and 4, based on a score of one each for whether there is no automatic stay on secured creditors' rights, secured creditors are paid first in bankruptcy, no majority creditor consent is required for reorganization, and management does not stay in place upon bankruptcy. The creditor rights score is simply an index and the extreme scores of 0 and 4 do not literally correspond to lack of any creditor rights or debtor rights. They simply indicate that bankruptcy codes confer control rights relatively more on one set of firm's claimants, likely favoring the bargaining and reorganization in their favor. In particular, creditor right index of 0 for a country does not imply that there is no supply of debt financing in this country.

Note that although the patent data is available from 1963 onwards, the information on the country-level index of creditor rights provided by Djankov et al. (2007) starts only in 1978. Therefore, the time period of our sample is 1978-2002.

1.2.4 Summary Statistics

Table 1 lists the 85 countries that appear in the NBER Patents data file along with the aggregate number of patents filed by firms in the country, the aggregate number of citations received by these patents, the number of firms filing patents from this country, and the mean and median number of patents filed by firms in this country. The table also displays the index of creditor rights in each of these countries. While for most countries the creditor rights index is unchanged over the sample period, a few countries experienced a change in creditor rights. For these countries, the values of the creditor rights is listed sequentially.[10]

1.3 Difference-in-difference test using *Changes* in Creditor Rights

To provide causal evidence on the impact of creditor rights on innovation, we exploit country level exogenous changes in creditor rights. A total of twelve countries underwent a change in creditor rights index over our sample period. Seven of these (Canada, Finland, Indonesia, Ireland, Israel, India and Sweden) experienced a decrease in creditor rights by one, and five (Denmark, United Kingdom, Lithuania, Romania and Russian Federation) experienced an increase. Table 2 lists these countries and their year of change in creditor rights. Since creditor rights changed in some countries in our sample but not in others, this "natural experiment" offers the opportunity to estimate the causal effect of creditor rights change through a difference-in-difference test.

To understand how this difference-in-difference is calculated, consider the effect on innovation due to the creditor rights change in Israel in 1995. A naive estimate would be to simply compute the difference in innovation before and after the creditor rights change. However, this estimate would also be affected by time-trends that coincide with the creditor rights change as well as other economy wide factors. To control for such factors, we also estimate this difference in innovation for a country such as Germany, which did not undergo a creditor rights change in 1995. The difference estimated for Germany provides an answer to the counter-factual question: "what would have been the difference in innovation in Israel if the creditor rights change *had not occurred*?". The difference between these two differences, therefore, captures the causal effect of the creditor rights change on innovation.

The difference-in-difference test has a number of attractive features. First, it is not subject to the criticism that country or industry level unobserved factors influencing innovation are correlated with the level of creditor rights in a country. This is because these tests exploit *within-country* differences *before* and *after* the creditor rights change vis-à-vis similar before-after differences in countries that never experienced such a change. Second, the time-series tests provide point estimates of the effect of changes in creditor rights on innovation using experiments of greatest relevance to policies concerned with promoting innovation.

1.3.1 Basic test

We implement the difference-in-difference test using the following regression:

$$y_{ict} = \beta_i + \beta_c + \beta_t + \beta_1 \delta_{ct} + \beta_2 * InnovationIntensity_{i,t-1} + \beta X + \varepsilon_{ict} \qquad (1)$$

where y is the natural logarithm of a measure of innovation for the USPTO patent class (i), country (c) and the year when the patent was applied for (t). For a country c that underwent a creditor rights *increase* in year m, δ_{ct} equals zero (one) for the years before (after) the change, i.e. for $t \leq m\,(t \geq m+1)$. In contrast for a country c that underwent a creditor rights *decrease* in year m, δ_{ct} equals one (zero) for the years before (after) the change, i.e. for $t \leq m\,(t \geq m+1)$.[11] For countries that did not experience a creditor rights change, δ_{ct} always equals zero. $\beta_i, \beta_c, \beta_t$ denote patent class, country and application year fixed effects while X denotes the set of control variables. Since δ_{ct} is defined to be one (zero) *one year after the change* for countries that decreased (increased) creditor rights, β_1 measures the difference-in-difference effect a year after the change. The Innovation Intensity for patent class i in year $(t-1)$, $InnovationIntensity_{i,t-1}$, is measured as the median number of patents applied by US firms in patent class i in year $(t-1)$. As justified before, instead of using a fixed time window to classify industries based on their propensity to patent, we use a moving window to measure the Innovation Intensity so as to capture the inter-temporal changes in the propensity to innovate caused by technological shocks. Since our proxy for Innovation Intensity is defined using patents issued to US firms, we exclude all patents issued to US firms (assignee code equal to 3) in y_{ict}. In these and all our other regressions, the standard errors are robust to heteroskedasticity and autocorrelation and are clustered by country. Given our hypothesis that stronger creditor rights lead to lower innovation, we predict that $\beta_1 < 0$.

Notice that compared to the usual difference-of-difference specification, which contains dummies for treatment groups and treatment periods only, including dummies for all the countries, all the application years as well as the patent classes leads to a much stronger test since we are able to control for time-invariant country and patent class specific determinants of innovation as well as time-varying effects that are common to all countries and all patent classes. The application year fixed effects also enable us to also control for the problem stemming from the truncation of citations, i.e., citations to patents applied for in later years would on average be lower than citations to patents applied for in earlier years. Similarly, the patent class fixed effects also enable us to control for time-invariant differences in patenting and citation practices across industries.

Columns 1-3 in Panel A of Table 3 present the results of this difference-in-difference test without any control variables. In all our tests, we employ in consecutive columns the logarithm of number of patents, the number of citations and the number of patenting firms as the dependent variable. We find that across Columns 1-3 β_1 is strongly negative.

1.3.2 Controlling for other determinants

Since we use US patents to proxy international innovation, this may introduce biases. Define the difference between the "true" level of innovation in a country and innovation as measured by USPTO patents and citations as the "USPTO bias". Given the country, patent class and application year fixed effects in (1) , the difference-in-difference coefficient β_1 would be biased only if time-varying omitted variables at the country/ patent class level that affect the USPTO bias are also correlated with the changes in creditor rights. Nevertheless, we control for potential determinants of the USPTO bias. Columns 4-6 of Panel A of Table 3 presents results of these tests.

An important determinant of the USPTO bias is the extent of bilateral trade that a country has with the US. Countries that export to the US would file more patents with the

USPTO, particularly in the more innovation-intensive industries. MacGarvie (2006) finds that citations to a country's patent are correlated with the level of exports and imports that the country has with the US. Therefore, in (1), we add for each country the logarithm of the level of imports and the level of exports that the country has with the US in each year at each 3-digit ISIC industry level, using data from Nicita and Olarreaga (2006).[12] Another important determinant of patenting by firms in a country may be the comparative advantage that the country possesses in its different industries. We employ as our proxy for industry level comparative advantage the ratio of value added in a 3-digit ISIC industry in a particular year to the total value added by that country in that year. The data for these measures come from United Nations Industrial Development Organization (UNIDO)'s statistics. Finally, since richer countries may innovate more and may also file more patents with the US, we also include the logarithm of real GDP per capita.

We find in Columns 4-6 of Panel A that none of the control variables are consistently significant in these difference-in-difference tests. Crucially however, β_1 continues to be negative and statistically significant. We find β_1 to be highest when the dependent variable is the logarithm of citations and lowest when it is the number of firms.

1.3.3 Causality or reverse-causality?

It is important to understand what caused the changes in creditor rights. Was it the case that creditor rights changed for reasons other than promoting growth and innovation, so that our evidence above can be interpreted truly as a causal effect of the change on innovation? Or, was it the case that creditor rights changes were part of an overall package to promote or give an extra boost to growth and innovation, so that the evidence above exhibits some reverse causality? Note that in either of these cases, the evidence lends support to our claim that creditor rights can affect the extent of innovative activity. Nevertheless, we examine reverse causality in Columns 7-9 of Panel A of Table 3 by examining the dynamic effect of these creditor rights changes. In Section 1.3.5 below, we describe the causes of the creditor rights changes in each country.

If the creditor rights change was effected to provide an extra boost to growth and innovation *already occurring* due to some other changes in the economy, then we might see an "effect" of the change even prior to the change itself. To examine this, we follow Bertrand and Mulainathan (2003) in decomposing our Creditor Rights Change variable into three separate time periods: (i) Creditor Rights Change (-2,-1), which captures any effects from two years before to a year before the change; (ii) Creditor Rights Change (0,1), which captures the effect in the year of the change and the year after the change; and (iii) Creditor Rights Change ($\geq$2), which captures the effect two years after the change and beyond. If the coefficient of Creditor Rights Change (-2,-1) is negative and statistically significant, that may be symptomatic of reverse causation. However, we find that the coefficients are positive and statistically significant in two of the three specifications for Creditor Rights Change (-2,-1), negative but statistically insignificant for Creditor Rights Change (0,1), and negative and statistically significant for Creditor Rights Change ($\geq$2). In fact, the coefficient estimates for Creditor Rights Change ($\geq$2) are consistently higher than the estimate of β_1 in Columns 1-6. The coefficient of Creditor Rights Change (-2,-1) being positive and significant in two of the three specifications suggests that innovation increased two years before the creditor rights change, which is puzzling. We investigate this effect in greater detail in Section 1.3.4 below. The significant negative effect of creditor rights changes being observed only two years after the change is consistent with evidence in Kondo (1999) that there is a one-and-a-half year lag between patent applications and R&D investment.

1.3.4 Country Level Changes in Patent Protection

Country level changes in the protection provided to patents affect the ex-ante incentives of firms to pursue innovative projects and, in turn, their filing of patents with the USPTO. Overlapping with the time of the creditor rights changes in our sample, Austria, Indonesia, Ireland, and Russia increased the length of patent protections in their countries from 18 to

20 years, from 14 to 20 years, from 16 to 20 years, 15 to 20 years respectively, while Israel introduced special patent protection for pharmaceuticals. In fact, in Indonesia, Ireland and Russia, the increase in patent protection preceded by a few years the creditor rights change.[13] To ensure that the difference-in-difference results above are not being driven by changes in patent protection, we re-estimate them by excluding these countries from our sample. Panel B of Table 3 replicates the results of Panel A using this reduced sample. We note that the estimate of β_1 is strongly negative in Columns 1-6 of Panel B. Interestingly, we find by comparing Columns 7-9 of Panel B to those in Panel A that the coefficient of Creditor Rights Change (-2,-1) is not statistically significant once we exclude the countries that experienced increases in patent protection. In Columns 7-9 of Panel B, we find that only the coefficient of Creditor Rights Change ($\geq$2) is negative and significant.

1.3.5 Causes of creditor rights changes

We now discuss the reasons behind the changes in the creditor rights in our "treatment" sample of countries. The weakening of creditor rights in Israel in 1995 was precisely to provide entrepreneurship a boost. It represented a greater tolerance towards debt undertaking and the over-extended borrowers who fell into financial trouble. In fact, "the changing orientation of Israel's economy from being socialist-based to more capitalistic can also be linked to the liberalization of the fresh-start policy. As entrepreneurship became a more widely-accepted activity in Israel, society began to acknowledge the incentives a more liberal fresh-start policy could provide to a private market economy" (Efrat, 1999).

Other changes have not necessarily occurred to promote such fresh starts. For instance, the primary objective of the weakening of creditor rights in Canada in 1992 was to increase the chances of survival of businesses that were experiencing financial difficulties, and, as a consequence, to save jobs (Martel, 1994), an ex-post objective rather than an ex-ante one to promote innovation per se. In case of India, the motivation for weakening of creditor rights in 1993 was to protect the domestic, uncompetitive firms who had been forced into bankruptcy by the deregulation and introduction of foreign competition in 1991 (Kang and Nayar, 2004), a lobbying-based outcome rather than one aimed at efficiency.

In contrast, the weakening of creditor rights in Finland in 1993 (by two points) and Indonesia in 1998 were prompted by the severity of ongoing crises. In the case of Finland, the real GDP had dropped by about 14% and unemployment had risen from 3% to nearly 20%. The creditor rights were however part of a larger stimulus package in both countries. In Finland, restrictions on foreign ownership were completely abolished and the accounting legislation was improved. These measures were attributed the acceleration in development of the stock market and the venture capital activity, and the rebounding of employment rates (Hyytinen, Kuosa and Takalo, 2001). In Indonesia, bankruptcy law reforms included secured transactions law reforms and reforms to anticorruption legislations.

Finally, the weakening of creditor rights in the United Kingdom in 1985 was largely to mirror the success of the United States Chapter 11 bankruptcy in providing a formal structure for reorganization of solvent but illiquid institutions (Armour, Cheffins and Skeel, Jr, 2002), whereas their strengthening in Russia in 1994, Lithuania in 1995 and Romania in 1999 were a part of their transition and were viewed as a way to boost lending (Haselmann, Pistor and Vig, 2006) and make more efficient the bankruptcy systems ridden by inexperienced judges.

These examples illustrate the following important points. First, creditor right changes have sometimes been introduced precisely to promote growth and innovation. Second, these changes have often arisen due to lobbying and job-saving objectives, exogenous to the issue of promoting innovation. And, third, these changes have also often been timed to turn around economies that are in crises or at the verge of growth spurts, but importantly, creditor right changes have been an important part of the overall stimulus package in these cases. These facts together, along with our empirical tests on reverse causality, give us confidence that the relationship between creditor right changes and innovation unearthed in our time-series tests is indeed economically meaningful and causal.

1.3.6 Economic magnitudes

The economic magnitude of the effect of creditor rights change on innovation is quite significant. For this purpose, we use Columns 1-3 of Panel A of Table 3. Compared to the counties that did not undergo a creditor rights change, the group of countries that underwent a creditor rights decrease generated 10.7% more patents, 15.4% more citations to these patents, and 9.2% more patenting firms. In contrast, the group of countries that underwent a creditor rights increase generated 9.7% less patents, 13.3% less citations to these patents, and 8.4% less patenting firms than those countries that did not experience a creditor rights change.

1.3.7 The effect of creditor rights changes on innovation by a typical firm

In Table 4, we display the results of difference-in-difference tests for innovation done by a typical firm in our sample. We employ as our measures of innovation the median (Columns 1 and 4), average (Columns 2 and 5) and the citation weighted average (Columns 3 and 6) number of patents held by a firm in a country, patent class, year. We find in Table 4 that β_1 is strongly negative and statistically significant. The economic magnitude for these average measures of innovation is lower than for the aggregate measures of innovation in Table 3.

Taken together, Table 3 and 4 suggest that the decrease (increase) in creditors rights in a country *caused* more (less) innovation at both the *extensive* and *intensive* margins.

1.4 The Causal Mechanism

Having examined the direct effect of creditor rights on innovation, we now describe our tests of the causal mechanism that leads to the negative effect of creditor rights on innovation. We test the hypothesis that the difference in innovation between more innovation-intensive industries (such as Biotechnology) and less innovation-intensive industries (such as Apparel & Textiles) would decrease with the strength of creditor rights. We first examine this hypothesis using cross-sectional tests and then using the changes in creditor rights.

1.4.1 Cross-sectional Tests

The regression below estimates inter-industry differences in innovation across different bankruptcy regimes:

$$
\begin{aligned}
y_{ict} &= \beta_i + \beta_c + \beta_t + \beta_1 \cdot (CreditorRights_{ct} * InnovationIntensity_{i,t-1}) \qquad (2) \\
&\quad + \beta_2 \cdot CreditorRights_{ct} + \beta_3 \cdot InnovationIntensity_{i,t-1} + \beta X + \varepsilon_{ict} \ ,
\end{aligned}
$$

where y is the natural logarithm of a measure of innovation for patent class (i), country (c) in year (t). $CreditorRights_{ct}$ is a measure of country c's strength of creditor rights in year t. As in (1), $InnovationIntensity_{i,t-1}$ equals the median number of patents applied by US firms in patent class i in year $(t-1)$ and y_{ict} excludes all patents issued to US firms.

Since we are primarily interested in the coefficient of the *interaction* of country level creditor rights with innovation intensity at the patent class level, we include country fixed effects (β_c) and patent class fixed effects (β_i) in all our specifications. This enables us to control for all time-invariant unobserved heterogeneity at the country and patent class levels. The application year fixed effects (β_t) control for inter-temporal differences as well as the problem stemming from the truncation of citations.

Our hypothesis is that $\beta_1 < 0$. Columns 1-3 in Panel A of Table 5 show the results of the test of equation (2). We find that for each of the three dependent variables, β_1 is negative and statistically significant.[14]

Controlling for bilateral trade, comparative advantages and GDP We now control for the effects of (i) the extent of bilateral trade that a country has with the US; (ii) comparative advantages that a country has in its different industries; and (iii) the country's GDP per capita. Note that unlike the difference-in-difference tests above, differences in industry level comparative advantages across different countries is an important concern in the cross-sectional tests since it affects our interpretation of β_1 in (2) as the relative effect of creditor rights on innovation. To see this, consider two countries with different level of creditor rights: call the country with lower creditor rights country 1 and the one with higher creditor rights country 2. Suppose country 1 and the US have a comparative advantage in Biotechnology while country 2 (which has higher creditor rights) possesses a comparative advantage in tangible, asset intensive industries such as Cement or Steel which have a lower propensity to patent. Now, even if our empirical results showed that $\beta_1 < 0$, this could be consistent with the interpretation that country 1 and the US innovate in biotechnology while country 2 innovates in Cement or Steel. However, since firms in Cement and Steel industries have a lower propensity to patent, we obtain that $\beta_1 < 0$. Such an interpretation would imply no relative effect of creditor rights on innovation other than a spurious one.

The measures for bilateral trade and comparative advantage are as described in Section 1.3.2. Since these variables may be correlated with the interaction of Creditor Rights and Innovation Intensity, we interact each of them with $InnovationIntensity_{i,t-1}$ as well.

Columns 4-6 of Panel A of Table 5 present the results of adding these controls to (2) .We find that among these controls, only exports display a significant effect – countries that export more file more patents with the US, and particularly so in the innovation-intensive industries. Importantly, β_1 continues to be negative and statistically significant. The coefficient decreases when the dependent variable is the logarithm of number of patents or number of citations but increases when it is the number of firms.

Controlling for other unobserved heterogeneity As additional tests for the interaction effect in (2) , we control for other forms of unobserved heterogeneity. First, we include interactions of our proxy for Innovation Intensity with the legal origin of the country to capture omitted variables at the country-patent class level. We also interacted other country level variables documented in the law and finance literature (LLSV 1998) such as Rule of Law, Enforcement of contracts, an index of Public Legal Enforcement and Efficiency of the Bankruptcy Procedure with our proxy for Innovation intensity. Since only the legal origin interactions were statistically significant, we report them in Columns 1-3 of Panel B of Table 5. Second, in Columns 4-6 and Columns 7-9 of Panel B, we control for time-varying unobserved factors at the country and patent class levels respectively by including (country*time) and (industry*time) fixed effects. Across all these columns, we find that β_1 stays negative and statistically significant.

Controlling for the effect of Financial Development Despite our inclusion of a country's GDP per capita, other country level variables, country and (country*time) fixed effects, it is possible that the weakness of creditor rights may actually be capturing the effect of financial development, which has been argued to boost innovation through greater competition (Romer (1990), Grossman and Helpman (1991), and Aghion and Howitt (1992)). For example, creditor rights may be designed to be stronger to boost credit and intermediation in poorly developed financial markets. Another orthogonal concern is that if financial contracts allow firms to get around the inefficiencies imposed by the bankruptcy code, then the effect of the code on real choices of firms would be muted. Since richness of contracting is likely related to the level of financial development (measured, for example, by quality of accounting standards), it may be important to control for variations in this level across countries.

To address these issues, we employ two measures of financial development: Accounting Standards and logarithm of Private Credit to GDP per capita (from La Porta et al., 1998 and Rajan and Zingales, 1998).[15] Requiring these variables reduces our sample size to around 40 countries. In Table 6, we show the results of tests including financial development and its interaction with Innovation intensity.[16] We find that β_1 continues to be strongly negative.

Economic magnitude of the effect The economic magnitude of the effect of the interaction term is quite significant. We use Columns 1-3 in Panel A of Table 5 to estimate these economic magnitudes. Consider two patent classes which differ by 1 patent per year in the median number of patents filed by US firms in that patent class. If Creditor Rights index is zero, then the more innovative patent class would generate 14.9% more patents in a year than the less innovative one. If instead the Creditor Rights index is one, then this difference is 10.4%. When the Creditor Rights index equals its maximum value of four, the more innovative intensive patent class generates 2.1% *less* patents in a year than the less innovative one. So, when we go from a country with Creditor Rights index of 0 to 1, the difference in innovation between two adjacent patent classes reduces by more than 30% and reverses when the index equals 4. The economic magnitudes for the number of citations and the number of firms are of a similar order or magnitude.

The effect of creditor rights on innovation by a typical firm In Table 7, we display the results of the cross-sectional tests for the innovation done by the typical firm in our sample. As in Table 4, we employ as our measure of innovation the median, average and the citation weighted average number of patents held by a firm in a country, patent class, year. We find that β_1 is strongly negative though the economic magnitudes for these average measures are lower than that for the aggregate measures in Table 5. Taken together, Table 5 and 7 suggest that the effect of creditor rights on inter-industry differences in innovation is present at both *extensive* and *intensive* margins.

Discussion of the cross-sectional test We observe in our estimates of the economic magnitude above that when the Creditor Rights index equals 4, the less innovation-intensive industry innovates *more* than the more innovation-intensive industry. This is consistent with the comparative advantage critique that we outlined above, i.e. countries where the Creditor Rights index equals 4 focus their innovation resources in the less innovation-intensive industries. Thus, despite our attempt to control for the effects of industry level comparative advantages in different countries, in these cross-sectional tests, our inference of the effect of the interaction of creditor rights with Innovation Intensity are affected by differences in comparative advantage.

To alleviate concerns about the effects of comparative advantage, we re-examine the interaction effect using exogenous changes in creditor rights.

1.4.2 Third-difference test

We now use the creditor rights changes to perform a third-difference test:

$$y_{ict} = [\beta_c + \beta_t + \beta_1 \delta_{ct}] * InnovationIntensity_{i,t-1} + \beta_i + \beta_c + \beta_t + \beta_2 \cdot \delta_{ct} + \beta X + \varepsilon_{ict} \quad (3)$$

where the variable definitions are identical to those in (1). This specification is equivalent to

$$\frac{\partial y_{ict}}{\partial InnovationIntensity_{i,t-1}} = \beta_c + \beta_t + \beta_1 \delta_{ct} \quad (4)$$

Thus β_1 now estimates the relative effect on innovation across different industries as a difference-in-difference. As before, our hypothesis is that $\beta_1 < 0$.

Panel A of Table 8 presents the results of this third-difference test. In Columns 1-3, we include our variables for bilateral trade, industry level comparative advantages and the country's GDP per capita. As in the cross-sectional tests, we also interact them with our proxy for Innovation Intensity. Across Columns 1-3, we find the coefficient β_1 to be strongly negative. As in the cross-sectional tests in Panel A of Table 5, only the coefficient of exports and its interaction with Innovation Intensity are positive and significant.

As in the direct effect of creditor rights changes, we test for reverse causality by examining the dynamic effect of the change in Columns 4-6. The negative and statistically significant effect on the interaction of Innovation Intensity with Creditor Rights Change (≥ 2) combined with the insignificant effects for the other two interactions suggest the absence of any reverse causality in the interaction effect too.

In Panel B of Table 8, we re-examine the third-difference by excluding countries that underwent a change in patent protection. We find that the coefficient β_1 in Panel B to be very similar to that in Panel A, which suggests that the third-difference results are robust to the changes in patent protection in Austria, Indonesia, Ireland, Israel and Russia.

The economic magnitude of the interaction effect in these time-series tests is quite significant. For this purpose, we use Columns 1-3 of Panel A of Table 8. Since the coefficient of innovation intensity is statistically indistinguishable from zero in Columns 1-6, there is no difference in innovation between two adjacent classes for the control group of countries. For the group of countries that underwent a creditor rights decrease, the more innovative class generated 13.2% more patents, 32.7% more citations to these patents, and 10.8% more patenting firms than its adjacent less innovative class. In contrast, for the group of countries that underwent a creditor rights increase, the more innovative class generated 11.7% less patents, 24.6% less citations to these patents, and 10.8% less patenting firms than its adjacent less innovative class.

Therefore, after controlling for unobserved heterogeneity of various kinds through Tables 3-8, we can infer that a decrease in the creditor rights leads firms to innovate more in aggregate and, in particular, leads firms in innovation-intensive industries to innovate even more compared to firms in conservative industries.

1.5 Evidence on Leverage and Growth

1.5.1 Evidence from Leverage Choice in G-7 Countries

Having confirmed the real implications of our theoretical priors, we examine next the financial implications. Specifically, we test whether an innovative firm will be financed with relatively less leverage than a conservative firm, when creditor rights become stronger. This difference-in-difference test is performed using a specification similar to that in equation (2), with y_{ict} being replaced by leverage for a given firm in country c in year t, and the measure of innovation (patenting intensity) being employed on the right hand side at the level of 2-digit SIC industry of the firm in that country.

To be consistent with the existing literature (e.g., Rajan and Zingales, 1995), we include as control variables other firm characteristics (tangible assets measured as property, plant and equipment by assets, profitability measured as EBITDA by assets, log of sales, and market to book ratio) as well as their interactions with country dummies. Due to limits on data availability, we focus on the G-7 countries using Worldscope database over the period 1990 to 2005. This sample of countries has reasonably well-developed debt and equity markets. Again, we test whether the coefficient β_1 on the interaction between creditor rights and innovation intensity is negative. This is indeed what we find in Table 9. In particular, when creditor rights are stronger, innovative industries take on relatively less leverage compared to other industries. This finding stays robust to different measures of leverage (book debt, market debt, debt inclusive of all non-equity liabilities, and debt net of cash and cash equivalents), though it is statistically insignificant in the case of net market debt as the leverage proxy.

This finding is important for two reasons. First, it shows that the theoretical backdrop finds support not only in its result linking creditor rights and innovation, but also in the specific mechanism we conjecture to be at play, which is that leverage is costly as a means of financing for innovative firms when creditor rights are strong. In other words, firms in innovative industries do appear to unwind the effect of stronger creditor rights through their choice of financing. They do so by undertaking smaller quantities of debt and keeping more cash reserves in order to pursue more innovative projects. Second, this finding suggests that one ought to be cautious about the approach in law and finance literature which ascribes greater lending associated with stronger creditor rights (at least implicitly) as an improvement in welfare and efficiency. Our results lead one to view such claims with caution as the change in creditor rights may be associated with a change in the underlying real activity, and the reason why stronger creditor rights lead to greater lending is because they discourage innovation in favor of more standard projects that can sustain greater borrowing.

1.5.2 Growth Effects

As our final inquiry, we ask how the differential impact of creditor rights on different industries, depending upon their innovation intensity, affects the growth rates of these industries? Again, we follow Rajan and Zingales (1998) methodology and employ as our dependent variable the growth rate in real value added over the period 1978-1992 for each ISIC (manufacturing) industry in a country. As in Rajan and Zingales (1998), we include the interaction of external financial dependence with various measures of a country's financial development, and control for unobserved heterogeneity at the country and industry levels through the respective fixed effects. Since we found in Table 6 that the interaction of financial development measures with patenting intensity affects our measures of innovation, we include this interaction as well. We test whether the coefficient of the interaction between creditor rights and patenting intensity accounts for growth over and above these effects. These tests also complement our results using patents as a proxy for innovation since they are devoid of any biases created by employing patents, and, in particular, USPTO patents, as a proxy for innovation.

We display the results of this test in Table 10. In columns 1-4, we include the interaction of financial development measures with external financial dependence while in columns 5-8 we include its interaction with patenting intensity. Across all these specifications, we find that the coefficient of the interaction between creditor rights and patenting intensity is strongly negative. In contrast, none of the interactions of financial development with external financial dependence or with patenting intensity are statistically significant. Using the specification in column (8), we can see that the economic magnitude of the effect is significant too. If we consider two ISIC industries which differ in the number of patents applied by 1 patent per year, the more innovative industry grows *faster* at a continuously compounded growth rate of 4.3% (1.8%) for a country with a creditor rights index of 1 (2). For a country with a creditor rights index of 4, the more innovative industry grows *slower* at a continuously compounded growth rate of 3.2%. Therefore, the difference in growth rates over the period 1978-1992 for two adjacent innovative industries more than doubles when we go from a creditor rights index of 1 to 2 and reverses when the index is equal to 4.

2 Discussion

2.1 USPTO Patents as a Proxy for Innovation

To compare innovation done by firms across countries, it is crucial to employ *patents filed in a single jurisdiction* by firms from these countries. This is because comparing domestic patents filed in the various countries would not accurately measure differences in ex-post innovation or the ex-ante incentives for innovation in these countries. There are several reasons for this. First, many developing countries such as India did not recognize process patents till the recent change brought about by the implementation of the TRIPS agreement (Rapp and Rozek, 1990). Second, till the recent implementation of the TRIPS (Trade-related Aspects of Intellectual Property Rights) agreement, the length of patent protection in most developing economies was lower (13-15 years) than that in the developed countries (17-20 years) (Rapp and Rozek, 1990). Third, while two countries may have identical patent laws on their books, their enforcement may differ substantially. For example, Argentina does have a patent law and the duration of protection under the law is fifteen years. However, according to Rapp and Rozek (1990), the combination of high inflation and a maximum fine fixed in 1864 means that there is practically no penalty for infringement. Finally, the scope and number of patents granted by patent offices in two different countries may be quite different due to differences in the patenting practices. For example, the Japanese patent system does not allow the different technical aspects of an invention to be included in the same application, which induces inventors to multiply the number of patent applications and consequently reduces the scope of patents.

In contrast, comparing patents granted in one jurisdiction alleviates such concerns of heterogeneity and provides standardization across patents in the strength of patent protection, the duration of protection, the penalties for patent infringement and therefore the nature of patent enforcement, and the patenting practices followed by the jurisdiction's patent office for all firms filing in the jurisdiction irrespective of which country the firms belong to.

Given its status as the technological leader, USPTO is the natural single jurisdiction of choice. Lall (2003) notes that "most researchers on international technological activity use US patent data, for two reasons. First, practically all innovators who seek to exploit their technology internationally take out patents in the USA, given its market size and technological strength. Second, the data are readily available and can be taken to an extremely detailed level." Furthermore, the US has the most advanced patenting system in the world (Kortum and Lerner, 1999)[17] and most innovating firms internationally file patents in the US (Cantwell and Hodson, 1991).[18] Finally, US patents are a high quality indicator of international technological activity. For example, Cantwell and Anderson (1996) note that the pattern of patenting in the US is a good indicator of technological activity in all industrialized and newly industrializing countries. Soete and Wyatt (1983) also note that although international patenting propensities remain lower than domestic patenting propensities, *international patents are on average of higher 'quality'*.

However, using patents filed with the USPTO introduces potential biases since it is likely that foreign firms file patents with the USPTO because they need to sell their products in the US. Paci, Sassu, and Usai (1997) find that the most important reasons for a firm to apply for a patent abroad are: (i) to protect goods to be exported to the countries concerned; (ii) to protect goods that may be subsequently produced in the foreign country, either directly or through a subsidiary company; (iii) to guarantee the payment of royalties from the granting of production licences; and (iv) to favor the establishment of patent exchange agreements as well as the exchange of know-how and other technological information. Hence, the controls we employed in our tests to control for such systematic biases for comparative advantages and bilateral trade patterns were quite important.

2.2 Related Literature

As a broad research enquiry, our work is close to the literature on endogenous growth pioneered by Romer (1990), Grossman and Helpman (1991), and Aghion and Howitt (1992).

This literature posits that investment in R&D and human capital is the central source of technical progress and an essential ingredient of growth. This theory stresses the need for government and private sector institutions which nurture competition and innovation, provide incentives for individuals to be inventive, and have positive externalities and spillover effects that can permanently raise a country's long-run growth rate. By providing empirical evidence highlighting the role of bankruptcy codes in encouraging innovation, our paper isolates an important legal institution that can affect country's growth.

Manso (2005) considers the optimal compensation scheme that motivates innovation and shows theoretically that the optimal scheme exhibits substantial tolerance (or even reward) for failure and reward for long-term success. He discusses in the paper how debtor-friendly bankruptcy codes could be considered as a way of motivating innovation. Landier (2006) considers a setting with endogenous cost of entrepreneurial failure and shows that there might be multiple equilibria, some that foster experimentation and others that promote conservatism. He shows that the bankruptcy code can resolve the multiplicity of equilibria, making countries with debtor-friendly codes more suitable for entrepreneurship and innovation. While Manso's model does not have leverage and Landier's model takes leverage as given, Acharya, Sundaram and John (2004) focus on the effect of bankruptcy code on the leverage choice of firms but take the real technology of the firm as given. In contrast to these papers, we empirically investigate the effect of bankruptcy codes on innovation and leverage.

The closest empirical piece to ours is the one by Fan and White (2003) who examine how changes in the personal bankruptcy law in various U.S. states (after the 1978 Act) affected entrepreneurship. In bankruptcy, the owner-entrepreneur retains assets up to the exemption level but not beyond. They find that the probability of households owning businesses is 35 percent higher if they live in states with unlimited rather than low exemptions. In contrast, our empirical work provides evidence that corporate bankruptcy codes affect the innovative pursuits of corporations. Baumol (2001) documents that more than 80% of innovation in the US is done by publicly traded corporations. Hence, our empirical results are potentially important additional evidence for what affects innovation in an economy.

Acharya, Amihud and Litov (2007) have a similar empirical objective as ours but focus instead on measures of conservatism, such as, the propensity of firms in the country to engage in diversifying mergers and reducing operating risk. They find that countries with stronger creditor rights exhibit greater conservatism and that the dominant effect is from the creditor right corresponding to whether the management stays in place during bankruptcy or not, and whether there is any stay on secured creditors' rights. In less directly related work, Chhava and Roberts (2006) and Nini, Smith and Sufi (2006) consider the effect on firm-level investments of creditor rights, captured in the form of covenants and capital expenditure restrictions that are explicitly contained in debt contracts. An important difference between these papers and ours lies in our focus on the ex-ante effects of creditor rights rather than on the ex-post ones (that is, once covenants bind or distress has occurred).

3 Conclusion

Identifying government and private means to promote innovation in economies is considered an important step towards generating sustainable long-run growth rates. In this paper, we hypothesized that debtor-friendly bankruptcy codes encourage firm-level innovation by promoting continuations upon failure. Employing industry-level cross-country data, we showed that innovative industries exhibit greater intensity of patent creation, patent citation and faster growth in countries with weaker creditor rights in bankruptcy; this finding is confirmed by within-country analysis that exploits time-series changes in creditor rights.

On the one hand, these results have important policy implications for the endogenous growth literature in that legal institutions governing financial contracts can play a first-order role in fostering innovation and growth. On the other hand, they suggest an altogether different approach to thinking about the design of bankruptcy codes in a normative sense, in particular, an approach that focuses on the ex-ante real investments undertaken by firms in response to bankruptcy codes rather than on the ex-post efficiency of continuation outcomes when firms are in distress. In addition, the results suggest a promising line of corporate-finance enquiry which examines how multi-national companies organize their innovative and standard operations. For example, do they locate their subsidiaries internationally such that innovative operations are funded under debtor-friendly bankruptcy regimes? More generally, shedding light on firm-level effects of bankruptcy codes on innovation appears to be a fruitful agenda for further research.

Figure 1: Differences in Innovation between Innovation-intensive and Non-intensive industries for US vis-a-vis Germany and Japan

This figure plots the time series of the ratio of patents and ratio of citations in two Innovation-intensive sectors (Biotechnology and Surgery and Medical Instruments) to those in a non-intensive sector Textiles and Apparel for the US vis--vis Germany and Japan. The solid line shows the trend for the US while the dotted line shows the same for Germany/ Japan.

References

[1] Acharya, V., Y. Amihud, and L. Litov, 2008, "Creditor Rights and Corporate Risk-taking," Working Paper, London Business School.

[2] Acharya, V., R. Sundaram, and K. John, 2004, "Cross-Country Variations in Capital Structures: The Role of Bankruptcy Codes," Working Paper, London Business School.

[3] Acharya, V., R. Leng, and R. Sundaram, 2006, "Do Bankruptcy Costs Affect Firm Leverage? Time-series & cross-country evidence," Working Paper, London Business School.

[4] Aghion, P. and Howitt, P., 1992, "A Model of Growth Through Creative Destruction," *Econometrica*, 60(2), 323–352.

[5] Allen, F. and D. Gale, 2000, *Comparing Financial Systems*, Cambridge, MA, MIT Press.

[6] Armour, John, Brian R. Cheffins, David A. Skeel, Jr., 2002, "Corporate Ownership Structure and the Evolution of Bankruptcy Law: Lessons from the UK, " Working Paper, Centre for Business Research and Faculty of Law, University of Cambridge.

[7] Baumol, W., 2001, *The free market innovation machine*, Princeton University Press.

[8] Bertrand, M. and S. Mulainathan, 2003, "Enjoying the Quiet Life? Corporate Governance and Managerial Preferences," *Journal of Political Economy*, 111, 1043–1075.

[9] Cantwell, J. and B. Andersen, 1996, "A Statistical Analysis of Corporate Technology Leadership Historically," *Economics of Innovation and New Technology*, 4(3),211-234.

[10] Cantwell, J. and C. Hodson, "Global R&D and UK Competitiveness," in MC Casson, ed, *Global Research Strategy and International Competitiveness*, Basil Blackwell, 1991.

[11] Chhava, Sudheer and M. Roberts, 2006, "Is Financial Contracting Costly? An Empirical Analysis of Debt Covenants and Corporate Investment," Working Paper, Wharton School of Business, University of Pennsylvania.

[12] Cohen, W., Nelson, R. and Walsh, J. 1996, "Appropriability Conditions and Why Firms Patent and Why They do Not in the American Manufacturing Sector," Paper presented at the OECD Conference on New Indicators for the Knowledge-Based Economy.

[13] Djankov, S., C. McLiesh and A. Shleifer, 2007, "Private Credit in 129 Countries," *Journal of Financial Economics*, 85(2), 299–329.

[14] Efrat, R., 1999, "The Transformation of The Israeli Bankruptcy System as a Reflection of Social Changes," *Vanderbilt Journal of Transnational Law.*

[15] Fan, Wei and M. J. White, 2003, "Personal Bankruptcy and the Level of Entrepreneurial Activity," *Journal of Law and Economics*, XLVI, 543–567.

[16] Gertner, Robert and D. Scharfstein, 1991, "A Theory of Workouts and the Effects of Reorganization Law," *Journal of Finance* 46(4), 1189-1222.

[17] Griliches, Z., 1990, "Patent statistics as economic indicators: A survey," *Journal of Economic Literature*, 28, 1661–1707.

[18] Grossman, G. and E. Helpman, 1991, "Innovation and Growth in the Global Economy," Cambridge: MIT Press.

[19] Hall, B. H., A. Jaffe and M. Trajtenberg. 2001. "The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools," NBER working paper.

[20] Hall, B., A. Jaffe, and M. Trajtenberg, 2005, "Market value and patent citations," *RAND Journal of Economics* 32, 101–128.

[21] Haselmann, R., K. Pistor, and V. Vig, "How Law affects Lending," 2006, Working Paper.

[22] Hyytinen, Ari, I. Kuosa and T. Takalo, 2001, "Law or Finance: Evidence from Finland," Working Paper, The Research Institute of The Finnish Economy.

[23] Kang, Nimrit and N. Nayar, 2004, "The Evolution of Corporate Bankruptcy Law in India," 2004, *Money and Finance*, Oct 03 - Mar 04, 37-58.

[24] King, Robert and R. Levine, "Finance and Growth: Schumpeter Might be Right," 1993, *Quarterly Journal of Economics*, CVIII, 3, 717-738.

[25] Kondo M., "R&D dynamics of creating patents in the Japanese industry," 1999, *Research Policy*, 28(6), 587-600.

[26] Kortum, Samuel and J. Lerner, "What is behind the recent surge in patenting?" 1999, *Research Policy*, 28, 1-22.

[27] Lall, Sanjaya, 2003, "Indicators of the relative importance of IPRs in developing countries," *Research Policy,* 32(9), 1657-1680.

[28] Landier, Augstin, 2006, "Entrepreneurship and the Stigma of Failure," Working Paper, Stern School of Business, New York University.

[29] La Porta, Rafael, F. Lopez-de-Silanes, A. Shleifer, and R. W. Vishny, 1997, "Legal determinants of external finance," *Journal of Finance*, 52, 1131-1150.

[30] La Porta, Rafael, F. Lopez-de-Silanes, A. Shleifer, and R. W. Vishny, 1998, "Law and finance," *Journal of Political Economy*, 101, 678-709.

[31] La Porta, Rafael, F. Lopez-de-Silanes, and A. Shleifer, 1999, "Corporate Ownership Around the World," *Journal of Finance*, vol. 54(2), pages 471-517, 04.

[32] MacGarvie, 2006, "Do firms learn from international trade?" *The Review of Economics and Statistics*, 88(1), 46-60.

[33] Manso, Gustavo, 2005, "Motivating Innovation," Working Paper, MIT.

[34] Martel, Jocelyn, 1994, "More on the Impact of Bankruptcy Reform in Canada, " Working Paper, Centre interuniversitaire de recherche en analyse des organisations

[35] Nicita A. and M. Olarreaga, 2006, "Trade, Production and Protection: 1976-2004," *World Bank Economic Review,* 21(1).

[36] Nini, Greg, D. C. Smith and A. Sufi, 2006, "Creditor Control Rights and Firm Investment Policy," Working Paper, University of Chicago, Graduate School of Business.

[37] Paci R., Sassu A., Usai S., 1997, "International patenting and national technological specialization," *Technovation*, 17(1), pp. 25-38.

[38] Pakes, A., and M. Shankerman, 1984, "The rate of obsolescence of patents, research gestation lags, and the private rate of return to research resources," in Zvi Griliches, ed., *R&D, Patents and Productivity,* University of Chicago Press, 98–112.

[39] Rapp, Richard T. and R. P.Rozek, 1990, "Benefits and costs of intellectual property protection in developing countries", *Journal of World Trade*, 24, 75-102.

[40] Rajan, R. and L. Zingales, "What Do We Know about Capital Structure? Some Evidence from International Data," 1995, *Journal of Finance*, vol. 50(5), pages 1421-1460.

[41] Rajan, R. and L. Zingales, "Financial dependence and growth," 1998, *American Economic Review*, 88:559–586.

[42] Romer, P., 1986, "Increasing Returns and Long-Rung Growth," *Journal of Political Economy*, 94(5), 1002–1037.

[43] Soete L. and S. Wyatt, "The use of foreign patenting as an internationally comparable science and technology output indicator," 1983, *Scientometrics*, January: 31-54.

[44] Sundaram, R. K., 2003, "Generalized Bandit Problems," Working Paper, Stern School of Business; forthcoming in *Social and Strategic Behavior: Essays in Honor of Jeffrey S. Banks* (David Austen-Smith and John Duggan, Eds).

Notes

[1]For example, the literature has documented an effect of legal institutions on the nature of external financing of enterprises (La Porta, Lopez-de-Silanes, Shleifer and Vishny, 1997, 1998), the ownership structure of firms (La Porta, Lopez-de-Silanes and Shleifer, 1999), the mix between market- and bank-dominated finance (Allen and Gale, 2000), and economic growth through the provision of financial access to firms (King and Levine, 1993, Rajan and Zingales, 1998).

[2]Entrepreneurs certainly seem to believe there is such a link: "The wider lesson is not to stigmatise failure but to tolerate it and learn from it: Europe's inability to create a rival to Silicon Valley owes much to its *tougher bankruptcy laws.*" - Lessons from Apple, The Economist, June 7, 2007 (Emphasis added)

[3]We discuss in detail in the main body of the paper the relative merits of different patent-based measures of innovation, and indeed of patents themselves as a measure of innovation.

[4]This is a score between 0 and 4, based on a score of one each for whether there is no automatic stay on secured creditors' rights, secured creditors are paid first in bankruptcy, no majority creditor consent is required for reorganization, and management does not stay in place upon bankruptcy.

[5]As Cohen, Nelson and Walsh (1996) find in their survey of patenting across various US industries, the propensity to patent is largely driven by technological characteristics of an industry. Since the US has had the best financial markets necessary to fund financially constrained high-growth sectors (Rajan and Zingales, 1998), the most vibrant research environment, the world's most advanced patenting system (Kortum and Lerner, 1999), and the preferred patenting jurisdication for innovating firms internationally (Cantwell and Hodson, 1991), we can make the reasonable assumption that the US ranking best reflects the technological propensity of an industry to innovate.

[6]Furthermore, based on existing studies of what caused the creditor rights to change, we argue that in case of some countries, the change occurred for exogenous reasons (e.g., to promote employment or protect domestic industries); in others the change occurred precisely to promote innovation and give managers-entrepreneurs a fresh start in default; whereas in some others the change was part of an overall package of reforms designed to stimulate growth following recessions.

[7]A caveat about potential biases created by the use of application year, particularly in the case of foreign patents, is in order. Since foreign firms usually file patents with the domestic patent office and then with the USPTO, readers may believe that the application year recorded with the USPTO does not capture the exact timing of the innovation. However, the Paris Convention which governs such firms filing both in the domestic and foreign country, mandates that if the inventor files a foreign patent application in any other Paris Convention signatory state within 12 months of the domestic filing, overseas patent-granting authorities

will treat the application as if it were filed on the first filing date. Therefore, the application year recorded with the USPTO would coincide with the application year for the domestic patent of the foreign firm.

[8]Pakes and Shankerman (1984) show that the distribution of the importance of patents is extremely skewed, i.e., most of the value is concentrated in a small number of patents. Hall et al. (2005) among others demonstrate that patent citations are a good measure of the value of innovations.

[9]An an alternative to patents as proxies of innovation, R&D spending across different industries could be a potential proxy for innovation intensity. However, in a cross-country setting, this presents several challenges. For example, accounting norms, particularly whether R&D is capitalized or is expensed, would have a mechanical effect on R&D spending. Griliches (1990) emphasized that there is a strong relationship in the US between R&D and the number of patents received at the cross-sectional level, across firms and industries. The median R-squared is of the order of 0.9.

[10]Readers may query how do we treat the patents that are filed by US subsidiaries of foreign firms and does the inclusion or exclusion of such patents affect our results. We identify such patents as those where the country of the "assignee" is non-US but the country of the "inventor" is recorded as US. Of the 3,333,701 patents in our sample, we identify 21,489 patents (0.6%) issued to US subsidiaries of foreign companies. Not surprisingly, excluding these patents does not change our results.

[11]To account for the two point creditor rights decrease in Finland, we code δ_{ct} to be two before the change and zero after the change for Finland. Since Russia underwent a creditor rights increase in 1994 and a decrease in 1998, for Russia we code δ_{ct} to be equal to zero till 1994, one for the years 1995-1998 and zero thereafter. For Lithuania, which underwent a creditor rights increase in 1995 and in 1998, we code δ_{ct} to be equal to two till 1994, one for the years 1995-1998 and zero thereafter.

[12]We match the patent classes to the 3-digit ISIC using a two-step procedure: first, the updated NBER patent dataset (patsic02.dta on Brownwyn Hall's homepage) assigns each patent to a 2-digit SIC. We then employed the concordance from 2-digit SIC to 3-digit ISIC codes. Since every patent is already assigned to a patent class in the original NBER patent dataset, this completes our match from the patent class to the 3-digit ISIC code.

[13]We thank Francesca Cornelli for sharing with us this data.

[14]We also check this result separately for the period 1978-1990 and 1991-2002. Furthermore, we also test by excluding those countries for which the aggregate number of patents over the period 1978-2002 is less than 100. Our results remain as strong for these sub-samples. We also perform two different robustness checks for the definition of Innovation Intensity. First, we verify that the results are unchanged if we compute Innovation Intensity as the median number of patents applied by US firms in the year $(t-2)$. We use the year $(t-2)$ since we find using the de-trended number of patents and citations for US firms that both follow

an AR(1) process. Second, we test by constructing Innovation Intensity using US patents filed by Japanese firms and excluding Japanese patents from the analysis. Our results are unaltered in both cases.

[15]Our results here are robust to the use of two other measures of financial development: (i) Total Capitalization to GDP is the ratio of the sum of equity market capitalization (as reported by the IFC) and domestic credit (IFS line 32a-32f but not 32e) to GDP from Rajan and Zingales (1998) and (ii) Domestic Private credit to GDP is the ratio of domestic credit to the private sector, which is from IFS line 32d, over GDP from Rajan and Zingales (1998).

[16]Since our regressions include country fixed effects, we estimate the effect of legal origin variables here by aggregating over the country fixed effects.

[17]According to Kortum and Lerner (1999), the key strengths of the American system include: (i) the awarding of the patent to the first to discover an innovation, rather than the first to file for an invention (as in the Japanese and European patenting systems); (ii) the principle that patent applications would not be published until they were awarded; and (iii) the broad interpretation of patent scope through the doctrine of equivalents.

[18]Cantwell and Hodson (1991) found in their study of patenting practices of the world's largest firms (from the Fortune listings) that over 85% of all these firms had recorded patenting in the US.

Table 1: Summary Statistics by Country

Country	# of Patents	# of Citations	# of Firms	Mean Patents	Mean Citations	Creditor Rights
Argentina	137	318	130	1.2	2.7	1
Australia	6452	26689	5448	2.1	8.8	3
Austria	6134	20946	4430	2.2	7.4	3
Belgium	6168	22641	3769	2.7	9.8	2
Brazil	648	1699	554	1.2	3.3	1
Bulgaria	253	972	239	1.2	4.5	1,2
Canada	24141	124569	18583	4.2	21.9	2,1
Chile	62	160	59	1.1	2.9	2
China	766	1646	598	1.5	3.3	2
China, Hong Kong	980	3595	810	1.6	5.8	4
Colombia	22	50	21	1.0	2.4	0
Croatia	46	41	36	1.5	1.4	3
Czech republic	69	68	64	1.2	1.2	3
Denmark	4489	16433	3062	2.3	8.2	2,3
Finland	7003	27521	4545	2.7	10.7	3,1
France	51491	212668	32716	7.2	29.9	0
Germany	147786	599389	77121	17.4	70.4	3
Greece	84	150	80	1.1	1.9	1
Hungary	1516	5192	1108	2.0	6.8	1
India	693	711	460	2.1	2.1	3,2
Indonesia	27	55	25	1.1	2.3	3,2
Ireland	639	2908	581	1.3	5.8	2,1
Israel	5133	22119	4152	2.4	10.3	4,3
Italy	21746	78787	15574	4.0	14.5	2
Japan	440855	2373939	155127	50.4	271.4	3,1
Malaysia	95	245	80	1.3	3.2	3
Mexico	404	1032	337	1.3	3.4	0
Netherlands	9328	34495	7240	2.5	9.3	3
New Zealand	780	2551	710	1.3	4.1	4
Norway	2174	7613	1820	1.6	5.8	2
Philippines	18	39	18	1.0	2.2	1
Poland	286	860	267	1.2	3.5	1
Portugal	60	207	56	1.1	3.8	1
Romania	55	179	53	1.1	3.6	1,2
Russian Federation	547	814	474	1.5	2.2	3,2,1
Saudi Arabia	35	46	33	1.1	1.4	3
Singapore	1006	3604	558	2.3	8.2	3
Slovenia	63	92	60	1.1	1.6	3
South Africa	1256	5254	1145	1.4	5.7	3
South Korea	23221	60968	7240	8.7	22.8	3
Spain	2011	5141	1755	1.5	3.9	2
Sweden	16761	71194	11463	3.5	14.8	2,1
Switzerland	18620	78961	13155	3.7	15.5	1
Taiwan	16726	49202	7571	6.6	19.4	2
Thailand	52	113	48	1.1	2.4	3,2
Turkey	32	124	30	1.1	4.1	2
Ukraine	70	88	63	1.1	1.4	3,2
United Kingdom	43056	211786	30315	6.2	30.5	4,3
Venezuela	322	1028	218	1.6	5.1	3
Others (includes countries with less than 15 patents)	159	404	146	1.1	2.6	

Table 2: Countries that underwent a Change in Creditor Rights

This table shows the list of countries that underwent a change in its creditor rights during the period 1978-1999. From the list of countries undergoing creditor rights changes, as documented in Appendix B of Djankov, McLeish and Shleifer (2007), we exclude those changes that occurred after the year 1998. This is to allow for at least a few years of patent data after the creditor rights change was effected. From the list of changes in Djankov, McLeish and Shleifer (2007), we exclude the changes in Armenia, Kazhakstan, Mongolia and Niger. For these countries, either the country does not have an entry in the patent data or the Creditor Rights index does not exist for a large part of the sample period.

Countries that underwent Decreases in Creditor Rights

Country code	Country Name	Year of change
ATX	Austria	1982
CAX	Canada	1992
FIX	Finland[1]	1993
IDX	Indonesia	1998
IEX	Ireland	1990
ILX	Israel	1995
INX	India	1993
SEX	Sweden	1995
RUX	Russian Federation	1998

Countries that underwent Increases in Creditor Rights

Country code	Country Name	Year of change
DKX	Denmark	1984
GBX	United Kingdom	1985
LTX	Lithuania	1995, 1998
ROX	Romania	1999
RUX	Russian Federation	1994

[1] Finland underwent a two point decrease in its creditor rights while all other countries experienced a one point change.

Table 3: Impact of Changes in Creditor Rights on Innovation

The OLS regressions below implement the following difference-in-difference test:

$$y_{ict} = \beta_i + \beta_c + \beta_t + \beta_1\delta_{ct} + \beta_2 InnovationIntensity_{i,t-1} + \beta X + \varepsilon_{ict}$$

where i,c,t refer to USPTO patent class i, country c and application year t respectively. The sample includes patents issued by the USPTO to non-US firms over the period 1978-2002. Innovation Intensity for USPTO patent class i is measured as the median number of patents held by a US firm in patent class i in the year t-1. δ_{ct} equals 1 for country c and years $t \geq m+1$ (years $t < m+1$) if a creditor rights reform initiated in year m increased (decreased) the rights provided to creditors. δ_{ct} equals 0 otherwise. The sample of changes in creditor rights in different countries is as displayed in Table 4. β_i, β_c, β_t denote patent class, country and application year dummies. Creditor Rights Change (-2,-1) equals δ_{ct} for the years m-2 to m-1 and is zero otherwise. Similarly, Creditor Rights Change (0,1) equals δ_{ct} for the years m to m+1 and zero otherwise while Creditor Rights Change (≥2) equals δ_{ct} for the years m+2 and beyond and zero otherwise. The robust Standard errors are clustered by country. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Panel A: Main Tests

Dependent Variable is Logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Firms	(4) Number of Patents	(5) Number of Citations	(6) Number of Firms	(7) Number of Patents	(8) Number of Citations	(9) Number of Firms
Creditor rights Change	-0.087**	-0.121**	-0.077**	-0.102**	-0.143**	-0.088**			
	(2.17)	(2.39)	(2.23)	(2.25)	(2.46)	(2.30)			
Creditor rights Change (≥2)							-0.099**	-0.138**	-0.089**
							(2.12)	(2.38)	(2.25)
Creditor rights Change (0,1)							-0.020	-0.053	-0.013
							(1.08)	(1.59)	(0.73)
Creditor rights Change (-2,-1)							0.041**	0.052	0.042**
							(2.33)	(1.53)	(2.30)
Innovation Intensity	0.042***	-0.022	0.023**	0.043***	-0.022	0.023**	0.043***	-0.021	0.024**
	(3.96)	(1.04)	(2.18)	(4.07)	(1.01)	(2.26)	(4.11)	(0.99)	(2.28)
Log of GDP per capita				0.665	0.962	0.462	0.649	0.939	0.448
				(1.26)	(1.60)	(1.15)	(1.23)	(1.57)	(1.12)
Value Added in 3-digit ISIC in a year / Total				-0.000	-0.004*	-0.000	-0.000	-0.006*	-0.000
Value Added by the country in that year				(0.95)	(1.70)	(1.22)	(0.96)	(1.70)	(1.23)
Log of Country's Imports to US in the 3-digit				-0.001	0.001	-0.000	-0.001	0.001	-0.000
ISIC industry in a year				(1.48)	(0.79)	(0.49)	(1.47)	(0.80)	(0.48)
Log of Country's Exports to US in the 3-digit				-0.001	-0.001	-0.000	-0.001	-0.001	-0.000
ISIC industry in a year				(1.36)	(1.17)	(0.59)	(1.37)	(1.18)	(0.60)
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86308	86308	86308	86308	86308	86308	86308	86308	86308
Adjusted R-squared	0.60	0.61	0.63	0.60	0.61	0.63	0.60	0.61	0.63

Panel B: Excluding countries that underwent a change in Patent Protection during our sample period (Austria, Indonesia, Ireland, Israel and Russia)

Dependent Variable is Logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Firms	(4) Number of Patents	(5) Number of Citations	(6) Number of Firms	(7) Number of Patents	(8) Number of Citations	(9) Number of Firms
Creditor rights Change	-0.095**	-0.117**	-0.077**	-0.121**	-0.155**	-0.095**			
	(2.12)	(2.20)	(2.01)	(2.23)	(2.34)	(2.12)			
Creditor rights Change (≥2)							-0.118**	-0.157**	-0.093**
							(2.13)	(2.43)	(2.12)
Creditor rights Change (0,1)							-0.015	0.009	-0.013
							(0.48)	(0.21)	(0.56)
Creditor rights Change (-2,-1)							-0.025	0.102	-0.023
							(0.81)	(1.18)	(0.86)
Innovation Intensity	0.043***	-0.018	0.021*	0.044***	-0.017	0.022**	0.044***	-0.016	0.022**
	(3.89)	(0.82)	(1.98)	(4.01)	(0.78)	(2.07)	(4.04)	(0.76)	(2.09)
Log of GDP per capita				0.759	1.062	0.511	0.740	1.041	0.496
				(1.33)	(1.62)	(1.16)	(1.30)	(1.60)	(1.14)
Value Added in 3-digit ISIC in a year / Total				-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Value Added by the country in that year				(0.13)	(0.88)	(0.38)	(0.13)	(0.88)	(0.38)
Log of Country's Imports to US in the 3-digit				-0.001	0.000	-0.000	-0.001	0.000	-0.000
ISIC industry in a year				(1.52)	(0.65)	(0.74)	(1.51)	(0.68)	(0.73)
Log of Country's Exports to US in the 3-digit				-0.001	-0.001	-0.000	-0.001	-0.001	-0.000
ISIC industry in a year				(1.58)	(1.29)	(0.92)	(1.58)	(1.28)	(0.93)
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	80440	80440	80440	80440	80440	80440	80440	80440	80440
Adjusted R-squared	0.60	0.62	0.63	0.60	0.62	0.63	0.60	0.62	0.63

Table 4: Impact of Changes in Creditor Rights on Average Innovation

The OLS regressions below implement the following difference-in-difference test:

$$y_{ict} = \beta_i + \beta_c + \beta_t + \beta_1\delta_{ct} + \beta_2 InnovationIntensity_{i,t-1} + \beta X + \varepsilon_{ict}$$

where i,c,t refer to USPTO patent class i, country c and application year t respectively. The sample includes patents issued by the USPTO to non-US firms over the period 1978-2002. Innovation Intensity for USPTO patent class i is measured as the median number of patents held by a US firm in patent class i in the year t-1. δ_{ct} equals 1 for country c and years $t \geq m+1$ (years $t < m+1$) if a creditor rights reform initiated in year m increased (decreased) the rights provided to creditors. δ_{ct} equals 0 otherwise. The sample of changes in creditor rights in different countries is as displayed in Table 4. β_i, β_c, β_t denote patent class, country and application year dummies. Creditor Rights Change (-2,-1) equals δ_{ct} for the years m-2 to m-1 and is zero otherwise. Similarly, Creditor Rights Change (0,1) equals δ_{ct} for the years m to m+1 and zero otherwise while Creditor Rights Change (≥2) equals δ_{ct} for the years m+2 and beyond and zero otherwise. The robust Standard errors are clustered by country. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Dependent Variable is Logarithm of:	(1) Median Patents	(2) Average Patents	(3) Citation weighted average Patents	(4) Median Patents	(5) Average Patents	(6) Citation weighted average Patents
Creditor rights Change	-0.032**	-0.046*	-0.111***	-0.035**	-0.051**	-0.120***
	(2.14)	(1.95)	(2.88)	(2.27)	(2.10)	(2.99)
Innovation Intensity	0.012*	0.020***	-0.048***	0.012*	0.020***	-0.047***
	(1.82)	(2.96)	(3.11)	(1.83)	(2.96)	(3.11)
Log of GDP per capita				0.094*	0.212	0.387*
				(1.82)	(1.60)	(1.69)
Value Added in 3-digit ISIC in a year / Total				0.000	-0.000	-0.000
Value Added by the country in that year				(0.89)	(0.06)	(0.93)
Log of Country's Imports to US in the 3-digit				-0.001***	-0.001***	0.001*
ISIC industry in a year				(3.90)	(2.93)	(1.75)
Log of Country's Exports to US in the 3-digit				-0.000	-0.000*	-0.000
ISIC industry in a year				(0.05)	(1.94)	(0.25)
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86308	86308	86308	86308	86308	86308
Adjusted R-squared	0.11	0.28	0.48	0.11	0.28	0.49

Table 5: Relative Impact of Creditor Rights on Aggregate Innovation in Different Industries

The OLS regressions below implement the following model

$$y_{ict} = \beta_i + \beta_c + \beta_t + \beta_1 (CreditorRights_{ct} * InnovationIntensity_{i,t-1}) + \beta_2 CreditorRights_{ct} + \beta_3 InnovationIntensity_{i,t-1} + \varepsilon_{ict}$$

where i,c,t refer to USPTO patent class i, country c and application year t respectively. The sample includes patents issued by the USPTO to non-US firms over the period 1978-2002. Innovation Intensity for USPTO patent class i is measured as the median number of patents held by a US firm in patent class i in the year t-1. The Creditor Rights index for country c is from DMS (2005) – a higher measure indicates stronger rights provided to creditors in bankruptcy. β_i, β_c, β_t denote patent class, country and application year dummies. The Standard errors are robust to heteroskedasticity and autocorrelation and are clustered by country. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Panel A: Main Tests

Dependent Variable is Logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Firms	(4) Number of Patents	(5) Number of Citations	(6) Number of Firms
Creditor rights * Innovation Intensity	-0.040**	-0.039**	-0.027*	-0.038**	-0.030*	-0.028**
	(2.36)	(2.14)	(1.88)	(2.42)	(1.95)	(1.99)
Creditor rights	0.011	0.134	-0.002	-0.013	0.096	-0.016
	(0.16)	(0.79)	(0.04)	(0.18)	(0.57)	(0.29)
Innovation Intensity	0.139***	0.074	0.089*	0.535	0.186	1.035**
	(2.70)	(1.29)	(1.88)	(1.01)	(0.21)	(2.41)
Log of GDP per capita				0.671	0.872	0.533
				(1.15)	(1.44)	(1.21)
Value Added in 3-digit ISIC in a year / Total Value Added by the country in that year				0.008	-0.010	0.004
				(0.74)	(0.75)	(0.52)
Log of Country's Imports to US in the 3-digit ISIC industry in a year				0.000	0.003	0.001
				(0.23)	(1.15)	(1.20)
Log of Country's Exports to US in the 3-digit ISIC industry in a year				0.004***	0.005**	0.004**
				(3.03)	(2.17)	(2.45)
Log of GDP per capita * Innovation Intensity				-0.036	-0.007	-0.091**
				(0.69)	(0.07)	(2.24)
Value Added in 3-digit ISIC in a year / Total Value Added by the country in that year * Innovation Intensity				-0.010	0.005	-0.007
				(0.99)	(0.36)	(0.79)
Log of Country's Imports to US in the 3-digit ISIC industry in a year * Innovation Intensity				-0.001	-0.002	-0.001
				(0.62)	(1.01)	(1.16)
Log of Country's Exports to US in the 3-digit ISIC industry in a year * Innovation Intensity				0.004***	0.005**	0.004**
				(3.22)	(2.35)	(2.51)
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	No	Yes	Yes	No
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85300	85300	83255	85300	85300	83255
Adjusted R-squared	0.60	0.60	0.61	0.61	0.62	0.63

Panel B: Tests controlling for legal origin and other time-varying unobserved factors at country and patent category levels

Dependent Variable is Logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Firms	(4) Number of Patents	(5) Number of Citations	(6) Number of Firms	(7) Number of Patents	(8) Number of Citations	(9) Number of Firms
Creditor rights * Innovation Intensity	-0.011*	-1.107**	-0.018*	-0.047***	-0.141***	-0.031***	-0.045***	-0.138***	-0.031***
	(1.66)	(2.22)	(1.72)	(3.74)	(2.69)	(3.24)	(3.58)	(2.62)	(3.18)
Creditor rights	0.001	-0.757	-0.017				0.069***	-0.107	0.057***
	(0.15)	(1.27)	(1.32)				(3.87)	(1.43)	(4.13)
Innovation Intensity	0.154***	-1.741	0.033	0.162***	0.286**	0.104***	0.145***	0.232	0.098***
	(4.86)	(0.71)	(0.64)	(4.71)	(1.97)	(3.89)	(4.17)	(1.58)	(3.60)
One if English Legal Origin * Innovation	-0.007	3.498	0.004						
Intensity	(0.22)	(1.42)	(0.08)						
One if French Legal Origin * Innovation	0.014	4.234*	0.095*						
Intensity	(0.47)	(1.79)	(1.87)						
One if German Legal Origin * Innovation	-0.027	4.498*	-0.004						
Intensity	(0.89)	(1.95)	(0.09)						
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Country * Application Year) Dummies	No	No	No	Yes	Yes	Yes	No	No	No
(Patent Category *Appln. Year) Dummies	No	No	No	No	No	No	Yes	Yes	Yes
Observations	83255	83255	83255	68457	68457	68457	68442	68442	68442
Adjusted R-squared	0.29	0.41	0.58	0.59	0.54	0.62	0.58	0.52	0.61

Table 6: Relative Impact of Creditor Rights on Innovation in Different Industries after controlling for the Effect of Financial Development

The OLS regressions below add a measure of Financial Development and the interaction of the measure of Financial development with patenting intensity to the basic model examined in Table 2. We use the following proxies for Financial Development: (1) Accounting Standards is an Index created by Center for International Financial Analysis & Research examining and rating companies' 1990 annual reports on their inclusion or omission of 90 items from LLSV (1998), (2) Log Private Credit to GDP per capita is the logarithm of the ratio of Domestic private credit (IFS line 32d) to the GDP per capita from LLSV(1998).[2] The dependent variable in the regressions is the logarithm of the total number of patents, the total number of citations to these patents, or the total number of patenting firms. i denotes USPTO patent class i, c denotes country c, and t denotes the application year. The sample includes patents issued by the USPTO to non-US firms over the period 1978-2002. Patent Intensity for USPTO patent class i is measured as the median number of patents held by a US firm in patent class i in the year (t-1). The Creditor Rights index for country c is from DMS (2005) – a higher measure indicates stronger rights provided to creditors in bankruptcy. The Standard errors are adjusted for clustering of residuals by country. *** and ** denote significance at the 1% and 5% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable is log of:	Number of Patents	Number of Patents	Number of Citations	Number of Citations	Number of Patenting Firms	Number of Patenting Firms
Which Financial Development measure?	Accounting standards	Log Private Credit to GDP per capita	Accounting standards	Log Private Credit to GDP per capita	Accounting standards	Log Private Credit to GDP per capita
Creditor rights * Median number of patents in US Patent Class	-0.038***	-0.039***	-0.130**	-0.132**	-0.025***	-0.023**
	(3.14)	(3.20)	(2.54)	(2.53)	(2.70)	(2.39)
Creditor rights	0.006	0.008	0.049	0.052	-0.005	-0.008
	(0.40)	(0.50)	(0.78)	(0.80)	(0.47)	(0.69)
Median number of patents in US Patent Class	0.463***	0.139***	1.004**	0.266*	0.344***	0.086***
	(3.97)	(4.22)	(2.02)	(1.89)	(3.77)	(3.32)
Financial Development Measure * Median number of patents in Patent class	-0.005***	-0.005	-0.011	-0.032	-0.004***	-0.066**
	(2.89)	(0.12)	(1.54)	(0.19)	(2.90)	(2.08)
Financial Development Measure	0.002	0.037	0.080***	0.367	0.002	0.095
	(0.35)	(0.47)	(2.93)	(1.10)	(0.40)	(1.55)
One if English Legal Origin	-0.340***	-0.450***	-0.362	-0.956*	-0.212***	-0.340***
	(3.68)	(3.84)	(0.92)	(1.91)	(2.93)	(3.70)
One if French Legal Origin	-0.519***	-0.387***	0.426	-1.051***	-0.370**	-0.274***
	(2.68)	(4.53)	(0.51)	(2.89)	(2.43)	(4.10)
One if German Legal Origin	0.668***	0.898***	2.806***	2.019***	0.589***	0.586***
	(10.85)	(30.69)	(10.68)	(16.18)	(12.21)	(25.60)
Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83458	83458	83458	83458	83458	83458
Adjusted R-squared	0.55	0.55	0.51	0.51	0.58	0.58

[2] The results are robust to the use of two other measures of financial development: (i) Total Capitalization to GDP is the ratio of the sum of equity market capitalization (as reported by the IFC) and domestic credit (IFS line 32a-32f but not 32e) to GDP from Rajan and Zingales (1998) and (ii) Domestic Private credit to GDP is the ratio of domestic credit to the private sector, which is from IFS line 32d, over GDP from Rajan and Zingales (1998).

Table 7: Relative Impact of Creditor Rights on Average Innovation in Different Industries

The OLS regressions below implement the following model:
$y_{ict} = \beta_i + \beta_c + \beta_t + \beta_1 \left(CreditorRights_{ct} * InnovationIntensity_{i,t-1} \right) + \beta_2 CreditorRights_{ct} + \beta_3 InnovationIntensity_{i,t-1} + \varepsilon_{ict}$ where i,c,t refer to USPTO patent class i, country c and application year t respectively. The sample includes patents issued by the USPTO to non-US firms over the period 1978-2002. Innovation Intensity for USPTO patent class i is measured as the median number of patents held by a US firm in patent class i in the year t-1. The Creditor Rights index for country c is from DMS (2005) – a higher measure indicates stronger rights provided to creditors in bankruptcy. β_i, β_c, β_t denote patent class, country and application year dummies. The Standard errors are robust to heteroskedasticity and autocorrelation and are clustered by country. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Dependent Variable is Logarithm of:	(1) Median Patents	(2) Median Patents	(3) Average Patents	(4) Average Patents	(5) Citation weighted average Patents	(6) Citation weighted average Patents
Creditor rights * Innovation Intensity	-0.018***	-0.013**	-0.020***	-0.016**	-0.311***	-0.329***
	(3.33)	(2.56)	(2.64)	(1.99)	(4.27)	(4.46)
Creditor rights	0.013	0.006	0.019	0.009	0.278**	0.291***
	(1.57)	(0.62)	(1.01)	(0.46)	(2.44)	(2.67)
Innovation Intensity	0.130***	-0.429***	0.136***	-0.266*	0.137	0.530
	(9.66)	(3.40)	(7.29)	(1.85)	(1.02)	(0.22)
Log of GDP per capita		0.029		0.150		0.226
		(0.49)		(1.13)		(0.61)
Value Added in 3-digit ISIC in a year / Total		-0.000		-0.000		-0.000
Value Added by the country in that year		(1.14)		(0.15)		(0.22)
Log of Country's Imports to US in the 3-digit		0.000		0.000		-0.019**
ISIC industry in a year		(0.31)		(0.02)		(2.17)
Log of Country's Exports to US in the 3-digit		-0.001		-0.000		0.008*
ISIC industry in a year		(0.54)		(0.14)		(1.69)
Log of GDP per capita * Innovation Intensity		0.056***		0.040***		-0.048
		(4.44)		(2.80)		(0.20)
Value Added in 3-digit ISIC in a year / Total		0.000		0.000		0.000
Value Added by the country in that year *		(1.25)		(0.16)		(0.21)
Innovation Intensity						
Log of Country's Imports to US in the 3-digit		-0.001		-0.000		0.019**
ISIC industry in a year * Innovation Intensity		(0.64)		(0.23)		(2.21)
Log of Country's Exports to US in the 3-digit		0.001		-0.000		0.008*
ISIC industry in a year * Innovation Intensity		(0.46)		(0.12)		(1.71)
US Patent Subcategory Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85284	85284	85284	85284	85284	85284
Adjusted R-squared	0.06	0.06	0.19	0.19	0.34	0.34

Table 8: Relative Impact of Changes in Creditor Rights on Innovation in Different Industries

The OLS regressions below implement the following model:

$$y_{ict} = \beta_i + [\beta_c + \beta_t + \beta_1 \delta_{ct}] * InnovationIntensity_{i,t-1} + \beta_2 \delta_{ct} + \beta X + \varepsilon_{ict}$$

where i,c,t refer to USPTO patent class i, country c and application year t respectively. The sample includes patents issued by the USPTO to non-US firms over the period 1978-2002. Innovation Intensity for USPTO patent class i is measured as the median number of patents held by a US firm in patent class i in the year t. δ_{ct} equals 1 for country c and years $t \geq m+1$ (years $t < m+1$) if a creditor rights reform initiated in year m increased (decreased) the rights provided to creditors. δ_{ct} equals 0 otherwise. The sample of changes in creditor rights in different countries is as displayed in Table 4. β_i, β_c, β_t denote patent class, country and application year dummies. Creditor Rights Change (-2,-1) equals δ_{ct} for the years m-2 to m-1 and is zero otherwise. Similarly, Creditor Rights Change (0,1) equals δ_{ct} for the years m to m+1 and zero otherwise while Creditor Rights Change (≥2) equals δ_{ct} for the years m+2 and beyond and zero otherwise. The Standard errors are robust to heteroskedasticity and autocorrelation and are clustered by country. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Panel A: Main Tests

Dependent Variable is Logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Firms	(4) Number of Patents	(5) Number of Citations	(6) Number of Firms
Creditor rights Change * Innovation Intensity	-0.124**	-0.283**	-0.103*			
	(2.06)	(2.20)	(1.71)			
Creditor rights Change	0.026	0.147	0.019			
	(0.28)	(0.86)	(0.23)			
Creditor rights Change (≥2) * Innovation Intensity				-0.136*	-0.311**	-0.118*
				(1.93)	(2.37)	(1.75)
Creditor rights Change (0,1) * Innovation Intensity				-0.044	-0.355	0.116
				(0.36)	(1.38)	(1.49)
Creditor rights Change (-2,-1) * Innovation Intensity				0.071	-0.278	0.057
				(0.36)	(0.92)	(0.44)
Creditor rights Change (≥2)				0.041	0.181	0.036
				(0.39)	(1.04)	(0.41)
Creditor rights Change (0,1)				0.038	0.385	-0.125
				(0.31)	(1.51)	(1.50)
Creditor rights Change (-2,-1)				-0.096	0.215	-0.080
				(0.50)	(0.70)	(0.63)
Innovation Intensity	2.020	5.246	3.400	1.928	5.417	3.227
	(0.33)	(0.53)	(0.92)	(0.31)	(0.55)	(0.89)
Log of GDP per capita* Innovation Intensity	-0.291	-0.689	-0.425	-0.281	-0.705	-0.406
	(0.43)	(0.65)	(1.07)	(0.42)	(0.67)	(1.03)
Value Added in 3-digit ISIC in a year / Total Value Added by the country in that year* Innovation Intensity	-0.000	0.000	-0.000	-0.000	0.000	-0.000
	(0.88)	(0.37)	(0.31)	(0.88)	(0.36)	(0.36)
Log of Country's Imports to US in the 3-digit ISIC industry in a year* Innovation Intensity	-0.001	-0.004	-0.000	-0.001	-0.003	-0.001
	(0.45)	(1.55)	(0.41)	(0.45)	(1.47)	(0.50)
Log of Country's Exports to US in the 3-digit ISIC industry in a year* Innovation Intensity	0.004***	0.004*	0.004***	0.004***	0.004*	0.004***
	(3.00)	(1.83)	(2.89)	(3.00)	(1.96)	(2.87)
Log of GDP per capita	0.971	1.679	0.904	0.946	1.673	0.872
	(1.16)	(1.52)	(1.37)	(1.14)	(1.51)	(1.34)
Value Added in 3-digit ISIC in a year / Total Value Added by the country in that year	0.000	-0.000	0.000	0.000	-0.000	0.000
	(0.66)	(0.73)	(0.06)	(0.67)	(0.72)	(0.10)
Log of Country's Imports to US in the 3-digit ISIC industry in a year	-0.000	0.004	0.000	-0.000	0.004	0.000
	(0.08)	(1.57)	(0.23)	(0.09)	(1.50)	(0.33)
Log of Country's Exports to US in the 3-digit ISIC industry in a year	0.004***	0.003*	0.004***	0.004***	0.004*	0.004***
	(2.89)	(1.68)	(2.88)	(2.89)	(1.81)	(2.88)
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies * Innovation Intensity	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies * Innovation Intensity	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86308	86308	86308	86308	86308	86308
Adjusted R-squared	0.60	0.61	0.63	0.60	0.61	0.63

Panel B: Excluding countries that underwent a change in Patent Protection during our sample period (Austria, Indonesia, Ireland, Israel and Russia)

Dependent Variable is Logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Firms	(4) Number of Patents	(5) Number of Citations	(6) Number of Firms
Creditor rights Change * Innovation Intensity	-0.125*	-0.237**	-0.081*			
	(1.72)	(2.00)	(1.67)			
Creditor rights Change	0.008	0.088	-0.011			
	(0.11)	(0.73)	(0.22)			
Creditor rights Change (≥2) * Innovation Intensity				-0.125*	-0.254**	-0.091*
				(1.68)	(2.15)	(1.84)
Creditor rights Change (0,1) * Innovation Intensity				-0.083	-0.436*	0.105
				(0.50)	(1.67)	(0.90)
Creditor rights Change (-2,-1) * Innovation Intensity				0.050	-0.235	0.071
				(0.30)	(0.94)	(0.64)
Creditor rights Change (≥2)				0.010	0.103	0.001
				(0.13)	(0.85)	(0.02)
Creditor rights Change (0,1)				0.068	0.458*	-0.121
				(0.40)	(1.69)	(1.00)
Creditor rights Change (-2,-1)				-0.079	0.157	-0.098
				(0.46)	(0.60)	(0.84)
Innovation Intensity	2.020	5.246	3.400	1.928	5.417	3.227
	(0.33)	(0.53)	(0.92)	(0.31)	(0.55)	(0.89)
Log of GDP per capita* Innovation Intensity	-0.299	-0.688	-0.472**	-0.298	-0.717	-0.456**
	(0.98)	(1.39)	(2.46)	(0.98)	(1.46)	(2.38)
Value Added in 3-digit ISIC in a year / Total Value Added by the country in that year* Innovation Intensity	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(1.07)	(0.02)	(0.75)	(1.05)	(0.00)	(0.77)
Log of Country's Imports to US in the 3-digit ISIC industry in a year* Innovation Intensity	-0.001	-0.003	-0.000	-0.001	-0.003	-0.000
	(0.32)	(0.94)	(0.28)	(0.30)	(0.86)	(0.33)
Log of Country's Exports to US in the 3-digit ISIC industry in a year* Innovation Intensity	0.004**	0.002	0.004***	0.004**	0.002	0.004***
	(2.04)	(0.71)	(2.73)	(2.10)	(0.88)	(2.73)
Log of GDP per capita	1.075***	1.782***	1.003***	1.055***	1.790***	0.972***
	(3.42)	(3.50)	(4.97)	(3.35)	(3.53)	(4.83)
Value Added in 3-digit ISIC in a year / Total Value Added by the country in that year	0.000	-0.000	0.000	0.000	-0.000	0.000
	(1.03)	(0.13)	(0.67)	(1.01)	(0.14)	(0.69)
Log of Country's Imports to US in the 3-digit ISIC industry in a year	-0.000	0.003	0.000	-0.000	0.003	0.000
	(0.07)	(1.05)	(0.01)	(0.09)	(0.97)	(0.06)
Log of Country's Exports to US in the 3-digit ISIC industry in a year	0.003*	0.001	0.003**	0.003*	0.002	0.003**
	(1.67)	(0.49)	(2.43)	(1.73)	(0.65)	(2.42)
US Patent Class Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies * Innovation Intensity	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Dummies * Innovation Intensity	Yes	Yes	Yes	Yes	Yes	Yes
Observations	80440	80440	80440	80440	80440	80440
Adjusted R-squared	0.60	0.62	0.63	0.60	0.62	0.63

Table 9: Tests of the Leverage hypothesis using data for G-7 countries

This table shows regression of 6 measures of leverage on creditor score, Innovation Intensity (number of patents of median firm in the 2-digit SIC industry in the US), and the interaction of creditor score and patenting intensity, and various fixed effects (country, year, and industry by country) and controls (tangibility, profitability, log of sales, and market to book ratio) as well the interaction of control variables with country dummies. The sample period is from 1990-2005. The robust standard errors are adjusted for clustering of residuals by country. ***, **,* denote significance at the 1%, 5%, and 10% levels respectively.

	(1) Book Debt	(2) Market Debt	(3) All non-equity liabilities	(4) Net Book Debt	(5) Net Market Debt	(6) Net All non-equity liabilities
Creditor rights * Innovation Intensity measured at the 2-digit SIC level	-0.59%***	-0.43%**	-0.71%***	-0.81%***	-0.34%	-0.95%***
	(2.99)	(2.21)	(2.96)	(2.79)	(1.04)	(2.75)
Creditor rights	-1.29%	-2.34%	-8.13%***	-1.89%	-1.45%	-8.73%***
	(0.95)	(1.61)	(3.58)	(0.80)	(0.59)	(2.81)
Innovation Intensity	0.71%**	0.52%	0.85%**	0.89%*	-0.23%	1.07%*
	(2.27)	(1.62)	(2.15)	(1.79)	(0.27)	(1.83)
Constant	7.02%*	20.22%***	47.46%***	-13.53%*	-6.97%	26.01%**
	(1.65)	(4.43)	(6.52)	(1.75)	(0.85)	(2.53)
One if French Legal Origin		-0.012		-0.169		-1.346
		(0.00)		(0.00)		(0.00)
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry * Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Other characteristics * Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60680	60669	60674	60696	60685	60696
Adjusted R-squared	0.20	0.26	0.28	0.29	0.13	0.30

Table 10: The Effect of Creditor Rights and Innovation Intensity on Growth

The dependent variable in the regressions below is the continuously compounded growth rate in Real Value Added for the period 1978 – 1992 for each ISIC industry in each country. The Creditor Rights index for a country is from DMS (2005) – a higher measure indicates stronger rights provided to creditors in bankruptcy. Innovation intensity is measured at the 3-digit ISIC level as the median number of patents issued to US firms in the 3-digit ISIC industry using Hall, Jaffe and Trajtenberg (2001). The measure of External dependence for each ISIC industry is from Rajan and Zingales (1998). We use the following proxies for Financial Development: (1) Accounting Standards is an Index created by Center for International Financial Analysis & Research examining and rating companies' 1990 annual reports on their inclusion or omission of 90 items from LLSV (1998), (2) Total Capitalization to GDP is the ratio of the sum of equity market capitalization (as reported by the IFC) and domestic credit (IFS line 32a-32f but not 32e) to GDP from Rajan and Zingales (1998), (3) Domestic Private credit to GDP is the ratio of domestic credit to the private sector, which is from IFS line 32d, over GDP from Rajan and Zingales (1998), (4) Log Private Credit to GDP per capita is the logarithm of the ratio of Domestic private credit (IFS line 32d) to the GDP per capita from LLSV(1998). The control variables include the legal Origin of a country, industry fixed effects at the level of each ISIC, and country fixed effects. Since the country fixed effects subsume variation in the financial development measures while industry fixed effects do the same for external financial dependence, they are excluded from the regressions. The Standard errors are adjusted for clustering of residuals by country. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Which Financial Development measure?	(1) Accounting Standards	(2) Total Capitalization to GDP	(3) Domestic Credit to GDP	(4) Log of Private Credit to GDP per capita	(5) Accounting Standards	(6) Total Capitalization to GDP	(7) Domestic Credit to GDP	(8) Log of Private Credit to GDP per capita
Creditor Rights * Innovation Intensity measured at 3-digit ISIC level	-0.018***	-0.016***	-0.016***	-0.018***	-0.016*	-0.022**	-0.023**	-0.025***
	(3.39)	(3.23)	(3.27)	(3.38)	(1.81)	(2.34)	(2.32)	(2.65)
Creditor Rights	0.022***	0.018***	0.019***	0.023***	0.020**	0.025**	0.025**	0.030***
	(3.44)	(3.01)	(3.07)	(3.44)	(2.16)	(2.55)	(2.54)	(2.85)
Innovation Intensity measured at 3-digit ISIC level	0.046***	0.048***	0.000[3]	0.047***	0.000	0.000	0.000	0.068**
	(3.35)	(3.26)	(.)	(3.33)	(.)	(.)	(.)	(2.43)
Financial Development Measure * External Dependence	-0.000	0.007	0.010	-0.005				
	(0.42)	(0.71)	(0.51)	(0.47)				
Financial Development Measure * Innovation Intensity measured at 3-digit ISIC level					-0.000	0.034	0.070	0.027
					(0.35)	(1.41)	(1.58)	(1.29)
One if English legal origin	0.027**	0.034**	-0.019**	0.027**	0.072*	0.076**	-0.004	0.013
	(1.97)	(2.55)	(2.34)	(2.00)	(1.86)	(2.62)	(0.37)	(0.75)
One if German legal origin	0.138***	0.140***	0.002	0.138***	0.135***	0.054***	-0.022	0.131***
	(9.83)	(9.77)	(0.28)	(9.86)	(7.93)	(4.14)	(1.37)	(8.74)
One if French legal origin	0.121***	0.041***	-0.012	0.043***	0.181***	0.056***	0.007	0.086**
	(3.34)	(2.79)	(0.89)	(2.83)	(4.68)	(4.02)	(0.53)	(2.50)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	464	387	408	464	464	387	408	464
Adjusted R-squared	0.64	0.62	0.62	0.64	0.64	0.63	0.63	0.64

[3] The variable is dropped from the regression here due to multi-collinearity

Figure 1: Differences in Innovation between Innovation-intensive and Non-intensive industries for US vis-à-vis Germany and Japan