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Creditor Rights and R&D Expenditures

Bruce Seifert and Halit Gonenc

ABSTRACT

Manuscript Type: Empirical

Research Question/Issue: This study examines the impact of creditor rights on R&D intensity (R&D/total assets). We argue that managers in countries with strong creditor rights have more incentives to reduce cash flow risk and therefore limit expenditures on R&D more than managers located in countries with weak creditor rights.

Research Findings/Insights: Using a sample of over 21,000 firms from 41 countries, our research is one of the first to document that strong creditor rights are indeed associated with reduced R&D intensity. This negative relationship is observed in market-based countries, but not in bank-based countries. Moreover, the results show that the negative effect of creditor rights on R&D intensity is usually stronger (more negative) for firms facing or near financial distress. We observe that the determinants for R&D intensity consist of both country and firm level variables and firm level variables appear to be more important in explaining the variance of R&D intensity.

Theoretical/Academic Implications: This study documents an important link between creditor rights and R&D intensity. Our empirical procedure specifically accounts for the fact that R&D intensity and debt are likely to be jointly determined.

Practitioner/Policy Implications: This research is important to policy makers interested in understanding the determinants of firms' R&D intensity. In particular, our study suggests a possible harmful effect of strong creditor rights, namely the possibility that R&D intensity will be lowered.

Keywords: Corporate Governance, Creditor Rights, Corporate Innovation, R&D Intensity

INTRODUCTION

R&D can be extremely important to both companies and countries. At the firm level, successful R&D investments can lead to new and better products and cheaper ways to manufacture them and therefore to increased cash flows. At the country level, those investments can be a catalyst for economic growth.¹ R&D expenditures can be substantial. Israel, for example, spends over four per cent of its GDP on R&D and the US is forecasted to spend more than 400 billion dollars in R&D in 2011.²

While stockholders generally have a favorable view of R&D³ because they get to reap most of the benefits, creditors have mixed emotions about R&D spending. On the one hand, creditors realize that for many companies R&D investments are essential and these firms cannot ultimately survive without it. On the other hand, creditors worry that R&D expenditures may not be successful and therefore earnings and cash flows will be less than desired and possibly, that their promised payments in terms of interest and principal

will not materialize. R&D spending is risky. Not only are outcomes highly uncertain but there is a great chance that R&D on a particular project/area will not be successful. Even if R&D turns out to be successful, it may be years before the benefits show up. The fact that there is a huge variance of outcomes associated with R&D intensity (R&D/total assets) and the fact that creditors do not share in any of the profits above their promised payouts make creditors wary about spending for R&D. Creditors will likely focus on the increased risk of more R&D intensity and not the additional benefits because they do not get any extra cash flow above their promised payments and therefore will probably prefer less to more spending on R&D. Shi (2003) provides empirical support for the idea that bondholders are worried more about the risk of R&D intensity than its benefits.

Creditors have many powers and use their powers to influence corporate decisions. Traditionally many researchers stressed the powers of creditors during periods of bankruptcy. More recently, researchers have documented the influence of creditors in investment decisions (Nini, Smith, & Sufi, 2009), capital structure choices (Roberts & Sufi, 2009), shareholder payouts (Brockman & Unlu, 2009) and innovative activities (Acharya & Subramanian, 2009). Creditors have powers because when a firm violates a private credit

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agreement, the agreement is generally renegotiated (as opposed to being called) and the terms of the agreement change as additional restrictions (for example, less investments, less debt, and fewer payouts) are imposed on the firm.

When firms are close to financial distress, managers will likely take actions to prevent this possibility. Managers who fear that financial distress is a possibility may undertake actions designed to reduce risk such as diversifying operations, employing less debt, and reducing capital expenditures. Strong creditor rights may make managers' lives worse during these times. Managers may discover that under strong creditor rights their decision-making powers are reduced more and the possibility of losing their jobs is greater than under weak creditor rights. Under these circumstances, it would seem reasonable that managers might try more risk reducing activities under strong creditor rights than under weak creditor rights.

Recent studies (Acharya, Amihud, & Litov, 2011; Acharya & Subramanian, 2009) indicate that managers in firms located in countries with strong creditor rights do, in fact, engage in more diversifying acquisitions, which result in poorer performance. These managers also lower cash flow risk, lower leverage, and have fewer innovations. Our paper focuses on another avenue managers might take to reduce risk, which is to limit R&D expenditures. We examine whether R&D intensity is, on average, greater in countries with weak creditor rights than in countries with strong creditor rights.

Our paper is one of the first to examine the linkage between creditor rights and R&D intensity. We investigate this relationship using data for more than 140,000 firm-year observations belonging to over 21,000 firms from 41 countries. To account for the fact that R&D intensity and debt are likely jointly determined, our empirical procedure treats both R&D intensity and the debt ratio as endogenous. Our analysis also specifically incorporates the impact of intellectual property rights on R&D decisions.

Our regressions and correlation analysis suggest that strong creditor rights decrease R&D intensity across all of our samples with the exception of bank-based countries. In general, we find that the impact of creditor rights is more negative for firms that are in financial distress or near financial distress. Our results are consistent with the view that managers worry more about the negative consequences of financial distress (for themselves and their company) in countries that have strong creditor rights than in countries with weak creditor rights. As a result, firms reduce risk more in countries with strong creditor rights. One of these risk-reducing strategies is limiting R&D intensity.

Another important finding of our research is that determinants of R&D intensity are largely invariant across our samples. In addition to the generally negative impact of creditor rights on R&D intensity, we find that patent rights, market to book ratios, and equity ratios all have a positive impact on R&D intensity while concentrated ownership has a negative influence. We observe that the determinants for R&D intensity consist of both country and firm level variables and firm level variables appear to be more important in explaining the variance of R&D intensity.

In addition, the determinants of the leverage equation (in our case the equity ratio) are basically the same across our samples. Cash flow and market to book ratios both have a positive effect on the firm's use of equity, while size and a measure of adverse selection reduce the amount of equity employed by firms.

The rest of the paper is as follows. In the next section, we briefly review some relevant literature and then we describe the data, our hypotheses, and our methodology. We then present our findings and finally our conclusions.

RELEVANT LITERATURE

R&D Investment and Financing of R&D

A number of authors (for example, Bhagat & Welch, 1995) have argued that R&D can be viewed as an investment for a firm. There are, however, differences between these expenditures and other investments. As Hall (2002) points out, 50 per cent or more of the expenditures for R&D can be tied up in salaries and wages of scientists and engineers. Since the knowledge base of these key individuals can be lost if these people are fired or leave the firm, R&D intensity should remain relatively constant year to year. Another difference between R&D and other investments is that there is a high degree of uncertainty (outcomes) associated with these expenditures. As Hall argues, there is a small probability of great success attached to R&D expenditures.

A problem that is likely worse for R&D than for other investments is the information asymmetric issue. Scientists, engineers, and insiders have more information than investors do, and firm insiders do not want to reveal this information to outsiders (especially their competitors) to solve this problem (Bhattacharya & Ritter, 1983). Bhagat and Welch (1995) and Bah and Dumontier (2001) argue that this can explain the use of internally generated funds to support R&D intensity.

Hall (1992) and Himmelberg and Petersen (1994) find that there is a positive relationship between R&D intensity and cash flow⁴ for US firms. Brown and Petersen (2009) show that the relationship between R&D and cash flow is still strong, unlike the relationship between physical investment and cash flow that has decreased over the years. Brown, Fazzari, and Petersen (2009) observe a significant relationship between cash flow (as well as external equity) and R&D intensity for young high-tech companies, but not for mature high-tech firms.

Research has shown that stronger intellectual property rights leads to more R&D intensity [see, for example, Wu (2009) for OECD countries and Lin, Lin, and Song (2010) for evidence from China]. Firms should conduct more R&D if they feel there is little chance that their R&D efforts will be stolen or imitated.

It has also been argued that debt should not be used to finance R&D. In most cases R&D does not have much liquidation value in the event of bankruptcy. In addition, firms with high R&D expenditures probably reflect high growth opportunities and hence suffer from the underinvestment problem (Myers, 1977) and thus equity is probably better suited to finance R&D. Bhagat and Welch (1995) show that there is a negative relation between last year's debt ratio for

US firms and this year's R&D expenditures. However, they found that this same relation was positive for Japanese firms and no significant relation was found for Canadian, British, and European (Germany, France, and Netherlands) firms. Friend and Lang (1988) and Hall (1992) also find a negative relationship for US firms between leverage and R&D expenditures. Bah and Dumontier (2001) find that R&D intensive firms have lower leverage levels than non-intensive R&D for firms in the US, UK, Japan, and Europe.

In summary, prior literature suggests that R&D intensity should be positively related to intellectual property rights and cash flow. Research has also shown the importance of equity financing for R&D.

Ownership Structure and Corporate Practices on R&D

A number of researchers have examined different types of ownership structures to see if some are more conducive to R&D. Francis and Smith (1995) find some evidence that firms with a high percentage of management ownership or firms that have a significant blockholder perform more R&D than firms whose shares are widely held. These results are consistent with the idea that concentrated ownership and/or monitoring can reduce agency costs of innovation. On the other hand, Yafeh and Yosha (2003) find that concentrated ownership (defined as the total ownership of the 10 largest shareholders) is associated with less R&D intensity for a sample of Japanese firms.

Other researchers have examined in more depth whether large shareholders help to promote R&D. Empirical findings have been mixed. See, for example, Wahal and McConnell (2000), Graves (1988), and Chung, Wright, and Media (2003) for the impact of institutional shareholders on R&D intensity. Tribo, Berrone, and Surroca (2007) find that the impact of large blockholders on R&D intensity depends on the type of blockholder. Banks have a negative influence, non-financial corporations have a positive impact and individuals have an insignificant influence. Some academics have focused on the impact of corporate practices on R&D. Lhuillery (2009), for example, finds that shareholder-oriented governance practices increase R&D intensity.

Scholars have also studied whether reducing the likelihood of hostile takeovers encourages more R&D. One possibility is that if the probability of hostile takeovers is lowered, managers become more entrenched and thus less likely to conduct R&D. On the other hand, some researchers have argued that the threat of hostile takeovers makes managers worry about short-term performance and if freed from that threat will concentrate more on long-term goals and do more R&D. The research has been decidedly mixed as to whether R&D intensity increases subsequent to antitakeover amendments (e.g., Johnson & Rao, 1997; Meulbroek, Mitchell, Mulherin, Netter, & Poulsen, 1990; Pugh, Page, & Jahera, 1992).⁵ In summary, a firm's ownership structure and its corporate practices likely affect its expenditures on R&D.

Creditor Rights and Shareholder Rights

There are a number of studies that have documented the effect of shareholder and creditor rights on different corpo-

rate policies. La Porta, Lopez-de-Silanes, Shleifer, and Vishny (2000) show that investors from countries that have strong minority shareholder rights obtain higher dividends than investors residing in countries that have low minority shareholder rights. These authors argue that their results support the "outcome model" where minority stockholders are able to extract dividends by using their legal powers (more rights lead to more dividends). The alternative model suggested by La Porta et al. (2000) is the "substitution model" where firms pay dividends now in order to be able to raise additional capital in the future. In this model, it is the firms residing in countries with poor minority stockholder rights that need to pay dividends in order to build a reputation of being fair to these shareholders. Shareholder rights have also been found to influence investment policies (Love, 2003) and ownership policies (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998, 1999).

More recently, Brockman and Unlu (2009) show that creditors influence dividend payouts significantly. In this case, creditors demand and managers agree to pay fewer dividends when creditor rights are weak. Their results are consistent with a "substitution model" (less dividends substitute for weak creditor rights). Nini et al. (2009) also demonstrate the power creditors have on their ability to influence investment policy. These authors find that 32 percent of private credit agreements between banks and firms have a capital expenditure restriction.⁶ The authors show that these restrictions are effective in reducing firm investment. Roberts and Sufi (2009) find that creditors have a significant effect on capital structure. Issues of net debt decrease after debt covenant violations, causing changes in capital structure. It should be noted that more than 25 percent of the firms in their sample experienced a violation in their covenants. Acharya et al. (2011) observe that firms in countries with strong creditor rights are more likely to engage in harmful diversifying mergers, have lower cash flow risk, and lower leverage, than companies in countries with weak creditor rights. Acharya and Subramanian (2009) find that firms in countries with strong creditor rights are more likely to reduce innovation measured in terms of patents and citations.

In summary, the results of many prior studies indicate that shareholder rights and creditor rights can and do influence corporate policies. Our research examines whether creditor rights in particular, similarly affect expenditures on R&D.⁷

HYPOTHESES

Our principle hypothesis is that firms located in countries with strong creditor rights will have lower R&D intensity. We justify this hypothesis by first noting that creditors are wary about expenditures for R&D since these outflows produce highly uncertain returns. Creditors share in the failures of R&D but do not reap any of the extra gains when R&D is successful since their promised payments are fixed. Shi's (2003) research shows that bondholders focus on the risk of R&D and not the benefits of R&D. In most cases, creditors will prefer less rather than more R&D intensity. Second, we observe that creditors have powers beyond bankruptcy and they use these powers to influence

corporate policies. In particular, research (Acharya & Subramanian, 2009; Acharya et al., 2011; Nini et al., 2009) indicates that managers in firms located in countries with strong creditor rights engage in activities designed to reduce the variance of cash flows (diversifying acquisitions, lower leverage, less investments and fewer innovations). Third, we note that management will likely pursue risk-reducing strategies, especially in times of financial distress. The greater are the powers of creditors, the more likely management will perform risk-reducing activities, which includes reducing R&D intensity since some of the consequences of financial distress (loss of decision-making and possible loss of jobs) are worse under strong creditor rights than under weak creditor rights. Moreover, Acharya et al. (2011) argue that in cases of default, strong creditor rights may lead to inefficient liquidation thus hurting shareholder value even more. Therefore, strong creditor rights create high costs for both managers and shareholders in cases of default and/or distress and both parties will agree to strategies (including reducing R&D investments) designed to reduce the risk of default and distress. In summary, under strong creditor rights, creditors, stockholders, and management will often see that it is in their best interest to reduce R&D intensity. Hypothesis 1 is as follows:

Hypothesis 1. There is a negative relationship between creditor rights and R&D intensity.

There is a large literature devoted to addressing whether bank-based systems (where banks supply most of the financing needs of firms) or market-based systems (where equity and public bond markets supply a large percentage of firms' financing needs) encourage or support R&D more.⁸ A number of studies (see, for example, Beck & Levine, 2002) suggest that the distinction between market-based and bank-based is not critical when it comes to economic growth. More recently, Hillier, Pintado, de Queiroz, and de la Torre (2011) report that bank-based systems are better than market-based systems in reducing the sensitivity of R&D intensity to a firms' internal cash flow.

We next examine whether the financial structure of a country (market or bank-based) influences the link between creditor rights and R&D intensity. Our hypothesis concerning creditor rights and R&D intensity should be applicable in market-based countries as creditors, stockholders, and management should agree to reduce R&D intensity when creditor rights are strong.

It is an empirical question as to whether Hypothesis 1 holds in bank-based countries. It is not clear how important creditor rights are to banks. On one hand, banks may be willing to lend more for R&D intensity if creditor rights are strong. On the other hand, firms may not want to borrow more for R&D if the consequences of financial distress are worse under strong creditor rights than under weak creditor rights. Also creditor rights may be largely irrelevant for banks if banks have other mechanisms to force repayment. Our second hypothesis is stated as follows:

Hypothesis 2. The negative relationship between creditor rights and R&D intensity is stronger in market-based countries as compared to bank-based countries.

Many managers are scared of the consequences of financial distress and will do their best to avoid it. We argue that strong creditor rights will increase the negative consequences of financial distress to managers (loss of decision-making and increased possibility of job loss). We proxy financial distress or close to financial distress as observations that have negative cash flows. Managers will probably increase their efforts to avoid financial distress and therefore will reduce R&D intensity more under strong creditor rights than under weak creditor rights. This leads us to our third hypothesis:

Hypothesis 3. The negative effect of creditor rights on R&D intensity is stronger for firms that are in financial distress or close to financial distress.

DATA AND METHODOLOGY

Data

Our financial data is gathered from Worldscope from 1980 to 2006 for 41 countries. We exclude financial firms and utilities and thus avoid any regulatory influences. Data from Worldscope does contain some errors and thus we winsorize the data. The top and bottom 1 per cent of all of our financial variables are set equal to the values for the 99 and 1 per cent level respectively for those variables. Hence, extreme outliers are eliminated.

For creditor rights we use the index by Djankov, McLiesh, and Shleifer (2007) that determines the powers of secured lenders during bankruptcy for the year 2003. Countries are scored according to four attributes. They are: "1) whether there are restrictions, such as creditor consent, when a debtor files for reorganization; 2) whether secured creditors are able to seize their collateral after the petition for reorganization is approved, that is, whether there is no automatic stay or asset freeze imposed by the court; 3) whether secured creditors are paid first out of the proceeds of liquidating a bankrupt firm; and 4) whether an administrator, and not management, is responsible for running the business during reorganization." (Djankov et al., 2007:302). This index has been stable over the period 1978–2003.

A number of studies have shown that patent protection is a good indicator of intellectual property rights (see, for example, Marron & Steel, 2000 and Ostergard, 2000) and thus we use the patent protection index of Ginarte and Park (1997) and Park (2008). This index considers five areas: (1) extent of coverage, (2) membership in international patent agreements, (3) provisions for loss of protection, (4) enforcement mechanisms, and (5) duration of protection (Ginarte & Park, 1997:284).⁹ In unreported results, we find that the correlations between intellectual property rights indices over five year intervals are high, indicating that there is a lot of stability over time in the index.

Table 1 lists all the variables used in this study and gives exact definitions for each of them.

Methodology

We investigate our hypotheses using the following two-equation system.

TABLE 1
Variable Definitions

| Variables | Definitions |
|------------------------------------|--|
| R&D Intensity | Research and Development Intensity (R&D Expenditures / Book Value of Total Assets) |
| Equity Ratio | [(Market Value of Equity / (Market Value of Equity + Book Value of Total Short and Long-term Debt)] |
| Creditor Rights | Country level scores from Djankov et al. (2007). |
| Cash Flow | [(Net income + Depreciation + R&D expenditures) / Book Value of Total Assets] |
| Market to Book | [(Market Value of Equity + Book Value of Debt) / Book Value of Total Assets] |
| Property Rights | The patent rights index for 1985 from Ginarte and Park (1997) and Park (2008). |
| High Tech Industries | A dummy variable, which is equal to 1 if the firm is in the following SIC codes 283 (drugs), 357 (office and computing equipment), 366 (communications equipment), 367 (electronic equipment), 382 (scientific instruments), 384 (medical instruments) and 737 (software) and 0 otherwise. |
| Size | The logarithm of book value of total assets in US dollars. |
| Adverse Selection | The standard deviation of monthly excess returns (Firm Stock Return – Local Market Return). |
| Ownership | Per cent of shares held by insiders and people who own at least five per cent of the outstanding stock. |
| Market and Bank-based countries | Market and bank-based countries are defined in Demirguc-Kunt and Levine (2001) and Demirguc-Kunt and Maksimovic (2002). |
| Developed and Developing countries | Developed and Developing countries are defined according to income classification of the World Bank. High-income economies are classified as developed countries, and low-income and middle-income economies are classified as developing countries. |

This table provides exact definitions of all variables. All data is from *Worldscope* unless otherwise noted.

$$\begin{aligned} \text{R\&D Intensity} = & b_0 + b_1 \text{ Equity Ratio} + b_2 \text{ Creditor Rights} \\ & + b_3 \text{ Cash Flow} + b_4 \text{ Market to Book} + b_5 \text{ Property Rights} \\ & + b_6 \text{ High Tech Industries} + b_7 \text{ Ownership} + e^{10} \end{aligned} \quad (1)$$

$$\begin{aligned} \text{Equity Ratio} = & c_0 + c_1 \text{ R\&D Intensity} + c_2 \text{ Creditor Rights} \\ & + c_3 \text{ Cash Flow} + c_4 \text{ Market to Book} + c_5 \text{ Size} \\ & + c_6 \text{ Adverse Selection} + u \end{aligned} \quad (2)$$

We hypothesize that a firm's R&D intensity is a function of its equity ratio, country's creditor rights index, cash flow, market to book ratio, country's level of intellectual property rights, whether the firm is in a high tech industry or not, and ownership structure. A firm's equity ratio is a function of its R&D intensity, country's creditor rights index, cash flow, market to book ratio, size, and measure of adverse selection.¹¹

We use a two-equation system because it is likely that both R&D intensity and debt policy (equity ratio) are endogenous. A firm probably makes both decisions jointly and, furthermore, the decision of one likely influences the other decision. As was previously discussed, R&D intensity should have a negative influence on leverage. Firms for many reasons prefer to fund R&D mostly with equity. On the other hand, Jensen and Showalter (2004) present a model where the amount of leverage affects total R&D expenditures. In a patent race these authors show that debt reduces

the amount of R&D expenditures. As a result, we use two-stage least squares to estimate the coefficients for Equations 1 and 2.

For the R&D intensity equation, greater use of equity should lead to greater amounts of R&D intensity. Firms residing in countries with greater intellectual property rights should conduct more R&D since the fruits of their labors are more likely to remain within the firm (i.e., not get stolen or illegally imitated). Assuming that external funds are more expensive than internal funds, greater cash flows should lead, on the margin, to more R&D intensity. Higher market to book ratios should indicate more investment opportunities and this should be associated with more R&D intensity. To account for the fact that certain industries historically do a lot of R&D, we use a dummy variable that equals one for firms in those industries. The impact of the per cent of shares held by insiders and influential outsiders is unclear on R&D intensity.¹² On one hand, increased ownership may align managers and blockholders to shareholder interests and increase R&D intensity. On the other hand, increased ownership by management may cause entrenchment and less R&D intensity. Also, increased ownership by blockholders may increase monitoring and reduce R&D intensity.

Our R&D equation has the direction of causation from more intellectual property rights to more R&D intensity. One could argue that as firms and countries do more R&D they might want more protection for their new inventions.

However, Kanwar and Evenson (2009) and Wu (2009) find that the link running from R&D to property rights is weak or non-existent. In addition, we use the property rights index at the beginning of our data period to reduce possible endogeneity issues.

For the equity ratio equation, we include many of the traditional leverage variables used in prior studies (see, for example, Rajan & Zingales, 1995). Since we are using the equity ratio instead of the leverage ratio, the signs for the coefficients on the independent variables should be just the opposite of the leverage ratio. The R&D intensity variable can be thought of as the ratio of an intangible asset to total assets and should have, as discussed above, a positive influence on the equity ratio. Greater cash flow, all other things being equal, should lead to a lower need for debt and hence have a positive influence on the equity ratio. High market to book ratios can indicate increased investment opportunities, which are associated with increased use of equity. Larger size can result in more diversified cash flows and less bankruptcy risk and hence more debt financing or less equity financing. Finally, we include a measure of adverse selection. All other things being equal, greater amounts of information asymmetry should lead to less use of equity.

The effect of creditor rights on the equity ratio is ambiguous. On one hand, stronger creditor rights should result in more people and institutions willing to lend money to firms (due to the increased chance of getting their investment returned) and hence leverage would increase. Djankov et al. (2007) report an increase in the supply of credit due to stronger creditor rights. On the other hand, firms may decrease the demand for credit because of stronger creditor rights. Acharya et al. (2011) find that leverage is reduced as a result of stronger creditor rights (firms are trying to reduce their bankruptcy risk).

RESULTS

Descriptive Statistics

Panels A and B of Table 2 provide descriptive statistics for our main variables. The mean (median) ratio of R&D to total assets is .026 (.000). Most firms do not report positive amounts of R&D in a given year, as 58 per cent of our yearly observations have zero R&D (data not reported in Table 2). Firms in Israel and the US have the two highest averages. Some countries report no R&D activity, which may indicate that only a little R&D takes place in that country, or alternatively, that R&D is underreported.

The equity ratio is measured as the ratio of the market value of equity to the sum of the market value of equity and the book value of debt (both short-term and long-term). Using market values of equity instead of book values of equity helps to minimize any impact of different accounting conventions in different countries. The mean and median of the equity ratio for the companies in our sample are .761 and .829.

Firms in our sample, generally, have a positive cash flow. It should be recalled that our measure of cash flow is net income plus depreciation plus R&D all divided by total assets, which should give a little higher number than the

more traditional measure of net income plus depreciation all divided by total assets. The intellectual property rights index in our sample has a low of .59 (Peru) and a high of 4.68 (United States). The average is 3.7. Creditor rights range from 0 to 4 with an average of 1.83.

Panel B of Table 2 reports statistical comparisons for the mean and median values between developing and developed countries and between bank-based and market-based countries. The level of R&D intensity is higher in developed and market-based countries. When we exclude US firms, more R&D intensity is actually performed in bank-based countries than in market-based ones. Firms in developed countries and in market-based countries use more equity than firms in developing countries and in bank-based countries.

Correlation Results

Panel A of Table 3 presents the country correlation coefficient between creditor rights and property rights. The relationship is positive but insignificant. Panel B of Table 3 gives the correlation coefficients for the firm level variables used in the regressions. The correlations in this Panel show that creditor rights is significantly negatively related to R&D intensity (consistent with Hypothesis 1) and property rights is significantly positively associated with R&D intensity.

Panel B shows that R&D intensity is positively related to the equity ratio, high tech industries dummy, and market to book ratio and negatively related to cash flow and ownership. All of these relationships are as expected except for cash flows. Moreover, the equity ratio is positively associated with market to book and cash flow and negatively related to size, creditor rights, and adverse selection.

Panel C gives the Variance Inflationary Factors (VIF) for the two equations. All the VIF are under 2 indicating no problems of multicollinearity.

Regression Results

We present our basic regression results in Table 4. This table reports the results for firms from all countries (Panel A), all countries excluding the US (Panel B), market and bank-based countries (Panels C and D) and developed and developing countries (Panels E and F). We examine all firms minus US firms to see if US firms are driving our main results.

Before presenting our regression results, we note that tests for endogeneity (see Wooldridge, 2000) show that the equity ratio is endogenous in the R&D intensity equation, while R&D intensity is endogenous in the equity ratio equation. These results suggest that a two-equation system is appropriate.

All Countries With and Excluding the US

R&D Intensity Equation. Our main result in Panels A and B in Table 4 is that strong creditor rights acts to reduce R&D intensity, findings that support Hypothesis 1. The coefficient for creditor rights is strongly significant when all countries are included or when all countries minus the US are examined.

TABLE 2
Sample Countries and Descriptive Statistics

| Panel A: Sample countries | # of Obs. | R&D Intensity | | Equity Ratio | | Market | Property Rights | Creditor Rights |
|---------------------------|-----------|---------------|--------|--------------|--------|--------|-----------------|-----------------|
| | | Mean | Median | Mean | Median | | | |
| | | Argentina | 267 | .00 | .00 | | | |
| Australia | 5,332 | .01 | .00 | .81 | .87 | 1 | 2.49 | 3 |
| Austria | 321 | .01 | .00 | .67 | .72 | 0 | 3.43 | 3 |
| Belgium | 372 | .02 | .00 | .69 | .70 | 0 | 4.09 | 2 |
| Brazil | 776 | .00 | .00 | .58 | .61 | 1 | 1.28 | 1 |
| Canada | 6,271 | .02 | .00 | .76 | .82 | 1 | 3.16 | 1 |
| Chile | 631 | .00 | .00 | .75 | .78 | 1 | 2.01 | 2 |
| China | 2,031 | .00 | .00 | .75 | .79 | 0 | 1.33 | 2 |
| Denmark | 661 | .03 | .00 | .72 | .76 | 1 | 3.63 | 3 |
| Finland | 664 | .03 | .01 | .70 | .73 | 0 | 3.31 | 1 |
| France | 2,753 | .02 | .00 | .72 | .77 | 0 | 3.76 | 0 |
| Germany | 2,440 | .03 | .00 | .74 | .79 | 0 | 3.84 | 3 |
| Greece | 177 | .00 | .00 | .69 | .70 | 0 | 2.33 | 1 |
| Hong Kong | 2,163 | .00 | .00 | .78 | .87 | 1 | 2.70 | 4 |
| Hungary | 116 | .00 | .00 | .75 | .78 | 0 | 2.28 | 1 |
| India | 2,483 | .00 | .00 | .69 | .77 | 1 | 1.03 | 2 |
| Ireland | 781 | .01 | .00 | .75 | .78 | 0 | 2.20 | 1 |
| Israel | 354 | .06 | .03 | .77 | .86 | 0 | 2.94 | 3 |
| Italy | 419 | .01 | .00 | .70 | .74 | 0 | 3.68 | 2 |
| Japan | 12,302 | .02 | .01 | .68 | .73 | 0 | 3.43 | 2 |
| Malaysia | 2,158 | .00 | .00 | .70 | .77 | 1 | 1.92 | 3 |
| Mexico | 724 | .00 | .00 | .70 | .77 | 1 | 1.35 | 0 |
| Netherlands | 2,032 | .01 | .00 | .74 | .78 | 1 | 3.77 | 3 |
| New Zealand | 254 | .01 | .00 | .79 | .81 | 0 | 2.70 | 4 |
| Norway | 1,137 | .02 | .00 | .63 | .64 | 0 | 3.15 | 2 |
| Pakistan | 463 | .00 | .00 | .71 | .79 | 0 | 1.18 | 1 |
| Peru | 168 | .00 | .00 | .70 | .73 | 1 | .59 | 0 |
| Philippines | 737 | .00 | .00 | .66 | .73 | 1 | 2.36 | 1 |
| Poland | 367 | .00 | .00 | .85 | .91 | 0 | 1.38 | 1 |
| Singapore | 1,497 | .00 | .00 | .77 | .83 | 1 | 1.71 | 3 |
| South Africa | 995 | .00 | .00 | .81 | .88 | 1 | 3.07 | 3 |
| South Korea | 4,287 | .01 | .00 | .55 | .53 | 1 | 2.65 | 3 |
| Spain | 612 | .00 | .00 | .76 | .80 | 0 | 2.81 | 2 |
| Sri Lanka | 78 | .00 | .00 | .62 | .63 | 0 | 2.78 | 2 |
| Sweden | 1,342 | .03 | .00 | .75 | .80 | 1 | 3.48 | 1 |
| Switzerland | 1,420 | .03 | .00 | .70 | .73 | 1 | 3.66 | 1 |
| Taiwan | 4,458 | .02 | .00 | .72 | .77 | 0 | 1.26 | 2 |
| Turkey | 253 | .00 | .00 | .80 | .85 | 1 | 1.20 | 2 |
| United Kingdom | 16,473 | .02 | .00 | .82 | .87 | 1 | 3.88 | 4 |
| United States | 60,553 | .04 | .00 | .80 | .87 | 1 | 4.68 | 1 |
| Venezuela | 88 | .00 | .00 | .66 | .75 | 0 | .92 | 2 |
| Total | 141,410 | .03 | .00 | .76 | .83 | 0 | 3.70 | 1.83 |

TABLE 2
Continued

| Panel B: Descriptive statistics | # of Firms | R&D Intensity | | Equity Ratio | | Cash Flow | | Market to Book | | Size | | Adverse Selection | | Ownership | |
|---------------------------------------|---------------|---------------|----------|--------------|----------|-----------|-----------|----------------|----------|-----------|-----------|-------------------|----------|-----------|----------|
| | | Mean | Median | Mean | Median | Mean | Median | Mean | Median | Mean | Median | Mean | Median | Mean | Median |
| All countries | 141,410 | .03 | .00 | .76 | .83 | .08 | .10 | 1.83 | 1.31 | 5.28 | 5.23 | .03 | .03 | .32 | .29 |
| <i>Developing</i> | 25,094 | .01 | .00 | .70 | .76 | .09 | .09 | 1.44 | 1.09 | 5.36 | 5.29 | .03 | .03 | .38 | .38 |
| <i>Developed</i> | 116,316 | .03 | .00 | .78 | .84 | .07 | .10 | 1.91 | 1.35 | 5.27 | 5.21 | .03 | .03 | .31 | .28 |
| Difference | | -.03 | .00 | -.08 | -.08 | .02 | -.01 | -.47 | -.26 | .10 | .08 | -.00 | .00 | .07 | .11 |
| Test statistics | | (-54)*** | [-40]*** | (-48)*** | [-42]*** | (15)*** | [-7.2]*** | (-42)*** | [-63]*** | (6.9)*** | [8.5]*** | (-23)*** | [-.4] | (35)*** | [22]*** |
| <i>Bank Based</i> | 30,454 | .01 | .00 | .71 | .75 | .09 | .09 | 1.47 | 1.17 | 6.23 | 6.13 | .03 | .02 | .41 | .40 |
| <i>Market Based</i> | 110,956 | .03 | .00 | .78 | .85 | .07 | .10 | 1.93 | 1.36 | 5.02 | 4.92 | .04 | .03 | .30 | .25 |
| Difference | | -.02 | .00 | -.07 | -.10 | .02 | -.01 | -.46 | -.19 | 1.21 | 1.21 | -.01 | -.01 | .11 | .15 |
| Test statistics | | (-35)*** | [7.0]*** | (-47)*** | [-52]*** | (16)*** | [-17]*** | (-44)*** | [-45]*** | (97)*** | [98]*** | (-70)*** | [-69]*** | (61)*** | [59]*** |
| All countries excluding US | 80,857 | .01 | .00 | .74 | .80 | .09 | .10 | 1.58 | 1.21 | 5.44 | 5.40 | .03 | .02 | .36 | .35 |
| <i>Developing</i> | 25,094 | .01 | .00 | .70 | .76 | .09 | .09 | 1.44 | 1.09 | 5.36 | 5.29 | .03 | .03 | .38 | .38 |
| <i>Developed</i> | 55,763 | .02 | .00 | .75 | .81 | .08 | .10 | 1.65 | 1.25 | 5.47 | 5.46 | .03 | .02 | .35 | .34 |
| Difference | | -.01 | .00 | -.06 | -.05 | .01 | -.01 | -.20 | -.16 | -.11 | -.17 | .00 | .01 | .03 | .04 |
| Test statistics | | (-33)*** | [-14]*** | (-31)*** | [-24]*** | (7.7)*** | [-7.6]*** | (-21)*** | [-41]*** | (-7.2)*** | [-7.4]*** | (26)*** | [47]*** | (13)*** | [6.9]*** |
| <i>Bank Based</i> | 30,454 | .01 | .00 | .71 | .75 | .09 | .09 | 1.47 | 1.17 | 6.23 | 6.13 | .03 | .02 | .41 | .40 |
| <i>Market Based</i> | 50,403 | .01 | .00 | .75 | .82 | .08 | .10 | 1.65 | 1.24 | 4.95 | 4.84 | .03 | .02 | .33 | .30 |
| Difference | | .00 | .00 | -.05 | -.07 | .01 | -.02 | -.19 | -.06 | 1.28 | 1.29 | -.01 | -.00 | .08 | .10 |
| Test statistics | | (5.2)*** | [51]*** | (-28)*** | [-31]*** | (7.2)*** | [-19]*** | (-20)*** | [-12]*** | (97)*** | [94]*** | (-37)*** | [-27]*** | (37)*** | [36]*** |

The data is collected from Worldscope for the period 1980–2006. Sample period varies by countries depending on data availability. *Market* is 1 if the country is a market-based and 0 if it is a bank-based country. Exact definitions of the variables are given in Table 1. The significance of differences between means and medians are based on a *t*-test for the mean differences and Wilcoxon Rank-sum test for median differences. The symbols ***, **, *, and † denote statistical significance at .1 per cent, 5 per cent, 1 per cent, and 10 per cent levels, respectively.

TABLE 3
Correlations

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|--|---------|---------|---------|---------|---------|---------|---------|---------|--------|------|
| Panel A: country level correlations (# of observations =41) | | | | | | | | | | |
| Creditor rights (1) | 1 | | | | | | | | | |
| Property rights (2) | .25 | 1 | | | | | | | | |
| Panel B: firm level correlations (all observations, # of observations = 141,242) | | | | | | | | | | |
| R&D intensity (3) | -.15*** | .22*** | 1 | | | | | | | |
| Equity ratio (4) | -.01*** | .13*** | -.07*** | 1 | | | | | | |
| Cash flow (5) | .04*** | -.04*** | .31*** | .10*** | 1 | | | | | |
| Market to book (6) | -.09*** | .15*** | -.21*** | .42*** | -.08*** | 1 | | | | |
| Size (7) | -.09*** | -.05*** | -.21*** | -.25*** | .27*** | -.21*** | 1 | | | |
| High tech industries (8) | -.11*** | .13*** | .48*** | .26*** | -.03*** | .26*** | -.20*** | 1 | | |
| Adverse selection (9) | -.18*** | .17*** | .24*** | -.03*** | -.41*** | .16*** | -.51*** | .21*** | 1 | |
| Ownership (10) | .16*** | -.11*** | -.10*** | -.00 | -.01*** | -.02*** | -.16*** | -.06*** | .06*** | 1 |
| Panel C: VIF values (# of observations = 141,242) | | | | | | | | | | |
| R&D intensity equation | 1.17 | 1.17 | 1.17 | 1.29 | 1.04 | 1.28 | 1.48 | 1.12 | 1.64 | 1.03 |
| Equity ratio equation | 1.11 | | | | 1.21 | 1.14 | | | | |

This table reports variance of inflation factors (VIF) and pairwise correlation coefficients and their significance levels. Exact definitions of the variables are given in Table 1. The symbols ***, **, *, and † denote statistical significance at .1 per cent, 1 per cent, 5 per cent, and 10 per cent levels, respectively.

TABLE 4
Two Stage Regression Results

| | Panel A: All countries | | Panel B: All countries excluding the US | | Panel C: Market-based countries | |
|----------------------|-------------------------------|-------------------|---|-------------------|---------------------------------|-------------------|
| | R&D Intensity | Equity Ratio | R&D Intensity | Equity Ratio | R&D Intensity | Equity Ratio |
| Intercept | -.04*** [.00] | .93*** [.00] | -.02*** [.00] | .93*** [.01] | -.04*** [.00] | .92*** [.00] |
| Equity ratio | .03*** [.00] | | .01*** [.00] | | .04*** [.00] | |
| Creditor rights | -.00*** [.00] | .00*** [.00] | -.00*** [.00] | .01*** [.00] | -.00*** [.00] | .00*** [.00] |
| Cash flow | -.02*** [.00] | .16*** [.00] | -.01*** [.00] | .23*** [.01] | -.02*** [.00] | .13*** [.01] |
| Market to book | .01*** [.00] | .04*** [.00] | .01*** [.00] | .05*** [.00] | .01*** [.00] | .03*** [.00] |
| Property rights | .01*** [.00] | | .01*** [.00] | | .01*** [.00] | |
| High tech industries | .05*** [.00] | | .03*** [.00] | | .05*** [.00] | |
| Ownership | -.01*** [.00] | | -.01*** [.00] | | -.01*** [.00] | |
| R&D Intensity | | 1.85*** [.03] | | 1.83*** [.07] | | 1.81*** [.03] |
| Size | | -.03*** [.00] | | -.04*** [.00] | | -.03*** [.00] |
| Adverse selection | | -2.60*** [.04] | | -3.04*** [.07] | | -2.53*** [.04] |
| Adjusted R square | .31 | .22 | .22 | .28 | .32 | .20 |
| # of observations | 141,242 | 141,242 | 80,826 | 80,826 | 110,791 | 110,791 |
| | Panel D: Bank-based countries | | Panel E: Developed countries | | Panel F: Developing countries | |
| | R&D Intensity | Equity Ratio | R&D Intensity | Equity Ratio | R&D Intensity | Equity Ratio |
| Intercept | -.02*** [.00] | .93*** [.01] | -.04*** [.00] | .92*** [.00] | -.01*** [.00] | .97*** [.01] |
| Equity ratio | .01 [.00] | | .04*** [.00] | | .01*** [.00] | |
| Creditor rights | .00*** [.00] | .00 [.00] | -.00*** [.00] | .01*** [.00] | -.00** [.00] | -.00† [.00] |
| Cash flow | .05*** [.01] | .45*** [.02] | -.02*** [.00] | .12*** [.00] | .01** [.00] | .54*** [.02] |
| Market to book | .00*** [.00] | .06*** [.00] | .01*** [.00] | .03*** [.00] | .00*** [.00] | .07*** [.00] |
| Property rights | .01*** [.00] | | .01*** [.00] | | .00*** [.00] | |
| High tech industries | .02*** [.00] | | .06*** [.00] | | .01*** [.00] | |
| Ownership | -.01*** [.00] | | -.02*** [.00] | | -.01*** [.00] | |
| R&D Intensity | | 1.31*** [.13] | | 1.69*** [.03] | | .76* [.31] |
| Size | | -.04*** [.00] | | -.03*** [.00] | | -.05*** [.00] |
| Adverse selection | | -3.70*** [.17] | | -2.39*** [.04] | | -3.33*** [.13] |
| Adjusted R square | .24 | .34 | .32 | .21 | .15 | .39 |
| # of observations | 30,451 | 30,451 | 116,149 | 116,149 | 25,093 | 25,093 |

This table reports the results from 2SLS regressions of equation 1 and 2. *R&D Intensity* and *Equity Ratio* are the two endogenous variables in the two stage regressions. Exact definitions of the variables are given in Table 1. All regressions include industry and year fixed effects. The robust standard errors are reported below the estimated coefficients. The symbols ***, **, *, and † denote statistical significance at .1 per cent, 1 per cent, 5 per cent, and 10 per cent levels, respectively.

All the coefficients for the R&D intensity equation have the expected sign except for the cash flow variable¹³. The coefficient for the equity ratio is positive which indicates that a greater use of equity is associated with more R&D intensity. This result is consistent with Jensen and Showalter's (2004) conjecture. Firms residing in countries with strong intellectual property rights have greater R&D intensity. More investment opportunities, measured by the market to book ratio, result in more R&D intensity. The coefficient is positive for firms that belong to high tech industries that historically have greater R&D intensity. The coefficient for ownership is negative, consistent with the results of Yafeh and Yosha (2003), which suggests that concentrated shareholder ownership has a negative influence on R&D.

Equity Ratio Equation. Using the entire sample and the entire sample minus US firms (Panels A and B), all the coefficients for the equity ratio equation have the expected signs in Table 4. Higher R&D intensity reduces the amount of debt. This result is in line with many researchers who have argued that debt should not be used, in general, to fund R&D. Higher cash flows lead to a higher equity ratio. This result is consistent with many studies that show higher profitability results in lower debt ratios. Bigger firms use relatively more debt, presumably because their cash flows are more diversified and thus suffer less bankruptcy risk. Greater investment opportunities result in greater use of equity. Our proxy for adverse selection suggests that firms with greater amounts of adverse selection have lower equity ratios, which is consistent with the idea that greater adverse selection costs increase the cost of equity. The creditor rights variable has a significant positive coefficient. As discussed earlier, the expected sign for this variable is ambiguous and researchers have found different results.

Roughly 40 per cent of our entire sample is US observations and we address whether the relationships we find for the entire sample also hold for the sample of non-US countries. All of the coefficients for both the R&D intensity equation and the equity ratio equation have the same signs in Panels A and B. Our findings indicate that the US firms are not driving our results.

Market-based vs. Bank-based Countries

R&D Intensity Equation. Table 4 also reports the results for the comparison of market and bank-based countries. Our most important result is that creditor rights has a negative impact on R&D intensity for market-based countries (Panel C) while for bank-based countries (Panel D), the relationship is just the opposite as the coefficient on creditor rights is positive. These results support hypothesis 2. In unreported results, we add two variables to the regressions in Panel A. The first is a dummy variable that equals one if the firm is located in a country that is market-based and zero otherwise. The second is an interaction term and equals the product of the market dummy variable and the creditor rights variable. The coefficient on the interaction term is negative and is significant at the one per cent level which indicates that the negative effect of creditor rights is stronger

in market-based countries than in bank-based countries. This result further supports Hypothesis 2.

The signs and significance of market to book, property rights, high tech industries and ownership are the same for market-based countries and bank-based countries and are the same as those in Panels A and B. The impact of cash flows on R&D intensity is different between bank-based (positive) and market-based (negative) countries. The coefficient for the equity ratio is positive for market-based countries (similar to Panels A and B) but insignificant for bank-based countries.

In unreported results, we also did a regression on the R&D intensity equation using all the observations and include a dummy variable that equals one if the firm is from a market-based country. The coefficient on the dummy variable is positive indicating, that all other things being equal, firms in market-based countries have higher R&D intensity than firms from bank-based countries.

Equity Ratio Equation. The results for the equity ratio equation are similar for bank and market-based countries. The only difference involves the impact of creditor rights on the equity ratio. For market-based countries creditor rights has a positive influence while it has an insignificant positive impact in bank-based countries.

Additional Evidence: Developed vs. Developing Countries

We next explore the possible influence of economic development on our results. Is the effect of creditor rights on R&D intensity different between developed and developing countries? Are there differences between financing patterns between the two sets of countries? Table 4 also gives the results for developed (Panel E) and developing (Panel F) countries.

R&D Intensity Equation. Our findings show that the determinants of R&D intensity are similar between developed and developing countries. In particular, the effect of creditor rights is negative and significant on R&D intensity in both sets of countries. The only difference between the determinants of R&D intensity is that cash flow has a negative effect on R&D intensity in developed countries but a positive effect in developing countries.

Equity Ratio Equation. The determinants of the equity ratio equation are the same for developing and developed countries with one exception. Creditor rights have a positive effect in developed countries and a negative effect in developing countries.

Creditor Rights for Healthy Firms vs. Distress Firms

Our third hypothesis is that the negative effect of creditor rights should be stronger for firms in distress or near distress than for healthy firms. We define firms that are in distress or near distress when their yearly cash flows are negative.

Evidence for Hypothesis 3 is presented in Table 5. For these R&D regressions, we replace the cash flow variable with a dummy variable (Negative Cash Flow) that equals one if the firm's yearly cash flows are negative and zero otherwise. We also add an interactive term (Negative Cash Flow*Creditor Rights). The interactive term allows us to examine the impact of creditor rights on R&D intensity when the firm is in financial distress or near financial distress.¹⁴ The coefficient for the interaction term for all countries, developed countries, and market-based countries is negative and significant, providing some support for Hypothesis 3.

Country vs. Firm-level Determinants of R&D

Researchers have debated the importance of country vs. firm factors in determining firm governance ratings. Doidge, Karolyi, and Stulz (2007) find that country factors are much more important in explaining governance ratings. They argue that it is too expensive and almost impossible for firms in countries with poor investor rights to be able to convince investors that their firm has good corporate governance. Krishnamurti, Sevic, and Sevic (2005) also stress the dominance of country factors while Durnev and Kim (2005) argue for the importance of firm factors [need for external financing, investment opportunities, and ownership structure (concentration of cash flow rights)]. Researchers have also addressed the question as to whether firms with good governance ratings perform better than companies with worse ratings.¹⁵

We build on these prior studies and ask whether the determinants of R&D intensity are more country specific or more firm specific. In Table 6, we report regressions using just country specific variables (creditor rights and intellectual property rights), just firm specific variables (equity ratio, cash flow, market to book, and ownership), and combined country and firm variables. For these regressions, we control for endogeneity by using the lags of the independent variables because it makes it easier to compare the combined effects of the country specific variables with the combined effects of the firm specific variables.

Table 6 indicates that both country and firm variables are separately important in explaining R&D intensity but firm variables appear collectively to be more important than country variables as regressions employing firm variables have higher adjusted R squares than those that just use country variables. The table also highlights that the R squares are higher for samples of market-based countries than bank-based countries.

Robustness Test: Tobit Regressions

It is possible that there are a number of firms in our dataset that do some R&D, but choose not to report it. As a result, we present in Table 7 Tobit regressions for the R&D intensity equation only (Equation 1). For each of our samples, we present the results for two regressions. The first uses the predicted values for the equity ratio instead of the actual equity ratio. The predicted values are derived by using all of the exogenous variables in Equations 1 and 2. The second regression replaces the actual equity ratio by its lag one

period. Both regression equations try to tackle the endogeneity issue between R&D intensity and the equity ratio.

Our main result is that creditor rights have a negative impact on R&D intensity for the entire sample, the entire sample excluding the US, developed countries, and the market-based countries. Creditor rights have a positive influence on R&D intensity for bank-based countries (consistent with the findings in Table 4).

The coefficients for the other variables are generally similar to those found earlier. One difference involves the equity ratio. When the lag of the equity ratio is used instead of the actual equity ratio, the resulting coefficient is positive implying the greater use of equity is associated with more R&D intensity. However, when the actual equity ratio is replaced by its predicted value, the resulting coefficient has a negative sign. With a couple of exceptions, the signs and significance of the other variables in the equation do not change depending on whether the predicted equity ratio or the lag of the equity ratio is used.

CONCLUSIONS

Previous papers have documented that managers often undertake risk-reducing activities when faced with strong creditor rights. These actions include diversifying acquisitions, reducing cash flow risk, and lower leverage. Our paper investigates the impact of creditor rights on another corporate decision, namely R&D investments. We hypothesize that firms residing in countries with strong creditor rights will have lower levels of R&D intensity. We test this hypothesis for firms in 41 countries and use a two-equation framework with both R&D intensity and the equity ratio as endogenous variables.

Our results are supportive of our main hypotheses. Creditor rights are associated with reduced levels of R&D intensity in all of our samples with the exception of bank-based countries. We also find that the negative effect of creditor rights on R&D intensity is usually stronger (more negative) for firms facing or near financial distress. Managers of these firms worry that their firms may soon face bankruptcy. As a result, they undertake activities to reduce risk including limiting R&D intensity.

Our results are very important because R&D is critical to many countries. Any unnecessary or unintended decrease in R&D can have major impacts for these countries. Our main result that stronger creditor rights reduce R&D intensity has important policy implications. Countries that have strong creditor rights may want to think about policies (perhaps tax policies) that could be used to stimulate R&D and thus offset the reduction in R&D associated with strong creditor rights.

We also observe that the determinants of R&D intensity are mostly the same for countries at different levels of development or for countries with different economic systems (bank or market-based). We find that patent rights, market to book ratios, and equity ratios, all generally have a positive impact on R&D intensity, while concentrated ownership on the part of insiders and blockholders has a negative impact. Both firm and country level variables help to explain R&D intensity with firm level variables appearing to be more important.

TABLE 5
Two Stage Regression Results for the Role of Negative Cash Flows

| | All countries R&D Intensity | All countries excluding the US R&D Intensity | Market-based countries R&D Intensity | Bank-based countries R&D Intensity | Developed countries R&D Intensity | Developing countries R&D Intensity |
|--------------------------------------|--------------------------------|--|--|--|---|--|
| Intercept | -.04*** [.00] | -.02*** [.00] | -.04*** [.00] | -.02*** [.00] | -.04*** [.00] | -.01*** [.00] |
| Equity ratio | .03*** [.00] | .01*** [.00] | .03*** [.00] | .01*** [.00] | .04*** [.00] | .01*** [.00] |
| Creditor rights | -.00*** [.00] | -.00*** [.00] | -.00*** [.00] | .00*** [.00] | -.00*** [.00] | -.00*** [.00] |
| Negative cash flow | .03*** [.00] | .01*** [.00] | .03*** [.00] | -.00 [.00] | .03*** [.00] | .00 [.00] |
| Negative cash flow * creditor rights | -.01*** [.00] | -.00 [.00] | -.01*** [.00] | .00 [.00] | -.01*** [.00] | .00 [.00] |
| Market to book | .01*** [.00] | .01*** [.00] | .01*** [.00] | .00*** [.00] | .01*** [.00] | .00*** [.00] |
| Property rights | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .00*** [.00] |
| High tech industries | .05*** [.00] | .03*** [.00] | .05*** [.00] | .02*** [.00] | .05*** [.00] | .01*** [.00] |
| Ownership | -.01*** [.00] | -.01*** [.00] | -.01*** [.00] | -.01*** [.00] | -.02*** [.00] | -.01*** [.00] |
| Adjusted R square | .32 | .23 | .33 | .22 | .33 | .14 |
| # of observations | 141,242 | 80,826 | 110,791 | 30,451 | 116,149 | 25,093 |

This table reports the results for the R&D equations only from the 2SLS regressions for the entire sample and several subsamples. Market and bank-based countries are defined in Demirguc-Kunt and Levine (2001) and Demirguc-Kunt and Maksimovic (2002). Developed and developing countries are defined according to income classifications of the World Bank. *R&D Intensity* and *Equity Ratio* are the two endogenous variables in the two stage regressions. Exact definitions of the variables are given in Table 1. All regressions include industry and year fixed effects. The robust standard errors are reported below the estimated coefficients. The symbols ***, **, *, and + denote statistical significance at .1 per cent, 5 per cent, and 10 per cent levels, respectively.

TABLE 6
Regression Results for Country vs. Firm-level Determinants of R&D

| | All countries | | All countries excluding the US | | Market-based countries | | Bank-based countries | | |
|-------------------------------|------------------|------------------|--------------------------------|------------------|------------------------|------------------|----------------------|------------------|------------------|
| Constant | -.01*** [.00] | -.02*** [.00] | .00 [.00] | -.00*** [.00] | -.01*** [.00] | -.02*** [.00] | .00 [.00] | .00*** [.00] | -.02*** [.00] |
| Creditor rights | -.01*** [.00] | -.00*** [.00] | -.00*** [.00] | -.00*** [.00] | -.01*** [.00] | -.01*** [.00] | .00*** [.00] | .00*** [.00] | .00*** [.00] |
| Property rights | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .00*** [.00] | .01*** [.00] | .01*** [.00] |
| Equity ratio _{t-1} | | .05*** [.00] | | .02*** [.00] | | .05*** [.00] | | .01*** [.00] | .01*** [.00] |
| Cash flow _{t-1} | | -.02*** [.00] | | -.01*** [.00] | | -.02*** [.00] | | .05*** [.00] | .05*** [.00] |
| Market to book _{t-1} | | .01*** [.00] | | .01*** [.00] | | .01*** [.00] | | .01*** [.00] | .01*** [.00] |
| Ownership _{t-1} | | -.02*** [.00] | | -.01*** [.00] | | -.02*** [.00] | | -.01*** [.00] | -.01*** [.00] |
| Country | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Year | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Adjusted R Sq. | .07 | .13 | .03 | .10 | .07 | .13 | .02 | .08 | .10 |
| # of Obs. | 138,188 | 138,188 | 77,601 | 77,601 | 109,425 | 109,425 | 28,763 | 28,763 | 28,763 |

This table reports the results from OLS regressions for the entire sample and several subsamples. Market and bank-based countries are defined in Demirguc-Kunt and Levine (2001) and Demirguc-Kunt and Maksimovic (2002). *R&D Intensity* is the dependent variable. All firm level variables are lagged with respect to the dependent variable. Exact definitions of the variables are given in Table 1. The robust standard errors are reported below the estimated coefficients. The symbols ***, **, * and † denote statistical significance at .1 per cent, 1 per cent, 5 per cent, and 10 per cent levels, respectively.

TABLE 7
Tobit Regression Results

| | All countries | | All countries excluding the US | | Market-based countries | | Bank-based countries | | Developed countries | | Developing countries | |
|-----------------------------|------------------|------------------|--------------------------------|------------------|------------------------|------------------|----------------------|------------------|---------------------|------------------|----------------------|------------------|
| | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| Intercept | -.06*** [.00] | -.13*** [.00] | -.02*** [.00] | -.10*** [.00] | -.09*** [.01] | -.16*** [.00] | -.05*** [.01] | -.08*** [.00] | -.03*** [.01] | -.11*** [.00] | -.03*** [.00] | -.04*** [.00] |
| Predicted equity ratio | -.09*** [.01] | -.11*** [.01] | -.11*** [.01] | -.07*** [.01] | -.07*** [.01] | -.05*** [.01] | -.05*** [.01] | -.09*** [.01] | -.09*** [.01] | -.02*** [.00] | -.02*** [.00] | -.02*** [.00] |
| Equity ratio _{t-1} | | .04*** [.00] | | .01*** [.00] | | .06*** [.00] | | .01*** [.00] | | .05*** [.00] | | .00** [.00] |
| Creditor rights | -.00*** [.00] | -.00*** [.00] | -.00*** [.00] | -.00*** [.00] | -.00*** [.00] | -.00*** [.00] | .01*** [.00] | .01*** [.00] | -.00*** [.00] | -.01*** [.00] | .01*** [.00] | .01*** [.00] |
| Cash flow | .02*** [.00] | -.00 [.00] | .04*** [.00] | .00 [.00] | .01*** [.00] | -.01** [.00] | .12*** [.01] | .09*** [.01] | .02*** [.00] | -.01 [.00] | .05*** [.01] | .04*** [.01] |
| Market to book | .01*** [.00] | .01*** [.00] | .02*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .00*** [.00] | .01*** [.00] | .01*** [.00] | .00*** [.00] | .00*** [.00] |
| Property rights | .02*** [.00] | .01*** [.00] | .02*** [.00] | .02*** [.00] | .02*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .01*** [.00] | .00*** [.00] | .00*** [.00] |
| High tech industries | .09*** [.00] | .08*** [.00] | .06*** [.00] | .05*** [.00] | .10*** [.00] | .09*** [.00] | .04*** [.00] | .03*** [.00] | .10*** [.00] | .09*** [.00] | .02*** [.00] | .02*** [.00] |
| Ownership | -.04*** [.00] | -.04*** [.00] | -.03*** [.00] | -.03*** [.00] | -.04*** [.00] | -.04*** [.00] | -.03*** [.00] | -.03*** [.00] | -.04*** [.00] | -.04*** [.00] | -.02*** [.00] | -.02*** [.00] |
| # of Obs. | 141,251 | 121,903 | 80,828 | 68,430 | 110,800 | 96,002 | 30,451 | 25,901 | 116,158 | 101,506 | 25,093 | 20,397 |

This table reports Tobit regression results on R&D (Research & Development Expenditures). The Predicted Equity Ratio is obtained by using all of the exogenous variables in equations 1 and 2. Exact definitions of the variables are given in Table 1. All regressions include industry and year fixed effects. The robust standard errors are reported below the estimated coefficients. The symbols ***, **, *, and † denote statistical significance at .1 per cent, 1 per cent, 5 per cent, and 10 per cent levels, respectively.

The determinants of the equity ratio are also similar across our samples. Cash flow, R&D intensity, and market to book ratios have a positive effect on the firm's use of equity, while size and a measure of adverse selection tend to reduce the amount of equity employed by firms.

We have examined the impact of creditor rights on R&D intensity. We have not taken into consideration that countries may differ in the enforcement of these rights. Future research might try to develop an index of enforcement of creditor rights and see the impact of that variable on our results. Another issue that we have not examined is whether countries' tax policies with respect to R&D are related to its creditor rights. Are higher creditor rights associated with more tax preferences for R&D? This issue is left for future research.

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NOTES

1. Many studies have documented the importance of R&D for economic growth. For the US see (Corrado, Hulten, & Sichel, 2009) and internationally see Goel and Ram (1994).
2. See <http://www.battelle.org/aboutus/rd/2011.pdf>.
3. Prior research has generally shown a significant market reaction to increased R&D intensity. See, for example, Szweczyk, Tsetsekos, and Zantout (1996) and Chan, Martin, and Kensinger (1990).
4. See also Harhoff (1998) for German firms, Bond, Harhoff, and Van Reenen (1999) for UK and German firms and Mulkey, Hall, and Mairesse (2001) for French and US manufacturing firms.
5. On a related topic, see also Cescon (2002) for a study on whether managers are guided primarily by short-term goals in Italy.
6. Prior studies using public bond covenants, as opposed to private credit agreements, did not find very many restrictions on investments (Billett, King, & Mauer, 2007; Smith & Warner, 1979).
7. Our research in some ways resembles Acharya et al. (2011). They are concerned with output measures of R&D while we focus on input measures.
8. For a review of this literature see Allen and Gale (1999) and Beck and Levine (2002).
9. Kanwar and Evenson (2009) make the point that the agreement on Trade Related Intellectual Property issues in 1994 brought countries' policies on property issues closer together but there are still substantial differences between countries.
10. In an earlier version of this paper, we included shareholder rights in the R&D equation. Our findings were generally supportive of the idea that increased shareholder rights resulted in more R&D. However, after including intellectual property rights in the equation the relationship between shareholder rights and R&D became very inconsistent. In the original version we used four estimates for shareholder rights and all showed a positive country correlation with our measure of creditor rights (ranging between .16 and .44). Two of the four estimates were significant. The correlation between shareholder rights and intellectual property rights was positive but insignificant.
11. Kaplan and Pathania (2010) make an interesting point. Firm responses to perception-based indicators are often affected by

the strength of the economy. This should not be a problem in our study since most of the explanatory variables are not perception-based indicators and the other independent variables are country based ones that do not change much over time.

12. Ideally we would like to have separate measures for ownership for insiders and ownership by blockholders. Unfortunately the data from Worldscope combines the two.
13. We argued previously that the effect of ownership on R&D intensity is ambiguous.
14. In this case, the coefficient on the creditor rights term represents the impact of creditor rights on R&D intensity when the cash flows are positive. The impact of creditor rights on R&D intensity when the cash flows are negative is the sum of the coefficient on creditor rights term plus the interaction term (Negative Cash Flow*Creditor Rights).
15. Ertugrul and Hegde (2009) find little systematic relationship between governance ratings and firm performance. On the other hand, Renders, Gaeremynck, and Sercu (2010) observe after controlling for endogeneity and selection bias, that there is a positive relationship between governance ratings and performance. Renders et al. (2010) review the literature and report prior studies generally show a positive relationship between good governance and performance.

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