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Corporate Governance and Innovation: Theory and Evidence*

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Abstract

We develop a theory of the effects of external corporate governance mechanisms — such as takeover pressure — and internal mechanisms — such as compensation contracts and monitoring intensity — on innovation by firms. Our theory generates the following testable predictions: (i) innovation varies non-monotonically in a U-shaped manner with takeover pressure, (ii) innovation increases with monitoring intensity, and (iii) the sensitivity of innovation to changes in takeover pressure declines with monitoring intensity. We show strong empirical support for these predictions using both *ex ante* and *ex post* measures of innovative activity. We use difference-in-difference tests that exploit the natural source of exogenous variation created by the passage of state-level anti-takeover laws to identify the effects of governance mechanisms on innovation. Our study suggests that innovation is fostered by either strong anti-takeover laws that significantly deter takeovers or an unhindered market for corporate control. Monitoring is most effective in enhancing innovation at intermediate levels of takeover pressure. Effective shareholder monitoring not only enhances innovation, but also reduces the sensitivity of innovation to variations in external takeover pressure created by the passage of anti-takeover statutes.

JEL: G31, G34, K22

Keywords: Anti-takeover laws, Blockholders, Corporate Governance, Innovation, External Governance, Internal Governance, Monitoring, Takeovers.

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1 Introduction

A growing body of empirical evidence shows that laws and institutions that influence corporate governance impact country-level economic growth (e.g., La Porta *et. al*, 1997, 2000). An independent strand of the literature demonstrates that innovation by firms is a key driver of economic growth (e.g., Aghion and Howitt, 2006). However, there is relatively limited *micro* evidence of how laws and institutions affect innovation by firms (and thereby economic growth) *through* the channel of corporate governance. In this study, we theoretically and empirically show how external governance mechanisms — such as anti-takeover laws that affect the market for corporate control — and internal governance mechanisms — such as monitoring and compensation contracts — interact to affect innovation.

Our model generates the following testable implications. First, innovation varies non-linearly in a U-shaped manner with the level of takeover pressure that a firm faces. Second, innovation is enhanced if managers are monitored more intensely. Third, a higher monitoring intensity lowers the sensitivity of innovation to takeover pressure (i.e., it leads to a "flatter" U-shaped relation between innovation and takeover pressure). We show strong empirical support for these predictions using *ex ante* and *ex post* measures of the intensity of innovative activity. A novel contribution of our analysis is to show how the interplay between expected takeover premia and private benefits leads to a *non-monotonic* relation between innovation and takeover pressure. Innovation is therefore fostered *either* by practically non-existent anti-takeover laws that permit an unhindered market for corporate control, *or* by anti-takeover laws that are severe enough to effectively deter takeovers.

We build a model in which the manager of a firm chooses its degree of innovation. For example, suppose the manager of a pharmaceutical company could invest in either one of the following two projects: (1) inventing and launching a new drug for a hitherto incurable disease; or (2) manufacturing and launching a generic substitute for an existing drug. Launching a generic substitute involves uncertainties due to customer demand as well as competition from other manufacturers. In contrast, inventing a new drug entails *additional* uncertainties associated with the process of exploration and discovery, whether such a drug could be administered to humans, and whether it would receive FDA approval. Therefore, a significant portion of the risk associated with manufacturing and launching a generic substitute lies in the marketing stage, while a relatively greater proportion of the risk associated with inventing a new drug lies in the *exploration* stage, when the very existence of the drug is unknown.

We formalize the essence of the above example in a two-period model in which the manager of a firm chooses to invest in one of two projects: a "more innovative" project and a "less innovative" project. The projects' payoffs are normally distributed and occur at the end of the second period. There is imperfect but symmetric information about the *true* expected payoffs (hereafter, the *intrinsic qualities*) of the projects. Agents have normally distributed priors on the projects' intrinsic qualities. The more innovative project differs from the less innovative one along three dimensions. First, the more innovative project has a higher mean quality. Second, the more innovative project is riskier than the less innovative one. Third, consistent with the fact that the more innovative project entails significantly greater uncertainty with respect to exploration, a larger proportion of the total risk of the more innovative project stems from uncertainty about its intrinsic quality.

The project that the manager chooses can be observed by all agents. At the end of the first period, agents observe a public signal about the payoff of the chosen project. The signal resolves partially the uncertainty associated with the project's terminal payoff. Based on this signal, all agents update their prior assessments of the project's intrinsic quality. The firm could potentially be taken over by a raider through a tender offer. The raider can alter the project's terminal payoff. At the time of the takeover, there is imperfect, but symmetric information about the payoff generated by the raider. The severity of external anti-takeover laws influences the takeover pressure the firm faces and, in turn, the firm's bargaining power when it negotiates with the raider. The firm's bargaining power is reflected in the minimum takeover premium the firm must be guaranteed to be taken over by the raider. A takeover is, therefore, successful if and only if the takeover premium exceeds a threshold that increases with the severity of external anti-takeover laws. Hence, the likelihood of a takeover declines with the severity of external anti-takeover laws.

We capture two frictions in our environment. First, even though the manager's project choice can be observed by all agents, it *cannot be verified* by a third party (such as a court of law) and hence cannot be contracted upon. Second, the manager derives pecuniary *private control benefits* that are also non-contractible. The magnitude of these private benefits declines with the intensity with which shareholders monitor the manager. If the firm is taken over at the end of the first period, the manager cedes her control benefits to the raider. The project's payoff *net* of the manager's control benefits (hereafter the project's net payoff) as well as the payoff conditional on the firm being taken over are contractible. Therefore, the shareholders can influence the manager's project choice through a compensation contract contingent on the project's contractible payoffs.

We derive the manager's optimal compensation contract and show that it can be implemented through an equity stake in the firm along with a payment that resembles a golden parachute in the event of a takeover. The golden parachute aligns the interests of the manager and shareholders by effectively compensating the manager for her loss of control benefits in the event of a takeover. The manager's optimal project choice maximizes the firm's *unconditional expected payoff* (expected payoff in the absence of a takeover) plus the *expected takeover premium* less the *expected loss of private benefits* in the event of a takeover. In choosing the degree of innovation, the manager faces the following trade-offs. On the one hand, the higher quality uncertainty associated with the more innovative project increases the firm's likelihood of being taken over and, therefore, increases the manager's expected loss of control benefits. On the other hand, the higher likelihood of a takeover for the more innovative project results in a larger expected takeover premium. The manager trades off the positive effect of greater innovation on the expected takeover premium against its negative effect on the expected loss of control benefits. Since the magnitude of private benefits depends upon the shareholders' monitoring intensity, this trade-off is itself influenced by the interaction between the internal intensity of monitoring of the manager and the external takeover pressure the firm faces.

Our model generates the following empirical predictions: (1) The degree of innovation varies in a U-shaped manner with takeover pressure. (2) A higher monitoring intensity enhances the degree of innovation. (3) A higher monitoring intensity lowers the sensitivity of the degree of innovation to takeover pressure, i.e., a higher monitoring intensity leads to a "flatter" U-shaped relation between innovation and takeover pressure.

The predicted U-shaped relationship arises as follows. When the takeover pressure is very low, the low likelihood of a takeover implies that the expected takeover premium and the expected loss of control benefits are both insignificant. Therefore, the manager chooses the more innovative project because it has a higher unconditional expected payoff. When takeover pressure is very high, *regardless* of the degree of innovation, the expected loss in control benefits is very high. Because the expected takeover premium increases with the degree of innovation, it is again optimal to choose the more innovative project. For moderate levels of takeover pressure, the effect of the higher loss of control benefits associated with the more innovative project dominates. It is therefore optimal for the manager to choose the less innovative project.

The above intuition implies that the manager chooses the less innovative project for moderate levels of takeover pressure because the effect of her expected loss of control benefits dominates in this case. As monitoring intensity increases, the manager's private benefits decline so that the relative importance of private benefits in influencing her project choice declines. Hence, the manager chooses the more innovative project over a larger range of values of the takeover pressure. Furthermore, because the U-shaped relation between innovation and takeover pressure is driven by the manager's potential loss of control benefits, an increase in the monitoring intensity also lowers the sensitivity of the manager's project choice to changes in takeover pressure. In other words, the U-shaped relation between innovation and takeover pressure becomes flatter as monitoring intensity increases.

We test the predictions of the model using *ex ante* and *ex post* measures of the degree of innovation. We use R&D intensity (the ratio of R&D to sales) as our *ex ante* measure of the degree of innovation while we employ patents filed with the US Patent Office as well as citations to these patents as our *ex post* measures. We employ levels of ownership by active shareholders, such as institutional blockholders and public pension funds, to proxy for internal monitoring intensity. We use the state-level index of the severity of anti-takeover statutes (hereafter referred to as "anti-takeover index") from Bebchuk and Cohen (2003) as our proxy for the external takeover pressure a firm faces.

We exploit the staggered passage of anti-takeover laws in various states as a natural source of exogenous variation to conduct time-series *difference-in-difference* tests. These tests enable us to identify the causal link between anti-takeover laws and the degree of innovation. First, to test for the predicted U-shaped relationship between the degree of innovation and takeover pressure, we include (1) the change in the anti-takeover index, and (2) its interaction with the value of the index prior to the change (hereafter referred to as the "non-linear term"). Second, to test for the predicted positive effect of monitoring intensity on the degree of innovation, we include our various proxies for monitoring intensity. Third, to test for the flattening of the U-shaped relationship with greater monitoring, we interact the non-linear term with our proxies for monitoring intensity.

We find strong empirical support for all the predictions of the theory. First, we find that the coefficient of the change in the anti-takeover index is negative while the coefficient of the non-linear term is positive. When the value of the anti-takeover index before a law-change was zero (four), as it was is in the case of Delaware (Indiana), a one point *increase* in the value of the index *decreases (increases)* annual patents, citations, and R&D intensity for firms incorporated in the state by 6%, 6%, and 3% (29%, 36%, and 12%) more, respectively, relative to firms in states that did not experience the law-change. Thus, when the takeover pressure was very low (Indiana), a *decrease* in takeover pressure *increased* the degree of innovation. When the takeover pressure was very high (Delaware), the *decrease* in takeover pressure *decreased* the degree of innovation. The empirical evidence therefore supports a statistically and economically significant U-shaped relationship between takeover pressure and the degree of innovation. Second, higher monitoring is associated with greater innovation – the presence of an additional blockholder (or public pension fund) is associated with 17% more annual patents, 20% more annual citations, and 3% higher R&D intensity. Finally, higher monitoring leads to a flatter U-shaped relationship between takeover pressure and innovation. The presence of an additional blockholder (or public pension fund) flattens the curvature of annual patents, citations, and R&D intensity by 13%, 11%, and 9%, respectively.

The difference-in-difference tests still might not capture the effects of anti-takeover laws if other unobserved state-wide changes that affect innovation also accompany the passage of these laws. To alleviate these concerns, we conduct difference-in-difference tests at the *division/subsidiary* level. For these tests, we use the NBER patents database to construct a *unique dataset* that identifies the specific division/subsidiary of a firm that filed a patent.[1] Consider the example of Xerox, which is incorporated in the state of New York (NY) and has research labs in Rochester, NY and in Palo Alto, CA. Suppose other state-wide changes that potentially affected innovation accompanied the passage of the anti-takeover law in NY in 1990. Such changes may have affected innovation in its research labs located in Rochester, but not necessarily in Palo Alto. Therefore, the difference in innovation by the Palo Alto labs netted against the difference in innovation for all other subsidiaries/divisions of firms that did not experience a law-change isolates the effect of the law-change. We also find strong empirical support for all our predictions in these tests.

Despite these results, "endogeneity" concerns potentially remain since it is possible that blockholders invest more in firms that are (or anticipated to be) successful innovators. To alleviate such concerns, we employ a firm's entry into, or exit from, the S&P 500 as an *instrument* for blockholder ownership as in Aghion et al (2008). Our results remain unaltered.

The results of innovative activity may be experienced only after a significant time lag. To examine the long-term effects of innovation, we carry out tests that investigate the effects of changes in anti-takeover laws on innovation at least three years after the changes. Our empirical results show that law-changes and monitoring intensity have their predicted effects on patents and citations three years after the change in the laws, while they have their predicted effects on R&D intensity within a year of such change. The results reflect the delayed effects of law-changes on *outputs* of innovation, such as patents and citations, but their immediate effects on *inputs* such as R&D.

In summary, we theoretically and empirically investigate the effects of external and internal governance mechanisms on innovation. A novel contribution of our theoretical analysis is the identification of the effects of the trade-off between expected takeover premia and control benefit losses on the degree of innovation. Our study suggests that innovation is fostered by anti-takeover laws that are either practically non-existent or severe enough to significantly deter takeovers.[2] Strong anti-takeover

[1] We first used the Directory of Corporate Affiliations to identify the divisions/subsidiaries of a firm. We then employed a name-matching algorithm to match the names of those divisions/subsidiaries to the "assignees" in the NBER patents database.

[2] Indeed, anecdotal evidence provides some support for this key insight derived from our theory. The state of California has essentially no laws preventing takeovers, but firms incorporated in California engage in a significant amount of innovative activity. On the other hand, the state of Massachusetts has very strong anti-takeover laws, but it also supports extensive innovation by firms.

laws may foster innovation by protecting the manager from losing control due to a takeover. An unhindered market for corporate control, however, also encourages innovation through the benefits of higher takeover premia for innovative firms. Monitoring is most effective in enhancing innovation at intermediate levels of takeover pressure. Effective shareholder monitoring not only enhances innovation, but also reduces the sensitivity of innovation to variations in external takeover pressure created by the passage of anti-takeover statutes.

2 Related Literature

From a theoretical standpoint, we contribute to the literature that examines the effects of corporate governance mechanisms on innovation.[3] Stein (1988) develops a model with asymmetric information between managers and investors about the interim outcome of projects. He shows that the threat of takeover induces myopic behavior on the part of managers. Zwiebel (1995) develops a model with asymmetric information about managerial ability and shows that, compared to managers of intermediate ability, both high-ability and low-ability managers are more likely to choose innovative projects. Burkart, Gromb, and Panunzi (1997) examine the costs and benefits of large shareholders and argue that monitoring by large shareholders imposes costs by reducing beneficial managerial discretion. Manso (2007) develops a theory to show that the compensation contracts that provide incentives to a CEO to innovate exhibit the twin features of tolerance for failure in the short term, and reward for long-term performance. Aghion, Reenen, and Zingales (2008) investigate the effects of institutional ownership on firm-level innovation. They predict and find that higher institutional ownership is positively associated with greater innovation. The existing studies thus examine how innovation is affected by *either* internal mechanisms such as managerial compensation contracts (Manso, 2007), large shareholder monitoring (Burkart, Gromb and Panunzi, 1997, Aghion, Zeenen, and Zingales, 2008) or managerial ability (Zwiebel, 1995), *or* by external mechanisms such as takeover pressure (Stein, 1988). We contribute to the preceding literature by examining how innovation is influenced by such internal *as well as* external governance mechanisms. By integrating external and internal

[3] Aghion et al (2002) theoretically and empirically show that there is an inverted-U shaped relationship between innovation and product market competition.

governance mechanisms in our framework, we show how the interactions between takeover premia and private control benefits lead to a non-monotonic relation between innovation and takeover pressure.

Our prediction of a U-shaped relation between innovation and takeover pressure is especially pertinent given the ongoing academic debate on the importance of the market for corporate control in fostering innovation. One strand of the literature argues that the market for corporate control disciplines managers and induces them to invest in value-enhancing innovative activities (Jensen, 1988). In contrast, another group of studies argues that strong anti-takeover laws may foster innovation by facilitating long-term contracting (Shleifer and Summers, 1988) or by encouraging long-term investments in innovation by managers (Stein, 1988). Our theory, which integrates long-term contracting and an external market for corporate control, supports *both* perspectives. An unhindered market for corporate control fosters innovation through the incentives provided by takeover premia that increase with the degree of innovation. Severe anti-takeover laws may, however, also induce innovation by mitigating the adverse effects of private control benefit losses on managers' incentives to engage in innovative activities.

From an empirical standpoint, our paper is related to studies that examine the effects of corporate governance on innovation. Meulbroek *et al.* (1990) document a negative correlation between R&D intensity in firms and the adoption of firm-level anti-takeover provisions. Atanassov (2007) empirically examines whether the reduction of takeover pressure due to the passage of state-level business combination laws leads managers to enjoy a "quiet life" or to shed their "managerial myopia". He finds that the passage of these laws lowers innovation as measured through patents and citations. Both these studies, however, test for a *monotonic relationship* between takeover pressure and innovation. Guided by our theory, we show that the relationship between takeover pressure and innovation is, in fact, *non-monotonic*. As a result, our findings support *both* the "quiet life" and the "managerial myopia" views. Our paper makes an additional empirical contribution by exploiting a unique feature of the NBER patents dataset that identifies the actual divisions/subsidiaries of firms that file the patent. We use this feature to conduct difference-in-difference tests at the division/subsidiary level done to isolate the pure effect of changes in anti-takeover on innovation.[4]

3 The Model

We consider a two-period model with dates $0, 1, 2$. At date 0, the manager of an all-equity firm chooses between two projects which differ in their *levels* of innovation. Henceforth, we denote the "more innovative" project by H and the "less innovative" project by L. The projects' payoffs occur at date 2. All agents are risk-neutral with a common discount rate that is normalized to zero.

3.1 Project Characteristics

The project $X \in \{H, L\}$ requires an initial investment C and generates a payoff of $P_X(2)$ at date 2.[5] The true expected returns of the projects (the expected returns from the perspective of a hypothetical omniscient agent) are unobservable to all agents, including the manager. As in Gibbons and Murphy (1992) and Holmstrom (1999), there is imperfect but symmetric information about the true expected returns of the projects. The projects differ from each other as follows. First, the more innovative project has a higher risk and a higher expected return than the less innovative one. Second, the more innovative project involves greater "exploration" relative to the less innovative one so that there is more uncertainty about its expected return.

To fix ideas, consider the following example. Suppose a pharmaceutical company could invest in either one of the following two projects: (1) inventing and launching a *new* drug (project H); or (2) manufacturing and launching a generic substitute for an existing drug (project L). Manufacturing and introducing a generic drug involves uncertainties arising from market demand, competition from other manufacturers, etc. In contrast, inventing a new drug entails *additional* uncertainties associated with the process of discovery and exploration, the uncertainty about whether such a drug could be administered to humans, and whether it would receive approval from the Food and Drug Administration

[4] Cremers and Nair (2005) empirically study the effects of external and internal governance mechanisms on equity prices. Our work complements their study by showing the *real* effects of governance mechanisms on firm-level innovation that, in turn, influences equity prices.

[5] The assumption that the projects require the same initial investment is not important for our analysis. We only require that the more innovative project have a higher net present value than the less innovative one.

(FDA).

The payoff of project $X \in \{H, L\}$ at date 2 is

$$P_X(2) = 2\widetilde{\mu}_X + \sigma_X \widetilde{z}_1 + \sigma_X \widetilde{z}_2. \tag{1}$$

The parameter $\widetilde{\mu}_X$ in (1) determines the *true* expected return of the project, which we refer to as the project's *quality.* All agents have symmetric, normally distributed prior beliefs about the project's quality. Formally,

$$\widetilde{\mu}_X \sim N(m_X, s_X^2), \tag{2}$$

where m_X refers to the *mean quality* of the project. The parameter s_X^2 is the variance in agents' beliefs about the project's quality, which we refer to as the *quality uncertainty* of the project.

In (1), $\widetilde{z}_1$ and $\widetilde{z}_2$ are independent standard normal random variables, which capture the *intrinsic uncertainties* associated with the project. The random variable $\widetilde{z}_1$ represents "first period" uncertainty, while $\widetilde{z}_2$ represents "second period" uncertainty. The parameter σ_X, which is common knowledge, captures the level of intrinsic uncertainty of project X.

Because the more innovative project H has a higher risk and higher expected return than the less innovative project L,

$$m_H > m_L \ , \ \sigma_H > \sigma_L. \tag{3}$$

Second, because the more innovative project is associated with a higher degree of quality uncertainty,

$$s_H > s_L. \tag{4}$$

Furthermore, we assume that

$$\frac{s_H}{\sigma_H} > \frac{s_L}{\sigma_L}, \tag{5}$$

which implies that, compared to the less innovative project L, a relatively greater proportion of the total uncertainty associated with the more innovative project H stems from imperfect information or uncertainty about its quality. For example, while a significant portion of the risk associated with manufacturing and launching a generic substitute lies in the marketing stage, a relatively greater proportion of the risk associated with inventing a new drug occurs in the *exploration* stage, when the very existence of the drug is unknown.

3.2 Intermediate Signals and Posterior Assessments of Project Quality

The manager's project choice at date 0 is observable by all agents in the economy. If the manager chooses project $X \in \{H, L\}$ at date 0, then all market participants observe a public signal at date 1 given by:

$$P_X(1) = \widetilde{\mu}_X + \sigma_X \widetilde{z}_1. \tag{6}$$

From (1), it follows that:

$$P_X(2) = P_X(1) + \widetilde{\mu}_X + \sigma_X \widetilde{z}_2, \tag{7}$$

so that the date 1 signal partially resolves the uncertainty about the date 2 payoffs.

Given the public signal, all agents update their assessments about the intrinsic quality of the project chosen by the manager. Using Bayes' rule (see DeGroot, 1981), the posterior distribution of the quality of project X is also normally distributed with mean $\widehat{m}_X$ and standard deviation $\widehat{s}_X$ given by:

$$\widehat{m}_X \equiv \frac{\sigma_X^2 m_X + s_X^2 P_X(1)}{s_X^2 + \sigma_X^2}, \tag{8}$$

$$\widehat{s}_X^2 \equiv \frac{s_X^2 \sigma_X^2}{s_X^2 + \sigma_X^2}. \tag{9}$$

We can rewrite the posterior mean given by (8) as

$$\widehat{m}_X = m_X + S_X \widehat{z}$$

where $\widehat{z}$ is a standard normal random variable and

$$S_X \equiv \frac{s_X^2}{\sqrt{s_X^2 + \sigma_X^2}} \tag{10}$$

It follows from (4), (5) and (10) that

$$S_H > S_L \tag{11}$$

Equation (11) implies that the uncertainty in the posterior assessments of project quality is higher for the more innovative project than for the less innovative one.

3.3 Private Control Benefits and Monitoring Intensity

The manager derives *pecuniary* private control benefits $\alpha \in (0, \infty)$ provided she still controls the firm in the second period. These private control benefits are *non-verifiable* and, therefore, non-contractible. The magnitude of the private control benefits parameter α declines with the monitoring intensity of the shareholders. For example, if the firm has a higher proportion of ownership by outside block-holders, then the manager will be better monitored so that the amount of private control benefits that she can extract is likely to be lower (Tirole, 2006).

3.4 Takeover Pressure

At date 1, the firm can be taken over by a raider through a tender offer. The raider could alter the terminal payoff of the project. If the raider takes control of the firm at date 1, the project's terminal payoff at date 2 is

$$P_X^{raider}(2) = P_X(1) + \widetilde{\mu}_X^{raider} + \sigma_X \widetilde{z}_3. \tag{12}$$

where $\widetilde{z}_3$ is a standard normal random variable independent of $\widetilde{z}_1$, $\widetilde{\mu}_X$, and $\widetilde{\mu}_X^{raider}$. As is the case for the project's true expected return $\widetilde{\mu}_X$ under the firm's incumbent management, the true expected return $\widetilde{\mu}_X^{raider}$ of the project under the raider, is also unobservable to all agents in the economy. There is imperfect but symmetric information about $\widetilde{\mu}_X^{raider}$. We assume that

$$\widetilde{\mu}_X^{raider} \sim N(m_X, s_X^2). \tag{13}$$

While the raider may alter the true expected second-period return of the project, the true expected return under the raider is drawn from the same distribution. This assumption captures the notion that, under the raider's control, the project is drawn from the same pool as the original project. We assume that $\widetilde{\mu}_X^{raider}$ is imperfectly correlated with $\widetilde{\mu}_X$ so that there is potential for value enhancement or destruction by the raider. To simplify the analysis, we assume that $\widetilde{\mu}_X^{raider}$ is independent of $\widetilde{\mu}_X$. If the raider takes over the firm, the incumbent manager loses her control benefits α to the raider.

The prevailing anti-takeover laws affect the firm's bargaining power in its negotiations with the raider. The more severe the anti-takeover laws are, the more difficult it is for the raider to take over the firm. We capture the severity of anti-takeover laws through the *minimum takeover premium* that the raider has to pay in order to take over the firm. We denote this minimum takeover premium by η. As anti-takeover laws become more severe, the minimum takeover premium η *increases* so that takeover pressure *decreases*.

The following lemma shows that, given free-rider problems in the face of a tender offer (Grossman and Hart, 1980) and the existence of private control benefits for the raider, it is optimal for the raider to make a tender offer that cedes the expected surplus he generates (net of his control benefits) through the takeover premium.

Lemma 1 (Likelihood of takeover) *The raider succeeds in taking over the firm if and only if*

$$E[\widetilde{\mu}_X^{raider}] = m_X \geq \widehat{m}_X + \eta. \tag{14}$$

In other words, the takeover is successful if the mean posterior assessment of the project quality $\widehat{m}_X$ is below the threshold $m_X - \eta$. As anti-takeover laws become severe, the parameter η increases. Thus, the level of the mean posterior quality of the project that could trigger a takeover falls, thereby reducing the likelihood of a takeover. The severity of anti-takeover laws, therefore, directly influences the *likelihood* of a successful takeover. We hereafter refer to the parameter η as the external *takeover pressure* faced by the firm.

3.5 Contracting between the Manager and Shareholders

At date 0, the manager and the shareholders enter into a long-term contract that specifies the manager's payoffs conditional on the project that she chooses. The contract cannot prevent the pool of shareholders at date 1 from tendering their shares to a raider if it is in their interests to do so. However, the contract can specify a severance payment to the manager in the event of a takeover at date 1.

The manager's project choice X, her private control benefits α, and the date 1 signal $P_X(1)$ are all observable but *not verifiable* and, therefore, non-contractible. However, the date 2 net cash flows of the firm if it is not taken over (i.e., $P_X(2) - \alpha$) as well as the firm's date 2 net cash flows if it is taken over(i.e., $P_X^{takeover}$) are both contractible. At date 0, the shareholders can therefore write a compensation contract contingent on the contractible cash flows. Denote this compensation contract by $w(Q_X)$, where Q_X denotes the contractible portion of the firm's cash flows and is defined as

$$\begin{aligned} Q_X &\equiv P_X(2) - \alpha \text{ if the firm is not taken over at date 1,} \\ &\equiv P_X^{takeover} \text{ if the firm is taken over at date 1.} \end{aligned} \tag{15}$$

Figure 1 summarizes the sequence of events in the model.

4 Equilibrium

In this section, we characterize the equilibrium of the model. We then derive the main results of the paper and generate the empirical implications. Before doing so, it is useful to describe the first–best benchmark.

4.1 First–Best Benchmark

The first–best environment is characterized as follows: (i) the project choice X is contractible, and (ii) the manager derives no private control benefits. Therefore, in this environment, the manager chooses the project that maximizes the total expected payoffs of the firm. The first-best project choice

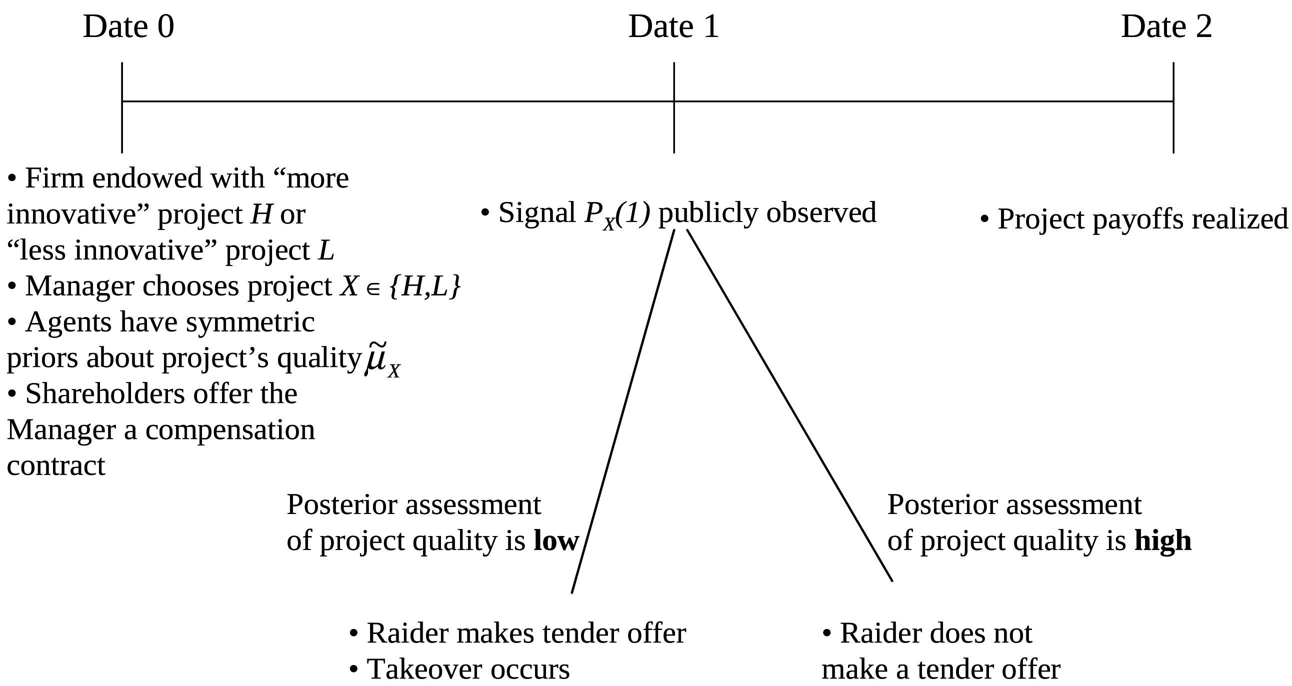

Figure 1: Timing and Sequence of Events

therefore maximizes

$$X^{FB} = \arg \max_{X \in \{H,L\}} \ E\underbrace{[(1 - 1_{takeover})\, P_X(2)]}_{payoff\ if\ no\ takeover} + \underbrace{1_{takeover} \cdot P_X^{takeover}}_{payoff\ if\ takeover\ occurs}, \tag{16}$$

where the indicator variable $1_{takeover}$ represents the event that the firm is taken over at date 1. Rearranging (16), we get

$$X^{FB} = \arg \max_{X \in \{H,L\}} \ \underbrace{E(P_X(2))}_{expected\ payoff} + \underbrace{E\left[1_{takeover}\left(P_X^{raider}(2) - P_X(2)\right)\right]}_{expected\ takeover\ premium} \tag{17}$$

Equation (17) implies that, in the first-best environment, the manager chooses the project that maximizes the total expected surplus of the firm, which is equal to the expected unconditional payoff of the project plus the expected takeover premium from selling the firm. Note that, because the firm can only be taken over if the raider offers a positive premium, the expected takeover premium term is strictly positive. The following proposition shows that the manager always chooses greater innovation in the first-best environment.

Proposition 1 (The First Best Project Choice) *In a first best setting, the manager always chooses the more innovative project.*

The more innovative project has a higher unconditional expected payoff than the less innovative one. Furthermore, from (11) it follows that the likelihood of a takeover is higher when the manager chooses the more innovative project, implying that the expected *takeover premium* in the right-hand side of (17) is also higher. It is therefore optimal for the manager to choose the more innovative project.

4.2 The Second Best Project Choice

At date 0, in order to maximize their expected payoffs, the shareholders design an optimal compensation contract $w^*(Q_X)$ for the manager, where Q_X is the contractible payoff defined in (15). The second best project choice $X^* \in \{H, L\}$ and the manager's compensation contract $w^*(Q_X)$ therefore solve the following optimization problem:

$$(X^*, w^*(Q_X)) \equiv \underset{X,\, w(Q_X)}{\arg\max}\, E[Q_X - w(Q_X)] \tag{18}$$

subject to the manager's participation constraint,

$$E[(1 - 1_{takeover}) \cdot \alpha + w(Q_X)] \geq U, \tag{19}$$

and the incentive compatibility constraint,

$$X^* = \arg \max_{X' \in \{H,L\}} E[(1 - 1_{takeover}) \cdot \alpha + w(Q_{X'})] \tag{20}$$

In constraint (19), the variable U denotes the manager's reservation payoff. Constraint (20) ensures that the manager's choice of the optimal project is incentive compatible.

Note that, because all agents are risk-neutral and there are no constraints on monetary transfers, the participation constraint (19) must be binding in the optimal contract.[6] This observation, in turn, implies that

$$E(w^*(Q_X)) = U - E\left[(1 - 1_{takeover}) \cdot \alpha\right].$$

Substituting for $E(w^*(Q_X))$ in (18) and using (15), and the law of iterated expectations, we obtain

$$X^* = \arg \max_{X \in \{H,L\}} \underbrace{E(P_X(2))}_{expected\ payoff} + \underbrace{E\left[1_{takeover}\left(P_X^{raider}(2) - P_X(2)\right)\right]}_{expected\ takeover\ premium} - \underbrace{E[1_{takeover} \cdot \alpha]}_{expected\ loss\ in\ control\ benefits} \tag{21}$$

Note that in deriving the second-best optimal project choice X^*, we have ignored the incentive compatibility constraint (20). We show later in Proposition 3 that, under the optimal contract, the constraint is indeed satisfied and the manager's optimal project choice solves (21). By (21), in the presence of private control benefits, the manager's optimal project choice maximizes the expected total unconditional payoff $E(P_X(2))$ of the project *plus* the expected takeover premium *less* the expected control benefits that are lost in the event of a takeover. Recall that, in the first-best environment, equation (17) implies that the manager maximizes the total expected surplus of the firm given by the first two terms of (21). However, in our second-best environment, in which the project choice is not contractible and private control benefits are present, the manager maximizes the total expected surplus of the firm minus the expected loss in control benefits due to a possible takeover at date 1. In that sense, the manager's project choice in our environment is *constrained efficient.*

The following proposition describes the constrained efficient project choice of the manager.

Proposition 2 (Constrained Efficient Project Choice) *The constrained efficient project choice solves*

$$\max_{X \in \{H,L\}} \underbrace{2m_X}_{expected\ unconditional\ payoffs} + \underbrace{\frac{S_X}{\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{\eta}{S_X}\right)^2\right]}_{expected\ takeover\ premium} - \underbrace{\alpha\Phi\left(-\frac{\eta}{S_X}\right)}_{expected\ loss\ in\ control\ benefits}, \tag{22}$$

where $\Phi(\cdot)$ is the cumulative standard normal distribution and S_X is defined in (10).

[6] If the participation constraint is not binding, the manager's compensation can be reduced by a constant amount that does not affect the incentive compatibility constraint (20) but strictly increases the shareholders' expected payoff.

The objective function in (22) illustrates the basic trade-off that the manager faces in choosing the degree of innovation. From (11), the fact that $S_H > S_L$ implies that the firm's likelihood of being taken over given by the term $\Phi\left(-\frac{\eta}{S_X}\right)$ is higher for the more innovative project so that the manager's expected loss of control benefits is also higher. However, the higher likelihood of being taken over also results in a larger expected takeover premium for the more innovative project. The manager's project choice trades off the positive effect of greater innovation on the expected takeover premium against its negative effect on the expected loss of control benefits. Furthermore, note that the expected takeover premium depends on the level of takeover pressure η that the firm faces while the expected loss in control benefits depends on both the level of takeover pressure η and the magnitude of the private control benefits α. Therefore, the above trade-off between the expected takeover premium and the expected loss in control benefits is itself influenced by the interaction between the shareholders' monitoring intensity (which affects α) and the extent of external takeover pressure the firm faces.

4.3 Optimal Contract for the Manager

We now derive an optimal contract for the manager.

Proposition 3 (Optimal Contract) *An optimal contract for the manager is one in which she always receives a fraction λ of the firm's terminal payoffs (i.e., λQ_{X^*}) and an additional payment, β, if the firm is taken over where*

$$\beta = (1-\lambda)\alpha, \tag{23}$$

and λ is chosen to satisfy the manager's participation constraint at equality.

$$U = 2m_{X^*}\lambda + (1-\lambda)\alpha + \lambda\frac{S_{X^*}}{\sqrt{2\pi}}\exp\left[-\left(\frac{\eta}{S_{X^*}}\right)^2\right] - \lambda\alpha\Phi\left(-\frac{\eta}{S_{X^*}}\right),$$

where X^* is the optimal project choice that satisfies (22).

While the optimal allocation of payoffs to the agents (shareholders and the manager) is unique, it can be *implemented* in different ways. In the above implementation, the manager receives a (restricted) equity stake of λ in the firm along with a severance payment of $\beta > 0$ if the firm is taken over at date 1. From an *ex ante* perspective, both the equity stake and the severance payment are optimal contractual devices that align the manager's incentives with those of the shareholders. The severance payment resembles a firm-level anti-takeover device, such as a *golden parachute* or a *poison pill,* in the sense that it makes it costlier for the raider to take over the firm. Other implementations of the optimal allocation of payoffs would have similar features because the manager must be compensated for his loss of control benefits subsequent to a takeover.

4.4 Innovation, External Takeover Pressure, and Monitoring

We now describe the effects of takeover pressure and monitoring intensity on the manager's choice of the degree of innovation.

Proposition 4 (Effect of Takeover Pressure on Innovation) *There exists a (possibly degenerate) interval $[\eta_{min}, \eta_{max}]$ of the external takeover pressure parameter η such that the manager chooses the more innovative project for $\eta \notin [\eta_{min}, \eta_{max}]$ and the less innovative project for $\eta \in [\eta_{min}, \eta_{max}]$. The interval $[\eta_{min}, \eta_{max}]$ is non-degenerate if and only if the private control benefits α are large enough.*

The above proposition confirms our intuition about the importance of private control benefits in our second-best environment. When private control benefits α are relatively small, the manager chooses the more innovative project for any level of takeover pressure η as she would do in the first-best environment. However, as private control benefits α increase, the above proposition tells us how the trade-off between the expected takeover premium and the expected loss in control benefits determines the manager's optimal project choice as takeover pressure changes. The manager chooses the more innovative project if the takeover pressure is either very high or very low while she chooses the less innovative project for intermediate levels of the takeover pressure.

To understand the intuition behind this result, consider first the case where the external takeover pressure is very low ($\eta > \eta_{max}$). In this case, a takeover is very unlikely, so the expected takeover premium as well as the expected loss in control benefits are insignificant (i.e., the second and third terms in (22) are relatively small). Therefore, the manager's optimal project choice is driven by the unconditional expected project payoff (the first term in (22)). The manager, therefore, chooses the more innovative project due to its higher unconditional expected payoff. Conversely, when takeover pressure is very high ($\eta < \eta_{\min}$), *regardless* of the project choice, the expected loss in control benefits is very high. Because the more innovative project generates a higher expected takeover premium, it is again optimal to choose the more innovative project. For moderate levels of takeover pressure, the effect of the expected loss of control benefits dominates so that the manager chooses the less innovative project, thus lowering the likelihood of a takeover.

The intuition underlying Proposition 4 suggests that the loss of control benefits due to a takeover plays a key role in generating the intermediate region within which lower innovation is chosen. As mentioned earlier, the control benefits the manager extracts (and, therefore, the control benefits she loses due to a takeover) depend on shareholders' monitoring intensity. The following proposition describes the effects of monitoring intensity on the degree of innovation.

Proposition 5 (Effect of Monitoring Intensity on Innovation)

The interval $[\eta_{min}(\alpha), \eta_{max}(\alpha)]$, for which the manager chooses lower innovation, increases as private control benefits α increase. More precisely,

$$[\eta_{min}(\alpha_1), \eta_{max}(\alpha_1)] \subset [\eta_{min}(\alpha_2), \eta_{max}(\alpha_2)], \text{ for } 0 < \alpha_1 < \alpha_2, \tag{24}$$

where we explicitly indicate the dependence of $\eta_{min}(.)$ and $\eta_{max}(.)$ on the private control benefits.

The intuition for the above result follows from the fact that, in the intermediate interval $[\eta_{min}(.), \eta_{max}(.)]$ the relative effect of the manager's expected loss of control benefits on her project choice is high, and thus she chooses the less innovative project. As the manager's control benefits increase, the potential losses she might incur due to a takeover also increase, and so the interval over which she chooses lower innovation increases.

To explore how the external takeover pressure and the internal monitoring intensity interact to affect the degree of innovation, we define the *expected excess payoff from higher innovation* $G(\eta, \alpha)$, as the expected payoff from the more innovative project H less the expected payoff from the less innovative project L. From Proposition 2, the expected excess payoff is given by:

$$\begin{aligned} G(\eta, \alpha) \quad \equiv \quad & 2m_H + \frac{S_H}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}\frac{\eta^2}{(S_H)^2}\right) - \alpha\Phi\left(-\frac{\eta}{S_H}\right) \\ & -2m_L + \frac{S_L}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}\frac{\eta^2}{(S_L)^2}\right) - \alpha\Phi\left(-\frac{\eta}{S_L}\right) \end{aligned} \tag{25}$$

The following proposition describes the interactive effects of monitoring intensity and takeover pressure on the degree of innovation.

Proposition 6 (Takeover Pressure, Monitoring Intensity, and Innovation) *There exists an* $\eta^* > 0$ *such that*

$$\begin{aligned} \frac{\partial^2 G}{\partial(-\alpha)\partial\eta} \quad & > \quad 0 \textit{ for } \eta < \eta^*, \\ \frac{\partial^2 G}{\partial(-\alpha)\partial\eta} \quad & < \quad 0 \textit{ for } \eta > \eta^* \end{aligned} \tag{26}$$

Figure 2 illustrates the result of Proposition 6 by showing the variation of the expected excess payoff from higher innovation with takeover pressure for different values of the manager's private control benefits. Proposition 4 and the figure show that the U-shaped relation between the degree of innovation and takeover pressure becomes "flatter" as monitoring intensity increases — that is, as α declines. The intuition is that, as the manager's private control benefits *decline*, so does the relative impact of the manager's expected loss of control benefits on the expected excess payoff from higher innovation. As a result, the expected excess payoff from higher innovation becomes *less sensitive* to changes in takeover pressure as the monitoring intensity increases. Hence, as illustrated by Figure 2, the U-shaped relation between the degree of innovation and takeover pressure becomes flatter as monitoring intensity increases.

4.5 Testable Hypotheses

The preceding theoretical predictions generate the following empirically testable hypotheses.

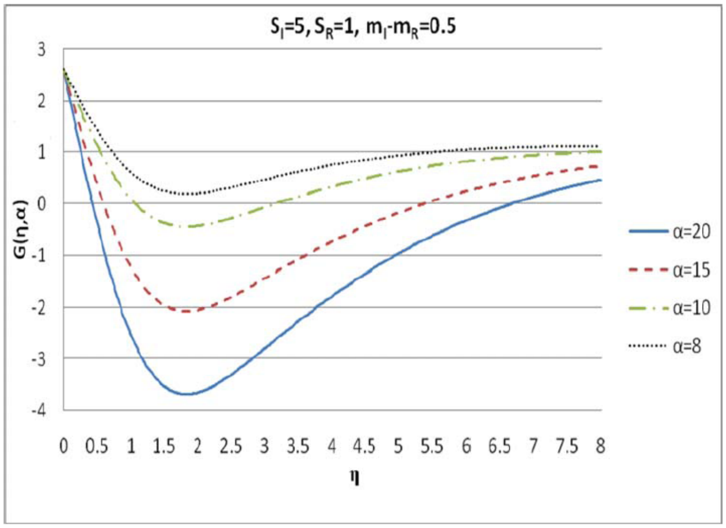

Figure 2: Variation of Expected Excess Payoff from Higher Innovation $G(\eta, \alpha)$ with Takeover Pressure η for various levels of Monitoring Intensity α.

Hypothesis 1 (External Governance and Innovation) *The degree of innovation varies in a U-shaped manner with external takeover pressure.*

Hypothesis 2 (Internal Monitoring and Innovation) *The degree of innovation increases with internal monitoring intensity.*

Hypothesis 3 (Interactive Effects of Monitoring and External Takeover Pressure) *The curvature of the U-shaped relation between the degree of innovation and external takeover pressure declines with monitoring intensity — that is, the U-shaped relation becomes "flatter".*

5 Empirical Analysis

5.1 Proxies for Innovation

We employ both *ex ante* and *ex post* measures to proxy for innovation by firms. Our *ex ante* measure of a firm's innovation done is its R&D intensity as measured by the ratio of its R&D expenditure to sales (obtained from Compustat).[7] We use patents and citations to patents as our ex post proxies

[7] It should be mentioned, however, that R&D expenditures are an input to innovative activity, along with factors such as physical and human capital, managerial/employee effort, and creativity. Moreover, R&D expenditures include investments made by firms to generate new innovations as well as the outlays for developing and commercializing these innovations.

for innovation. We employ data on patents filed by US firms with the US Patent Office (USPTO) and citations on these patents from the NBER Patents data, as constructed by Hall, Jaffe and Trajtenberg (2001). While the filing of a patent indicates successful innovation, the trail of citations on these patents captures the economic value underlying the innovation (Griliches et. al. 1987).

We use two broad metrics for our ex post measures of innovation. First, we employ a simple count of the number of patents that were filed by a firm in a particular year. Second, to measure the importance and drastic nature of innovation, we measure all subsequent citations (until 2002) made to these patents. While these citations reveal the economic importance of a patent, they suffer from a severe truncation bias because patent citations are received for many years after the patent is applied for and granted. Another potential concern with using citations is that different industries might have different propensities to cite patents. When we later detail our empirical approach, we discuss how we address these concerns.

Since the year of application captures the relevant date of the innovation for which a patent is filed, we date our patents according to the year in which they were applied for. This also avoids anomalies that may be created due to the time lag between the date the patent was applied for and the date when it was granted (Griliches et. al., 1987). Note that although we use the application year as the relevant year for our analysis, the patents appear in the database only after they are granted. Hence, we use the patents actually granted (rather than the patent applications) for our analysis.[8]

5.2 Proxies for External Takeover Pressure

As discussed in Section 3.4, the external takeover pressure parameter η in our model captures the severity of anti-takeover laws. Accordingly, we use the state-level index of anti-takeover laws compiled by Bebchuk and Cohen (2003) as the empirical proxy for external takeover pressure. In the "difference-in-difference" tests that we employ below in our empirical analysis, we rely on the passage of anti-takeover laws as a natural source of exogenous variation in takeover pressure (see Bertrand

[8] Readers may question our treatment of patents that are filed by US subsidiaries of foreign firms and whether the inclusion/ exclusion of such patents affects our results. We identify such patents as those where the country of the "assignee" is non-US but the country of the "inventor" is recorded as US. Of the 331,014 patents in our sample, we identify 6689 patents (~2.0%) issued to US subsidiaries of foreign companies. Not surprisingly, excluding these patents does not change our results.

and Mullainathan, 2003). We compile the list of states that passed second generation anti-takeover laws as well as the number of anti-takeover statutes that prevailed in each state before the passage of such laws. Various states passed five different kinds of statutes to deter the takeover of firms incorporated in their states – the Control Share acquisition, Fair-price, Business Combination, Poison Pill Endorsement, and Constituencies statutes.[9]

In contrast to Bertrand and Mullainathan (2003) who only examine the passage of the Business Combination statute, we examine the effect of the passage of all these five statutes. Relying on the finding by Karpoff and Malatesta (1989) that investor reaction was the most negative to the announcement of the passage of Business Combination laws, Bertrand and Mullainathan argue that these laws were the most stringent and, therefore, focus only on their passage. However, the passage of various anti-takeover laws were likely triggered by one another. Such correlation means that a law with lower investor reaction may not be necessarily weaker – investors may have anticipated the passage of this law upon observing the passage of a previous law. Consistent with this, *a priori*, we take no stand on the effectiveness of the different forms of laws. Instead, we focus on the changes in innovation around the time of passage of the first piece of anti-takeover laws in the firm's state of incorporation. To the extent the passage of subsequent laws in a given state is eased by the enactment of the first law, we believe it is the first law that represents a truly exogenous shock and therefore examine the impact of this change.[10]

5.3 Proxy for Monitoring Intensity: Active Shareholders

Our proxies for monitoring intensity are constructed using block ownership data from CDA Spectrum as in Cremers and Nair (2005). Since the NBER patent data is available at an annual frequency, we employ the institutional shareholdings at the end of December of each year. As in Cremers and

[9]Briefly, a control share statute requires a hostile bidder to put its offer to a vote of shareholders early in the process. A fair-price statute requires a bidder who gains control to pay remaining minority shareholders the same price it paid for shares acquired in the original bid. Business combination statutes restrict bidders from merging their assets with those of the target for a specified number of years. Poison pills are rights which entitle the existing holder to significant value in the event of an acquisition without board approval. Constituencies statutes allow managers to take into account the interests of nonshareholders in defending against a takeover. See Bebchuk and Cohen (2003) for further details.

[10]We have examined our results by altering the timing of the passage of the law to be the passage of the last anti-takeover law in a state. We find that while the effects are economically lower by about 20%, they continue to be both statistically and economically significant.

Nair (2005), we define a blockholder as a shareholder with greater than 5% ownership of the firm's outstanding shares and we employ three different proxies for monitoring intensity: (i) the number of institutional blockholders, (ii) the total percentage of shares owned by blockholders, and (iii) the number of public pension fund blockholders.

5.4 Control Variables

We control for other potential determinants of innovation as follows. To control for the potential dependence of innovation on firm size, we include the logarithm of sales. We also control for the potential dependence of innovation on the age of the firm. Because past R&D intensity could positively affect the number of current patents, the extent of current patent citations, and the level of current R&D expenditures, we include the lagged values of the ratio of past R&D expenditures to sales in our analysis. Innovation may be more likely when investment opportunities are greater. We therefore use Tobin's Q to control for investment opportunities. As documented in the endogenous growth literature, industry competition may affect firm innovation. Therefore, to control for the impact of industry competition on innovation, we use a sales-based Herfindahl measure for the 4-digit SIC industry as a measure of competition.

To control for the possible effects of cash flow constraints and capital intensity on innovation, we also include the lagged values of (i) the ratio of Cash to Assets, (ii) the ratio of EBITDA to Assets, (iii) the Kaplan-Zingales measure of Cash Flow constraints, (iv) the ratio of net property, plant, and equipment (Net PPE) to Assets, (v) the ratio of book value of Equity to Assets in our analyses. Since none of these variables are statistically significant in any of our specifications and therefore do not alter our results, we do not report these results. The data on total assets, sales, industry SIC, R&D expenditures, book equity, debt, Net PPE, cash, and EBITDA come from Compustat. We construct the age of the firm as the number of years since the IPO as reported in CRSP.

In practice, firms may adopt internal anti-takeover provisions such as poison pills. As discussed in Section 4.3, the optimal contract in our model also exhibits such features. Therefore, to control for the effects of firm-level anti-takeover mechanisms on innovation, we include the firm-level index of anti-takeover provisions as compiled by Gompers, Ishii, and Metrick (2003) as an additional control variable.

5.5 Sample Construction and Descriptive Statistics

Blockholder ownership information is available after 1980, while the NBER patents data end in 2002. The time period of our sample is therefore 1980 to 2002. To be included in the sample, a firm must have filed at least one patent during our sample period. For our empirical analysis, we focus on the patents granted to US Corporations in the NBER patent dataset.[11] Each assignee in the NBER dataset is assigned a unique and time-invariant identifier. First, we match the assignee names in the NBER patent dataset to the names of divisions/ subsidiaries belonging to a Corporate family from the Directory of Corporate Affiliations. We then match the name of the Corporate parent to Compustat. This matching process is done using name matching algorithms together with manual verification of 5% of the matched pairs. Our final sample consists of 15,838 firm-year observations. Since Compustat files report only the state of incorporation for the latest available year, we measure the state of incorporation in 2002.[12]

Panel A of Table 1 shows the summary statistics for our various proxies. Note that since our main unit of observation is a firm-year, all these summary statistics are calculated for the firm-year level of aggregation. The average firm in our sample applies for and is granted 20.9 patents per year and receives about 104 citations per year subsequently. With respect to R&D intensity, the average firm in our sample invests 54% of its annual sales revenue in R&D. The mean number of blockholders in our sample is 1.5 and the average number of public pension fund blockholders is 3.2. The average percentage of shares owned by all blockholders together is 13.8%.

In Panel B, we examine the correlations among our proxies for monitoring intensity and logarithm of sales as a proxy for firm size. While the number of blockholders and the total percentage of shares

[11] Assignee code equal to 2 identifies US non-government assignees (mainly US Corporations).

[12] To alleviate concerns that our results are affected by this form of coding, we have cross-checked the state of incorporation for a sub-sample of firms using the Investor Responsibility Research Center (IRRC) dataset. Of the close to 3,000 firms in our sample, according to the IRRC dataset, only 39 firms had a state of incorporation different from that recorded by Compustat in 2002. Excluding these firms from our sample does not alter any of our results.

This evidence of few firms having a state of incorporation different from the latest recorded in Compustat is consistent with similar findings in Bertrand and Mulainathan (2003).

owned by blockholders are very highly correlated (0.87), the correlation between the number of public pension funds and the other two proxies for monitoring intensity is very low.

Table 2 lists the states that passed the second generation anti-takeover laws, the year in which the first law was passed, the value of the state anti-takeover index before the passage of the first law, and the value of the index after the law reform was completed.

5.6 Time Series "Difference-in-Difference" Tests

5.6.1 Empirical Specification

We employ the passage of anti-takeover laws in various states as a natural source of exogenous variation along with a difference-in-difference approach to identify the causal link between anti-takeover statutes and innovation.[13] As Bertrand and Mullainathan (2003) argue, there is empirical and anecdotal evidence that anti-takeover legislation impedes the threat of a hostile takeover. The passage of anti-takeover laws enables us to examine the effects of *changes* in takeover pressure on *changes* in innovation, which is econometrically preferable to the examination of a relationship between the *levels* of the two variables.[14]

To understand the difference-in-difference approach, consider the following example. Suppose we want to estimate the effect of the passage of anti-takeover laws on innovation for firms incorporated in Massachusetts in 1988. A naive estimate would be to simply compute the change in innovation for such firms between two time periods, the period before the law was passed (i.e., 1981-1988) and the

[13] We have analyzed our hypotheses using cross-sectional tests. Here, we employ fixed effects at the firm and application year levels. In these tests, we find results that are consistent with our hypotheses. However, there are significant endogeneity concerns in the tests despite the presence of firm fixed effects, which subsume time-invarying effects at the state level. For example, it is possible that, due to the presence of universities such as Stanford and Berkeley, firms located in California benefited *relatively* more during the technological booms of the 1990s than in other periods. Furthermore, due to the geographical clustering of innovative firms in Silicon Valley and Route 128, firms located in these areas benefited relatively more during the technological booms of the 1990s than in other periods. The firm fixed effects, which subsume the state fixed effects, cannot control for such *time-varying* unobserved determinants of innovation at the state level. Moreover, compared to other firms in their industries, leading firms such as Microsoft, Intel, etc. may have been *relatively* more successful at innovating in those years in which there was a positive technological shock than in the years in which such a shock did not occur. Again, firm dummies will not capture such time-varying unobserved determinants. Due to such endogeneity concerns, we do not report these cross-sectional results for brevity; they are available on request.

[14] Examining levels of innovation is problematic since they could be affected by various unobserved factors at the state level, such as the presence of elite universities or the geographical clustering of firms in the Silicon Valley or in Route 128, as well as firm-level unobserved factors such as a firm's ability to attract talented scientists and researchers, the manner in which the work environment in the firm fosters creativity in its scientists and researchers, etc.

period after the law was passed (i.e., 1989-2002). However, this estimate might also be affected by time-trends that coincide with the passage of the law as well as other economy-wide factors. To control for such factors, we can also estimate this before-after difference in innovation for firms incorporated in states that did not pass an anti-takeover law in 1988. The before-after difference estimated using this control group of firms provides an answer to the counter-factual question: "what would have been the difference in innovation in Massachusetts if the law *had not been passed*?" The difference between these two differences, therefore, captures the causal effect of the change in the law on innovation.

To empirically analyze the non-linear relation between innovation and takeover pressure predicted by the theory, we begin with the predicted functional relationship:

$$y = b_0 + b_1 TI + b_2 TI^2 + b_3 MI + b_4 MI * TI^2 \tag{27}$$

where y denotes the level of innovation, TI denotes the state-level index of anti-takeover laws, and MI denotes monitoring intensity. To identify the coefficients β_1, β_2, and β_4 in (27) using the changes in state-level anti-takeover laws, differentiate y w.r.t. TI to obtain

$$\Delta y = (b_1 + 2b_2 TI + 2b_4 MI * TI) * \Delta TI \tag{28}$$

We implement (28) as a difference-in-difference specification using the following regression model:

$$\begin{aligned} y_{ist} \;=\; & \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{s,t} + \beta_2 \cdot (TI_s * \Delta TI_{s,t}) + \beta_3 \cdot MI_{i,t-1} \\ & + \beta_4 \cdot \{(TI_s * \Delta TI_{s,t}) * MI_{i,t-1}\} + \beta X + \varepsilon_{ist} \; ; t \in [1981, 2002] \end{aligned} \tag{29}$$

where i and s respectively denote firm i incorporated in state s, β_i, β_t respectively denote firm and application year fixed effects, and the vector X represents the set of control variables. For a state that passed an anti-takeover law in year m, $\Delta TI_{s,t}$ is equal to the actual change in the value of the anti-takeover index if $t \in [m+1, 2002]$; $\Delta TI_{s,t}$ is equal to zero otherwise. For states that never passed (did pass) the law, TI_s is equal to the *constant value* of the anti-takeover index (before the law-change). Because we measure our proxies for monitoring intensity at the end of December of each year while institutional shareholdings may change throughout the year, we examine the effect of monitoring intensity with a time lag of 1 year, i.e., $MI_{i,t-1}$. Because almost none of the firms in our sample change their states of incorporation, the firm fixed effects subsume state fixed effects. The marginal effect of monitoring intensity, β_3, is measured as a usual OLS coefficient.

Note that in (29), the application year fixed effects enable us to also control for the problem stemming from the truncation of citations (i.e., citations to patents applied for in later years would on average be lower than citations to patents applied for in earlier years). Furthermore, since firms seldom change the primary industries in which they operate, firm fixed effects also soak up *time-invarying* differences in the dependent variable at the industry level. This is important since patenting and citation practices may differ across industries.

Hypotheses 1, 2, and 3 predict that

$$\beta_1 < 0,\ \beta_2 > 0,\ \beta_3 > 0,\ \beta_4 < 0 \tag{30}$$

5.6.2 Results

Table 3 illustrates the results of our difference-in-difference tests. In all our regressions, we estimate standard errors that are robust to heteroskedasticity and autocorrelation. We account for clustering of standard errors by firm in the OLS regressions.[15] In Panel A, the dependent variable is the logarithm of the number of patents applied for (and eventually granted) by a firm in a particular year. For each of the three different proxies for monitoring intensity, we report two specifications: one that includes Tobin's Q, the Gompers, Ishii, Metrick (2003) index of firm-level anti-takeover provisions, and the lagged value of R&D/ Sales while the other excludes them. Consistent with our hypotheses $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$, and $\beta_4 < 0$. Except for the estimates of β_1 which are statistically significant at the ten percent level or higher, the estimates of β_2, β_3 and β_4 are all statistically significant at the one

[15] Bertand, Duflo and Mulainathan (2004) point out that the standard errors from OLS regressions for difference-in-difference tests are inconsistent because the dependent variables may be highly correlated. Following the suggestions of Bertrand et al., we have estimated standard errors by accounting for clustering at the firm level. We cluster at the firm level since the standard errors are smaller when clustering is done at the state level (as Bertrand et al. suggest) vis-a-vis when they are clustered at the firm level.

percent level.

In Panel B, we find similar results using the logarithm of the number of citations as the dependent variable. The number of observations in Panel B is lower than in Panel A since the number of subsequent citations is zero for some patents. These observations thus are excluded from the log specification that we employ in Panel B. To account for this censoring when the number of citations is zero, we employ the Tobit model instead of OLS to examine the effects using the unconditional sample.[16] As shown by Panel C, employing the Tobit model does not change the results, and all the coefficients are, in fact, statistically stronger. In Panel D, we employ the logarithm of R&D/Sales as the dependent variable and find similar results.

The economic magnitudes of all the effects are significant. Using the coefficients in Column 1 of Panels A, B, and D, we estimate the following economic effects of the U-shaped relationship. When the value of the anti-takeover index before a law-change was zero (four), as it was is in the case of Delaware (Indiana), a one point *increase* in the value of the index *decreases (increases)* annual patents, citations and R&D/ Sales for firms incorporated in the state respectively by 6%, 6%, and 3% (29%, 36%, and 12%) more than those firms incorporated in states that did not experience a law-change. Using the sample median values, a one point *increase* in the value of the index *decreases (increases)* annual patents, citations and R&D/ Sales on average by 0.18, 0.9, and 0.0015 (0.87, 5.4, and 0.006) respectively. Using the sample mean values, these effects are an order of magnitude larger. To summarize, when the takeover pressure was relatively low (Indiana), a decrease in takeover pressure increased the level of innovation. When the takeover pressure was relatively high (Delaware), the decrease in takeover pressure decreased the level of innovation. This evidence is consistent with the presence of a U–shaped relationship between takeover pressure and the degree of innovation as predicted by Hypothesis 1.

Using our proxies for monitoring intensity, we find that, consistent with Hypothesis 2, higher monitoring is associated with greater innovation. The presence of an additional blockholder (or public

[16] Readers may be concerned whether the incidental parameters problem would lead to inconsistent coefficient estimates in a fixed effects Tobit model. Using Monte Carlo simulations of the fixed effects Tobit model, Greene (2003) finds that even for finite samples, the coefficients are consistently estimated. However, the estimate of standard errors are biased when the length of the panel is small and fixed. Greene finds that this bias in standard errors decreases as the panel size increases so that the estimates of standard errors are consistent in large panel data samples.

pension fund) is associated with 17% more annual patents, 20% more annual citations, and 3% higher R&D/ Sales while a one standard deviation increase in the total blockholder ownership is associated with 19% more annual patents, 23% more annual citations, and 3% higher R&D/ Sales.

Finally, as predicted by Hypothesis 3, we find that higher monitoring leads to a flattening of the U-shaped relationship between takeover pressure and innovation. The presence of an additional blockholder (or public pension fund) flattens the curvature of annual patents, citations, and R&D/ Sales by 13%, 11%, and 9% respectively while a one standard deviation increase in the total blockholder ownership flattens the curvature of annual patents, citations, and R&D/ Sales by 15%, 13%, and 10% respectively.

5.6.3 Discussion of the Time-Series Tests

In our time-series tests, we examine the *changes* in innovation due to the passage of state-level anti-takeover laws. Apart from the fixed effects that control for time-invarying heterogeneity, examining changes using a difference-in-difference test alleviates concerns about biases induced due to *time-varying* omitted variables at the firm or state-level.

Despite these advantages, a concern remains: what if there are other state-wide changes that accompany the passage of the law? For example, when New York passed its anti-takeover law in 1990, there might have been other changes that accompanied the passage of the law and affected innovation. If these changes occur only in New York but not in other states, then the difference-in-difference estimation above would overstate the economic effect of the law-change. To examine this issue, we turn to our next set of tests that exploit the geographical location of the innovation.

5.7 Division-Level Time Series "Difference-in-Difference" Tests

5.7.1 Test Specification

To control for the effects of changing economic conditions that accompany the passage of an anti-takeover law in a state, we exploit a unique feature of our data. The NBER patents data records the location of the innovation through the state where a patent was filed. Thus, while Xerox may be headquartered in Rochester, NY, its research labs are located in Rochester, NY as well as in Palo Alto, CA. The NBER patent data enable us to distinguish between patents filed by Xerox's Palo Alto Research Center and its Rochester laboratories. Now, if New York passed an anti-takeover law, it would affect innovation at its Palo Alto Research Center and its Rochester laboratories. This is because the change in the law in New York should affect innovation policy as decided at corporate headquarters. Such change in innovation policy at the corporate headquarters level would translate into differences in innovation at all subsidiaries and divisions. However, any state-wide economic changes accompanying the change in the law are likely to affect only the innovation at Xerox's Rochester laboratories. Therefore, if we estimate the change in innovation at Xerox's Palo Alto research center and control for the change in innovation in California by estimating this before-after difference for California firms, then this difference-in-difference isolates the pure effect of the change in the law.

Therefore, to separate the effect of the change in anti-takeover law from the effect of state-wide economic changes accompanying the law-change, we examine the impact on innovation outside the state of incorporation for firms incorporated in the state of change and compare the change to innovation at firms unaffected by the law-change. We implement these tests using the following specification:

$$\begin{aligned} y_{kist} &= \beta_i + \beta_t + \beta_1 \cdot TI_{s,t} + \beta_2 \cdot (TI_s * \Delta TI_{s,t}) \\ &\quad + \beta_3 MI_{i,t-1} + \beta_4 \left(TI_s * \Delta TI_{s,t} * MI_{i,t-1}\right) + \beta X + \varepsilon_{kict} \end{aligned} \tag{31}$$

where k, i, s respectively denote division k of firm i incorporated in state s. The other variables are as defined in (29). While the above specification is similar to the time-series tests, there are three important differences. First, unlike the time-series results in which the unit of observation was the firm, here the unit of observation is the subsidiary/division filing the patent. Second, since R&D expenditures are not available at such a granular level, we examine only patents and citations. Third, and most importantly, for those firms that are incorporated in states passing the anti-takeover law, y_{kist} includes only those patents or citations granted to subsidiaries/ divisions outside the state of incorporation.

5.7.2 Test results

Panels A and B of Table 4, respectively, report the results with the logarithm of patents and patent citations as the dependent variables. Panel C employs the Tobit model with the logarithm of citations to account for the censoring of observations with zero citations. Across all the specifications in Panels A, B, and C, we find that the coefficients β_1 to β_4 retain their predicted signs and are all statistically significant at the five percent level or higher.

The economic magnitudes of the effects are higher in the division/subsidiary level regressions than in the firm-level regressions. Using the coefficients in Column 1 of Panels A and B, we estimate the following economic effects of the U-shaped relationship. When the value of the anti-takeover index before a law-change was zero (four), as it was is in the case of Delaware (Indiana), a one point *increase* in the value of the index *decreases (increases)* annual patents and citations for subsidiaries/ divisions outside the state of incorporation respectively by 31% and 33% (28% and 46%) more relative to those subsidiaries/ divisions of firms that did not experience a law-change. The presence of an additional blockholder is associated with 46% more annual patents and 56% more annual citations, while a one standard deviation increase in the total blockholder ownership is associated with 58% more annual patents and 69% more annual citations. Finally, the presence of an additional blockholder flattens the curvature of annual patents and citations by 12% and 10% respectively while a one standard deviation increase in the total blockholder ownership flattens the curvature of annual patents and citations by 14% and 12% respectively.

5.8 Endogeneity of Blockholder Ownership

Institutional blockholders may invest relatively more in firms that are successful innovators. While our firm fixed effects should account for any *time-invarying* unobserved differences in the quality of firms, it is quite possible that institutional blockowners have information about the *time-varying* unobserved characteristics of firms, which leads them to buy/retain block ownership in the relatively successful ones. In this case, the effect of monitoring intensity will be biased upwards. To alleviate concerns about such endogeneity of blockholder ownership, we follow Aghion *et al* (2008) who use a firm's membership in the S&P 500 as an instrument for blockholder ownership.

The inclusion of a firm in the S&P 500 has a large random component attached to it and seems unrelated to the fundamental performance of firms (Shleifer, 1986). However, institutional blockholders are likely to own blocks in a firm that belongs to the S&P 500 (see Wei and Pruitt, 1989). Thus, changes in institutional blockholder ownership upon a firm's entry into the S&P 500 or its exit from the S&P 500 are related *neither to the firm's innovation performance nor its future innovation prospects.* Therefore, a firm's entry into the S&P 500 or its exit from the S&P 500 serves as a useful instrument for changes in blockholder ownership.

Following the methodology described in Section 5.6, we employ a difference-in-difference to estimate the effect of monitoring intensity using this instrumental variable. For the sample of firms that enter the S&P 500 between 1979 and 2001, we first estimate the difference in innovation before and after entry into the S&P 500. To control for other factors that may account for such a difference, we also estimate this before-after difference for the control group of firms that never entered the S&P 500 during this period. The difference of these two differences estimates the causal effect of changes in monitoring intensity and its interaction with changes in takeover pressure.

We estimate the following model using entry into and exit from the S&P 500:

$$\begin{aligned} y_{ist} &= \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{st} + \beta_2 \cdot (TI_s * \Delta TI_{st}) + \beta_3 \cdot SP_{i,t-1} \\ &\quad + \beta_4 \cdot \{(TI_s * \Delta TI_{s,t}) * SP_{i,t}\} + \beta X + \varepsilon_{is,t} \ ; \ t \in [1981, 2002] \end{aligned} \tag{32}$$

where, except for $SP_{i,t-1}$, all the other variables are as defined before. For the tests that use the entry into S&P 500 as an instrument, $SP_{i,t}$ is defined as follows: $SP_{i,t}$ equals 1 for all $t \geq n$ if a firm is introduced into the S&P 500 in year n and 0 otherwise. For the tests that use the exit from S&P 500 as an instrument, $SP_{i,t}$ is defined as follows: $SP_{i,t}$ equals 1 for all $t < n$ if a firm is removed from the S&P 500 in year n and 0 otherwise. Thus, for the S&P 500 entry (exit) sample, the variable $SP_{i,t}$ captures the increase (decrease) in blockholder ownership.

Table 5 reports the results of these tests. Columns (1)-(3) show the results that use entry into S&P

500 as the instrument while columns (4)-(6) show the results using firms' exits from S&P 500. The estimates for β_1 to β_4 retain their predicted signs and are all statistically significant. Furthermore, their magnitudes are very similar to those observed in Table 3.

5.9 Long-Term Effects of Innovation

The results of innovative activity could be experienced only after a significant time lag. In our previous tests, we examine the effects of changes in anti-takeover laws and monitoring intensity on innovation at least a year after the change. To examine the long-term effects of innovation, we carry out tests that investigate the effects of changes in anti-takeover laws on innovation *at least three years* after the changes. Since the results using all the three proxies for Monitoring Intensity are quite similar, we report results using only number of blockholders in the interest of brevity. Table 6 presents these results. We decompose the effects examined earlier in Table 3 into two separate effects: (i) the effect in the year after the change to two years after the change, as captured by the terms containing the State Anti-takeover Change Dummy (1,2); and (ii) the effect at least three years after the law-change, as captured by the terms containing the State Anti-takeover Change Dummy (≥ 3). As shown in Columns 1-3, when we use our *ex post* proxies for innovation (patents and citations), the coefficients of the terms containing State Anti-takeover Change Dummy (≥ 3) are all statistically significant at the five percent level or higher. However, the coefficients of terms containing the State Anti-takeover Change Dummy (1,2) are not statistically significant. In contrast, Column 4 shows that, when we use an ex ante measure of innovation (R&D intensity), the effects are statistically significant for the year after the law-change and beyond. The results reflect the *delayed* effects of law-changes on *outputs* of innovation such as patents and citations, but they also demonstrate its immediate effects on R&D, which is an *input* to innovation.

5.10 Review of Evidence in Existing Literature

As we described in Section 2, Meulbroek *et al.* (1990) document a negative correlation between R&D intensity in firms and the adoption of firm-level anti-takeover provisions. Atanassov (2007) finds that the passage of business combination laws lowers innovation as measured through patents and patent citations. Both these empirical studies, however, test for a *monotonic relationship* between takeover pressure and innovation. Our theoretical and empirical analyses have shown that the relationship between takeover pressure and innovation is, in fact, *non-monotonic*. Furthermore, we have documented that takeover pressure and monitoring intensity not only have direct effects on innovation but they also interact with each other to influence innovation. An empirical specification that fits a linear relationship among innovation, takeover pressure, and monitoring intensity might potentially over or underestimate the economic effects of takeover pressure and monitoring intensity on innovation.

To examine whether this is indeed the case, we drop all the *non-linear* effects predicted by our theory and estimate the following regression:

$$y_{ist} = \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{s,t} + \beta_2 \cdot MI_{i,t-1} + \beta X + \varepsilon_{ist} \ ; t \in [1981, 2002]$$

where all the variables are as previously defined. Table 7 reports the results of these tests. In Columns 1-4, we estimate the effect of passage of all anti-takeover laws (as in all our analysis above) while in Columns 5-8 we follow Atanassov (2007) by examining solely the effect of passage of business combination laws.

We find that consistent with the evidence documented in Atanassov (2007), the coefficient of the passage of antitakeover laws, in general, and the coefficient of the passage of business combination laws, in particular, is negative. Furthermore, we find that the coefficient of GIM index is negative and statistically significant in six of the eight specifications, which is consistent with the evidence in Meulbroek *et al.* (1990). However, as expected, when a linear fit is employed in a U-shaped relationship, the coefficient of the passage of anti-takeover laws is lower in magnitude in Columns 1-4 of Table 7 than that of the linear effect in Table 3. Similarly, as expected when the interactive effects of monitoring and takeover pressure on innovation are not taken into consideration, the coefficient on monitoring intensity is lower in magnitude in Table 7 than that in Table 3. The preceding discussion highlights the importance of integrating the effects of takeover pressure and monitoring intensity on innovation.

6 Conclusion

We develop a parsimonious model to investigate how corporate governance mechanisms — such as monitoring intensity and takeover pressure — affect a firm's incentives to engage in innovation. Our model generates three testable predictions: (i) there is a U–shaped relationship between innovation and the takeover pressure the firm faces, (ii) the likelihood that a firm innovates increases with monitoring intensity, and (iii) the sensitivity of innovation to takeover pressure declines with monitoring intensity. Using ex ante and ex post measures of innovative activity, we show strong empirical support for the model's predictions. Our time series tests exploit the natural source of exogenous variation created by the passage of state-level anti-takeover laws to identify the effects of governance mechanisms on innovation. By integrating long-term contracting and a market for corporate control, our theory shows how the interplay between takeover premia and private benefits leads to a *non-monotonic* relation between innovation and takeover pressure. From a policy standpoint, our results show that innovative activity is fostered by anti-takeover laws that are either practically non-existent or are strong enough to significantly deter takeovers. Effective monitoring not only enhances innovation, but also lowers the sensitivity of innovation to variations in external takeover pressure created by the passage of anti-takeover statutes. Monitoring is, however, most effective in enhancing innovation at intermediate levels of takeover pressure.

Appendix A – Proofs of Lemmas and Propositions

Proof of Lemma 1

The expected payoff to the firm at date 1 if it is not taken over is $E_1[P_X(2)]$. Because the incumbent manager loses her control benefits if the firm is taken over, the total payoff to the firm's stakeholders (shareholders + manager) if the firm is taken over, and (hypothetically) no takeover premium is paid, is $E_1[P_X(2)] - \alpha$. External anti-takeover laws, however, ensure that, for the takeover to be successful, the firm's stakeholders must receive a total expected payoff

$$E_1[P_X(2)] - \alpha + \eta, \text{ where } \eta > 0. \tag{33}$$

It follows directly from (1), (12), and (33) that the raider must generate a surplus for the firm. By the discussion in Sections 11.5.1 and 11.5.2 of Tirole (2006), free-riding by shareholders, and the fact that the raider obtains private control benefits, together ensure that it is optimal for the raider to make a tender offer that cedes the surplus it generates (less the control benefits it captures) to the firm. After the takeover, therefore, the firm's current stakeholders (shareholders + manager) receive a total payoff at date 1 of

$$P_X^{takeover} = E_1\left[P_X^{raider}(2)\right] - \alpha, \tag{34}$$

where the expectation is with respect to the information available at date 1. It follows directly from (33) and (34) that the takeover is successful only if

$$E_1\left[P_X^{raider}(2)\right] \geq E_1\left[P_X(2)\right] + \eta, \tag{35}$$

that is, the raider must increase the firm's expected payoff, conditional on the information available at date 1 by at least η. By (1), (8), (12), (13), and (35), it follows that the raider succeeds in taking over the firm if

$$E[\widetilde{\mu}_X^{raider}] = m_X \geq \widehat{m}_X + \eta$$

Proof of Proposition 1

In the first-best setting, the manager maximizes the sum of the first two terms in (22). Because $S_H > S_L$ by (11), it follows immediately that the manager always chooses the innovative project. $\Diamond$

Proof of Proposition 2

$$E(P_X(2)) = E(2\tilde{\mu}_X + \sigma_X\tilde{z}_1 + \sigma_X\tilde{z}_2) = 2m_X. \tag{36}$$

$$E(1_{takeover}\alpha) = \alpha E(1_{takeover}) = \alpha Prob\{m_x(0) \geq m_x(0) + S_X\hat{z} + \eta\} = \alpha\Phi(-\frac{\eta}{S_X}), \tag{37}$$

where $\Phi(\cdot)$ is the cumulative distribution function for standard normal distribution.

$$\begin{aligned} P_X^{raider}(2) - P_X(2) &= P_X(1) + \tilde{\mu}_X^{raider} + \sigma_X\tilde{z}_2 - (P_x(1) + \tilde{\mu}_x + \sigma_x\tilde{z}_3) \\ &= \tilde{\mu}_X^{raider} - \tilde{\mu}_X + \sigma_X(\tilde{z}_2 - \tilde{z}_3) \end{aligned} + \tag{38}$$

From equation (38),

$$\begin{aligned} E[1_{takeover}(P_X^{raider}(2) - P_X(2))] &= E[1_{takeover}(\tilde{\mu}_X^{raider} - \tilde{\mu}_X)] + \sigma_X E[1_{takeover}(\tilde{z}_2 - \tilde{z}_3)] \\ &= E[1_{takeover}\tilde{\mu}_X^{raider}] - E[1_{takeover}\tilde{\mu}_X] + \sigma_X E[1_{takeover}] \cdot E(\tilde{z}_2 - \tilde{z}_3) \\ &= E(1_{takeover})m_X - E[1_{takeover}\tilde{\mu}_X] \\ &= \Phi(-\tfrac{\eta}{S_X})[m_X - E(\tilde{\mu}_X|S_X\hat{z} \leq -\eta)]. \end{aligned} \tag{39}$$

Let

$$Y = S_X\hat{z} = \frac{s_X^2\sigma_X[\frac{\tilde{\mu}_X - m_X}{\sigma_X} + \tilde{z}_1]}{(s_X)^2 + \sigma_X^2}.$$

$$Cov(\tilde{\mu}_X, Y) = \frac{(s_X)^4}{(s_X)^2 + \sigma_X^2}.$$

$$E(\tilde{\mu}_X|Y=y) = m_X + \frac{Cov(\tilde{u}_X, Y)}{Var(Y)} y = m_X + y\frac{(s_X)^4}{(s_X)^2+\sigma_X^2}/S_X^2 = m_X + y.$$

$$\begin{aligned} E(\tilde{\mu}_X|S_X\hat{z} \le -\eta) &= m_X + \quad \tfrac{1}{\Phi(-\frac{\eta}{S_X})} \int_{-\infty}^{-\eta} f(y)E(\tilde{\mu}_X|y)\,dy \\ &= m_X + \quad \tfrac{1}{\Phi(-\frac{\eta}{S_X})} \int_{-\infty}^{-\eta} f(y)y\,dy \\ &= m_X + \quad \tfrac{1}{\Phi(-\frac{\eta}{S_X})} \int_{-\infty}^{-\eta} \tfrac{1}{\sqrt{2\pi}S_X} e^{-\frac{y^2}{2S_X^2}} y\,dy \\ &= m_X + \quad \tfrac{1}{\Phi(-\frac{\eta}{S_X})} (-\tfrac{S_X}{\sqrt{2\pi}} e^{-\frac{y^2}{2S_X^2}} |_{-\infty}^{-\eta}) \\ &= m_X - \quad \tfrac{1}{\Phi(-\frac{\eta}{S_X})} \tfrac{S_X}{\sqrt{2\pi}} e^{-\frac{\eta^2}{2S_X^2}}. \end{aligned} \tag{40}$$

From equation (39) and (40),

$$E[1_{takeover}(P_X^{raider}(2) - P_X(2))] = \frac{S_X}{\sqrt{2\pi}} e^{-\frac{\eta^2}{2S_X^2}}. \tag{41}$$

Proposition 2 follows from (36), (37), and (41). $\Diamond$

Proof of Proposition 3

The manager's objective function is

$$\alpha + E[w(Q_X) - 1_{takeover}\alpha],$$

or equivalently

$$E[w(Q_X) - 1_{takeover}\alpha].$$

The shareholder's objective function is

$$E[Q_X - w(Q_X)].$$

One way to make the project choice incentive compatible is to make the manager's objective function proportional to the shareholder's objective function, that is,

$$w(Q_x) - 1_{takeover}\alpha = m[Q_X - w(Q_X)],$$

or

$$w(Q_X) = \frac{m}{m+1}Q_X + \frac{\alpha}{m+1}1_{takeover},$$

where m is a parameter to be determined. Let $\lambda = \frac{m}{m+1}$. Then

$$w(Q_X) = \lambda Q_X + (1-\lambda)\alpha 1_{takeover}.$$

m can be solved from the manager's binding participation constraint, that is, $U = m[2m_X + \frac{S_X}{\sqrt{2\pi}} exp(-\frac{\eta^2}{2S_X^2}) - \alpha\Phi(-\frac{\eta}{S_X})] + \alpha$.

Proof of Proposition 4

Define the expected excess payoff from the innovative project over the routine project as:

$$G(\eta) = 2m_H - 2m_L + F(\eta)$$

where:

$$F(\eta) = \frac{S_H}{\sqrt{2\pi}}exp(-\frac{\eta^2}{2S_H^2}) - \alpha\Phi(-\frac{\eta}{S_H}) - \frac{S_L}{\sqrt{2\pi}}exp(-\frac{\eta^2}{2S_L^2}) + \alpha\Phi(-\frac{\eta}{S_L}). \tag{42}$$

Note that:

$$\begin{aligned} \frac{\partial F(\eta)}{\partial\eta} &= \frac{S_H}{\sqrt{2\pi}}exp(-\frac{\eta^2}{2S_H^2})(-\frac{\eta}{S_H}) + \alpha\frac{1}{\sqrt{2\pi}}exp(-\frac{\eta^2}{2S_H^2})\frac{1}{S_H} \\ &= [\frac{1}{\sqrt{2\pi}S_H}exp(-\frac{\eta^2}{2S_H^2}) - \frac{1}{\sqrt{2\pi}S_L}exp(-\frac{\eta^2}{2S_L^2})](\alpha - \eta) \\ &= [f_{S_H}(\eta) - f_{S_L}(\eta)](\alpha - \eta), \end{aligned}$$

where $f_{S_X}(\eta)$ is the density function for η distributed $N(0, S_X)$. The properties of the normal distribution imply that $f_{S_H}(\eta)$ and $f_{S_L}(\eta)$ cross only once for $\eta \geq 0$. Let $\hat{\eta}$ satisfy $f_{S_H}(\hat{\eta}) = f_{S_L}(\hat{\eta})$. Then $f_{S_H}(\eta) < f_{S_L}(\eta)$ for $\eta \in [0, \hat{\eta})$ and $f_{S_H}(\eta) > f_{S_L}(\eta)$ for $\eta \in (\hat{\eta}, +\infty)$ so that:

$$\frac{\partial F(\eta)}{\partial\eta}\begin{cases} < 0 & \text{if } \eta \in [0, min(\hat{\eta}, \alpha)); \\ = 0 & \text{if } \eta = \hat{\eta} \text{ or } \alpha; \\ > 0 & \text{if } \eta \in (min(\hat{\eta}, \alpha), max(\hat{\eta}, \alpha)); \\ < 0 & \text{if } \eta > max(\hat{\eta}, \alpha). \end{cases}$$

From the behavior of $\frac{\partial F(\eta)}{\partial\eta}$ described above, it follows that:

(i) $min(\alpha, \hat{\eta})$ is a local minimum for $F(\eta)$;

(ii) $F(\eta)$ is weakly decreasing in η if $\alpha = \hat{\eta}$.

We will first prove the following Remark: If $\alpha \leq \hat{\eta}$, then $F(\eta) > 0$ $\forall\eta \in [0, +\infty)$. To see this note that since $F(\infty) = 0$, condition (ii) implies that $F(\eta) > 0$ if $\alpha = \hat{\eta}$. The remark then follows because $\frac{\partial F(\eta)}{\partial\alpha} = \Phi(-\frac{\eta}{S_L}) - \Phi(-\frac{\eta}{S_H}) < 0$.

Given the preceding Remark, the necessary and sufficient condition for the interval (η_{min}, η_{max}) to exist is:

$$G(\hat{\eta}) < 0 \tag{43}$$

where $G(\eta_{\min}) = G(\eta_{\max}) = 0$ and $\hat{\eta} = S_H S_L\sqrt{\frac{2(lnS_H - lnS_L)}{S_H - S_L}}$by setting $f_{S_X}(\hat{\eta}) = f_{S_L}(\hat{\eta})$. Substituting for $\hat{\eta}$ in $F(\eta)$ and rearranging terms, the necessary and sufficient condition described in (43) becomes:

$$\alpha > \alpha_{MIN} \equiv \frac{2(m_L - m_H) - \frac{S_H}{\sqrt{2\pi}}exp[-\frac{S_L(lnS_H - lnS_L)}{S_H - S_L}] + \frac{S_L}{\sqrt{2\pi}}exp[-\frac{S_H(lnS_H - lnS_L)}{S_H - S_L}]}{\Phi[-S_H\sqrt{\frac{2(lnS_H - lnS_L)}{S_H - S_L}}] - \Phi[-S_L\sqrt{\frac{2(lnS_H - lnS_L)}{S_H - S_L}}]} > 0. \tag{44}$$

Proof of Proposition 5

Let $\bar{\eta}$ satisfy $G(\bar{\eta}) = 0$, so that $\bar{\eta} = \eta_{\min}$ or $\eta_{\max}$ are the thresholds defined above that satisfy $G(\eta_{\min}) = G(\eta_{\max}) = 0$ for all $\alpha > \alpha_{MIN}$ defined in (44). Using the Implicit Function theorem:

$$\frac{d\bar{\eta}}{d\alpha} = \frac{-\frac{\partial G}{\partial\alpha}}{\frac{\partial G}{\partial\eta}}|_{\eta=\bar{\eta}} = \frac{\Phi(\frac{-\eta}{S_H}) - \Phi(-\frac{\eta}{S_L})}{\frac{\partial F(\eta)}{\partial\eta}}|_{\eta=\bar{\eta}}. \tag{45}$$

The numerator of (45) is positive. From the proof of proposition 4, the denominator of (45) is negative for $\bar{\eta} = \eta_{min}$, and positive for $\bar{\eta} = \eta_{max}$. This complete the proof.

Proof of Proposition 6

$$\frac{\partial^2 G}{\partial(-\alpha)\partial\eta} = -\frac{1}{\sqrt{2\pi}}exp(-\frac{\eta^2}{2S_H^2})\frac{1}{S_H} + \frac{1}{\sqrt{2\pi}}exp(-\frac{\eta^2}{2S_L^2})\frac{1}{S_L} \underbrace{=}_{\text{from the proof of proposition (4)}} f_{S_L}(\eta) - f_{S_H}(\eta). \tag{46}$$

From the proof of proposition (4) $f_{S_L}(\eta) - f_{S_H}(\eta) < 0$ for $\eta < \hat{\eta}$, and $f_{S_L}(\eta) - f_{S_H}(\eta) > 0$ otherwise.

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Table 1: Summary Statistics and Correlations

Panel A in this table displays the summary statistics for the proxies for innovation and the proxies for monitoring intensity. Panel B displays the correlation between the proxies for Monitoring intensity. Since the unit of observation is a firm-year, all the summary statistics and correlations are computed at the firm-year level of aggregation.

Panel A: Summary Statistics (Number of firm-year observations = 15838)

Variable	Mean	Median	Std. Dev.	Min	Max
Proxies for Innovation:					
Number of Patents	20.9	3.0	87.5	1	3072
Number of Citations	104.4	15.0	571.7	0	21042
R&D/Sales	0.54	0.05	3.9	0	99.4
Proxies for Monitoring Intensity:					
Total Blockholder ownership %	13.8%	13.4%	10.6%	0	79.7%
Number of Blockholders	1.5	2	1.1	0	9
Number of Public Pension Funds	3.2	2	3.2	0	14

Panel B: Correlation between various proxies of Monitoring Intensity

	Total Blockholder ownership %	Number of Blockholders	Number of Public Pension Funds
Number of Blockholders	0.87		
Number of Public Pension Funds	0.06	0.08	
Logarithm of Sales (Proxy for Firm Size)	0.07	0.08	0.62

All the above correlations are significant at the 1% level

Table 2: List of State Level Changes in Anti-Takeover Laws

This table shows the list of states that underwent a change in the laws preventing takeover of firms incorporated in that state. This list is based on Bebchuk and Cohen (2003). The Year of Change shows the year in which the law was passed. “Value Before” and “Value After” list the values of the aggregate state level anti-takeover index before and after the change.

STATE	Year of Change	Value Before	Value After	STATE	Year of Change	Value Before	Value After
ARIZONA	1988	0	4	NEW JERSEY	1990	2	4
COLORADO	1990	0	1	NEW MEXICO	1988	0	1
CONNECTICUT	1989	1	2	NEW YORK	1990	3	4
DELAWARE	1989	0	1	NORTH CAROLINA	1988	0	3
FLORIDA	1988	0	4	NORTH DAKOTA	1994	0	1
GEORGIA	1989	1	4	OHIO	1991	3	5
HAWAII	1989	0	3	OKLAHOMA	1988	0	1
IDAHO	1989	1	5	OREGON	1988	0	3
ILLINOIS	1990	2	4	PENNSYLVANIA	1989	0	4
INDIANA	1990	4	5	RHODE ISLAND	1991	0	4
IOWA	1990	0	2	SOUTH CAROLINA	1989	0	3
KANSAS	1989	0	2	SOUTH DAKOTA	1991	0	5
KENTUCKY	1989	1	4	TENNESSEE	1989	0	5
LOUISIANA	1988	1	3	TEXAS	1998	0	1
MARYLAND	1990	2	3	UTAH	1988	0	2
MASSACHUSETTS	1988	0	4	VERMONT	1999	0	1
MICHIGAN	1989	2	3	VIRGINIA	1989	0	3
MINNESOTA	1988	0	3	WASHINGTON	1988	0	2
MISSISSIPPI	1988	1	3	WISCONSIN	1988	2	5
NEBRASKA	1989	0	2	WYOMING	1990	0	3
NEVADA	1988	0	2				

Table 3: Difference-of-difference Regressions exploiting Exogenous passage of State level Anti-Takeover laws

$$y_{ist} = \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{st} + \beta_2 \cdot (TI_s * \Delta TI_{st}) + \beta_3 \cdot MI_{i,t-1} + \beta_4 \cdot \{MI_{i,t-1} * (TI_s * \Delta TI_{st})\} + \beta \cdot X + \varepsilon_{ist}, t \in [1981,2002]$$

The variable y_{ist} is a measure of innovation in year t for firm i incorporated in state s. The variable y is either the *logarithm of (a)* the number of patents applied for (and eventually granted) in year t (Panel A), (b) the number of subsequent citations to these patents (Panels B and C), and (c) the ratio of R&D expenditures to sales in year t (Panel D). OLS regressions are employed in Panels A, B and D. In Panel C, Tobit model regressions are employed to account for the truncation in the log specification due to zero citations. The sample consists of firms that applied for a patent over the period 1981-2002 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. The variable ΔTI_{st} equals the change in the anti-takeover index in state s for all $t \geq m+1$, where m is the year when the first anti-takeover statute was passed in state s; this variable equals 0 otherwise. For states that never passed (did pass) the law, the variable TI_s is equal to the constant value of the anti-takeover index (before the law-change). The variable MI_{it} denotes the monitoring intensity of firm i in year t. The variables β_i and β_t denote firm & application year fixed effects. The vector X denotes the set of control variables. In Panels A, B and D, the standard errors are robust to heteroskedasticity and autocorrelation and are clustered by firm. In Panel C, the standard errors are not clustered by firm. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

Panel A: OLS Regressions using Log of Patents as Dependent Variable

Which Proxy for Monitoring Intensity?	Predicted Sign	(1) Number of Blockholders	(2) Number of Blockholders	(3) Total blockholder ownership %	(4) Total blockholder ownership %	(5) Number of Public Pension Funds	(6) Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.062**	-0.064**	-0.061*	-0.062**	-0.064**	-0.067**
		(1.98)	(2.04)	(1.93)	(1.98)	(2.05)	(2.15)
State Anti-takeover Index Change * Value of Index Before Change (Hypothesis 1)	+	0.079***	0.080***	0.075***	0.075***	0.068***	0.070***
		(4.36)	(4.41)	(4.21)	(4.24)	(3.87)	(3.93)
Proxy for Monitoring Intensity (Hypothesis 2)	+	0.154***	0.140***	1.667***	1.552***	0.108***	0.100***
		(9.28)	(11.74)	(9.54)	(12.03)	(9.81)	(10.48)
State Anti-takeover index Change * Value of Index Before Change* Proxy for Monitoring Intensity (Hypothesis 3)	-	-0.010***	-0.010***	-0.105***	-0.106***	-0.003***	-0.003***
		(7.72)	(7.83)	(6.99)	(7.01)	(3.82)	(3.90)
GIM Index		0.010		0.010		0.006	
		(0.84)		(0.87)		(0.56)	
Current Log of Sales	+	0.072***	0.072***	0.072***	0.072***	0.062***	0.061***
		(7.87)	(7.89)	(7.87)	(7.89)	(7.19)	(7.19)
Lagged R&D/ Sales	+	0.001***		0.001***		0.001***	
		(2.84)		(2.83)		(2.76)	
Lagged Tobin's Q	?	-0.001		-0.001		-0.004	
		(0.32)		(0.29)		(0.85)	
Lagged Herfindahl Index	?	-0.245*	-0.245*	-0.249*	-0.249*	-0.228	-0.230
		(1.70)	(1.71)	(1.73)	(1.74)	(1.58)	(1.60)
Firm age	?	0.002	0.003	0.003	0.005	0.008	0.009
		(0.04)	(0.06)	(0.07)	(0.09)	(0.15)	(0.17)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		15838	15838	15838	15838	15838	15838
Adjusted R-squared		0.20	0.20	0.20	0.20	0.21	0.21

Panel B: OLS Regressions using Log of Citations as Dependent Variable

Which Proxy for Monitoring Intensity?	Predicted Sign	(1) Number of Blockholders	(2) Number of Blockholders	(3) Total blockholder ownership %	(4) Total blockholder ownership %	(5) Number of Public Pension Funds	(6) Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.067*	-0.069*	-0.066*	-0.068*	-0.064*	-0.068*
		(1.83)	(1.89)	(1.78)	(1.84)	(1.73)	(1.84)
State Anti-takeover Index Change * Value of Index Before Change (Hypothesis 1)	+	0.094***	0.095***	0.089***	0.089***	0.067***	0.068***
		(4.37)	(4.42)	(4.29)	(4.32)	(2.92)	(2.96)
Proxy for Monitoring Intensity (Hypothesis 2)	+	0.184***	0.167***	1.950***	1.801***	0.096***	0.088***
		(7.69)	(9.86)	(8.25)	(10.41)	(7.55)	(7.83)
State Anti-takeover index Change * Value of Index Before Change* Proxy for Monitoring Intensity (Hypothesis 3)	-	-0.010***	-0.010***	-0.109***	-0.110***	-0.002***	-0.002***
		(6.05)	(6.15)	(5.37)	(5.39)	(2.67)	(2.74)
GIM Index		0.008		0.009		0.006	
		(0.51)		(0.53)		(0.33)	
Current Log of Sales	+	0.050***	0.051***	0.050***	0.051***	0.042***	0.042***
		(4.46)	(4.56)	(4.44)	(4.53)	(3.75)	(3.80)
Lagged R&D/ Sales	+	0.000		0.000		0.000	
		(0.63)		(0.58)		(0.60)	
Lagged Tobin's Q	?	0.003		0.004		-0.000	
		(0.58)		(0.67)		(0.04)	
Lagged Herfindahl Index	?	-0.062	-0.059	-0.069	-0.066	-0.064	-0.064
		(0.33)	(0.31)	(0.36)	(0.34)	(0.33)	(0.33)
Firm age	?	0.044	0.046	0.046	0.049	0.047	0.049
		(0.80)	(0.84)	(0.82)	(0.87)	(0.80)	(0.84)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		13869	13869	13869	13869	13869	13869
Adjusted R-squared		0.44	0.44	0.44	0.44	0.44	0.44

Panel C: Tobit Model Regressions using Log of Citations as Dependent Variable (marginal effects)

Which Proxy for Monitoring Intensity?	Predicted Sign	(1) Number of Blockholders	(2) Number of Blockholders	(3) Total blockholder ownership %	(4) Total blockholder ownership %	(5) Number of Public Pension Funds	(6) Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.088***	-0.088***	-0.087***	-0.087***	-0.087***	-0.090***
		(4.47)	(4.50)	(4.42)	(4.45)	(4.50)	(4.61)
State Anti-takeover Index Change * Value of Index Before	+	0.106***	0.105***	0.099***	0.098***	0.041***	0.040***
Change (Hypothesis 1)		(7.75)	(7.70)	(7.46)	(7.41)	(2.80)	(2.77)
Proxy for Monitoring Intensity	+	0.211***	0.213***	2.248***	2.243***	0.149***	0.138***
(Hypothesis 2)		(10.90)	(17.34)	(11.20)	(17.55)	(17.52)	(21.26)
State Anti-takeover index Change * Value of Index Before	-	-0.013***	-0.013***	-0.144***	-0.144***	-0.002***	-0.002***
Change* Proxy for Monitoring Intensity (Hypothesis 3)		(9.35)	(9.37)	(9.17)	(9.19)	(2.97)	(3.02)
GIM Index		0.006		0.007		0.001	
		(0.40)		(0.43)		(0.05)	
Current Log of Sales	+	0.091***	0.091***	0.091***	0.091***	0.067***	0.067***
		(12.34)	(12.33)	(12.38)	(12.39)	(9.16)	(9.16)
Lagged R&D/ Sales	+	0.000		0.000		0.000	
		(1.09)		(1.06)		(1.08)	
Lagged Tobin's Q	?	0.016***		0.016***		0.012***	
		(3.50)		(3.51)		(2.62)	
Lagged Herfindahl Index	?	-0.364***	-0.366***	-0.376***	-0.378***	-0.384***	-0.385***
		(3.67)	(3.69)	(3.80)	(3.82)	(3.94)	(3.95)
Firm age	?	0.018***	0.017***	0.018***	0.018***	0.007***	0.006**
		(7.61)	(7.25)	(7.67)	(7.30)	(2.80)	(2.46)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		15838	15838	15838	15838	15838	15838
Probability > Chi-squared Wald Statistic		0.00	0.00	0.00	0.00	0.00	0.00

Panel D: OLS Regressions using Log of R&D/ Sales as Dependent Variable

		(1)	(2)	(3)	(4)	(5)	(6)
Which Proxy for Monitoring Intensity?	Predicted Sign	Number of Blockholders	Number of Blockholders	Total blockholder ownership %	Total blockholder ownership %	Number of Public Pension Funds	Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.031*	-0.032*	-0.031*	-0.032*	-0.031*	-0.033*
		(1.74)	(1.79)	(1.75)	(1.79)	(1.70)	(1.80)
State Anti-takeover Index Change * Value of Index Before Change (Hypothesis 1)	+	0.035***	0.035***	0.035***	0.036***	0.039***	0.040***
		(2.97)	(3.00)	(3.04)	(3.07)	(2.69)	(2.70)
Proxy for Monitoring Intensity (Hypothesis 2)	+	0.025**	0.016**	0.264**	0.152*	0.042***	0.038***
		(2.33)	(2.20)	(2.22)	(1.88)	(7.14)	(7.33)
State Anti-takeover index Change * Value of Index Before Change* Proxy for Monitoring Intensity (Hypothesis 3)	-	-0.003***	-0.003***	-0.032***	-0.033***	-0.001**	-0.001**
		(2.63)	(2.69)	(3.02)	(3.06)	(2.05)	(2.09)
GIM Index		-0.009		-0.009		-0.010	
		(1.06)		(1.06)		(1.19)	
Current Log of Sales	+	-0.381***	-0.384***	-0.382***	-0.384***	-0.403***	-0.405***
		(13.00)	(13.12)	(13.01)	(13.13)	(13.79)	(13.94)
Lagged R&D/ Sales	+	0.001**		0.001**		0.001**	
		(2.47)		(2.47)		(2.47)	
Lagged Tobin's Q	?	-0.001		-0.001		-0.002	
		(0.24)		(0.25)		(0.33)	
Lagged Herfindahl Index	?	-0.218*	-0.214*	-0.217*	-0.213*	-0.217*	-0.213*
		(1.88)	(1.84)	(1.87)	(1.83)	(1.90)	(1.86)
Firm age	?	-0.048	-0.048	-0.047	-0.047	-0.046	-0.046
		(1.45)	(1.44)	(1.44)	(1.43)	(1.57)	(1.57)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		12496	12496	12496	12496	12496	12496
Adjusted R-squared		0.18	0.18	0.18	0.18	0.19	0.19

Table 4: Difference-of-difference Regressions using Innovation outside State of Incorporation for the Treatment Sample

$$y_{kist} = \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{st} + \beta_2 \cdot (TI_s * \Delta TI_{st}) + \beta_3 \cdot MI_{i,t-1} + \beta_4 \cdot \{MI_{i,t-1} \cdot (TI_s * \Delta TI_{st})\} + \beta \cdot X + \varepsilon_{kist}, t \in [1981,2002]$$

The variable y_{ist} is a measure of innovation in year t for division/ subsidiary k of firm i incorporated in state s. The variable y is either the *logarithm of (a)* the number of patents applied in year t and eventually granted (Panel A) and (b) the number of subsequent citations to these patents (Panels B and C). The sample consists of divisions/ subsidiaries of firms that applied for (and were eventually granted) a patent over the period 1981-2002 by the U.S. Patent Office. For firms incorporated in states that passed the anti-takeover law, the variable y includes only those patents applied for (and eventually granted) by subsidiaries/ divisions outside the state of incorporation and citations to these patents. The variable ΔTI_{st} equals the change in the value of the state-level takeover index for state s and years $t \geq m+1$ if a anti-takeover law change was completed in year m in state s; this variable equals 0 otherwise. For states that never passed (did pass) the law, the variable TI_s is equal to the constant value of the anti-takeover index (before the law-change). The variable MI_{it} denotes the monitoring intensity of firm i. The variables β_i and β_t denote firm and application year fixed effects. The vector X denotes the set of control variables. In Panels A and B, the standard errors are robust to heteroskedasticity and autocorrelation and are clustered by firm. In Panel C, the standard errors are not clustered by firm. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

Panel A: OLS Regressions using Log of Patents as Dependent Variable

Which Proxy for Monitoring Intensity?	Predicted Sign	(1) Number of Blockholders	(2) Number of Blockholders	(3) Total blockholder ownership %	(4) Total blockholder ownership %	(5) Number of Public Pension Funds	(6) Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.371***	-0.331***	-0.366***	-0.326***	-0.387***	-0.349***
		(9.49)	(9.27)	(9.57)	(9.27)	(9.38)	(8.91)
State Anti-takeover Index Change * Value of Index Before Change (Hypothesis 1)	+	0.154***	0.138***	0.168***	0.152***	0.096**	0.094**
		(2.92)	(2.89)	(3.14)	(3.13)	(2.08)	(2.18)
Proxy for Monitoring Intensity (Hypothesis 2)	+	0.379***	0.375***	4.337***	4.276***	0.126***	0.122***
		(15.02)	(15.43)	(16.41)	(16.68)	(30.99)	(32.42)
State Anti-takeover index Change * Value of Index Before Change* Proxy for Monitoring Intensity (Hypothesis 3)	-	-0.019***	-0.018***	-0.219***	-0.220***	-0.004***	-0.004***
		(9.43)	(9.83)	(9.14)	(9.59)	(5.91)	(6.51)
Current Log of Sales	+	0.092***	0.092***	0.099***	0.101***	0.030	0.037
		(3.81)	(4.14)	(3.71)	(4.12)	(1.17)	(1.61)
Lagged R&D/ Sales	+	0.001*		0.001*		0.000	
		(1.71)		(1.88)		(1.52)	
Lagged Tobin's Q	?	0.007*		0.007*		0.002	
		(1.74)		(1.92)		(0.50)	
Lagged Herfindahl Index	?	0.030	0.057	0.031	0.047	0.135	0.105
		(0.14)	(0.30)	(0.14)	(0.25)	(0.63)	(0.56)
Firm age	?	0.042**	0.013	0.049***	0.017	0.024	0.000
		(2.44)	(0.40)	(2.94)	(0.51)	(1.47)	(0.01)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		31326	36438	31326	36438	31326	36438
Adjusted R-squared		0.13	0.13	0.15	0.14	0.13	0.12

Panel B: OLS Regressions using Log of Citations as Dependent Variable

Which Proxy for Monitoring Intensity?	Predicted Sign	(1) Number of Blockholders	(2) Number of Blockholders	(3) Total blockholder ownership %	(4) Total blockholder ownership %	(5) Number of Public Pension Funds	(6) Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.396***	-0.350***	-0.391***	-0.345***	-0.424***	-0.378***
		(8.60)	(8.06)	(8.61)	(8.01)	(8.87)	(8.16)
State Anti-takeover Index Change * Value of Index Before Change (Hypothesis 1)	+	0.194***	0.18***	0.21***	0.196***	0.118**	0.126**
		(3.08)	(3.10)	(3.22)	(3.25)	(2.08)	(2.33)
Proxy for Monitoring Intensity (Hypothesis 2)	+	0.442***	0.436***	4.941***	4.870***	0.133***	0.129***
		(15.42)	(15.63)	(16.72)	(17.02)	(22.98)	(24.00)
State Anti-takeover index Change * Value of Index Before Change* Proxy for Monitoring Intensity (Hypothesis 3)	-	-0.020***	-0.020***	-0.230***	-0.235***	-0.004***	-0.005***
		(7.55)	(7.92)	(7.27)	(7.66)	(4.96)	(5.62)
Current Log of Sales	+	-0.081**	-0.070**	-0.076**	-0.063*	-0.136***	-0.119***
		(2.38)	(2.22)	(2.09)	(1.88)	(3.60)	(3.46)
Lagged R&D/ Sales	+	0.001		0.001		0.001	
		(1.28)		(1.34)		(1.47)	
Lagged Tobin's Q	?	0.020***		0.020***		0.010	
		(3.37)		(3.50)		(1.60)	
Lagged Herfindahl Index	?	0.218	0.270	0.228	0.261	0.355	0.314
		(0.95)	(1.29)	(0.98)	(1.24)	(1.61)	(1.59)
Firm age	?	0.078**	0.046	0.088***	0.052	0.059*	0.031
		(2.57)	(1.33)	(2.77)	(1.41)	(1.95)	(0.92)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		26526	30914	26526	30914	26526	30914
Adjusted R-squared		0.22	0.21	0.22	0.22	0.20	0.20

Panel C: Tobit Model Regressions using Log of Citations as Dependent Variable (marginal effects)

Which Proxy for Monitoring Intensity?	Predicted Sign	(1) Number of Blockholders	(2) Number of Blockholders	(3) Total blockholder ownership %	(4) Total blockholder ownership %	(5) Number of Public Pension Funds	(6) Number of Public Pension Funds
State Anti-takeover Index Change (Hypothesis 1)	-	-0.441***	-0.403***	-0.435***	-0.399***	-0.456***	-0.421***
		(5.46)	(5.75)	(5.24)	(5.59)	(6.48)	(7.22)
State Anti-takeover Index Change * Value of Index Before Change (Hypothesis 1)	+	0.134***	0.146***	0.15***	0.156***	0.038	0.068**
		(5.08)	(6.00)	(5.82)	(6.57)	(1.03)	(2.11)
Proxy for Monitoring Intensity (Hypothesis 2)	+	0.440***	0.442***	4.931***	4.868***	0.160***	0.155***
		(37.09)	(41.16)	(39.41)	(43.19)	(36.60)	(39.35)
State Anti-takeover index Change * Value of Index Before Change* Proxy for Monitoring Intensity (Hypothesis 3)	-	-0.020***	-0.021***	-0.242***	-0.250***	-0.004***	-0.005***
		(12.90)	(14.66)	(13.97)	(15.52)	(8.82)	(10.62)
Current Log of Sales	+	0.113***	0.085***	0.115***	0.084***	0.058***	0.020**
		(10.70)	(9.19)	(10.87)	(9.10)	(5.59)	(2.21)
Lagged R&D/ Sales	+	0.000		-0.000		-0.000	
		(0.02)		(0.01)		(0.61)	
Lagged Tobin's Q	?	0.031***		0.030***		0.018***	
		(5.43)		(5.26)		(3.28)	
Lagged Herfindahl Index	?	-0.087	-0.178**	-0.115	-0.211**	-0.052	-0.124
		(0.94)	(2.13)	(1.25)	(2.54)	(0.59)	(1.58)
Firm age	?	-0.004**	-0.003*	-0.005**	-0.003*	-0.013***	-0.011***
		(2.15)	(1.70)	(2.55)	(1.95)	(7.59)	(7.30)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		31326	36438	31326	36438	31326	36438
Probability > Chi-squared Wald Statistic		0.00	0.00	0.00	0.00	0.00	0.00

Table 5: Difference-of-difference Regressions Exploiting Exogenous Passage of State level Anti-Takeover laws using S&P 500 index entry and exit as Instrument for changes in Blockholder Ownership

$$y_{ist} = \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{st} + \beta_2 \cdot \left(TI_s * \Delta TI_{st}\right) + \beta_3 \cdot SP_{i,t-1} + \beta_4 \cdot \left\{SP_{i,t-1} * \left(TI_s * \Delta TI_{st}\right)\right\} + \beta \cdot X + \varepsilon_{ist}, t \in [1981,2002]$$

The variable y_{ist} is a measure of innovation in year t for firm i incorporated in state s. The variable y is either the *logarithm of (a)* the number of patents applied for (and eventually granted) in year t (Columns 1 and 3), (b) the number of subsequent citations to these patents (Columns 2 and 4), and (c) the ratio of R&D expenditures to sales in year t (Columns 3 and 6). All regressions are estimated using OLS. The sample consists of firms that applied for a patent over the period 1981-2002 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. The variable $\Delta TI_{s,t}$ equals the change in the anti-takeover index in state s for all $t \geq m+1$, where m is the year when the first anti-takeover statute was passed in state s; this variable equals 0 otherwise. For states that never passed (did pass) the law, the variable TI_s is equal to the constant value of the anti-takeover index (before the law-change). For the sample using entry into S&P 500 as an instrument, the variable $SP_{i,t}$ is defined as follows: $SP_{i,t}$ equals 1 for all $t \geq n$ if a firm is introduced into the S&P 500 in year n; $SP_{i,t}$ equals 0 otherwise. For the sample using exit from S&P 500 as an instrument, $SP_{i,t}$ is defined as follows: $SP_{i,t}$ equals 1 for all $t < n$ if a firm is removed from the S&P 500 in year n; $SP_{i,t}$ equals 0 otherwise. The variables β_i and β_t denote firm and application year fixed effects respectively. The vector X denotes the set of control variables. The standard errors are robust to heteroskedasticity and autocorrelation and are clustered by firm. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

Dependent variable is the logarithm of:	Predicted Sign	(1) Number of Patents	(2) Number of Citations	(3) R&D/ Sales	(4) Number of Patents	(5) Number of Citations	(6) R&D/ Sales
		Sample using entry into S&P 500 as Instrument			Sample using exit from S&P 500 as Instrument		
State Anti-takeover Index Change (Hypothesis 1)	-	-0.051***	-0.056**	-0.026***	-0.056***	-0.060***	-0.029***
		(3.23)	(2.57)	(2.80)	(3.50)	(2.76)	(3.12)
State Anti-takeover Index Change * Value of Index Before	+	0.030***	0.039***	0.027***	0.031***	0.036***	0.028***
Change (Hypothesis 1)		(3.58)	(3.40)	(5.19)	(3.77)	(3.20)	(5.38)
S&P 500 Entry/ Exit	+	0.366***	0.305***	0.278***	0.240**	0.344*	0.303***
(Hypothesis 2)		(5.44)	(3.69)	(8.18)	(2.01)	(1.81)	(3.75)
State Anti-takeover index Change * Value of Index Before	-	-0.047***	-0.072***	-0.018**	-0.048***	-0.043*	-0.020**
Change* S&P 500 Entry/ Exit (Hypothesis 3)		(2.67)	(3.10)	(2.11)	(2.62)	(1.93)	(2.33)
GIM Index		0.011	0.011	-0.009	0.013	0.012	-0.006
		(1.13)	(0.70)	(1.28)	(1.32)	(0.79)	(0.95)
Current Log of Sales	+	0.059***	0.042***	-0.427***	0.059***	0.042***	-0.417***
		(9.07)	(4.74)	(24.25)	(9.15)	(4.71)	(23.75)
Lagged Tobin's Q	?	-0.002	0.005	-0.000	-0.001	0.006	0.001
		(0.91)	(0.92)	(0.05)	(0.46)	(1.19)	(0.35)
Lagged Herfindahl Index	?	-0.278	-0.653	-0.408**	-0.334	-0.715*	-0.431**
		(1.06)	(1.63)	(2.18)	(1.26)	(1.77)	(2.29)
Firm age	?	0.044*	0.077**	-0.031*	0.043*	0.078**	-0.033*
		(1.72)	(2.17)	(1.75)	(1.69)	(2.17)	(1.80)
Firm Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		15838	13869	12496	15838	13869	12496
Adjusted R-squared		0.21	0.43	0.20	0.21	0.43	0.19

Table 6: Dynamic Effect of Exogenous Passage of State level Anti-Takeover laws

$$y_{ist} = \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{st}^{1,2} + \beta_2 \cdot \Delta TI_{st}^{\geq 3} + \beta_3 \cdot \left(TI_s * \Delta TI_{st}^{1,2}\right) + \beta_4 \cdot \left(TI_s * \Delta TI_{st}^{\geq 3}\right)$$
$$+ \beta_5 \cdot MI_{i,t-1} + \beta_6 \cdot \left\{MI_{i,t-1} * \left(TI_s * \Delta TI_{st}^{1,2}\right)\right\} + \beta_7 \cdot \left\{MI_{i,t-1} * \left(TI_s * \Delta TI_{st}^{\geq 3}\right)\right\} + \beta \cdot X + \varepsilon_{ist}; t \in [1981,2002]$$

The variable y_{ist} is a measure of innovation in year t for firm i incorporated in state s. y is either the *logarithm of (a)* the number of patents applied for (and eventually granted) in year t (Column 1), (b) the number of subsequent citations to these patents (Columns 2 and 3), and (c) the ratio of R&D expenditures to sales in year t (Column 4). The sample consists of firms that applied for a patent over the period 1981-2002 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. Let m denote the year when the first statute was passed in state s. Then, the variable $\Delta TI_{st}^{1,2}$ equals the number of anti-takeover statutes passed by state s if $t = m+1$ or $m+2$ and 0 otherwise. The variable $\Delta TI_{st}^{\geq 3}$ equals the number of anti-takeover statutes passed by state s if $t \geq m+3$ and it equals 0 otherwise. For states that never passed (did pass) the law, the variable TI_s is equal to the constant value of the anti-takeover index (before the law-change). The variable MI_{it} denotes the monitoring intensity of firm i in year t – number of blockholders is the only proxy that we employ here. The variables β_i and β_t denote firm & application year fixed effects. The vector X denotes the set of control variables. In Columns 1, 2, and 4, the standard errors are robust to heteroskedasticity and autocorrelation and are clustered by firm. In Column 3, the standard errors are not clustered by firm. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

Dependent Variable is logarithm of:	(1) Number of Patents	(2) Number of Citations	(3) Number of Citations	(4) R&D/ Sales
Regression Model:	OLS	OLS	Tobit	OLS
State Anti-takeover Change (1,2)	-0.051	-0.064	-0.060	-0.105***
	(0.94)	(0.89)	(0.99)	(2.74)
State Anti-takeover Change (>=3)	-0.310***	-0.327***	-0.370***	-0.114**
	(3.14)	(2.85)	(7.13)	(2.05)
State Anti-takeover Change (1,2) * Index Value	0.059***	0.074***	0.078***	0.040***
Before Change	(3.03)	(2.81)	(3.29)	(3.24)
State Anti-takeover Change (>=3) * Index Value	0.091***	0.108***	0.122***	0.041***
Before Change	(4.36)	(4.42)	(8.10)	(2.92)
Proxy for Monitoring Intensity (Number of	0.151***	0.181***	0.207***	0.024**
Blockholders)	(9.10)	(7.60)	(10.70)	(2.23)
State Anti-takeover Change (1,2) * Index Value	-0.009***	-0.011***	-0.015***	-0.002*
Before Change * Monitoring Intensity	(3.94)	(3.66)	(5.06)	(1.87)
State Anti-takeover Change (>=3) * Index Value	-0.010***	-0.010***	-0.013***	-0.003**
Before Change * Monitoring Intensity	(7.24)	(5.50)	(8.57)	(2.50)
GIM Index	0.010	0.009	0.007	-0.009
	(0.90)	(0.54)	(0.45)	(1.04)
Current Log of Sales	0.071***	0.049***	0.089***	-0.383***
	(7.88)	(4.41)	(12.17)	(13.04)
Lagged R&D/ Sales	0.001***	0.000	0.001	0.001**
	(2.90)	(0.66)	(1.16)	(2.47)
Lagged Tobin's Q	-0.001	0.003	0.015***	-0.001
	(0.28)	(0.66)	(3.48)	(0.22)
Lagged Herfindahl Index	-0.248*	-0.071	-0.365***	-0.221*
	(1.70)	(0.37)	(3.70)	(1.91)
Firm age	0.007	0.049	0.019***	-0.046
	(0.14)	(0.87)	(7.88)	(1.43)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Application Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	15838	13869	15838	12528
Adjusted R-squared	0.20	0.44		0.23
Probability > Chi-squared Wald Statistic	N/A	N/A	0.00	N/A

Table 7: Review of Evidence in Existing Literature – Difference-of-difference Regressions including only the Linear Effect

$$y_{ist} = \beta_i + \beta_t + \beta_1 \cdot \Delta TI_{st} + \beta_2 \cdot MI_{i,t-1} + \beta \cdot X + \varepsilon_{ist}, t \in [1981,2002]$$

The variable y_{ist} is a measure of innovation in year t for firm i incorporated in state s. y is either the *logarithm of (a)* the number of patents applied for (and eventually granted) in year t (Column 1), (b) the number of subsequent citations to these patents (Columns 2 and 3), and (c) the ratio of R&D expenditures to sales in year t (Column 4). The sample consists of firms that applied for a patent over the period 1981-2002 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. The variable ΔTI_{st} equals the change in the anti-takeover index in state s for all $t \geq m+1$, where m is the year when the first anti-takeover statute was passed in state s; this variable equals 0 otherwise. The variable MI_{it} denotes the monitoring intensity of firm i in year t – only the number of blockholders is employed as a proxy. The variables β_i and β_t denote firm & application year fixed effects. The vector X denotes the set of control variables. In Columns 1,2, and 3, the standard errors are robust to heteroskedasticity and autocorrelation and are clustered by firm. In Column 4, the standard errors are not clustered by firm. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All Anti-takeover Laws				Only Business Combination Laws			
Dependent variable is logarithm of:	Number of Patents	Number of Citations	Number of Citations	R&D/ Sales	Number of Patents	Number of Citations	Number of Citations	R&D/ Sales
Regression Model:	OLS	OLS	Tobit	OLS	OLS	OLS	Tobit	OLS
State Anti-takeover Index Change	-0.044***	-0.039*	-0.067***	-0.016*	-0.077**	-0.072*	-0.113***	-0.068***
	(2.95)	(1.92)	(3.63)	(1.77)	(2.53)	(1.73)	(2.96)	(3.69)
Proxy for Monitoring Intensity (Number	0.094***	0.118***	0.153***	0.002	0.095***	0.119***	0.155***	0.002
of Blockholders)	(12.78)	(10.79)	(14.46)	(0.46)	(12.88)	(10.87)	(14.63)	(0.54)
GIM Index	-0.005**	-0.009***	-0.004	-0.003**	-0.005**	-0.009***	-0.004	-0.003**
	(2.31)	(2.65)	(1.14)	(2.02)	(2.35)	(2.68)	(1.19)	(1.97)
Current Log of Sales	0.073***	0.052***	0.092***	-0.380***	0.073***	0.051***	0.092***	-0.381***
	(10.91)	(5.83)	(12.48)	(22.22)	(10.91)	(5.83)	(12.48)	(22.32)
Lagged R&D/ Sales	0.001***	0.000	0.001	0.001***	0.001***	0.000	0.001	0.001***
	(3.01)	(0.67)	(1.13)	(3.15)	(3.01)	(0.68)	(1.14)	(3.15)
Lagged Tobin's Q	-0.002	0.003	0.015***	-0.001	-0.001	0.003	0.015***	-0.001
	(0.56)	(0.51)	(3.41)	(0.44)	(0.55)	(0.52)	(3.43)	(0.40)
Lagged Herfindahl Index	-0.251***	-0.074	-0.374***	-0.225***	-0.255***	-0.077	-0.382***	-0.221***
	(2.83)	(0.55)	(3.77)	(3.55)	(2.88)	(0.57)	(3.84)	(3.50)
Firm age	0.003	0.046	0.019***	-0.047**	0.003	0.045	0.019***	-0.046**
	(0.13)	(1.30)	(7.85)	(2.55)	(0.11)	(1.29)	(7.73)	(2.54)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Application Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15838	13869	15838	12496	15838	13869	15838	12496
Adjusted R-squared	0.21	0.43	N/A	0.20	0.19	0.43	N/A	0.18
Probability > Chi-squared Wald Statistic	N/A	N/A	0.00	N/A	N/A	N/A	0.01	N/A