Legal Shareholder Protection and Corporate R&D Investment

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Abstract

This paper investigates the effect of shareholder protection law on corporate R&D investment. I find that the institutional protection of shareholder benefits reduces both underinvestment and overinvestment in R&D projects. If we increase shareholder protection from the weakest to the strongest, R&D investment will increase by up to 96% for firms that may underinvest, but will decrease by as large as 84% for firms which may overinvest. Shareholder protection further significantly enhances the growth of firms in R&D intensive industries. The results consistently show that strong legal shareholder protection significantly improves the efficiency of corporate R&D investment.

JEL Classification Codes: G15, G31

Keywords: Shareholder protection, R&D, underinvestment, overinvestment

1 Introduction

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Corporate R&D investment is a major form of technological innovation which has long been regarded as the main driver of economic growth (e.g., Romer (1986, 1990); Aghion and Howitt (1992)). While R&D investment is important, its high degree of information asymmetry forces innovative firms to encounter external financing constraints and agency conflicts, both of which distort investment efficiency of firm innovation. On the one hand, small and new innovative firms operate with the "funding gap" for investment and may underinvest in R&D projects (Hall and Lerner (2009)); on the other hand, there are striking examples like General Motors, which spent almost $40 billion in R&D during the 1980s but generated a loss of $6.5 billion in the early 1990s and an opportunity loss of over $100 billion (Jensen (1993)). So how can we mitigate the underinvestment and also discipline managers for overinvestment in R&D around the world?

In this paper I show that enforcing strong legal shareholder protection is an effective tool to improve the efficiency of corporate R&D investment. The literature has shown that as shareholder protection protects minority shareholders and disciplines managerial behavior, it influences a number of firm policies. For example, stronger shareholder rights expand firms' access to external financing,[1] reduce earnings management[2] and cash holdings,[3] increase payout,[4] and influence firms' hedging policies,[5] loan contracting,[6] convertible bond design,[7] and so on. However, less is understood regarding the effects of shareholder protection on firm investment policies. Currently, researchers have shown that shareholder protection law influences

[1] e.g., La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997).

[2] e.g., Leuz, Nanda, and Wysocki (2003).

[3] e.g., Dittmar, Mahrt-Smith, and Servaes (2003), Kusnadi and Wei (2011).

[4] e.g., La Porta, Lopez-de-Silanes, Shleifer, and Vishny (2000), Alzahrani and Lasfer (2012)

[5] e.g., Lel (2012)

[6] e.g., Ge, Kim, and Song (2012)

[7] e.g., Korkeamaki (2005)

the sensitivities of investment to Tobin's Q and cash flow (Mclean, Zhang, and Zhao (2012), Kusnadi, Titman, and Wei (2007)) and encourages risk taking (John, Litov, and Yeung (2008)). In this study, I directly focus on the level of R&D investment. Using an effective double sorting procedure to identify firms that may under- or overinvest *ex ante*, I provide robust evidence that institutional protection of shareholder benefits reduces both under- and overinvestment in R&D. In addition, I deliver micro evidence that shareholder-friendly code significantly boosts both asset and sales growth of firms in R&D intensive industries. Considering the potentially serious distortions in R&D and the essential role of firm innovation in economic growth, these findings provide important policy implications on promoting growth and development.

In theory, shareholder protection can improve the efficiency of corporate R&D investment from two different channels. First, shareholder protection law expands firms' access to external financing and so reduces underinvestment in R&D projects due to external financing constraints. Second, legal protection of shareholders mitigates agency conflicts between managers and shareholders. Thus, it also reduces the likelihood of overinvestment and underinvestment in R&D that are caused by managerial pursuit of private gains. As a result, shareholder protection is able to mitigate both under- and overinvestment issues in R&D projects.

To empirically assess the influences of shareholder protection on R&D investment, I compile a panel data set of 52,339 firm-year observations from 38 countries over the period 1993-2008. My empirical strategy is to first identify and construct two sub-samples: firms that are *likely to* underinvest (underinvestment sample), and firms that are *likely to* overinvest (overinvestment sample). I double sort firms with growth opportunities and the availability of resources for investment to construct these samples. The idea is that firms with good growth opportunities but without sufficient resources for investment may underinvest. By contrast, firms with poor growth opportunities but ample resources for investment may overinvest. After I identify the under- and overinvestment samples, I examine the effects of shareholder protection on R&D investment for each sub-sample separately. Because shareholder protection reduces both underinvestment and overinvestment in R&D, it should increase R&D investment for firms that are likely to underinvest, but reduce R&D spending for firms that may overinvest.

The empirical results confirm the predictions. Using five different proxies for shareholder

protection and four distinct categories of measures of the availability of resources for investment,[8] I find a strong and *positive* relation between shareholder rights and R&D investment for firms that are likely to underinvest, but a significantly *negative* relation for firms that may overinvest. The results hold when including industry fixed effects as well as firm level Tobin's Q, cash flow and size. Moreover, the results are also robust to controlling for an array of country characteristics such as economic and financial development, education, creditor rights, political rights and laws on employee dismissal and patent protection. I also construct indexes based on individual sorting variables to provide a comprehensive evaluation on firms' likelihood of inefficient investment, and obtain the same conclusion.

The economic effects of shareholder protection on R&D investment are large. For example, if we increase the measures of legal shareholder protection from the weakest to the strongest, the median R&D expense to book assets ratio will *increase* by *30% – 96%* for firms that are likely to underinvest, but will *decrease* by *27% – 84%* for firms that may overinvest. These results consistently show that the institutional protection of shareholder benefits reduces both underinvestment and overinvestment in R&D projects. Furthermore, a comparison between different dimensions of shareholder protection law shows that disclosure requirements exert a larger impact on improving R&D investment efficiency than do the other aspects of shareholder protection.

To check for the robustness of the results, I perform a series of additional tests. I first show that the potential issues in the measurement of R&D due to discretion over disclosure and cross-country accounting differences do not affect the main findings. The results are also robust to the inclusion of additional country level controls. I further show that the effects of shareholder rights on R&D investment do not derive from the effects of investor protection on earnings management. Moreover, I use Tobit regressions and find that the findings are robust to

[8]The proxies for shareholder protection are: the anti-self-dealing index from Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), legal origin from La Porta et al. (1997), and indexes on the disclosure requirements, public enforcement and liability standard from La Porta, Lopez-de-Silanes, and Shleifer (2006). The four different categories of variables to measure the availability of resources for investment are: information asymmetry, free cash flow, financial constraints and external financial dependence. The assumption is that the availability of resources for investment will be positively correlated with free cash flow and negatively correlated with the other three categories of variables. Each category contains 2 to 4 different variables. I use Tobin's Q to measure growth opportunities. All different combinations give qualitatively similar results. Please see Section 3 for variable definitions.

the censoring bias in R&D investment data. I then replicate the tests in a sub-sample without observations from the US. The results also hold when I adopt country mean regressions and Fama-MacBeth regressions, suggesting that the results are not driven by small sets of countries or years. Finally, I experiment with different ways of ranking and sampling and demonstrate that the results are not sensitive to ranking or sampling procedures.

I further explore the following question: can shareholder protection law increase the growth rates of firms which operate in R&D intensive industries? As shareholder protection reduces both under- and overinvestment in R&D, it should help firms to accomplish a more efficient capital allocation to productive R&D investment, and to achieve a more optimal level of R&D investment. So shareholder rights should disproportionately help firms that depend on R&D investment for their growth. Therefore, innovative firms will have relatively higher growth rates in countries with greater legal shareholder protection. To evaluate the growth effects of shareholder protection law, I regress firm growth on the interactions between legal shareholder rights and the R&D intensity of industries. I find strong evidence that in countries with better protection of equity holder rights, firms in innovative industries have significantly higher growth rates in both sales and assets. The economic effects are large. For firms operating in R&D intensive industries like computer programming, holding other factors constant, the difference in growth rates between operating in the US (which enforces the strongest shareholder protection) and operating in Uruguay (which enforces the weakest shareholder protection) is as large as *22%* annually. These findings provide direct evidence on the micro channel through which legal shareholder rights promotes growth of an economy. Furthermore, the results hold after I control the impacts of financial market development on external-financing dependent industries (Rajan and Zingales (1998); Brown, Martinsson, and Petersen (forthcoming)) and R&D intensive industries (Beck and Levine (2002); Hsu, Tian, and Xu (2011)), suggesting that legal shareholder protection law exerts an independent impact on the growth of R&D intensive industries beyond the influences by financial development.

The paper proceeds as follows: Section 2 reviews the related literature and highlights this paper's contribution. After developing the hypothesis in Section 3, I present the empirical design in Section 4 and describe the data, sample and variable constructions in Section 5.

Section 6 analyzes the influences of legal shareholder protection on R&D investment and growth of innovative firms. Section 7 concludes.

2 Related Literature

This study contributes to several lines of literature. First, it contributes to the empirical research that examines the economic effects of shareholder protection on firm policies. While there is much effort in understanding the impacts of legal shareholder protection on financing policies of corporations (La Porta et al. (1997, 1998), etc.), there is limited attention to the influences of equity holder rights on firms' investment policies. In a related paper, John, Litov, and Yeung (2008) show that shareholder protection promotes firm risk taking behavior; Brown, Martinsson, and Petersen (forthcoming) show that strong shareholder rights increase R&D investment for firms that are dependent on external financing. By contrast, my paper shows that shareholder rights do not uniformly exert a positive impact on the level of R&D – While strong shareholder protection increases R&D for firms that may underinvest, it actually *reduces* R&D for firms that may overinvest. These evidence suggest that legal protection of shareholders helps firms achieve an overall more efficient capital allocation to productive R&D investment. In a different study, Mclean, Zhang, and Zhao (2012) show that shareholder protection increases investment sensitivity to Tobin's Q and reduces investment sensitivity to cash flow. My study differs from McLean et al. in two aspects. First, McLean et al. combine capital expenditures and R&D spending, and examine aggregate corporate investment. By contrast, I focus on R&D investment only and find that shareholder protection exerts a large influence on R&D investment. In the Empirical Appendix (Table A.2), I further provide evidence that in fact, the influence of shareholder protection on the level of capital expenditures is only marginal.[9]

[9]There might be two reasons for the different effects of shareholder protection on R&D investment and capital expenditures. First, compared with capital expenditures, investment in R&D projects requires larger amount of capital over a longer term. So R&D investment will depend more on external financing than do capital expenditures. Thus, the effects of shareholder protection on external financing will have a greater impact on R&D investment. Second, the inherent information asymmetry of R&D projects increases the costs for outside investors to effectively monitor managers. Therefore, managers may have substantial discretion over R&D investment decisions. By contrast, capital expenditures involve a lower degree of information asymmetry and agency conflicts than R&D investment. As legal shareholder protection aligns the interests of managers and shareholders, it will have a larger influence on R&D investment than on capital expenditures. A detailed analysis of the reasons for the different effects is beyond the scope of this study.

Second, McLean et al. focus on the effects of legal protection of shareholders on the investment sensitivities to Tobin's Q and cash flow. By contrast, I focus on the level of R&D investment and provide direct evidence that shareholder protection significantly reduces both underinvestment and overinvestment in R&D. This is the key contribution of my paper.

More importantly, this study contributes to the institution and growth literature by identifying a micro channel through which shareholder rights promotes the growth of an economy. While researchers have shown that legal shareholder protection significantly affects corporate decisions and financial development, as mentioned in the introduction, there is limited evidence on the micro channel through which the legal protection of shareholder benefits influences the economic growth. In related studies, Rajan and Zingales (1998) show that external-financing dependent sectors grow faster in countries with more developed financial markets; Brown, Martinsson, and Petersen (forthcoming) find that the access to equity financing increases corporate R&D investment and growth for firms that rely relatively more on external sources for financing. Beck and Levine (2002) show that financial development also enhances the growth of industrial sectors with high R&D intensity. Hsu, Tian, and Xu (2011) provide further evidence that while equity market development enhances the innovation productivity, credit market development discourages innovation. My paper shows that, after controlling the influences of stock/credit market development on external-financing dependent/R&D intensive industries, shareholder protection still exerts a large and significantly positive impact on growth of firms in R&D intensive industries. The finding suggests that, in addition to the channel of expanding external financing, legal shareholder protection law also disciplines firm insiders, improving the investment efficiency and promoting growth for the R&D intensive industries. In another study, Acharya and Subramanian (2009) show that creditor rights impedes the growth of innovative industries. My study shows that while creditor-friendly environment negatively influences growth of innovative industries, shareholder-friendly code significantly promotes the growth of industries that are dependent on innovation.

This paper also relates to the studies on the relation between corporate governance and firm innovation. Researchers have shown that a variety of corporate governance mechanisms

such as antitakeover provisions,[10] optimal compensation scheme,[11] and institutional ownership[12] significantly influence corporate innovation. This line of research mainly focuses on the effects of firm level corporate governance mechanisms on firm innovation, but the research that evaluates the influence of country level corporate governance on corporate innovation is limited.[13] Filling the gap in the literature, I show that shareholder protection, one of the determinants of country level corporate governance, also shapes corporate innovation.

My research further contributes to the cross-country studies of firm innovation. Current studies have shown that creditor rights (Acharya and Subramanian (2009)), labor protection (Acharya, Subramanian, and Baghai (2010a, b)), labor market regulations (Bassanini and Ernst (2002)), financial development (Brown, Martinsson, and Petersen (forthcoming); Hsu, Tian, and Xu (2011)), and patent laws (Moser (2005); Qian (2007)) affect firm innovation across countries. I show that shareholder protection is another important country level factor that exerts a large impact on firm innovative activities around the world.

3 Hypothesis Development

I frame the empirical analysis around two theoretical considerations. First, legal shareholder rights increase firms' access to external financing and so reduce underinvestment in R&D projects due to external financing constraints. In an imperfect market, firms may face external financing constraints on both equity financing (Myers and Majluf (1984)) and debt financing (Stiglitz and Weiss (1981)) due to information asymmetry. The inability to obtain sufficient external capital will force firms with good growth opportunities to underinvest. Because R&D investment involves intrinsically high degree of information asymmetry and is highly dependent on external financing, the underinvestment issue in R&D will be particularly severe. However, this investment inefficiency might be less pronounced in countries with stronger share-

[10] e.g., Mahoney, Sundaramurthy, and Mahoney (1997); Harforda, Mansib, and Maxwell (2008); Atanassov (2008); Becker-Blease (2011); Sapra, Subramanian, and Subramanian (2009)); Chemmanur and Tian (2010).

[11] e.g., Manso (2011); Francis, Hasan, and Sharma (2010).

[12] e.g., Aghion, Reenen, and Zingales (2008).

[13] An exception is Acharya and Subramanian (2009) who show that debtor-friendly code discourages firm innovation.

holder protection. Under a regime with stronger shareholder protection law, stockholders enjoy greater rights on firm disclosure, voting and litigation. As their benefits are better protected, investors are more willing to provide external financing. La Porta et al. (1997, 1998) show that stronger shareholder rights are associated with larger stock markets, higher market valuations, and greater access to external financing for corporations. Thus, shareholder protection relieves firms' external financing constraints and so will reduce the associated underinvestment in R&D.

Second, shareholder protection will also reduce the investment distortions due to the misalignment between the interests of firm insiders (such as managers and large shareholders) and those of outside minority shareholders. There are several theories that explain potential sub-optimal investment decisions from the perspective of conflicts of interests. For example, Jensen and Meckling (1976) and Jensen (1986, 1993) argue that firm insiders have the tendency to build an empire and expropriate resources for private benefits at the cost of outsiders. When a firm has abundant resources for investment, insiders may overinvest. Alternatively, Narayanan (1985) and Stein (1989) suggest that due to managerial myopia, firm managers have the incentive to underinvest to boost short term performance. In another study, Bertrand and Mullainathan (2003) find that firm managers pursue a "quiet life" as they preserve resources for private benefits. They may avoid expanding into a profitable new line of products, and are also reluctant to terminate unprofitable plants. This leads to both underinvestment and overinvestment. Career concerns of managers will also induce overinvestment and underinvestment (e.g., Holmstrom and Costa (1986); Hirshleifer and Thakor (1992); Boot (1992); Baker (2000)). Thus, the agency problem indeed distorts investment.

Because R&D investment is usually associated with project-specific knowledge, outside investors will have to incur greater costs and so are less able to monitor firm insiders' investment on innovative projects. In addition, due to the uncertainties of R&D projects, it is hard to evaluate firm insiders' role and hold them responsible for project failures. Therefore, managers maintain greater discretion over, and are more likely to expropriate private benefits from, investment on R&D projects, and so exacerbate the agency issues and associated distortions in R&D.

However, because legal protection of stockholder benefits mitigate the agency conflicts,

it can potentially alleviate the investment distortions in R&D. By granting greater rights and power to outside investors, shareholder protection reduces insiders' incentives to expropriate (Shleifer and Wolfenzon (2002)). The literature has shown that as shareholder protection reduces agency conflicts, it leads to larger dividend payout (La Porta et al. (2000)), smaller cash holdings (Dittmar, Mahrt-Smith, and Servaes (2003)) and greater risk taking behavior (John, Litov, and Yeung (2008)). Considering the significant impacts of shareholder protection on mitigating agency problems, legal shareholder rights may also reduce both overinvestment and underinvestment in R&D projects arising from conflicts of interests.

In sum, as shareholder protection expands firms' access to external financing and reduces firm insiders' incentives to expropriate, it reduces both underinvestment and overinvestment in R&D projects.

Main hypothesis: *Shareholder protection law reduces both underinvestment and overinvestment in R&D projects.*

The previous analysis also provides implications to the growth effects of legal shareholder rights on firms in innovative industries. First of all, because legal protection expands external financing to firms with promising projects, firms in countries with greater shareholder protection will make better use of growth opportunities and so grow faster. This channel is especially important for firms that depend on R&D for growth but are subject to external financing constraints. Brown, Fazzari, and Petersen (2009) show that external equity financing exerts a large impact on the R&D investment of young and innovative firms. By expanding firms' access to external financing, shareholder rights will disproportionately enhance the growth rates of R&D intensive firms. Second, as stronger shareholder rights mitigate the distortions in R&D spending that come from agency conflicts, it helps firms to achieve a more efficient allocation of capital to productive investment. For example, in countries where shareholders have greater rights to demand for voting and disclosure, managers will have less incentives to underinvest in R&D due to myopia and so will be more likely to achieve growth from innovation. In addition, shareholder rights will reduce managers' tendency to preserve private benefits and encourage managers to innovate and terminate existing unprofitable ones, which helps channel limited funds to better improve innovation productivity and growth. Thus the theoretical considerations

also motivate the prediction that firms which depend R&D for growth will achieve significantly higher growth in countries with stronger legal shareholder protection. And because it is typically firms operating in R&D intensive industries that critically depend R&D for growth, I predict that legal shareholder protection will enhance the growth of firms operating in R&D intensive industries.

Growth effects hypothesis: *Shareholder protection law enhances the growth of firms operating in R&D intensive industries.*

4 Empirical Design

4.1 The Construction of Overinvestment and Underinvestment Samples

The previous theoretical analyses suggest that the effects of shareholder protection on the level of R&D investment differs between firms that may underinvest and those that may overinvest. Thus, my empirical strategy is to first identify firms that may under- or overinvest *ex ante*, classify the firms into underinvestment/overinvestment sample, and then assess the relation between legal shareholder rights and R&D investment in each sub-sample. Because shareholder protection reduces both underinvestment and overinvestment in R&D, I expect a positive relation between R&D investment and shareholder protection for firms that are likely to underinvest, but a negative relation for firms that are likely to overinvest.

Specifically, to identify firms that may under- or overinvest and construct the underinvestment and overinvestment samples, I double sort firms with growth prospects and the availability of resources for investment. The idea is that firms with good growth opportunities but without sufficient resources for investment are likely to underinvest. By contrast, firms that have poor growth opportunities but with ample resources for investment may overinvest. To classify, I first sort the full sample into two sub-samples according to the availability of resources for investment (top half, labeled as "High"; bottom half, labeled as "Low", respectively). Then I further sort each sub-sample into halves ("High" and "Low", respectively) according to the median growth opportunities of the two sub-samples, respectively. I classify firms with low availability of resources for investment but high growth opportunities as the underinvestment

sample; and firms with high resource availability and low growth prospects as the overinvestment sample. By design, the classification is to obtain sub-samples that may make inefficient investment decisions *ex ante*.

I use Tobin's Q to measure growth opportunities, and four different categories of variables to measure the availability of resources for investment. The first category is information asymmetry. Information asymmetry reduces the availability of resources for investment because it increases external financing costs. The second category is free cash flow. Jensen and Meckling (1976) and Jensen (1986) show that free cash flow increases agency costs as managers have incentives to invest free cash flow for private benefits. The third category is financial constraints. Financially constrained firms presumably have relatively smaller amount of resources available for investment than do financially unconstrained firms. The last category is external financial dependence. Because external financing is more costly than internal financing, firms that are dependent on external financing will have lower resource availability for investment than firms that depend on internal cash flows.

In addition to using Tobin's Q and individual variables that proxy for firms' resource availability to evaluate firms' tendency to under- or overinvest, I also construct indexes to extract information of all variables and provide a comprehensive evaluation on firms' likelihood of inefficient investment. Specifically, I tabulate the $Underinvestment$ index and $Overinvestment$ index. The $Underinvestment$ ($Overinvestment$) index of a firm-year observation equals the number of times that this observation is classified into the underinvestment (overinvestment) sample when double sorting with Tobin's Q and the individual variables. Higher value of the indexes indicates higher likelihood of under- or overinvestment.

4.2 Regression Models

After I construct the underinvestment sample and the overinvestment sample, I estimate the following regression model for each sample separately to evaluate the effects of shareholder protection on R&D investment:

$$R\&D_{i,\ j,\ t} = \alpha_0 + \alpha_1 * Share.Protec._j + \beta * Control_{i,\ j,\ t-1} + Year + Indus. + \epsilon_{i,\ j,\ t} \quad (1)$$

where i, j, t are subscripts for firm, country and year, respectively. $Year$ and $Indus.$ represent year fixed effects and industry fixed effects at the 2-digit SIC code level. Because shareholder protection will reduce both underinvestment and overinvestment in R&D, I predict that $\alpha_1>0$ for the underinvestment sample, and that $\alpha_1<0$ for the overinvestment sample.

To test the growth effects of shareholder protection on firms which operate in R&D intensive industries, I regress firm growth rates on the interaction term between shareholder protection and industry level R&D intensity, and control a series of variables. I use the industry median (at the 2-digit SIC level) R&D to book assets ratio and R&D to capital expenditures ratio to measure R&D intensity. In all regressions, I include industry and country dummies at the 2-digit SIC level, and so do not include the R&D intensity or shareholder protection variables in the regressions. The regression model is the following:

$$\begin{aligned} Firm\ Growth_{i,\ j,\ v,\ t} &= \gamma_0 + \gamma_1 * Share.Protec._j * R\&D\ Intensity_v \\ &\quad +\lambda * Control_{i,\ j,\ t-1} + Country \\ &\quad +Year + Indus. + \varepsilon_{i,\ j,\ v,\ t} \end{aligned} \tag{2}$$

v is the subscript for industry. $R\&D\ Intensity_v$ is the R&D intensity of industry v. Because shareholder protection will increase the growth rates of firms that depend on R&D, I predict that the γ_1 will be positive and significant.

5 Data and Sample

5.1 Data Sources

To implement the empirical tests, I obtain firm and country level data from various sources. I collect firm fundamental data from the Xpressfeed version of Compustat Global for international firms and Compustat North America for US and Canadian firms. I obtain daily stock price data from Compustat Daily Security database and CRSP Daily Stocks database. Analysts' forecast data are from I/B/E/S Summary History database. Daily stock indexes and annual exchange rates are from Bloomberg and Compustat Global Currency database,

respectively. The sample is over the period 1993-2008.[14]

I collect country level variables from several sources. The measures of shareholder protection are from Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1997) and La Porta, Lopez-de-Silanes, and Shleifer (2006). Economic development data is from Penn World Table 6.3. The measures of private credit market and stock market development are based on the World Development Indicator database. Data on creditor protection, education, patent protection, labor protection and political rights are from Djankov, McLiesh, and Shleifer (2007), Barro and Lee (2010), Park (2008), Botero, Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2010), and Puddington, Piano, Eiss, and Roylance (2007), respectively.

5.2 Sample Selection

I delete utility firms and financial firms by dropping observations with SIC codes between 6000 and 6999 or between 4900 and 4999. I drop an observation if (1) there is a negative value in either R&D expense (XRD) or book assets (AT), or (2) the sum of long term debt (DLTT) and debt in current liability (DLC) is larger than book assets. I also delete any firm year observations with missing data. The final sample includes 52,339 firm-year observations from 36 countries.[15]

5.3 Variable Construction

I measure R&D investment as the R&D expense (XRD) divided by book assets (AT) at the end of the previous fiscal year. This variable is subject to several measurement issues. First, the accounting for spending on R&D differs across countries. While the US accounting rule requires firms to treat R&D spending as expense, accounting rules of other countries like Japan and France allow firms to capitalize R&D expenditures under certain conditions. Second, firms exert discretion over reporting R&D and may choose not to disclose spending on R&D.

[14]There are few observations of international firms in Compustat Global prior to 1993.

[15]The requirement of no missing observation in R&D expense reduces the number of observations from 111,252 to 52,339. In robustness tests, I show that the results still hold if I use the sample of 111,252 observations and replace the missing R&D with zero.

Third, the measurement of R&D of non-innovative firms may bring noises to the regressions. To mitigate these concerns, I perform several robustness tests and show that these measurement issues in R&D do not affect the main findings.

I use the anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$) and indexes on public enforcement ($Publ\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) to measure shareholder protection. $ASDI$ is from Djankov et al. (2008). It is based on legal rules prevailing in 2003 for 72 countries. This index mainly focuses on private enforcement mechanisms, such as disclosure, approval, and litigation that govern a specific self-dealing transaction. $ASDI$ ranges from 0 to 1. Djankov et al. (2008) show that $ASDI$ generally works better than the previous anti-director rights index introduced by La Porta et al. (1998) in explaining stock market development across countries. In addition to $ASDI$ that focuses on private enforcement, I also use an index on public enforcement from La Porta et al. (2006) to measure shareholder protection. $Publ\_Enforce$ combines supervisor attributes, power delegation, investigative power and criminal and noncriminal sanctions for violations of security laws. Private enforcement and public enforcement mechanisms jointly shape shareholder protection of a country. The literature also emphasizes the importance of two specific private enforcement mechanisms: disclosure requirements and liability standards in influencing firm policies and stock market development (Mclean, Zhang, and Zhao (2012); La Porta et al. (2006)). Therefore I further include the disclosure index and the liability index from La Porta et al. (2006) as proxies for shareholder protection. Because public enforcement, disclosure requirements and liability standards are the three dimensions of security laws examined in La Porta et al. (2006), choosing these three indexes can also provide a comparison between the effects of different aspects of security laws on R&D investment efficiency. All the three indexes on security laws range from 0 to 1. Finally, I use English legal origin ($Legal\_ENG$) from La Porta et al. (1997) to measure shareholder protection. It is a dummy variable that takes 1 for English common law countries, and 0 otherwise. La Porta et al. (1997) find that shareholder protection is stronger in common law countries than in civil law countries.[16]

[16]Another popular proxy for shareholder protection is anti-director rights index. There are three versions of anti-director rights index: original anti-director index (La Porta et al. (1998)), revised anti-director index (Djankov et al. (2008)) and corrected anti-director index (Spamann (2010)). I obtain supporting results with

5.4 Summary Statistics

Appendix A provides variable definitions on the measures of growth opportunities, cash flow, and the availability of resources for investment, as well as country level control variables. Table A.1 presents the summary statistics of country level control variables.

I winsorize all firm level variables at the 1% and 99% cutoff points of the sample to reduce the effect of outliers.[17] Table 1 provides the summary statistics. Panel A reports the descriptive statistics of firm level variables. The average R&D expense to book assets ratio is 6.4%. Statistics on firm size shows that the sample includes small firms with book assets of $17.85 million at the 5th percentile, and large firms with book assets of $5 billion at the 95th percentile.

Panel B shows the sample distribution across countries. Among the 38 countries in the sample, there are 13 common law countries and 25 civil law countries. The distribution of observations across countries is not even. For example, US observations account for 61.5% of the sample.[18] The cross country statistics on R&D investment shows that there is a large variation on the level of average firm R&D investment in different countries. For example, while R&D expense accounts for over 8% of book assets for firms operating in the US and Denmark, it is on average 0.1% of book assets for firms in Chile. Panel C suggests that there is also considerable variation in R&D investment across industries. The average R&D expense to book assets ratio ranges from 0.2% in the retail trade industry to 10% in the service industry.

Insert Table 1 About Here.

the original anti-director index, but not with the other anti-director indexes. While the original and revised anti-director rights indexes are significantly correlated with firms' access to external financing, the anti-director index from Spamann (2010) is not.

[17]The results with alternative winsorization at 5% and 95% cutoff points are similar.

[18]To mitigate the potential bias from the dominant country in the sample, I estimate the firm level regressions without US firms. I also estimate the country level regressions. In both cases, the main findings still hold.

6 Empirical Results

6.1 Shareholder Protection and R&D Investment: Full Sample Results

I first present the overall effects of shareholder protection on firm R&D investment in the full sample. In all regressions, I include both firm level and country level control variables as well as fixed effects for each year and each 2-digit SIC industry. The regressions presented in Table 2 show that there is no significant relation between shareholder rights and R&D investment in the full sample. Four out of five of the measures of shareholder protection do not enter the regressions significantly. This finding is not surprising. The opposing effects of shareholder protection on R&D investment for firms that may underinvest and for firms which may overinvest could offset each other.

As for control variables, Tobin's Q and cash flow are positively correlated with firm R&D investment, indicating that firms with better growth opportunities and more cash flow invest relatively more on R&D projects. As for country variables, creditor protection is negatively correlated with R&D investment, consistent with Acharya and Subramanian (2009) that creditor rights discourage firm innovation. Both political rights and openness are insignificant in the regressions. Moreover, there is a significant and positive relation between financial development and R&D investment, suggesting that a stronger financial sector boosts firm investment on R&D projects. Government spending is negatively associated with R&D investment. Education and patent protection have positive and significant impacts on firm innovations. GDP per capita appears to be negatively correlated with R&D investment. Stronger labor protection against dismissal is associated with more R&D investment, supporting the evidence from Acharya, Baghai, and Subramanian (2010a) that dismissal law promotes firm innovation.

Insert Table 2 About Here.

6.2 Shareholder Protection and R&D Investment: Sub Sample Results

6.2.1 The Results of Grouping with Tobin's Q and Information Asymmetry

In the sub-sample analysis, I group firms according to growth opportunities (Tobin's Q) and the availability of resources for investment to classify firms that may underinvest or overinvest. I first use information asymmetry as the measure of the resource availability. As information asymmetry leads to external financing constraints, a higher degree of information asymmetry implies lower availability of resources for investment. In Panel A of Table 3, I report the results with residual volatility as the proxy for information asymmetry. Columns 1-5 report the results for firms with high (above median) Tobin's Q and high residual volatility. These firms are likely to underinvest because external financing constraints brought by information asymmetry will force firms to forgo growth opportunities. In contrast, Columns 6-10 report the coefficient estimates for firms with low (below median) Tobin's Q in the sub-sample of firms with below median residual volatility. These firms may overinvest as they do not have good growth opportunities but can easily obtain external financing. The regressions show that shareholder protection enters significantly and positively in regressions 1-5, but the association turns significantly negative in regressions 6-10. The results are consistent with the predictions that stronger shareholder protection is associated with greater (smaller) amount of R&D investment for firms that may underinvest (overinvest).

The economic magnitude of the coefficients for shareholder protection is consequential. In Fig. 1, using the estimation results from Panel A of Table 3 and samples grouped with Tobin's Q and residual volatility, I plot the predicted R&D investment to book assets ratio of firms that may underinvest or overinvest for different extent of shareholder protection. I evaluate all the independent variables at the median value of the underinvestment sample and the overinvestment sample, respectively. As shown in Panel A of Fig. 1, for firms that may underinvest, all else equal, an increase of the anti-self-dealing index from 0 (weakest) to 1 (strongest) will lead R&D investment to book assets ratio to increase from 9.81% to 16.11%, a 64% (16.11%/9.81%-1) increase. The result on legal origin shows that in common law countries, firms that may underinvest have 30% (12.71%/9.81%-1) more R&D investment than their coun-

terparts operating in civil law countries. Among the three dimensions of security laws, disclosure has the greatest effects on R&D investment. An increase of public enforcement, disclosure and liability standards from the weakest to the strongest will result in an 36% (12.71%/9.81%-1), 96% (19.21%/9.81%-1) and 65% (16.21%/9.81%-1) increase in investment on R&D projects, respectively.

Panel B of Fig. 1 shows that for firms that may overinvest, all else equal, an increase of ASDI from 0 to 1 will reduce R&D investment to book assets ratio from 2.99% to 0.99%, a decrease of 67% (1-0.99%/2.99%). Furthermore, a firm that may overinvest will make 27% (1-2.19%/2.99%) less R&D investment in common law countries compared with their counterparts in civil law countries. Disclosure still exerts the largest influence on R&D investment among the three dimensions of security laws for firms that may overinvest. If we increase disclosure requirements from 0 to 1, R&D investment of firms that may overinvest will be 84% (1-0.49%/2.99%) lower, while an increase of public enforcement or liability from 0 to 1 is associated with a drop by 33% (1-1.99%/2.99%) and 60% (1-1.19%/2.99%) of R&D investment, respectively.

Insert Fig. 1 About Here.

In Panel B of Table 3, I report the results with standard deviation of excess returns as the measure of information asymmetry. The results are similar to Panel A. In Panels C and D, I use forecast error and forecast dispersion to measure information asymmetry, respectively. The results generally confirm the previous findings. Shareholder protection is still positively and significantly correlated with R&D investment for firms that may underinvest. The only exception is that when analysts' forecast data are used to measure information asymmetry, shareholder rights are insignificantly correlated with R&D investment for firms that may overinvest.

Insert Table 3 About Here.

6.2.2 The Results of Grouping with Tobin's Q and Free Cash Flow

In addition to information asymmetry, I also use free cash flow to measure the availability of resources for investment. When grouping with Tobin's Q and free cash flow, I classify

firms with higher Tobin's Q but lower level of free cash flow as firms that may underinvest, and the other extreme as firms which may overinvest. Table 4 reports the results. In Panels A and B, I use $FCF1$ and $FCF2$ to measure free cash flow, respectively. The results show that all measures of shareholder protection are significantly and positively correlated with R&D investment for firms that may underinvest, and that these measures enter negatively in regressions in the overinvestment sample. This further lends support to the predictions that better legal shareholder protection lowers the likelihood of both underinvestment and overinvestment in R&D projects.

Insert Table 4 About Here.

6.2.3 The Results of Grouping with Tobin's Q and Financial Constraints

I also use financial constraints to measure the availability of resources for investment. Greater financial constraints are associated with fewer resources available for investment. I use $1/Size$, *payout ratio* and Whited and Wu index (WW *index*) to proxy for financial constraints. The central message from Table 5 is that shareholder protection is positively correlated with R&D investment for firms with higher Tobin's Q and a higher degree of financial constraints, while the relation turns negative for firms in the other extreme. Thus, the evidence from grouping with Tobin's Q and financial constraints also confirms previous findings, supporting the positive effects of shareholder protection on R&D investment efficiency.

Insert Table 5 About Here.

6.2.4 The Results of Grouping with Tobin's Q and External Financial Dependence

Grouping with Tobin's Q and external financial dependence also provides evidence that is consistent with the predictions. Firms that possess profitable investment opportunities but are highly dependent on costly external financing may not fully explore R&D investment opportunities. In contrast, insiders of firms that mainly use internal financing for investment exert substantial discretion and may overinvest in the absence of good projects. Table 6 reports the

results of regressions in which I use firm level (Panel A) and industry level (Panel B) measures of external financial dependence, respectively. In the regressions, all measures of shareholder protection are significantly and positively correlated with R&D investment for firms that may underinvest, and shareholder protection significantly reduces R&D investment for firms which may overinvest. Again, the results are supportive to the positive effects of shareholder protection law on R&D investment efficiency.

Insert Table 6 About Here.

6.2.5 The Results of Grouping with the Underinvestment/Overinvestment Index

In the previous analysis, I use Tobin's Q and individual variables that proxies firms' resource availability to evaluate firms' tendency to under- or overinvest. Instead, to use the information of all variables and provide a comprehensive evaluation on firms' likelihood of inefficient investment, I further construct indexes based on all the individual variables. Specifically, I create two indexes – *Underinvestment* index and *Overinvestment* index. *Underinvestment* (*Overinvestment*) index of a firm-year observation equals the number of times that the firm-year observation is classified into the underinvestment (overinvestment) sample when double sorting with Tobin's Q and the individual variables. In total I use eleven variables to proxy for firms' resource availability. Therefore, by construction both indexes range from 0 to 11. I classify a firm with the *Underinvestment* (*Overinvestment*) index larger than 4 to be likely to underinvest (overinvest). I use 4 as the benchmark because 4 is at the 75 percentile of both indexes, and so the corresponding under- or overinvestment sample each constitutes one quarter of the full sample. The sample size is consistent with the size of the sample obtained with previous double sorting procedures. Second, 4 is the minimum to fully disentangle the underinvestment and overinvestment samples. Therefore, using 4 as the benchmark can maximize the number of observations and guarantee that there is no overlapping between the underinvestment and overinvestment samples. In unreported results, I also obtain similar results by using 5 and 6 as the benchmark. The grouping with the underinvestment and overinvestment indexes is superior to the previous procedure of double sorting with Tobin's Q and individual variables. The reason is

that the indexes extract information from all variables, while the double sorting procedure each time only uses information from Tobin's Q and an individual variable that proxy for resource availability.

The results are reported in Table 7. As we can see, shareholder protection significantly increases R&D of firms that may underinvest, but reduces R&D for firms that may overinvest, further confirming the previous findings.

Insert Table 7 About Here.

6.3 Robustness to the Measurement Issues of R&D

The measurement of R&D is subject to biases from missing values. About half of the firm-year observations have missing value in R&D expense. In the main tests, I exclude observations with missing data in R&D expense. On the other extreme, I examine if the results still hold after replacing missing values in R&D with zero. This replacement increases the sample from 52,339 observations to 111,252 observations. I then create groupings and ranking variables, and estimate the effects of shareholder protection on R&D investment in the larger sample. For brevity, I report the estimation results on sub-samples formed by grouping with the *Underinvestment* and *Overinvestment* indexes in Panel A of Table 8. The results confirm the positive (negative) effect of shareholder protection on R&D investment for the underinvestment (overinvestment) sample. The results on sub-samples formed by grouping with alternative variables are also similar to the results in the main text and are available upon request.

To mitigate the concern about the bias from cross-country differences in accounting for R&D spending, I include a dummy variable that indicates the adoption of International Financial Reporting Standards (IFRS). The dummy indicator equals 1 for countries that adopt IFRS, and 0 otherwise. While the accounting standard in the US requires that expenditures on R&D be charged to expense immediately when incurred, IFRS identified certain circumstances that justify the capitalization and deferral of development costs. Among the 38 countries in my sample, 20 countries permit the usage of IFRS, while the other 18 countries do not. Admittedly, controlling the adoption of IFRS can not fully capture the difference in accounting

for R&D. Even within countries that adopt IFRS, firms may still exert discretion in treating R&D spending as either expenditure or expense. However, considering that adopting IFRS or not constitutes a major difference between accounting systems of different countries and that it is almost impossible to examine how do firms of each country report R&D, controlling the adoption of IFRS is able to capture the major variations in R&D ascribed to the accounting difference and well serve the purpose of the robustness test. Panel B of Table 8 reports the results and shows that the inclusion of the dummy indicator for the adoption of IFRS does not change the main results.

I also restrict the tests to high tech firms to rule out the noises in the measurement of R&D expense that come from firms without much innovation activities. Following Brown et al. (2009), I select firms in industries with 2-digit SIC code of 28, 35, 36, 38 or 73 to form a reduced sample of high-tech firms only, and re-run the regressions. Panel C of Table 8 shows that the results are similar to previous findings.

Insert Table 8 About Here.

6.4 Additional Country Level Controls

To show that the results are robust to additional country level controls, I further include several other categories of country variables. These variables include stock market development, cultural variables, earnings opacity and country governance indicator. I first add them one category at a time in Panels A-D of Table 9, and then include all of the variables into the regressions, as reported in Panel E. The results still hold.

Insert Table 9 About Here.

6.5 Additional Robustness Tests

In the following, I implement seven additional categories of robustness tests. To save space, I only report the results on the sub-samples grouped by the *Underinvestment* and *Overinvestment* indexes. The results of robustness tests on sub-samples with alternative grouping variables are similar and are available upon request.

6.5.1 Earnings Management

I first test that the effects of shareholder protection on R&D investment do not derive from the effects of shareholder rights on earnings management. Firms may engage in earnings management by manipulating R&D expense (Roychowdhury (2006)). Leuz, Nanda, and Wysocki (2003) show that stronger shareholder rights reduce managerial incentives for private benefits and correspondingly lower the likelihood of manipulating earnings. It is possible that shareholder protection influences R&D investment because it affects firms' earnings management. To control for this possibility, I remove firms that may manipulate earnings by dropping observations with small earnings (the absolute value of the earnings to book assets ratio smaller than 0.01), and re-estimate the regressions. None of the results change.

6.5.2 Censoring Bias

I next test that the results are not determined by censoring bias on R&D investment. There are 6,026 firm year observations, or 12% of the sample that have zero R&D expense. Because R&D investment is left censored at zero, the previous empirical results may have censoring bias. I use Tobit regressions to adjust for the censoring bias and obtain similar results.

6.5.3 Removing Observations from the US

The findings are also robust to the exclusion of firms from the US. The US observations account for over 60% of the sample. One concern is that the results are driven by the dominant country. To mitigate this concern, I restrict the sample to non-US firms and re-do the tests. The results show that the exclusion of US observations does not alter the conclusion.

6.5.4 Country Mean Regressions

I further test that the results are not driven by any particular set of countries. Besides the US, countries like Japan and the UK also account for significant portion of the sample. There is concern that the main results are driven by some countries other than the US. Thus, I use

country level regressions which assign equal weight to each country-year to check for robustness. Specifically, I tabulate the country-year average of the firm level variables of the underinvestment sample and the overinvestment sample, respectively. Then I estimate the country level regressions at each sub-sample separately. The results confirm the previous findings.

6.5.5 Fama-MacBeth Regressions

Another concern is that the results may be driven by observations from certain years. The sample period over 1993-2008 covers the Asian financial crisis during 1997-1998, the technology boom in the 1990s and the real-estate boom in the 2000s. To show that the results are not driven by any particular periods, I run Fama-MacBeth regressions and obtain the same conclusion.

6.5.6 Alternative Ranking Procedures

In previous tests, I construct the ranking variables by the whole sample. Because firm level variables vary significantly across countries, years and industries, ranking by the whole sample may cause observations from some countries, years or industries to cluster in certain sub-samples. Alternatively, I experiment with ranking variables within each country, year, 2-digit SIC industry and each 2-digit SIC industry of each country, respectively. In each case, I obtain qualitatively similar results.

6.5.7 Alternative Grouping Procedure

Finally, alternative grouping procedure does not alter the results either. In the main tests, I adopt the dichotomy sampling procedure to separate the sample into a top half and a bottom half. To show that the results are robust to alternative sampling procedure, I also try a different way to group firms. Specifically, I sort the sample into quintiles based on the availability of resources for investment. Then within the top two quintiles (High) and the bottom two quintiles (Low), I further sort each sub-sample into quintiles based on Tobin's Q. The sub-sample of firms in the top two quintile Tobin's Q groups within the Low availability group is classified as the underinvestment sample. In contrast, the sub-sample of firms in the

bottom two quintile Tobin's Q groups within the High availability group is considered as the overinvestment sample. The results continue to hold when I group firms into quintiles.

Insert Table 10 About Here.

6.6 Shareholder Protection and Growth of R&D Intensive Industries

After confirming the positive impact of legal shareholder protection on the efficiency of R&D investment, I further explore the following important question: can shareholder protection law increase the growth rates of firms that depend on R&D for growth? To evaluate the growth effects of legal shareholder rights on innovative firms, I regress firms' annual real growth rates on the interaction between equity holder protection and R&D intensity of the firms' industries. In all regressions, I control for firm level size (one over book assets in the last period) and the natural log of initial size; and country level variables including domestic credit to GDP ratio, stock market capitalization to GDP ratio, GDP per capita and government spending. Because Acharya and Subramanian (2009) show that creditor rights reduce the growth rate of innovative industries, I also include the interaction between R&D intensity and creditor rights. I use both sales growth and asset growth to measure firm growth. In all regressions, I include country, industry and year fixed effects. Because running the growth regressions does not require no missing value in R&D, I use the sample with 111,252 observations. After requiring no missing value in R&D intensity and firm growth, the final sample for the growth regressions has 83,672 firm-year observations. Table 11 reports the summary statistics.

Insert Table 11 About Here.

Table 12 reports the regression results of firm growth. Panel A displays the results on sales growth. In Columns 1-5 I use industry median R&D to book assets to measure R&D intensity. Columns 6-10 instead report the results with industry median R&D to capital expenditures ratio to evaluate the intensity of R&D activities. In all regressions, the coefficient of the interaction term between R&D intensity and the proxy for shareholder rights is positive and significant. These results suggest that, holding other factors constant, firms in R&D intensive industries have faster sales growth in countries with stronger legal protection of shareholder ben-

efits. As for comparison, we can see that among different dimensions of shareholder protection, disclosure requirements exert the largest growth effects on firms of R&D intensive industries.

The economic effects are large. Take disclosure for example. The median annual sales growth of a firm in an industry with R&D intensity at the 75 percentile like engineering services (SIC=8711) will be 10.5% (coefficient*median R&D/AT=1.986*0.053) higher if the firm operates in the US (Disclose=1) than if it operates Uruguay (Disclose=0). For industries with R&D intensity at the 95 percentile like computer programming industry (SIC=7371), the difference is as large as 22.0% (coefficient*median R&D/AT=1.986*0.111) annually. These results consistently show that shareholder protection exerts a large and positive impact on the sales growth of firms operating in R&D intensive industries.

Panel B shows that for regressions of asset growth, the coefficients on measures of legal shareholder protection are positive but mostly insignificant. One interesting comparison between the results on sales growth and asset growth is that, the interaction terms between R&D intensity and stock market development are positive and significant in regressions of asset growth but not in regressions for sales growth. The results also show that the development of credit markets and stock markets have different impacts on R&D intensive industries – while the interaction terms between credit market development and R&D intensity enter the regressions with mostly negative coefficients, the impacts of stock market development on innovative industries are positive and significant. These results are consistent with Hsu, Tian, and Xu (2011).

Insert Table 12 About Here.

7 Conclusion

In this paper, using an effective tool to identify firms that may under- or overinvest *ex ante*, I show that shareholder protection significantly increases R&D investment for firms that are likely to underinvest and reduces R&D investment for firms that may overinvest. Firms operating in R&D intensive industries also grow faster under stronger shareholder protection. These results suggest that by expanding firms' access to external financing and reducing insiders' incentives for private benefits, shareholder protection significantly improves the efficiency of

corporate R&D investment, and enhance the growth of innovative firms. Finally, among different dimensions of shareholder protection, disclosure exerts the largest impact on R&D investment, highlighting the significance of disclosure in disciplining managerial investment behavior.

The findings in this paper provide an important policy implication regarding R&D investment. While R&D investment is critical to economic growth, its efficiency may be distorted by agency and market frictions. This paper provides robust evidence that strengthening shareholder protection is an effective tool to enhance the efficiency of R&D investment around the world. This policy implication is particularly valuable for developing countries like Malaysia and China which focus on promoting economic growth through R&D investment. For these countries, enforcing stronger degree of shareholder protection can be crucial for the effective implementation of innovation focused economic policies.

Acknowledgements

This paper is from Chapter One of my dissertation at the University of South Carolina. I thank the Moore School of Business for funding support. I am grateful to Jean Helwege (chair), Shingo Goto, Steve Mann, Eric Powers and Hong Yan for their constant and great support. I am especially thankful to Yongqiang Chu for valuable discussions and guidance. I also acknowledge Art Boman, James Brown, Sadok El Ghoul, Shingo Goto, Omrane Guedhami, Robert Kieschnick, Tanakorn Makaew, Robert Nash, Liang Shao, Benedicte Reyes, Xuan Tian, Sergey Tsyplakov, Po-Hsuan Hsu, Shu Yan, and Donghang Zhang for helpful suggestions. The paper also benefits from participants at presentations at the AIB 2010, SFA 2010, MFA 2011, EFA 2011, FMA 2011 and University of South Carolina. I am responsible for all errors in the paper.

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Appendix

A Variables Definitions

A.1 Measures of Growth Opportunities and Cash Flow

I use market to book ratio to proxy for Tobin's Q ($Tobin's\ Q$). The numerator is the sum of market value of equity (the product of stock closing price at the fiscal year end and the number of outstanding shares[19]) and book assets minus the sum of common equity (CEQ) and deferred taxes (TXDB). The denominator is book assets.

Cash flow ($Cashflow$) is the sum of income before extraordinary items (IB) and depreciation and amortization (DP) plus R&D expense divided by book assets at the end of the previous fiscal year.

A.2 Measures of Availability of Resources for Investment

Information asymmetry

I use four variables from the literature to measure information asymmetry: residual volatility, standard deviation of excess return, forecast error and forecast dispersion (e.g., Dierkens (1991); Krishnaswami and Subramaniam (1999); Drobetz, Grüninger, and Hirschvogl (2010)) to measure information asymmetry. Residual volatility is the standard error of the residual from the market model. It assumes that market information is the only information that firm insiders share with outside investors. The residual in the market model thus captures the information asymmetry regarding firm-specific information between insiders and outsiders. However, by assuming that market information is the only shared information, this variable may overestimate the degree of information asymmetry. For example, industry-specific information may not be embedded in the market, but can be still captured by both firm insiders and outsiders. The standard deviation of market adjusted return is similar in concept with residual volatility. It is estimated as the dispersion of daily stock return in excess of the domestic market return in the previous year. I also use two variables constructed with analysts' forecast data to measure information asymmetry. The first one is forecast error. I first calculate the monthly absolute value of the difference between the mean of forecasted earnings per share (EPS) and the actual EPS. Then I take the yearly average and scale it by price per share at the fiscal year end to obtain forecast error. Large forecast error suggests that managers may hold up firm-specific information and so analysts lack the sufficient information to forecast earnings of firms. Therefore, higher forecast error is associated with

[19]Compustat North America provides fiscal year end closing price of equity and the number of outstanding shares, but Compustat Global does not provide these for non-US firms directly. To compute market value of equity for non-US firms, I use the Compustat Security Daily database. For each firm I identify the issues that should be included in the computation of market value of equity. Then I obtain data on the closing price and outstanding volume at the fiscal year end of each issue.

greater information asymmetry. The second variable is forecast dispersion. It is the average of monthly standard deviation of analyst forecast on EPS of the previous fiscal year. Higher dispersion between analysts in forecasting firms' future earnings implies that analysts lack guidance and information to reach consensus, and so corresponds to higher degree of information asymmetry.

Free cash flow

I use two variables to measure free cash flow. The first measure, $FCF1$, is operating income before depreciation (OIBDP) minus the sum of income tax (TXT), change in deferred taxes (change in TXDITC), interest expense (XINT) and total dividends (DVT), following Lehn and Poulsen (1989), Chae, Kim, and Lee (2009) and Chi and Lee (2010). The second measure, $FCF2$, is earnings before tax, depreciation and amortization (EBITDA), also following Chae, Kim, and Lee (2009). Both free cash flow measures are scaled by book assets at the end of the previous fiscal year.

Financial constraints

I use three variables to measure financial constraints.[20] The first variable is 1/Size, or the inverse of book assets in US million dollars. Hadlock and Pierce (2010) find that size is a particularly useful measure of financial constraints. Bakke and Whited (2010) suggest that size can be regarded as exogenous because managers can not choose size in the short term. The second variable is payout ratio. The intuition is that financially constrained firms pay significantly less dividend than financially unconstrained firms (Fazzari, Hubbard, and Petersen (1988)). Payout ratio is calculated as the total dividend (DVT) plus stock repurchase (PRSTKC) divided by income before extraordinary items (IB). The third variable is Whited and Wu index (WW index) from Whited and Wu (2006). Whited and Wu show that firms sorted by WW index are consistent with characteristics of financially constrained firms. It is calculated as follows:

$$\begin{aligned} WW\ index &= -0.091 Cashflow - 0.062 DIV\_POS + 0.021 TLTD - 0.044 LNTA \\ &\quad + 0.102 ISG - 0.035 SG \end{aligned} \tag{3}$$

where Cashflow is $Cashflow$ previously defined. DIV_POS is a dummy variable that equals one if the firm distributes cash dividends, and zero otherwise. TLTD is long term debt (DLTT) divided by book assets. LNTA is the natural log of book assets value in US dollars. ISG is industry sales growth rate at the 2-digit SIC code. SG is the firm's sales growth.

External financial dependence

Following Rajan and Zingales (1998) and Duchin, Ozbas, and Sensoy (2010), I construct external financial dependence as the sum of capital expenditures (CAPX) and R&D expense (XRD) minus the

[20] In unreported results, I also use the KZ index to measure financial constraints but do not get significant results.

sum of income before extraordinary items (IB) and depreciation and amortization (DP) of the previous fiscal year, divided by the sum of CAPX and XRD. In addition to the firm level measure of external financial dependence, I also construct an industry level measure, which is the median of firm level external financial dependence at each 2-digit SIC code industry at each year.

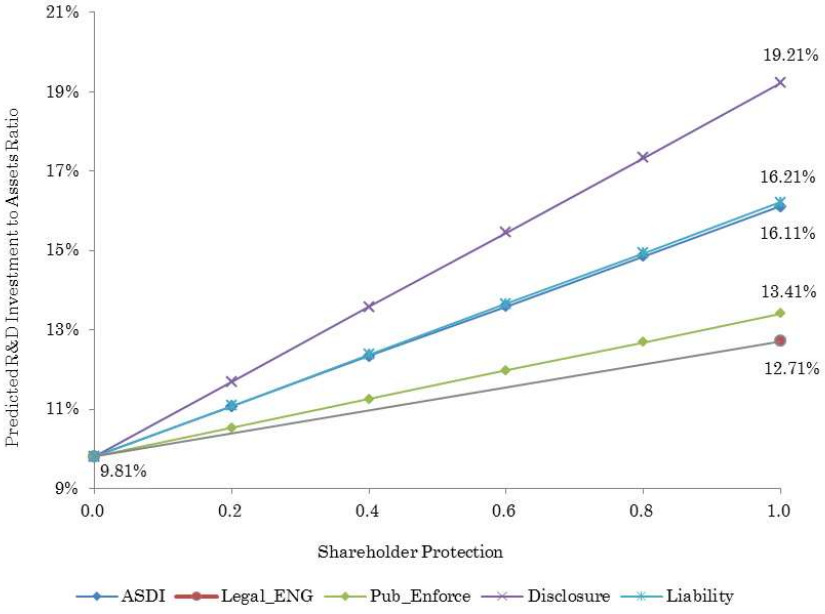
A.3 Country Level Control Variables

To control the influences of other country level factors, I specifically include the following variables as country level controls: *GDP per capita* is real GDP per capita in US dollars at 2005 constant price level. *Openness* is the sum of export and import to GDP ratio. *Government Spending* is the government spending to GDP ratio. *GDP per capita*, *Openness* and *Government Spending* are from Penn World Table 6.3. *Creditor Rights* is a measure of creditor protection from Djankov, McLiesh, and Shleifer (2007). *Political Rights* is an index of political rights from Puddington et al. (2007). *Private Credit/GDP* is from World Development Indicator (WDI) database. It is private credit by deposit money banks and other financial institutions divided by GDP. Stock market development ($Stk.Mkt.Cap./GDP$) is stock market capitalization to GDP ratio, and is also from WDI. *Education* is the average schooling years of age above 25 populations in 1990 from Barro and Lee (2010). *Patent Protection* is an index on patent protection from Park (2008). *Labor Protection* is from Botero et al. (2004). It is a measure of labor protection granted by law or mandatory collective agreements against dismissal. Cultural variables – three indexes that evaluate the degree of collectivism, assertiveness and power distance of a country, are from House et al. (2004). *Earnings opacity* is the average of the indexes on earning aggressiveness, loss avoidance and earnings smoothing from Bhattacharya et al. (2003). $IFRS\ Dummy$ equals one if a country permits the usage of the International Financial Reporting Standard (IFRS), and zero otherwise. The data on IFRS adoption is from Deloitte (2012). World Governance Indicator (WGI), an index that evaluates the extent of country level governance, is from Kaufmann, Kraay, and Mastruzzi (2010). It is the average of the indexes on six dimensions of governance that cover political stability, rule of law, control of corruption, voice & accountability, government effectiveness and regulatory quality.

Figure 1: Predicted R&D Investment Under Different Degrees of Shareholder Protection

This figure plots the predicted R&D investment of the underinvestment sample (Panel A) and the overinvestment sample (Panel B) for different degrees of shareholder protection. To classify, I first sort the full sample into two sub-samples according to information asymmetry measured by residual volatility (above median as High, below median as Low). Then I sort each sub-sample into top half and bottom half according to the median of Tobin's Q at each sub-sample (Top half as High, bottom half as Low). I classify firms with high information asymmetry and high Tobin's Q as the underinvestment sample; and firms with low information asymmetry and low Tobin's Q as the overinvestment sample. Anti-self-dealing index (ASDI), English legal origin (Legal_ENG), public enforcement (Pub_Enforce), disclosure requirements (Disclosure) and liability standards (Liability) are the measures of shareholder protection. All the five measures of shareholder protection range from 0 to 1. The predicted R&D investment is based on regression coefficients in Panel A of Table 3. The independent variables are evaluated at the median of the underinvestment sample and the overinvestment sample, respectively.

Panel A: Underinvestment Sample



Panel B: Overinvestment Sample

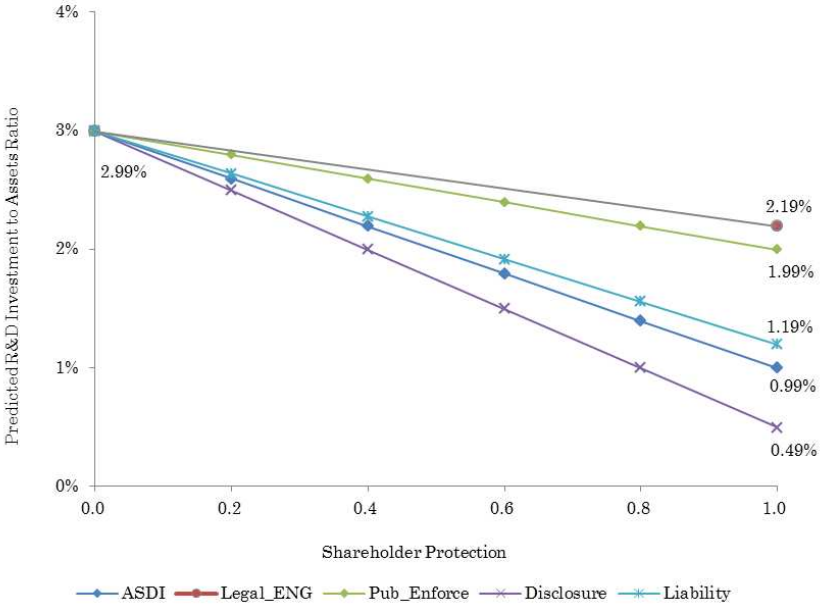


Table 1: Summary Statistics: 1993-2008

Panel A shows summary statistics for firm level variables, and Panels B and C show the summary statistics across countries and industries, respectively. The sample period is t =1993 to t=2008. $R\&D$ is research and development expense (XRD) to book assets (AT) ratio. $Tobin's\ Q$ is the sum of market value of equity and book assets minus the sum of common equity (CEQ) and deferred taxes (TXDB) and divided by book assets. Cashflow is the sum of income before extraordinary items (IB) and depreciation and amortization (DP) plus R&D expense, divided by book assets. *Residual volatility* is the standard error of the residual from the market model estimated using daily stock returns. $Stdev.\ of\ Exc.\ Ret.$ is the standard deviation of daily stock returns in excess of domestic stock market return. $Fore.\ Error$ is the mean of the absolute difference between the monthly average of estimated EPS and actual EPS during, scaled by price per share at the fiscal year end. $Fore.\ Disper.$ is the mean of monthly standard deviation of analyst forecast of EPS. $FCF1$ is operating income before depreciation (OIBDP) minus the sum of tax (TXT), interest expense (XINT) and total dividends, divided by book assets. $FCF2$ is earnings before tax and depreciation (EBITDA) scaled by book assets. $1/Size$ is one over book assets in US million dollars. *Payout Ratio* is total dividend plus stock repurchase divided by income before extraordinary items. *WW index* is a measure of financial constraints calculated following Whited and Wu (2006). Firm level measure of external financial dependence ($Ext.\ Fin.\ Dep.\ (firm)$) is the sum of capital expenditures (CAPX) and R&D expense (XRD) minus the sum of income before extraordinary items (IB) and depreciation, divided by the sum of CAPX and XRD. Industry level measure of external financial dependence ($Ext.\ Fin.\ Dep.\ (indus.)$) is the yearly average of firm level external financial dependence at each 2-digit SIC code industry. $ASDI$ is the anti-self-dealing index from Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008). $Legal\_ENG$ is a dummy variable for English legal origin. It equals to 1 for observations from countries of English legal origin, and zero for observations from countries of the other legal origins. $Pub\_Enforce$, $Disclosure$ and *Liability* are indexes on public enforcement, disclosure requirements and liability standards, respectively, from La Porta, Lopez-de-Silanes, and Shleifer (2006).

Panel A: Summary statistics of firm level variables

Variable	Frequency	Mean	Median	Std.	Min.	Max.	5%	25%	75%	95%
Dependent Variable: R&D Investment										
R & D_t	52339	0.064	0.026	0.092	0.000	0.719	0.000	0.005	0.087	0.254
Measure of Growth Opportunities										
Tobin's Q_{t-1}	52339	1.815	1.380	1.224	0.556	10.898	0.748	1.021	2.157	4.438
Measure of Cash Flow										
Cashflow_{t-1}	52339	0.117	0.108	0.148	-1.026	1.699	-0.108	0.048	0.184	0.362
Measure of Information Asymmetry										
$\text{Residual Volatility}_{t-1}$	46629	0.034	0.029	0.019	0.006	0.137	0.012	0.020	0.043	0.071
$\text{Stdev. of Exc. Ret.}_{t-1}$	42917	0.035	0.030	0.019	0.009	0.138	0.013	0.021	0.044	0.073
Fore. Error_{t-1}	31657	0.335	0.009	2.916	0.000	135.175	0.000	0.003	0.034	0.731
$\text{Fore. Disper.}_{t-1}$	28394	6.995	0.068	69.179	0.000	1453.270	0.008	0.025	0.561	10.458
Measure of Free Cash Flow										
FCF1_{t-1}	43434	0.043	0.067	0.181	-3.474	0.628	-0.264	0.022	0.117	0.231
FCF2_{t-1}	52245	0.084	0.103	0.197	-3.042	0.807	-0.265	0.038	0.175	0.328
Measure of Financial Constraints										
1/Size_{t-1}	52339	0.012	0.004	0.018	0.000	0.119	0.000	0.001	0.015	0.056
$\text{Payout Ratio}_{t-1}$	38160	0.022	0.006	0.045	0.000	1.659	0.000	0.000	0.029	0.091
WW index_{t-1}	39876	-0.278	-0.279	0.099	-0.533	0.009	-0.437	-0.351	-0.201	-0.118
Measure of External Financial Dependence										
$\text{Ext. Fin. Dep. (firm)}_{t-1}$	43588	0.336	0.185	4.063	-315.110	119.173	-2.552	-0.455	0.762	3.395
$\text{Ext. Fin. Dep. (indus.)}_{t-1}$	49496	-0.012	0.110	0.400	-5.238	0.892	-0.702	-0.273	0.282	0.444

Panel B: Summary statistics by country

Country	Frequency	Sample Composition	R&D	Legal_ENG	ASDI	Disclosure	Public Enforcement	Liability
Argentina	3	0.01%	0.013	0	0.342	0.500	0.583	0.220
Australia	655	1.25%	0.050	1	0.757	0.750	0.900	0.660
Austria	53	0.10%	0.024	0	0.213	0.250	0.167	0.110
Belgium	95	0.18%	0.061	0	0.544	0.417	0.150	0.440
Brazil	7	0.01%	0.024	0	0.274	0.250	0.583	0.330
Canada	807	1.54%	0.078	1	0.642	0.917	0.800	1.000
Chile	8	0.02%	0.001	0	0.625	0.583	0.600	0.330
China	118	0.23%	0.013	0	0.763			
Denmark	167	0.32%	0.091	0	0.463	0.583	0.367	0.553
Finland	303	0.58%	0.049	0	0.457	0.500	0.317	0.660
France	545	1.04%	0.055	0	0.379	0.750	0.767	0.220
Germany	806	1.54%	0.063	0	0.282	0.417	0.217	0.000
Greece	40	0.08%	0.010	0	0.217	0.333	0.317	0.495
Hong Kong, China	81	0.15%	0.012	1	0.963	0.917	0.867	0.660
Hungary	9	0.02%	0.056	0	0.181			
India	254	0.49%	0.014	1	0.579	0.917	0.667	0.660
Indonesia	49	0.09%	0.003	0	0.653	0.500	0.617	0.660
Ireland	99	0.19%	0.035	1	0.789	0.667	0.367	0.440
Israel	174	0.33%	0.075	1	0.725	0.667	0.633	0.660
Italy	23	0.04%	0.042	0	0.421	0.667	0.483	0.220
Japan	11487	21.95%	0.021	0	0.499	0.750	0.000	0.660
Korea	13	0.02%	0.022	0	0.469	0.750	0.250	0.660
Lithuania	1	0.00%	0.001	0	0.357			
Malaysia	290	0.55%	0.007	1	0.950	0.917	0.767	0.660
Netherlands	207	0.40%	0.068	0	0.203	0.500	0.467	0.888
New Zealand	78	0.15%	0.028	1	0.950	0.667	0.333	0.440
Norway	112	0.21%	0.047	0	0.421	0.583	0.317	0.385
Pakistan	23	0.04%	0.003	1	0.408	0.583	0.583	0.385
Philippines	27	0.05%	0.011	0	0.215	0.833	0.833	1.000
Poland	7	0.01%	0.011	0	0.288			
Russian Federation	8	0.02%	0.003	0	0.440			
Singapore	216	0.41%	0.020	1	1.000	1.000	0.867	0.660
Spain	19	0.04%	0.043	0	0.374	0.500	0.333	0.660
Sri Lanka	7	0.01%	0.001	1	0.392	0.750	0.433	0.385
Sweden	424	0.81%	0.076	0	0.333	0.583	0.500	0.275
Switzerland	424	0.81%	0.056	0	0.267	0.667	0.333	0.440
United Kingdom	2509	4.79%	0.055	1	0.950	0.833	0.683	0.660
United States	32191	61.50%	0.083	1	0.654	1.000	0.900	1.000
Sum	52339	100.00%						
Max	32191	61.50%	0.091	1	1.000	1.000	0.900	1.000
Min	1	0.00%	0.001	0	0.181	0.250	0.000	0.000
Median	97	0.19%	0.026	0	0.449	0.667	0.500	0.553

Panel C: Summary statistics by industry

Industry	Frequency	Sample Composition	Mean of R&D
Agriculture, Forestry, And Fishing	192	0.37%	0.037
Mining	682	1.30%	0.013
Construction	1046	2.00%	0.005
Manufacturing	34820	66.53%	0.069
Transportation and Communications Services	738	1.41%	0.036
Wholesale Trade	2267	4.33%	0.018
Retail Trade	3788	7.24%	0.002
Other Services (Excluding Utility Services)	8686	16.60%	0.101
Public Administration	120	0.23%	0.017
Total	52339	100.00%	
Max	34820	66.53%	0.101
Min	120	0.23%	0.002

Table 2: Shareholder Protection and R&D Investment: Full Sample

This table reports the effects of shareholder protection on R&D investment, estimated using the full sample. The dependent variable is R&D expense to book assets ratio. Anti-self-dealing index (ASDI), English legal origin (Legal_ENG), public enforcement (Pub_Enforce), disclosure requirements (Disclosure) and liability standards (Liability) are the measures of shareholder protection. Firm level variables are defined in Table 1. *GDP per capita* is real GDP per capita in thousand US dollars at 2005 constant price level. Openness is the sum of export and import to GDP ratio. *Govt. Spend.* is the government spending to GDP ratio. GDP per capita, openness and government spending are from Penn World Table 6.3. *Fin. Develop.* is from World Development Indicator (WDI) database. It is private credit by deposit money banks and other financial institutions divided by GDP. *Credi. Rights* is a measure of creditor protection from Djankov, McLiesh, and Shleifer (2007). *Poli. Rights* is an index of political rights from Puddington et al. (2007). *Education* is the average schooling years of age above 25 populations in 1990 from Barro and Lee (2010). *Patent Protect.* is an index on patent protection from Park (2008). *Labor Protec.* is a measure of labor protection granted by law or mandatory collective agreements against dismissal. It is from Botero, Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2004). All regressions include industry dummies at the 2-digit SIC code level as well as year fixed effects. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

	(1)	(2)	(3)	(4)	(5)
ASDI	0.012				
	(0.011)				
Legal_ENG		0.006			
		(0.004)			
Pub_Enforce			0.009		
			(0.006)		
Disclosure				0.016	
				(0.013)	
Liability					0.018*
					(0.009)
Cashflow	0.076***	0.076***	0.076***	0.076***	0.076***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Tobin's Q	0.022***	0.022***	0.022***	0.022***	0.022***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
1/Size	1.055***	1.053***	1.055***	1.057***	1.058***
	(0.133)	(0.135)	(0.135)	(0.132)	(0.130)
Creditor Rights	-0.005*	-0.005**	-0.005**	-0.004	-0.004
	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
Openness	0.002	0.003	0.006	0.006	0.006
	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)
Private Credit/GDP	0.015**	0.015**	0.016**	0.013**	0.013**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Govt. Spend.	-0.121*	-0.105*	-0.111*	-0.137**	-0.155**
	(0.061)	(0.057)	(0.063)	(0.064)	(0.069)
Poli. Rights.	0.001	0.001	-0.004	-0.003	-0.004
	(0.003)	(0.003)	(0.005)	(0.005)	(0.004)
Education	0.003*	0.003*	0.003	0.003*	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Patent Protec.	0.010**	0.012***	0.009**	0.010**	0.011**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
GDP per capita	-0.000	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Labor Protec.	0.039***	0.036***	0.026**	0.036**	0.039**
	(0.014)	(0.012)	(0.011)	(0.013)	(0.015)
Constant	-0.089***	-0.087***	-0.064***	-0.077***	-0.069***
	(0.016)	(0.017)	(0.023)	(0.023)	(0.022)
Observations	52339	52339	52196	52196	52196
R-squared	0.427	0.427	0.427	0.427	0.427

Table 3: The Results of Grouping with Tobin's Q and Information Asymmetry

This table reports the effects of shareholder protection on R&D investment, estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) grouped with Tobin's Q and information asymmetry. Panels A-D report the estimation results with residual volatility, standard deviation of excess returns, forecast error and dispersion as the measure of information asymmetry, respectively. I first sort the full sample into two sub-samples according to each measure of information asymmetry (above median as High, below median as Low). Then I sort each sub-sample into top half and bottom half according to the median of Tobin's Q at each sub-sample (Top half as High, bottom half as Low). The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection. Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. For brevity this table only reports the coefficient estimates on measures of shareholder protection. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

Panel A: Residual Volatility as the Measure of Information Asymmetry

	High Tobin's Q + High Infor. Asymmetry (**Underinvestment Sample**)					Low Tobin's Q + Low Infor. Asymmetry (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.113***					-0.008*				
	(0.028)					(0.004)				
Legal_ENG		0.044***					-0.003*			
		(0.008)					(0.002)			
Pub_Enforce			0.066***					-0.003		
			(0.011)					(0.003)		
Disclosure				0.140***					-0.013***	
				(0.034)					(0.004)	
Liability					0.085***					-0.010***
					(0.024)					(0.002)
Observations	12426	12426	12419	12419	12419	11154	11154	11114	11114	11114
R-squared	0.360	0.361	0.360	0.360	0.360	0.406	0.406	0.406	0.407	0.407

Panel B: Stdev. of Excess Return as the Measure of Information Asymmetry

	High Tobin's Q + High Infor. Asymmetry (**Underinvestment Sample**)					Low Tobin's Q + Low Infor. Asymmetry (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.119***					-0.006				
	(0.031)					(0.005)				
Legal_ENG		0.044***					-0.002			
		(0.008)					(0.002)			
Pub_Enforce			0.068***					-0.000		
			(0.012)					(0.003)		
Disclosure				0.151***					-0.009	
				(0.037)					(0.006)	
Liability					0.091***					-0.008**
					(0.027)					(0.003)
Observations	11509	11509	11504	11504	11504	10200	10200	10149	10149	10149
R-squared	0.355	0.355	0.355	0.355	0.355	0.405	0.405	0.405	0.405	0.406

Panel C: Analyst Forecast Error as the Measure of Information Asymmetry

	High Tobin's Q + High Infor. Asymmetry (**Underinvestment Sample**)					Low Tobin's Q + Low Infor. Asymmetry (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.057**					-0.004				
	(0.022)					(0.006)				
Legal_ENG		0.026***					0.001			
		(0.007)					(0.002)			
Pub_Enforce			0.037***					0.002		
			(0.010)					(0.003)		
Disclosure				0.077***					-0.007	
				(0.026)					(0.005)	
Liability					0.055***					-0.002
					(0.018)					(0.002)
Observations	7749	7749	7742	7742	7742	7965	7965	7943	7943	7943
R-squared	0.484	0.485	0.484	0.484	0.484	0.426	0.426	0.426	0.426	0.426

Panel D: Analyst Forecast Dispersion as the Measure of Information Asymmetry

	High Tobin's Q + High Infor. Asymmetry (**Underinvestment Sample**)					Low Tobin's Q + Low Infor. Asymmetry (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.091***					-0.013				
	(0.022)					(0.016)				
Legal_ENG		0.034***					0.004			
		(0.006)					(0.006)			
Pub_Enforce			0.052***					-0.000		
			(0.008)					(0.009)		
Disclosure				0.112***					-0.008	
				(0.021)					(0.014)	
Liability					0.075***					-0.004
					(0.017)					(0.011)
Observations	6664	6664	6656	6656	6656	7159	7159	7101	7101	7101
R-squared	0.548	0.550	0.550	0.548	0.549	0.413	0.413	0.412	0.412	0.412

Table 4: The Results of Grouping with Tobin's Q and Free Cash Flow

This table reports the effects of shareholder protection on R&D investment, estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) grouped with Tobin's Q and free cash flow. Panels A-B report the results with FCF1 and FCF2 as the measure of free cash flow, respectively. I first sort the full sample into two sub-samples according to each measure of free cash flow (above median as High, below median as Low). Then I sort each sub-sample into top half and bottom half according to the median of Tobin's Q at each sub-sample (Top half as High, bottom half as Low). The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection. Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. For brevity this table only reports the coefficient estimates on measures of shareholder protection. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

Panel A: FCF1 as the Measure of Free Cash Flow

	High Tobin's Q + Low Free Cash Flow (**Underinvestment Sample**)					Low Tobin's Q + High Free Cash Flow (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.055***					-0.013***				
	(0.017)					(0.004)				
Legal_ENG		0.021***					-0.004***			
		(0.006)					(0.001)			
Pub_Enforce			0.029***					-0.006***		
			(0.008)					(0.002)		
Disclosure				0.059***					-0.012**	
				(0.020)					(0.005)	
Liability					0.045***					-0.010***
					(0.015)					(0.003)
Observations	10786	10786	10783	10783	10783	10842	10842	10803	10803	10803
R-squared	0.496	0.496	0.496	0.496	0.496	0.460	0.460	0.460	0.460	0.460

Panel B: FCF2 as the Measure of Free Cash Flow

	High Tobin's Q + Low Free Cash Flow (**Underinvestment Sample**)					Low Tobin's Q + High Free Cash Flow (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.065**					-0.015***				
	(0.026)					(0.003)				
Legal_ENG		0.029***					-0.005***			
		(0.008)					(0.001)			
Pub_Enforce			0.035***					-0.007***		
			(0.013)					(0.002)		
Disclosure				0.090***					-0.014***	
				(0.032)					(0.004)	
Liability					0.066***					-0.010***
					(0.019)					(0.003)
Observations	13269	13269	13261	13261	13261	12772	12772	12724	12724	12724
R-squared	0.488	0.489	0.488	0.488	0.489	0.494	0.494	0.494	0.494	0.494

Table 5: The Results of Grouping with Tobin's Q and Financial Constraints

This table reports the effects of shareholder protection on R&D investment, estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) grouped with Tobin's Q and financial constraints. Panels A-C report the results with 1/Size, payout ratio and WW index as the measure of financial constraints, respectively. I first sort the full sample into two sub-samples according to each measure of financial constraints (above median as High, below median as Low). Then I sort each sub-sample into top half and bottom half according to the median of Tobin's Q at each sub-sample (Top half as High, bottom half as Low). The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection. Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. For brevity this table only reports the coefficient estimates on measures of shareholder protection. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

Panel A: 1/Size as the Measure of Financial Constraints

	High Tobin's Q + High Financial Constraints (**Underinvestment Sample**)					Low Tobin's Q + Low Financial Constraints (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.097***					-0.011**				
	(0.027)					(0.004)				
Legal_ENG		0.038***					-0.002			
		(0.007)					(0.002)			
Pub_Enforce			0.053***					-0.003		
			(0.012)					(0.003)		
Disclosure				0.098***					-0.009*	
				(0.032)					(0.005)	
Liability					0.062**					-0.006*
					(0.023)					(0.003)
Observations	13282	13282	13275	13275	13275	13195	13195	13121	13121	13121
R-squared	0.358	0.359	0.358	0.357	0.357	0.356	0.356	0.355	0.355	0.355

Panel B: Payout Ratio as the Measure of Financial Constraints

	High Tobin's Q + High Financial Constraints (**Underinvestment Sample**)					Low Tobin's Q + Low Financial Constraints (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.075***					-0.017***				
	(0.024)					(0.003)				
Legal_ENG		0.027***					-0.006***			
		(0.006)					(0.001)			
Pub_Enforce			0.044***					-0.009***		
			(0.010)					(0.002)		
Disclosure				0.090***					-0.018***	
				(0.026)					(0.004)	
Liability					0.048***					-0.011***
					(0.015)					(0.003)
Observations	9211	9211	9209	9209	9209	9004	9004	8967	8967	8967
R-squared	0.374	0.374	0.374	0.374	0.374	0.531	0.531	0.531	0.531	0.531

Panel C: WW Index as the Measure of Financial Constraints

	High Tobin's Q + High Financial Constraints (**Underinvestment Sample**)					Low Tobin's Q + Low Financial Constraints (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.126***					-0.013***				
	(0.038)					(0.004)				
Legal_ENG		0.044***					-0.004***			
		(0.009)					(0.001)			
Pub_Enforce			0.070***					-0.006***		
			(0.014)					(0.002)		
Disclosure				0.141***					-0.014***	
				(0.042)					(0.004)	
Liability					0.057*					-0.010***
					(0.029)					(0.002)
Observations	10130	10130	10127	10127	10127	10053	10053	10010	10010	10010
R-squared	0.350	0.350	0.350	0.350	0.349	0.431	0.431	0.430	0.430	0.430

Table 6: The Results of Grouping with Tobin's Q and External Financial Dependence

This table reports the effects of shareholder protection on R&D investment, estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) grouped with Tobin's Q and external financial dependence. Panels A and B report the results with firm level and industry level measures of external financial dependence, respectively. I first sort the full sample into two sub-samples according to each measure of external financial dependence (above median as High, below median as Low). Then I sort each sub-sample into top half and bottom half according to the median of Tobin's Q at each sub-sample (Top half as High, bottom half as Low). The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection. Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. For brevity this table only reports the coefficient estimates on measures of shareholder protection. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

Panel A: Firm Level Measure of External Financial Dependence

	High Tobin's Q + High Ext. Fin. Dep. (**Underinvestment Sample**)					Low Tobin's Q + Low Ext. Fin. Dep. (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.082***					-0.011**				
	(0.024)					(0.004)				
Legal_ENG		0.031***					-0.004**			
		(0.007)					(0.002)			
Pub_Enforce			0.044***					-0.004*		
			(0.011)					(0.002)		
Disclosure				0.104***					-0.010**	
				(0.028)					(0.004)	
Liability					0.065***					-0.006**
					(0.018)					(0.003)
Observations	11383	11383	11375	11375	11375	10680	10680	10644	10644	10644
R-squared	0.390	0.390	0.390	0.390	0.390	0.310	0.310	0.310	0.310	0.310

Panel B: Industry Level Measure of External Financial Dependence

	High Tobin's Q + High Ext. Fin. Dep. (**Underinvestment Sample**)					Low Tobin's Q + Low Ext. Fin. Dep. (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.064**					-0.012***				
	(0.024)					(0.003)				
Legal_ENG		0.026***					-0.004***			
		(0.006)					(0.001)			
Pub_Enforce			0.037***					-0.003***		
			(0.009)					(0.001)		
Disclosure				0.076***					-0.009**	
				(0.025)					(0.003)	
Liability					0.060***					-0.005**
					(0.017)					(0.002)
Observations	18713	18713	18703	18703	18703	5692	5692	5676	5676	5676
R-squared	0.324	0.325	0.324	0.324	0.325	0.200	0.200	0.200	0.200	0.200

Table 7: The Results of Grouping with the Underinvestment And Overinvestment Indexes

This table reports the effects of shareholder protection on R&D investment, estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) grouped with the *Underinvestment* index and *Overinvestment* index. The *Underinvestment* (*Overinvestment*) index is the number of times that the firm-year observation is sorted into underinvestment (overinvestment) sample by double sorting with Tobin's Q and individual variables that measure resource availability. A firm-year observation with the underinvestment (overinvestment) index of over 4 is classified into the underinvestment (overinvestment) sample. The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection. Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. For brevity this table only reports the coefficient estimates on measures of shareholder protection. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

	Underinvestment Index > 4 (**Underinvestment Sample**)					*Overinvestment* Index > 4 (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	0.123***					-0.016***				
	(0.017)					(0.003)				
Legal_ENG		0.046***					-0.005***			
		(0.006)					(0.001)			
Pub_Enforce			0.066***					-0.007***		
			(0.008)					(0.002)		
Disclosure				0.144***					-0.018***	
				(0.020)					(0.004)	
Liability					0.078***					-0.012***
					(0.013)					(0.003)
Observations	11997	11997	11992	11992	11992	9742	9742	9696	9696	9696
R-squared	0.352	0.352	0.352	0.351	0.351	0.484	0.484	0.484	0.485	0.485

Table 8: Robustness Tests for the Issues in the Measurement of R&D

This table reports the coefficient estimates of shareholder protection in Models 1-10 of Table 7 after addressing the issues in the measurement of R&D. The coefficients are estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) that are grouped with the *Underinvestment* index and *Overinvestment* index. Panel A reports the results on the sample that does not require no missing data in R&D but replaces missing values in R&D with zero. Panel B reports the results of the tests with additional control for a dummy indicator for the adoption of the International Financial Reporting Standards (IFRS). Panel C reports the coefficient estimates of the tests on the sample of high-tech firms, or the sample of firms with 2-digit SIC code of 28, 35, 36, 38 or 73. The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection ($Share.Protec.$). Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2 do. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

	Underinvestment Index > 4 (**Underinvestment Sample**)					Overinvestment Index > 4 (**Overinvestment Sample**)				
	ASDI	Legal_ENG	Pub_Enforce	Disclosure	Liability	ASDI	Legal_ENG	Pub_Enforce	Disclosure	Liability
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Replace Missing R&D with Zero										
Share.Protec.	0.107***	0.040***	0.057***	0.128***	0.071***	-0.017***	-0.006***	-0.008***	-0.018***	-0.014***
	(0.027)	(0.007)	(0.011)	(0.033)	(0.024)	(0.003)	(0.001)	(0.002)	(0.004)	(0.003)
Panel B: Control Difference in Accounting Standard										
Share.Protec.	0.097**	0.039***	0.051***	0.101*	0.054*	-0.016***	-0.006***	-0.008***	-0.020***	-0.012***
	(0.037)	(0.010)	(0.018)	(0.051)	(0.030)	(0.005)	(0.002)	(0.003)	(0.007)	(0.004)
Panel C: High-tech Firms										
Share.Protec.	0.134***	0.050***	0.074***	0.160***	0.082**	-0.020**	-0.007***	-0.009***	-0.018*	-0.009
	(0.037)	(0.009)	(0.014)	(0.045)	(0.029)	(0.008)	(0.002)	(0.003)	(0.009)	(0.005)

Table 9: Add More Controls

This table reports the coefficient estimates of shareholder protection in Models 1-10 of Table 7 after controlling additional country level variables. The coefficients are estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) that are grouped with the *Underinvestment* index and *Overinvestment* index. Panel A reports the results after adding stock market development. Stock market development is stock market capitalization to GDP ratio from WDI. Panel B reports the coefficient estimates after controlling three cultural variables – collectivism, assertiveness and power distance from House et al. (2004). Panel C reports the coefficient estimates after including an index on earnings opacity, which is the average of the indexes on earning aggressiveness, loss avoidance and earnings smoothing from Bhattacharya et al. (2003). Panel D reports the estimates after controlling the index on country level governance from Kaufmann, Kraay, and Mastruzzi (2010). Panel E reports the results after including all the additional controls mentioned above. The dependent variable is R&D investment. Anti-self-dealing index ($ASDI$), English legal origin ($Legal\_ENG$), public enforcement ($Pub\_Enforce$), disclosure requirements ($Disclosure$) and liability standards ($Liability$) are the measures of shareholder protection ($Share.Protec.$). Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2 do. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

	Underinvestment Index > 4 (**Underinvestment Sample**)					Overinvestment Index > 4 (**Overinvestment Sample**)				
	ASDI	Legal_ENG	Pub_Enforce	Disclosure	Liability	ASDI	Legal_ENG	Pub_Enforce	Disclosure	Liability
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Add Stock Market Development										
Share.Protec.	0.116***	0.045***	0.067***	0.135***	0.071***	-0.013***	-0.004***	-0.005***	-0.013***	-0.009***
	(0.019)	(0.006)	(0.010)	(0.023)	(0.014)	(0.003)	(0.001)	(0.002)	(0.004)	(0.003)
Panel B: Add Cultural Variables										
Share.Protec.	0.106***	0.042***	0.068***	0.138***	0.059***	-0.019***	-0.007***	-0.012***	-0.020***	-0.013***
	(0.028)	(0.010)	(0.020)	(0.036)	(0.016)	(0.004)	(0.002)	(0.003)	(0.006)	(0.003)
Panel C: Add Earnings Opacity Variables										
Share.Protec.	0.142***	0.049***	0.087***	0.133***	0.060***	-0.021***	-0.008***	-0.013***	-0.021***	-0.012***
	(0.032)	(0.011)	(0.019)	(0.038)	(0.017)	(0.005)	(0.002)	(0.003)	(0.006)	(0.004)
Panel D: Add World Governance Indicator										
Share.Protec.	0.120***	0.045***	0.066***	0.141***	0.076***	-0.016***	-0.005***	-0.007***	-0.018***	-0.012***
	(0.017)	(0.005)	(0.008)	(0.020)	(0.012)	(0.003)	(0.001)	(0.002)	(0.004)	(0.003)
Panel E: Add All the Above Variables										
Share.Protec.	0.111***	0.039***	0.071***	0.132***	0.056***	-0.024***	-0.010***	-0.014***	-0.019*	-0.011**
	(0.035)	(0.012)	(0.023)	(0.043)	(0.018)	(0.007)	(0.003)	(0.005)	(0.010)	(0.004)

Table 10: Additional Robustness Tests

This table reports the coefficient estimates of shareholder protection in Models 1-10 of Table 7 in robustness tests. The coefficients are estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) that are grouped with the *Underinvestment* index and *Overinvestment* index. Panel A replicates the results by removing firms with small earnings (the absolute earnings to assets ratio smaller than 0.01). Panel B reports the results with Tobit regressions. Panel C reports the results on the sample restricted to non-US firms. Panel D reports the results of country mean regressions estimated with the mean of firm variables at the country level. Panel E reports the Fama-MacBeth regression results. Panels F-I report the results of the tests in which I create the rankings within each year, each country, each 2-SIC industry, and industry combined with country, respectively. Panel J reports the results of regressions on samples formed by sorting firms into quintiles. The dependent variable is R&D investment. Anti-self-dealing index (*ASDI*), English legal origin (*Legal_ENG*), public enforcement (*Pub_Enforce*), disclosure requirements (*Disclosure*) and liability standards (*Liability*) are the measures of shareholder protection (Share.Protec.). Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

	Underinvestment Index > 4 (**Underinvestment Sample**)					Overinvestment Index > 4 (**Overinvestment Sample**)				
	ASDI	Legal_ENG	Pub_Enforce	Disclosure	Liability	ASDI	Legal_ENG	Pub_Enforce	Disclosure	Liability
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Alternative Explanation–Earnings Management										
Share.Protec.	0.128***	0.048***	0.069***	0.149***	0.081***	-0.016***	-0.005***	-0.008***	-0.017***	-0.011***
	(0.032)	(0.008)	(0.013)	(0.040)	(0.027)	(0.003)	(0.001)	(0.002)	(0.004)	(0.003)
Panel B: Tobit Regressions										
Share.Protec.	0.115***	0.043***	0.061***	0.135***	0.074***	-0.018***	-0.006***	-0.009***	-0.021***	-0.014***
	(0.018)	(0.006)	(0.009)	(0.021)	(0.013)	(0.003)	(0.001)	(0.002)	(0.004)	(0.003)
Panel C: Remove US Observations										
Share.Protec.	0.123***	0.046***	0.066***	0.144***	0.078***	-0.016***	-0.005***	-0.007***	-0.018***	-0.012***
	(0.031)	(0.008)	(0.013)	(0.039)	(0.026)	(0.003)	(0.001)	(0.002)	(0.004)	(0.003)
Panel D: Country Mean Regressions										
Share.Protec.	0.045	0.038**	0.065**	0.078*	0.048*	-0.022**	-0.011***	-0.011**	-0.014	-0.008
	(0.038)	(0.017)	(0.025)	(0.043)	(0.028)	(0.010)	(0.002)	(0.005)	(0.010)	(0.007)
Panel E: Fama-MacBeth Regressions										
Share.Protec.	0.092**	0.051***	0.078**	0.124**	0.063**	-0.052	-0.008***	-0.002	-0.033*	-0.013***
	(0.032)	(0.013)	(0.031)	(0.042)	(0.021)	(0.038)	(0.002)	(0.005)	(0.018)	(0.004)
Panel F: Ranking By Year										
Share.Protec.	0.102***	0.037***	0.055***	0.123***	0.070***	-0.018***	-0.006***	-0.010***	-0.019***	-0.011***
	(0.027)	(0.007)	(0.011)	(0.031)	(0.023)	(0.004)	(0.001)	(0.002)	(0.005)	(0.003)
Panel G: Ranking By Country										
Share.Protec.	0.081**	0.033***	0.049***	0.098**	0.070***	-0.017***	-0.005***	-0.008**	-0.020***	-0.011***
	(0.033)	(0.011)	(0.017)	(0.039)	(0.025)	(0.004)	(0.002)	(0.003)	(0.005)	(0.003)
Panel H: Ranking By Industry										
Share.Protec.	0.054**	0.021***	0.027**	0.062**	0.046***	-0.013*	-0.004*	-0.005	-0.016**	-0.010**
	(0.021)	(0.007)	(0.011)	(0.027)	(0.015)	(0.006)	(0.002)	(0.003)	(0.007)	(0.004)
Panel I: Ranking By Industry & Country										
Share.Protec.	0.075***	0.028***	0.043***	0.079***	0.059***	-0.018**	-0.006**	-0.010**	-0.024***	-0.012**
	(0.019)	(0.006)	(0.011)	(0.026)	(0.018)	(0.007)	(0.002)	(0.004)	(0.008)	(0.005)
Panel J: Grouping with Quintiles										
Share.Protec.	0.156***	0.061***	0.089***	0.204***	0.107***	-0.022***	-0.008***	-0.011***	-0.021***	-0.016***
	(0.043)	(0.011)	(0.018)	(0.053)	(0.035)	(0.004)	(0.001)	(0.002)	(0.005)	(0.004)

Table 11: Summary Statistics of Variables in the Growth Regressions: 1993-2008

This table reports the summary statistics of variables included in the regressions of firm growth. The sample period is t =1993 to t=2008. Asset Growth and Sales Growth are the real growth rate of assets and sales, respectively. $Ln(1 + R\&D/AT)$ $(Indus.)$ is the industry median of the natural logarithm of one plus R&D to book assets ratio at the 2-digit SIC level. $Ln(1 + R\&D/CAPX)$ $(Indus.)$ is constructed in a similar way but based on R&D to capital expenditures ratio. $1/Size$ is one over book assets in million dollars. $Ln(Initial\ Size)$ is the logarithm of book assets in million dollars at the end of the first year when the firm entered into the sample. *GDP per capita* is GDP per capita in thousand US dollars at 2005 constant price level. *Govt. Spend.* is the government spending to GDP ratio. *Credit. Rights* is a measure of creditor protection. *Fin. Develop.* is private credit by deposit money banks and other financial institutions divided by GDP. *Stk. Mkt. Develop.* is stock market capitalization to GDP ratio.

Variable	Frequency	Mean	Median	Std.	Min.	Max	5%	25%	75%	95%
Measure of Firm Growth										
Asset Growth$_t$	83672	0.137	0.062	0.491	-0.831	31.698	-0.272	-0.045	0.196	0.717
Sales Growth$_t$	83672	0.161	0.088	0.567	-0.882	14.443	-0.296	-0.032	0.231	0.721
Measure of R&D Intensity										
Log(1+R&D/CAPX) (Indus. Med.)$_{t-1}$	83667	0.533	0.239	0.507	0.000	1.424	0.000	0.088	0.924	1.424
Log(1+R&D/AT) (Indus. Med.)$_{t-1}$	83672	0.034	0.015	0.037	0.000	0.111	0.000	0.004	0.053	0.111
Measure of External Financial Dependence										
Ext.Fin.Dep. (Indus. Med.)$_{t-1}$	83672	-0.111	0.017	0.489	-5.238	0.892	-1.033	-0.396	0.251	0.477
Control Variables										
1/Size$_{t-1}$	83672	0.014	0.005	0.029	0.000	1.371	0.000	0.001	0.017	0.058
ln(Initial Size)$_{t-1}$	83672	4.710	4.555	2.042	-3.612	10.443	1.661	3.268	6.032	8.335
Credit Rights	83672	1.644	1.000	1.039	0.000	4.000	1.000	1.000	2.000	4.000
Private Credit/GDP$_{t-1}$	83672	0.015	0.015	0.004	0.001	0.023	0.007	0.012	0.018	0.020
Stk.Mkt.Cap./GDP$_{t-1}$	83672	1.151	1.156	0.488	0.058	4.714	0.406	0.780	1.427	1.789
GDP per capita$_{t-1}$	83672	32.137	33.674	9.393	1.638	47.996	9.566	28.799	39.578	42.534
Govt. Spend.$_{t-1}$	83672	0.113	0.096	0.036	0.035	0.320	0.082	0.085	0.140	0.170

Table 12: The Growth Effects of Shareholder Protection on Firms in R&D Intensive Industries

This table reports the growth effects of shareholder protection on firms in R&D intensive industries. The dependent variables are annual real growth rates in sales (Panel A) and assets (Panel B), respectively. Columns 1-5 report the results with industry median R&D to book assets ratio as the measure of R&D intensity. Columns 6-10 instead use industry median R&D expense to capital expenditures to measure R&D intensity. 1/Size is one over book assets in million dollars. *Ln*(*initial size*) is the natural logarithm of the initial firm size. *Fin. Develop.* is private credit by deposit money banks and other financial institutions divided by GDP. *Stk. Mkt. Develop.* is stock market capitalization to GDP ratio. *Credit. Rights* is a measure of creditor protection. *GDP per capita* is GDP per capita in thousand US dollars. *Govt. Spend.* is the government spending to GDP ratio. Anti-self-dealing index (ASDI), English legal origin (Legal_ENG), public enforcement (Pub_Enforce), disclosure requirements (Disclosure) and liability standards (Liability) are the measures of shareholder protection (Share.Protec.). All regressions include industry dummies at the 2-digit SIC code level as well as country and year fixed effects. Country level clustered standard errors are in the parenthesis. ∗, ∗∗, and ∗ ∗ ∗ denote significance at the 10%, 5%, and 1% level.

Panel A: Sales Growth as the Measure of Firm Growth

	R&D Intensity: Log(1+R&D/AT) (Indus. Median)					R&D Intensity: Log(1+R&D/CAPX) (Indus. Median)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R&D Intensity*ASD	**1.120****					**0.083*****				
	(0.432)					**(0.029)**				
R&D Intensity*Legal_ENG		**0.644*****					**0.045*****			
		(0.183)					**(0.012)**			
R&D Intensity*Disclose			**1.986*****					**0.137*****		
			(0.392)					**(0.026)**		
R&D Intensity*Pub_Enforce				**0.877*****					**0.062*****	
				(0.299)					**(0.019)**	
R&D Intensity*Liability					**1.186*****					**0.086*****
					(0.348)					**(0.023)**
R&D Intensity*Private Credit/GDP	-0.358	-0.414	-0.563*	-0.198	-0.659**	-0.022	-0.025	-0.036*	-0.010	-0.043**
	(0.295)	(0.332)	(0.294)	(0.340)	(0.313)	(0.018)	(0.020)	(0.018)	(0.020)	(0.019)
R&D Intensity*Stk.Mkt.Cap./GDP	0.256	0.159	0.101	0.096	0.193	0.019	0.013	0.010	0.009	0.016
	(0.227)	(0.229)	(0.226)	(0.237)	(0.223)	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)
R&D Intensity*Creditor Rights	-0.136**	-0.044	0.064	0.056	0.037	-0.010**	-0.003	0.004	0.004	0.003
	(0.065)	(0.065)	(0.067)	(0.073)	(0.089)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Ext.Fin.Dep.*Private Credit/GDP	0.031***	0.032***	0.030***	0.030***	0.030***	0.030***	0.032***	0.030***	0.030***	0.030***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Ext.Fin.Dep.*Stk.Mkt.Cap./GDP	-0.009	-0.010	-0.008	-0.008	-0.008	-0.009	-0.010	-0.008	-0.009	-0.008
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
1/Size	0.664**	0.666**	0.656**	0.656**	0.654**	0.666**	0.668**	0.658**	0.658**	0.656**
	(0.313)	(0.313)	(0.314)	(0.314)	(0.314)	(0.312)	(0.312)	(0.313)	(0.313)	(0.313)
Ln(Initial Size)	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Private Credit/GDP	0.010	0.011	0.012	0.001	0.014	0.010	0.011	0.013	0.000	0.016
	(0.060)	(0.060)	(0.061)	(0.061)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
Stk.Mkt.Cap./GDP	0.073**	0.075**	0.080***	0.080***	0.078**	0.071**	0.073**	0.078**	0.078**	0.075**
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
GDP per capita	-0.018	-0.018	-0.019	-0.019	-0.019	-0.018	-0.018	-0.019	-0.019	-0.019
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Govt.Spend.	-0.010	-0.010	-0.014	-0.014	-0.014	-0.010	-0.010	-0.014	-0.014	-0.014
	(0.012)	(0.013)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.012)	(0.013)	(0.012)
Constant	1.184*	1.195*	1.357*	1.381*	1.384*	0.555*	0.555*	1.353*	1.381*	1.382*
	(0.609)	(0.609)	(0.686)	(0.691)	(0.690)	(0.327)	(0.328)	(0.687)	(0.692)	(0.691)
Observations	83657	83657	82708	82708	82708	83652	83652	82703	82703	82703
R-squared	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038

Panel B: Asset Growth as the Measure of Firm Growth

	R&D Intensity: Log(1+R&D/AT) (Indus. Med.)					R&D Intensity: Log(1+R&D/CAPX) (Indus. Med.)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R&D Intensity*ASD	**0.106**					**0.002**				
	(0.471)					**(0.032)**				
R&D Intensity*Legal_ENG		**0.211**					**0.014**			
		(0.208)					**(0.014)**			
R&D Intensity*Disclose			**0.918***					**0.054**		
			(0.470)					**(0.033)**		
R&D Intensity*Pub_Enforce				**0.112**					**0.008**	
				(0.371)					**(0.025)**	
R&D Intensity*Liability					**0.690****					**0.045****
					(0.307)					**(0.021)**
R&D Intensity*Private Credit/GDP	-0.289	-0.314	-0.393	-0.264	-0.478	-0.018	-0.019	-0.024	-0.016	-0.029
	(0.361)	(0.380)	(0.367)	(0.390)	(0.385)	(0.022)	(0.023)	(0.022)	(0.025)	(0.023)
R&D Intensity*Stk.Mkt.Cap./GDP	0.787**	0.715**	0.664*	0.751**	0.686**	0.057**	0.051**	0.049**	0.053**	0.050**
	(0.325)	(0.329)	(0.330)	(0.369)	(0.324)	(0.021)	(0.022)	(0.022)	(0.024)	(0.021)
R&D Intensity*Creditor Rights	-0.006	0.006	0.060	0.020	0.059	0.000	0.001	0.004	0.002	0.004
	(0.057)	(0.054)	(0.062)	(0.073)	(0.062)	(0.004)	(0.004)	(0.005)	(0.006)	(0.004)
Ext.Fin.Dep.*Private Credit/GDP	0.024***	0.024***	0.024***	0.024***	0.024***	0.023***	0.023***	0.023***	0.023***	0.024***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Ext.Fin.Dep.*Stk.Mkt.Cap./GDP	-0.010	-0.011	-0.011	-0.010	-0.011	-0.009	-0.010	-0.010	-0.009	-0.010
	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
1/Size	1.369***	1.369***	1.368***	1.368***	1.367***	1.370***	1.370***	1.369***	1.369***	1.368***
	(0.287)	(0.287)	(0.288)	(0.288)	(0.288)	(0.288)	(0.288)	(0.289)	(0.289)	(0.289)
Ln(Initial Size)	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Private Credit/GDP	-0.030	-0.029	-0.027	-0.031	-0.025	-0.030	-0.029	-0.027	-0.031	-0.025
	(0.065)	(0.065)	(0.066)	(0.066)	(0.065)	(0.066)	(0.065)	(0.066)	(0.067)	(0.066)
Stk.Mkt.Cap./GDP	0.061**	0.063**	0.062**	0.060**	0.062**	0.057**	0.059**	0.058**	0.056*	0.058**
	(0.028)	(0.028)	(0.027)	(0.029)	(0.027)	(0.028)	(0.028)	(0.027)	(0.029)	(0.027)
GDP per capita	-0.011	-0.012	-0.011	-0.011	-0.011	-0.011	-0.012	-0.011	-0.011	-0.011
	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)
Govt.Spend.	-0.018*	-0.018*	-0.020**	-0.020**	-0.020**	-0.018*	-0.018*	-0.021**	-0.020**	-0.021**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Constant	0.634**	0.635**	1.032	1.044	1.045	1.019	1.022	1.033	1.047	1.044
	(0.271)	(0.272)	(0.737)	(0.740)	(0.740)	(0.730)	(0.730)	(0.739)	(0.742)	(0.742)
Observations	83672	83672	82723	82723	82723	83667	83667	82718	82718	82718
R-squared	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039

Empirical Appendix for the Paper "Legal Shareholder Protection and Corporate R&D Investment"

Table A.1: Summary Statistics of Country Level Control Variables: 1993-2008

This table reports the summary statistics of country level control variables included in the regressions. *GDP per capita* is GDP per capita in thousand US dollars at 2005 constant price level. *Openness* is the sum of export and import to GDP ratio. *Govt. Spend.* is the government spending to GDP ratio. *Creditor Rights* is a measure of creditor protection. *Poli. Rights* is an index of political rights. *Private Credit/GDP* is private credit by deposit money banks and other financial institutions divided by GDP. *Stk.Mkt.Cap./GDP* is stock market capitalization to GDP ratio. *Education* is the average schooling years of age above 25 populations in 1990. *Patent Protec.* is an index on patent protection. *Labor Protection* is a measure of labor protection granted by law or mandatory collective agreements against dismissal. The three cultural variables – *Collectivism*, *Power Distance* and *Assertiveness* are indexes that evaluate the degree of collectivism, power distance and assertiveness of a country. *Earnings Opacity* is the average of the indexes on earning aggressiveness, loss avoidance and earnings smoothing. *IFRS Dummy* equals one if a country permits the usage of the International Financial Reporting Standard (IFRS), and zero otherwise. World Governance Indicator (WGI) is an index that evaluates the extent of country level governance. It is the average of the indexes on six dimensions of governance that cover political stability, rule of law, control of corruption, voice & accountability, government effectiveness and regulatory quality. *Fin. Develop.*, *Govt. Spend.*, *GDP per capita* and *Stk. Mkt. Develop.* are time varying across different years. The other country level variables are time constant.

Variable	Frequency	Mean	Median	Std.	Min.	Max.	5%	25%	75%	95%
Creditor Rights	52339	1.474	1.000	0.821	0.000	4.000	1.000	1.000	2.000	4.000
Openness	52339	0.329	0.245	0.341	0.166	4.566	0.180	0.225	0.273	0.731
Private Credit/GDP$_{t-1}$	52339	1.614	1.684	0.349	0.156	2.311	0.975	1.355	1.886	2.054
Govt. Spend.$_{t-1}$	52339	0.109	0.094	0.031	0.037	0.320	0.082	0.085	0.136	0.157
Poli. Rights	52339	1.066	1.000	0.508	1.000	7.000	1.000	1.000	1.000	1.000
Education	52339	11.130	12.278	1.700	2.283	12.278	7.867	9.888	12.278	12.278
Patent Protec.	52339	4.649	4.875	0.428	1.233	4.875	4.167	4.417	4.875	4.875
GDP per capita$_{t-1}$	52339	33.776	33.276	6.055	2.424	46.729	26.299	29.202	39.037	41.870
Labor Protec.	52339	0.144	0.143	0.150	0.000	0.857	0.000	0.143	0.143	0.571
Stk. Mkt. Develop.$_{t-1}$	52336	1.127	1.095	0.402	0.068	4.010	0.543	0.780	1.382	1.789
Collectivism	52093	4.175	4.170	0.181	3.890	5.620	3.990	4.170	4.170	4.590
Power Distance	52093	2.831	2.850	0.094	2.190	3.530	2.700	2.850	2.850	2.860
Assertiveness	52093	4.501	4.320	0.633	2.810	5.560	3.610	4.320	4.320	5.560
Earnings Opacity	51907	-0.144	-0.155	0.033	-0.297	-0.041	-0.175	-0.155	-0.118	-0.097
IFRS Dummy	52339	0.366	0.000	0.518	1.000	0.000	0.000	0.000	1.000	1.000
WGI	52339	1.404	1.523	0.285	-0.907	1.875	1.063	1.217	1.523	1.625

Table A.2: The Effects of Shareholder Protection on Capital Expenditures

This table reports the effects of shareholder protection on capital expenditures, estimated separately on the underinvestment sample (Columns 1-5) and the overinvestment sample (Columns 6-10) grouped with the *Underinvestment* index and *Overinvestment* index. In this section, I examine the effects of shareholder protection on capital expenditures for firms that may underinvest or overinvest. The regression equation is as following:

$$CAPX_{i,\ j,\ t} = \alpha_0 + \alpha_1 * Share.Protec._j + \beta * Control_{i,\ j,\ t-1} + \epsilon_{i,\ j,\ t}$$

where i, j, t are subscripts for firm, country and year, respectively. $CAPX$ is capital expenditures scaled by book assets at the end of previous fiscal year.The *Underinvestment* (*Overinvestment*) index is the number of times that the firm-year observation is sorted into underinvestment (overinvestment) sample by double sorting with Tobin's Q and individual variables that measure resource availability. A firm-year observation with the underinvestment (overinvestment) index of over 4 is classified into the underinvestment (overinvestment) sample. The dependent variable is capital expenditures, measured as capital expenditures to book assets ratio (CAPX/AT). Anti-self-dealing index (ASDI), English legal origin (Legal_ENG), public enforcement (Pub_Enforce), disclosure requirements (Disclosure) and liability standards (Liability) are the measures of shareholder protection. Please see Table 1 for variable definitions. All regressions include the same control variables as regressions in Table 2. For brevity this table only reports the coefficient estimates on measures of shareholder protection. Country level clustered standard errors are in the parenthesis. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level.

	Underinvestment Index > 4 (**Underinvestment Sample**)					*Overinvestment* Index > 4 (**Overinvestment Sample**)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ASDI	-0.013*					-0.006				
	(0.008)					(0.008)				
Legal_ENG		-0.004					-0.002			
		(0.003)					(0.003)			
Pub_Enforce			-0.007*					-0.005		
			(0.004)					(0.004)		
Disclosure				-0.004					0.003	
				(0.009)					(0.010)	
Liability					0.012**					0.002
					(0.006)					(0.006)
Observations	11,253	11,253	11,232	11,232	11,232	9,119	9,119	9,105	9,105	9,105
R-squared	0.211	0.210	0.210	0.210	0.211	0.293	0.293	0.294	0.293	0.293