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. 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 innovation. We use cross-sectional and time-series difference-in-difference tests to identify the causal effects of governance mechanisms on innovation.

Our study suggests that innovation is fostered by either an unhindered market for corporate control or strong anti-takeover laws that significantly deter takeovers. 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 encourage innovation *ex ante* by reducing the likelihood of *ex post* private control benefit losses. The *interplay* between the relative magnitudes of these conflicting forces causes innovation to vary non-monotonically with takeover pressure.

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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). There is, however, relatively limited *micro* evidence of how laws and institutions affect innovation by firms *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, increasing monitoring intensity lowers the sensitivity of innovation to takeover pressure leading 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 innovation. 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 manager's project choice is observable. At the end of the first period, agents observe a public signal about the payoff of the chosen project. The signal partially resolves 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 is observable, it is non-verifiable and, therefore, *non-contractible*. Second, the manager derives pecuniary *private control benefits* that are also non-contractible. The manager's private benefits decline 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. 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. The higher likelihood of a takeover for the more innovative project, however, 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 private benefits decline with monitoring intensity, this trade-off is influenced by the interaction between the intensity of monitoring of the manager and the 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 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 greater innovation because it has a higher unconditional expected payoff. When takeover pressure is very high, the expected takeover premium and the expected loss in control benefits are both high. The effect of the expected takeover premium, however, dominates. Because the expected takeover premium increases with the degree of innovation, it is again optimal to choose greater innovation. For moderate levels of takeover pressure, the effect of the higher loss of control benefits associated with greater innovation dominates. It is therefore optimal for the manager to choose lower innovation to reduce the likelihood of losing her control benefits.

The above intuition implies that the manager chooses lower innovation for moderate levels of takeover pressure because the effect of her expected loss of control benefits dominates. As monitoring intensity increases, the manager's private benefits decline so that the relative importance of private benefits in influencing the degree of innovation declines. Hence, the manager chooses greater innovation 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 degree of innovation to changes in takeover pressure. The U-shaped relation, therefore, 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 as our *ex ante* measure of the degree of innovation. 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 institutional blockholders 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 first test our hypotheses using cross-sectional tests, where we include firm and year fixed effects. First, we show that innovation varies in a U-shaped manner with the anti-takeover index. Second, we find a strong positive relation between innovation and our proxy for monitoring intensity. Finally, we show that the curvature of the U-shaped relationship between innovation and the anti-takeover index declines with monitoring intensity, that is, the U-shaped relationship becomes flatter. The identifying assumptions in the cross-sectional tests are that *time-varying* unobserved determinants of innovation at the firm, industry, and state levels are uncorrelated with both the anti-takeover index and the proxy for monitoring intensity.

To weaken the identifying assumptions in the cross-sectional tests, we next conduct time-series *difference-in-difference* tests. These tests exploit the staggered passage of anti-takeover laws in various states as a natural source of exogenous variation to identify the causal effects of takeover pressure *changes* on innovation. Our difference-in-difference methodology differs from that used in prior studies such as Bertrand and Mulainathan (2003) and Giroud and Mueller (2008). While these studies consider the effects of the passage of the business combination laws, we investigate the *sequential* effects of the passage of *every* anti-takeover law during our sample period. Moreover, to test for the

predicted U-shaped relationship between innovation and takeover pressure, our difference-in-difference specification incorporates non-linear effects.

Our time-series tests provide strong empirical support for all our predictions. 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)* R&D intensity, patents and citations for firms incorporated in the state, respectively, by 19%, 17%, and 18% (25%, 11%, and 14%) *more* than for those firms incorporated in states that never experienced a 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 the degree of innovation and takeover pressure. Second, higher monitoring is associated with greater innovation – a one standard deviation increase in the total blockholder ownership is associated with 12% higher R&D/ sales, 26% more annual patents, and 27% more annual citations. Finally, higher monitoring leads to a flatter U-shaped relationship between takeover pressure and innovation. A one standard deviation increase in the total blockholder ownership flattens the curvature of annual R&D/ Sales, patents, and citations by 8%, 6%, and 6% 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

[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.

empirical support for all our predictions in these tests.

Since blockholders may invest more in firms that are likely to be successful innovators, our proxy for monitoring intensity is potentially endogenous. We conduct instrumental variable tests in which we employ a firm's entry into, or exit from, the S&P 500 as an instrument for blockholder ownership (see Aghion, Van Reenen, and Zingales, 2008). Our results remain unaltered.

2 Related Literature

From a theoretical standpoint, we contribute to the literature that examines the effects of corporate governance mechanisms on innovation.[2] Stein (1988) develops a model with asymmetric information about the interim outcomes of projects between managers and investors. He shows that the threat of takeover induces myopic behavior on the part of managers. Burkart, Gromb, and Panunzi (1997) examine the costs and benefits of large shareholders and argue that *ex post* monitoring by large shareholders imposes costs *ex ante* 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 *et al* (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), and large shareholder monitoring (Burkart *et al*, 1997, Aghion *et al*, 2008), *or* by external mechanisms such as takeover pressure (Stein, 1988). In reality, innovation is driven by the interactions among the market for corporate control, compensation contracts, and monitoring. By integrating external and internal governance mechanisms in our framework, we demonstrate how the interactions between takeover premia and private control benefits lead to the novel prediction that innovation varies in a U-shaped manner with takeover pressure.

The predicted U-shaped relationship between innovation and takeover pressure is especially pertinent given the ongoing debate on the importance of the market for corporate control in fostering innovation. One strand of the literature (the "quiet life" view) argues that laws that hinder the market for corporate control encourage managerial slack and cause them to refrain from investing in

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

innovative activities (Jensen, 1988). In contrast, another strand of the literature (the "managerial myopia" view) 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, shows that both perspectives are correct, albeit only "locally". When takeover pressure is above a threshold, a decrease in takeover pressure *decreases* innovation, which is consistent with the "quiet life" view. When takeover pressure is below the threshold, a decline in takeover pressure *increases* innovation, which is consistent with the "managerial myopia" view. 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. The *interplay* between the relative magnitudes of these conflicting forces causes innovation to vary non-monotonically with takeover pressure.

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*.[3]

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

[3] 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. Giroud and Mueller (2008) examine the differential effect of business combination laws on competitive and non-competitive industries.

"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.[4] 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 (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,

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

[4] 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.

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), the variables $\widetilde{z}_1$ and $\widetilde{z}_2$ are independent standard normal random variables, which capture the *intrinsic uncertainties* associated with the project. The random variables $\widetilde{z}_1$ and $\widetilde{z}_2$ represent "first period" uncertainty and "second period" uncertainty, respectively. 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, 1970), 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 positive relationship between the minimum takeover premium and the severity of anti-takeover laws is consistent with the evidence in Comment and Schwert (1995) that the passage of anti-takeover laws resulted in significant increases in takeover premia.

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 1 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.

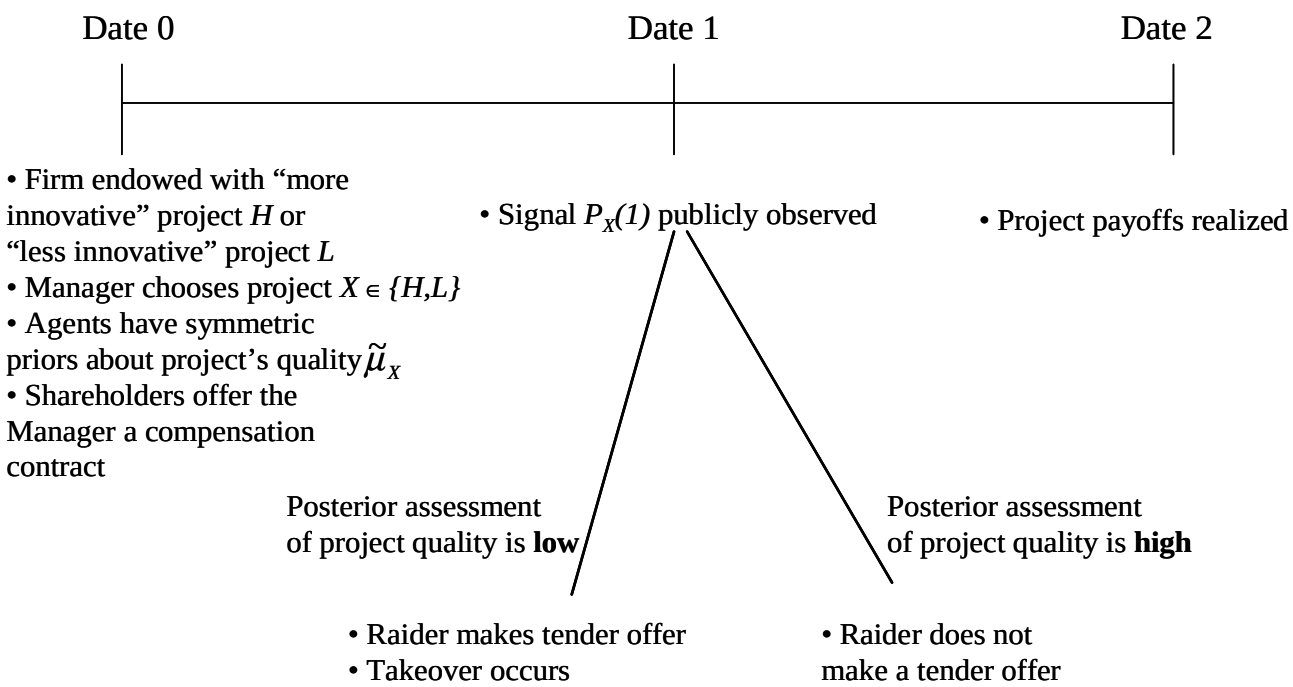

Figure 1: Timing and Sequence of Events

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 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.[5] 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.

The following proposition describes the second best project choice of the manager.

[5] 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.

Proposition 2 (Second Best Project Choice) *The second best project choice solves*

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

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

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 the level 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.

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

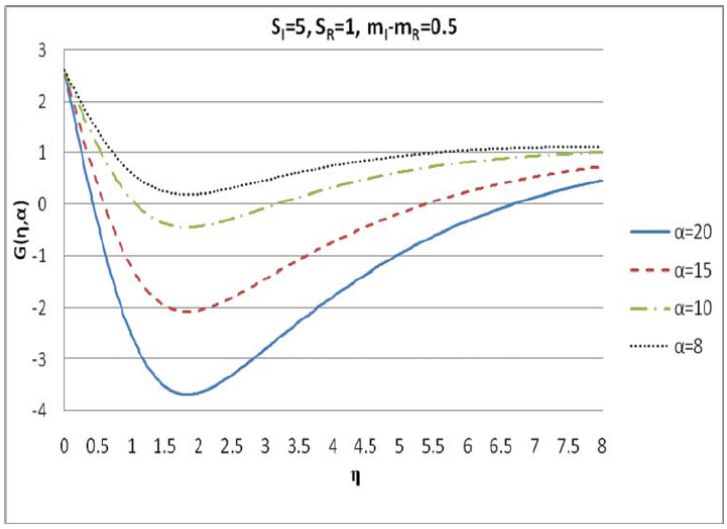

Figure 2: Variation of Expected Excess Payoff from Higher Innovation $G(\eta, \alpha)$ with Takeover Pressure η for various levels of Monitoring Intensity α.

Hypothesis 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".*

In the model, the choice of the degree of innovation by the manager and her compensation contract are *simultaneously* and *endogenously* determined by the takeover pressure, η, and the private benefits, α. In other words, the parameters η and α are *inputs* to the model, whereas the compensation contract and the degree of innovation are *outputs*. In particular, our predictions relating innovation to takeover pressure and monitoring intensity already *incorporate* the fact that the manager's compensation contract responds optimally to the takeover pressure and monitoring intensity that she faces. Moreover, as discussed in Section 4.3, the manager's contract can be implemented in different ways through combinations of financial securities and additional payoffs contingent on a takeover. Hence, our testable hypotheses also reflect the possibility that the firm could alter its financial structure and takeover provisions in response to changes in the external takeover pressure (for example, through anti-takeover laws) to implement the optimal payoffs of agents as described by Proposition 3. To closely tie our empirical analysis to the theory, and to avoid "endogeneity" problems

in our econometric analysis, we examine the relationship between innovation and proxies for external takeover pressure and monitoring intensity without including *endogenous* firm-level variables such as compensation contracts, insider ownership, and capital structure.

5 Empirical Analysis

5.1 Proxies for Innovation

We employ both *ex ante* and *ex post* measures to proxy for innovation by firms. We use R&D intensity, calculated as the ratio of a firm's R&D expenditures to sales, as our *ex ante* measure of a firm's innovation. We use two broad metrics for our *ex post* measures of innovation. First, using data on patents filed by US firms with the US Patent Office (USPTO) constructed by Hall, Jaffe, and Trajtenberg (2001), we employ a simple count of the number of patents that were filed by a firm in a particular year. Second, to capture the economic importance of innovation, we measure all subsequent citations (until 2002) made to these patents (see Griliches,Pakes, and Hall, 1987). Since the year of application for a patent 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 any 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. 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, for our analysis, we use the patents actually granted.[6]

5.2 Proxies for External Takeover Pressure

We undertake both cross-sectional and time-series tests of our hypotheses. 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. The index attaches to each state a score from 0 to 5 that is equal to its number of standard anti-takeover statutes. These statutes are

[6] 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.

called the Control Share acquisition, Fair-price, Business Combination, Poison Pill Endorsement, and Constituencies statutes.[7] Given our discussion in Section 4.5, the state-level anti-takeover index serves as a viable exogenous proxy for takeover pressure. In our time-series "difference-in-difference" tests, we rely on the passage of anti-takeover laws as a natural source of exogenous variation in takeover pressure to identify the causal effects of takeover pressure on innovation.

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). Because 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 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. We run our tests using all of the above proxies. Because the results are similar using each of the three proxies,for brevity, we only report the results using the total percentage of shares owned by blockholders.

Institutional blockholders may invest relatively more in firms that are successful innovators. To alleviate such "endogeneity" concerns, we repeat our tests using a firm's membership in the S&P 500 as an instrument for blockholder ownership (see Aghion *et al*, 2008).

5.4 Sample Construction and Descriptive Statistics

Our sample period ranges from 1980 to 1995. We begin our sample in 1980 because blockholder ownership data are available from 1980 onwards. We terminate the sample in 1995 for two reasons. First, patents applied for in later years may not have been granted and therefore would not be present in the NBER dataset. Furthermore, because the NBER dataset extends only till 2002, citations to recent patents are not present in the data, which further exacerbates the problems stemming from "truncation bias." Second, it is conceivable that the effects of law changes on innovation decay over time so that innovation undertaken several years after the laws are passed are more likely to be affected by other factors. We therefore follow Bertrand and Mullainathan (2003) and Giroud and

[7] See Bebchuk and Cohen (2003) for detailed descriptions of these statutes.

Mueller (2008) in ending our sample in 1995.[8]

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.[9] 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. In order to remove the effect of outliers, we winsorize our sample at the 1% and 99% levels. Our final sample consists of 10,377 firm-year observations.

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 (median) firm in our sample invests 18% (4%) of its annual sales revenue in R&D while the average (median) firm in our sample applies for and is granted 19.5 (3) patents per year and receives about 197.8 (15) citations per year subsequently. Thus, compared to the median firm, the average firm in our sample invests 4.5 times more in R&D, applies for and is granted 6.5 times more patents and receives about 13.2 times more citations. In contrast to this skewness in the distribution of our proxies for innovation, the average and median percentage of shares owned by all blockholders together are 13.8% and 13.4% respectively.

The top panel of Table 2 lists the states in which firms in our sample are incorporated. The bottom panel lists the states that form part of our sample and had passed anti-takeover laws during the period 1980-1995. This panel also lists the year in which the law was passed, the value of the state anti-takeover index before the passage of the law, and the change in the value of the index (which equals the number of anti-takeover statutes passed in that year).

5.5 Univariate Analysis

Before we proceed to our formal empirical analysis, we undertake a preliminary univariate analysis. Figure 3 shows a scatter plot of our *ex ante* and *ex post* measures of innovation against the anti-

[8] We thank Antoinette Schoar and Luigi Zingales for bringing the above issue to our attention. We have also run our tests by extending the sample till the year 2002. The results support our hypotheses.

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

takeover index after controlling for firm and time specific effects. We display the scatter plots for high (above the median) and low (below the median) levels of blockholder ownership. The dependent variable in these plots is the residual obtained from a regression of the measure of innovation on firm and year dummies. The scatter plots provide preliminary support for our hypotheses. There is a U-shaped relationship between innovation and takeover pressure. Innovation increases with monitoring intensity and the U-shaped relationship becomes flatter.

5.6 Cross-sectional Tests

We begin our formal analysis by testing the main implications of the theory using cross-sectional tests.

5.6.1 Empirical Specification

We use the empirical specification described below:

$$y_{ist} = \beta_0 + \beta_i + \beta_t + \underbrace{\beta_1 TI_{s,t} + \beta_2 TI_{s,t}^2}_{\text{U-shaped Relation}} + \underbrace{\beta_3 MI_{i,t-1}}_{\text{Monitoring Intensity}} + \underbrace{\beta_4 \left(TI_{s,t}^2 * MI_{i,t-1}\right)}_{\text{Flattening of U-Shape}} + \beta \cdot X + \varepsilon_{ist} \quad (27)$$

where y_{ist} is the measure of innovation of firm i incorporated in state s in year t. The variable $TI_{s,t}$ denotes the value of the anti-takeover index for state s at the end of year t, while the variable $MI_{i,t-1}$ denotes the monitoring intensity for firm i at the end of year $t-1$. Because we measure the 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 one year.

The variables β_i, β_t denote "firm" and "year" dummies respectively. The firm fixed effects captured by β_i control for *time-invariant* unobserved determinants of innovation at the firm level. They also control for time-invariant unobserved determinants of innovation at the state and industry levels because firms rarely change their primary industry or their state of incorporation in our sample.[10] The fact that firm fixed effects subsume industry fixed effects is important because innovation patterns vary across industries. The year fixed effects captured by β_t control for inter-temporal differences in innovation that are constant across states and firms as well as problems stemming from the truncation bias in citations.

[10] Of the the 2151 firms in our sample, 33 change their state of incorporation during our sample period.

In the above specification, X denotes a vector of control variables that are potential determinants of innovation. To control for the potential dependence of innovation on firm size, we include the logarithm of assets. Because past R&D intensity could positively affect current innovation, we include the lagged R&D to sales ratio. Because innovation may be more likely when investment opportunities are greater, we include Tobin's Q to control for a firm's investment opportunities. Aghion *et al* (2005) show that innovation varies in an inverted U-shaped manner with industry competition. Accordingly, we include a sales-based Herfindahl measure for the 4-digit SIC industry and its square as additional controls. Finally, we also control for the potential dependence of innovation on the age of the firm.

Based on Hypothesis 1, which implies a U-shaped relation between innovation and takeover pressure, we predict that $\beta_1 < 0, \beta_2 > 0$. Based on Hypothesis 2, we predict that $\beta_3 > 0$. Based on Hypothesis 3, which implies that the U-shaped innovation-takeover pressure relation becomes "flatter" with monitoring intensity, we predict that $\beta_4 < 0$.

Table 3 reports the results of our analysis. In columns 1–3, the dependent variable is the logarithm of the ratio of R&D expenditures to sales. In columns 4–6, the dependent variable is the number of patents applied for (and eventually granted). In columns 7–9, the dependent variable is the number of subsequent citations to these patents. For each of these dependent variables, we estimate the regression with and without any of our control variables. Moreover, for each of our regression, we estimate standard errors that are robust to both heteroskedasticity and autocorrelation, and we cluster these standard errors by firm. Because firms incorporated in Delaware account for almost half of our observations (see Table 2), as an additional robustness check, we examine the results by excluding Delaware firms.[11]

Across columns 1-9 of Table 3, we find that $\beta_1 < 0$ and $\beta_2 > 0$. All the coefficients are statistically significant at the 1% level. An examination of the values of β_1 and β_2 in these models reveals that the value at which innovation attains its minimum, $-\beta_1/(2 * \beta_2)$, lies in the range 0-5 of possible values of the anti-takeover index. Using the coefficients in columns 2, 5, and 8, we find that when the value of the index in a state is zero (four), as it is in California (Pennsylvania in 1992), a one point *increase* in the value of the index *decreases* (*increases)* R&D/ sales, patents, citations for firms incorporated in the state respectively by 28%, 22%, and 23% (30%, 14%, and 19%) annually. Thus,

[11] We have also examined the results obtained by *excluding* firms that either opted out of any of the anti-takeover statutes or decided to reincorporate to another state after the passage of the anti-takeover laws. We lose 134 firm-year observations when we exclude such firms. However, our results remain almost identical to the ones we report here.

consistent with Hypothesis 1, we find strong evidence of a U-shaped relationship between innovation and the level of the anti-takeover index.

Table 3 also shows that $\beta_3 > 0$. Across columns 1-9, the coefficients are statistically significant at the 1% level. A one standard deviation increase in total blockholder ownership is associated with 20% higher R&D/ Sales, 14% more annual patents, 15% more annual citations. These results are consistent with Hypothesis 2 that higher monitoring intensity is associated with greater innovation.

Finally, we find that across columns 1-9, $\beta_4 < 0$. A one standard deviation increase in the total blockholder ownership flattens the curvature of annual patents, citations, and R&D/ Sales by 4.1%, 3.7%, and 3.8% respectively. Thus, consistent with Hypothesis 3, we find that higher monitoring leads to a flattening of the U-shaped relationship between takeover pressure and innovation.

Among our control variables, we find that firm size is positively associated with our innovation proxies. Furthermore, consistent with Aghion *et al.* (2005), we find evidence of an inverted U-shaped relationship between innovation and competition. Finally, we find that younger firms patent and receive citations relatively more than older firms.

5.6.2 Discussion of the cross-sectional tests

The inclusion of firm and year fixed effects in the regression model only control for *time-invariant* unobserved heterogeneity at the firm, industry, state, and year levels. However, the identifying assumptions in the cross-sectional tests are that *time-varying* unobserved determinants of innovation at the firm, industry, and state levels are uncorrelated with both the anti-takeover index and the proxy for monitoring intensity. To weaken these identifying assumptions, we next conduct time-series "difference–in–difference" tests.

5.7 Time Series "Difference-in-Difference" Tests

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. 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.

We compile the list of states that passed 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.[12] We examine the effects of the passage of *each* of these five laws across states. Therefore, *a priori,* we take no stand on the effectiveness of the different laws.

5.7.1 Empirical Specification

To implement the difference-in-difference approach, we take into account the *sequential* effects of the passage of each law in a state on innovation by firms. Our difference-in-difference methodology incorporates the sequential effect of the passage of *every* anti-takeover law passed in a particular state on innovation during our sample period.

To illustrate our strategy, consider the state of Connecticut that passed a law *twice* in our sample period: the fair price statute in 1984 and the business combination statute in 1989. To examine the effects of the fair price statute passed in Connecticut in 1984 (respectively the business combination statute in 1989) on firms incorporated in Connecticut, we first compute the average value of innovation for each firm during the period 1981-1984 (respectively 1985-1989). Next, for each year over the period 1985-1989 (respectively 1990-1995), we compute the *incremental innovation* for each firm over the average level of innovation in the period prior to the passage of the most recent law. Specifically, for each year over the period 1985-1989 (respectively 1990-1995), we subtract the average innovation for the firm over the period 1981-1984 (respectively 1985-1989) from the level of innovation for that firm in that year. However, this difference estimated for firms incorporated in Connecticut 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 also estimate the difference in innovation for firms incorporated in states that *never passed an anti-takeover law.* 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 Connecticut if the anti-takeover law *had not been passed* in 1984 (respectively 1989)?" The difference between these two differences, therefore, captures the causal effect of the change in the

[12] While we rely primarily on Bebchuk and Cohen (2003) for the list of law passages, we cross-checked them using the list provided in Bertrand and Mulainathan (2003) and Karpoff and Malatesta (1989). In those instances where the year of passage of the law did not coincide across these three studies, we cross-checked the year using Lexis-Nexis' annotated state statutes.

law on innovation.

We implement the difference-in-difference approach as follows. Suppose state s passes n anti-takeover laws in years $t_1, ..., t_n$ $(n \geq 1)$, where t_l denotes the year in which state s passed the lth law. We denote the time period from year $t_l + 1$ to year t_{l+1}, i.e., the period during which all the l laws are effective in state s, as m_l. Thus, $m_l \equiv [t_l + 1, t_{l+1}]$. Let $TI_s(m_l)$ denote the value of the anti-takeover index during the period m_l. We then have $TI_{s,t} = TI_s(m_l)$ for any $t \in m_l$, where $TI_{s,t}$ is the value of the state-level anti-takeover index for state s at the end of year t.

In Appendix B, we show that, in order to investigate the impact of the passage of $(l+1)th$ law in state s in any year $t \in m_{l+1}$ on the change in innovation, the following regression model implements the difference-in-difference approach outlined above:

$$\begin{aligned} y_{ist} - \overline{y}_{is}(m_l) \quad = \quad & \beta_0 + \beta_t + \underbrace{\beta_1 \left[TI_{s,t} - TI_s\left(m_l\right)\right] + \beta_2 \left[TI_{s,t}^2 - TI_s^2(m_l)\right]}_{\text{U-shaped relation}} + \\ & \underbrace{\beta_3 \left[MI_{i,t-1} - \overline{MI}_i\left(m_l\right)\right]}_{\text{Monitoring Intensity}} + \underbrace{\beta_4 \left[MI_{i,t-1} * TI_{s,t}^2 - \overline{MI}_i(m_l) * TI_s^2(m_l)\right]}_{\text{Flattening of U-shaped relation}} \\ & + \beta \cdot \left[X_{ist} - \overline{X}_{is}(m_l)\right] + \varepsilon_{ist} \end{aligned} \tag{28}$$

where $\overline{y}_{is}(m_l)$ and $\overline{X}_{is}(m_l)$ denote the average of both our measure of innovation and the set of control variables, respectively for firm i during the period $m_l \equiv [t_l + 1, t_{l+1}]$.[13] $\overline{MI}_i(m_l)$ denotes the average level of monitoring intensity of firm i over the time period $[t_l, t_{l+1} - 1]$. Note that, consistent with our cross-sectional tests where we examine the effects of *lagged* monitoring intensity, the average of the monitoring intensity is taken over the period $[t_l, t_{l+1} - 1]$ rather than $[t_l + 1, t_{l+1}]$. The variable $TI_{s,t}$ denotes the value of the anti-takeover index in state s at the end of year t. The variable β_t denotes year fixed effects. Besides identifying the coefficients in the difference-in-difference estimation (see Appendix B), β_t also enables us to control for inter-temporal variation in the *difference* in innovation as well as problems stemming from the truncation of citations. Note that unlike the cross-sectional tests in Section 5.6, we do not include firm fixed effects in (28) because the difference in innovation measure that we employ as the dependent variable cancels out any time-invarying firm and state specific factors.

[13] For $t \in [t_0, t_1]$, where t_0 is the initial year of the sample, we set $m_l = t_0$. For the set of firms that never experience a law change, $m_l = t_0$ $\forall t$.

Hypotheses 1, 2, and 3 predict that

$$\beta_1 < 0,\ \beta_2 > 0,\ \beta_3 > 0,\ \beta_4 < 0 \tag{29}$$

5.7.2 Results

Table 4 illustrates the results of our difference-in-difference tests. As in our cross-sectional tests, we estimate standard errors that are clustered by state of incorporation, and are robust to both heteroskedasticity and autocorrelation. In columns 1-3, the dependent variable is the logarithm of the ratio of R&D expenditures to sales. In columns 4-6, the dependent variable is the number of patents applied for (and eventually granted) and in columns 7-9, the dependent variable is the number of subsequent citations to these patents. As in the cross-sectional tests, we estimate the regression with and without any of our control variables for each of these dependent variables. We also examine the results by excluding the observations for firms incorporated in the state of Delaware. Consistent with our hypotheses we find that $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$, and $\beta_4 < 0$ across all the specifications. By examining the values of β_1 and β_2 in columns 1-9, we find that the value at which innovation attains its minimum, $-\beta_1/(2 * \beta_2)$, lies in the range 0-5 of possible values of the anti-takeover index.

The economic magnitudes of all the effects are significant. Using the coefficients in columns 2, 5, and 8, 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)* R&D/ Sales, patents and citations for firms incorporated in the state respectively by 19%, 17%, and 18% (25%, 11%, and 14%) annually more than for those firms incorporated in states that never experience a law-change. These economic magnitudes are quite similar to those obtained using the cross-sectional tests in Section 5.6 above. 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.

Consistent with Hypothesis 2, higher monitoring is associated with greater innovation. A one standard deviation increase in the total blockholder ownership is associated with 12% higher R&D/

sales, 26% more annual patents, and 27% more annual citations.

Finally, as predicted by Hypothesis 3, higher monitoring leads to a flattening of the U-shaped relationship between takeover pressure and innovation. A one standard deviation increase in the total blockholder ownership flattens the curvature of annual R&D/ Sales, patents, and citations by 8%, 6%, and 6% respectively.

5.7.3 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. The tests alleviate concerns about biases induced due to *time-varying* omitted variables at the firm or state-level that could potentially be correlated with the anti-takeover index and our proxy for monitoring intensity. There could, however, be *other* state-wide changes such as changes in compensation practices, provisions that affect the degree of competition in product and/or labor markets that accompany the passage of the law and that also impact innovation. Our next set of tests is designed to address this issue.

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

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 and incorporated 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. Anti-takeover laws passed by New York would likely affect innovation at its Palo Alto Research Center and its Rochester laboratories. However, any state-wide economic changes accompanying the law are more likely to affect 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 all states that never passed the law, then such a difference-in-difference isolates the *pure* effect of the law. In other words, in order to separate the effect of the anti-takeover law from the effect of state-wide economic changes accompanying the law, we examine the impact on innovation in divisions/subsidiaries *outside* the state of incorporation for firms incorporated in the state. We then compare the change to innovation

at firms unaffected by the law.

5.8.1 Empirical Specification

Analogous to (28), we implement the tests using the following specification:

$$\begin{aligned} y_{kist} - \overline{y}_{kis}(m_l) &= \beta_0 + \beta_t + \beta_1 \left[TI_{s,t} - TI_s\left(m_l\right)\right] + \beta_2 \left[TI_{s,t}^2 - TI_s^2(m_l)\right] + \\ & \beta_3 \left[MI_{i,t-1} - \overline{MI}_i\left(m_l\right)\right] + \beta_4 \left[MI_{i,t-1} * TI_{st}^2 - \overline{MI}_i(m_l) * TI_s^2(m_l)\right] + \\ & \beta \cdot \left[X_{ist} - \overline{X}_{is}(m_l)\right] + \varepsilon_{kist} \end{aligned} \tag{30}$$

The variable y_{kist} denotes the level of innovation in year t for subsidiary/division k of firm i where k is located *outside* the state of incorporation s of firm i. The other variables are defined similarly as in (28) . Note that while the above specification is similar to the specification described in (28), there are three important differences. First, unlike the time-series results in which the unit of observation is the firm, here the unit of observation is the subsidiary/division filing the patent. Second, because R&D expenditures are not available at such a granular level, we only examine patents and citations. Third, and most importantly, for those firms that are incorporated in states passing the anti-takeover law, the variable y_{kist} includes *only* those patents or citations granted to subsidiaries/ divisions *outside* the state of incorporation. Note that as in (28), time-invarying specific factors that influence innovation at the subsidiary/division, firm or state levels are netted out from the difference in innovation that we employ as a dependent variable.

5.8.2 Test results

Table 5 reports the results of the tests. The coefficients β_1 to β_4 retain their predicted signs and except for the coefficient of change in anti-takeover index in column 6, the rest are all statistically significant at the five percent level or higher. The economic magnitudes of all the effects are still significant. Using the coefficients in columns 2 and 5, 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 3% and 4% (11% and 13%) more relative to those subsidiaries/

divisions of firms that never experienced a law-change. A one standard deviation increase in the total blockholder ownership is associated with 64% more patents and 53% more citations. A one standard deviation increase in the blockholder ownership flattens the curvature of patents and citations by 3.3% and 2.8% respectively.

5.9 Endogeneity of Blockholder Ownership

Institutional blockholders may invest relatively more in firms that are successful innovators. While our firm fixed effects account for any *time-invariant* 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. We relax the preceding identifying assumption using a firm's membership in the S&P 500 as an *instrument* for blockholder ownership. As Aghion *et al* (2008) argue, changes in institutional blockholder ownership upon a firm's entry into the S&P 500 or its exit from the S&P 500 are unlikely to be related to the firm's innovation performance or its future innovation prospects.

We employ a difference-in-difference specification 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 1994, 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:

$$\begin{aligned} y_{ist} - \overline{y}_{is}(m_l) &= \beta_0 + \beta_t + \beta_1 \left[TI_{s,t} - TI_s\left(m_l\right)\right] + \beta_2 \left[TI_{s,t}^2 - TI_s^2(m_l)\right] + \beta_3 SP_{i,t-1} \\ &\quad + \beta_4 SP_{i,t-1} \left[TI_{s,t}^2 - TI_s^2(m_l)\right] + \beta \cdot \left[X_{ist} - \overline{X}_{is}(m_l)\right] + \varepsilon_{ist} \end{aligned} \tag{31}$$

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, $SP_{i,t-1}$ is defined as follows: $SP_{i,t-1}$ equals 1 for all $t-1 \geq n$ 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, $SP_{i,t-1}$ is defined as follows: $SP_{i,t}$ equals 1 for all $t-1 < n$ 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 6 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 coefficient estimates β_1 to β_4 retain their predicted signs and are all statistically significant.

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 of the firm at date 1 if it is not taken over is $E_1\left[P_X(2)\right]$. 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 $E_1\left[P_X(2)\right]-\alpha$. External anti-takeover laws, however, ensure that, for the takeover to be successful,

the firm's stakeholders must receive a total expected payoff

$$E_1\left[P_X(2)\right] - \alpha + \eta, \text{ where } \eta > 0. \tag{32}$$

It follows directly from (1), (12), and (32) that the raider must generate a surplus for the firm. From the discussion in Sections 11.5.1 and 11.5.2 of Tirole (2006), free-riding by shareholders coupled with 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 he generates (less the control benefits he captures) to the firm. After the takeover, the firm's current stakeholders (shareholders + manager) therefore receive a total payoff at date 1 of

$$P_X^{takeover} = E_1\left[P_X^{raider}(2)\right] - \alpha, \tag{33}$$

where the expectation in (33) is with respect to the information available at date 1. It follows from (32) and (33) that the takeover is successful if and only if

$$E_1\left[P_X^{raider}(2)\right] \geq E_1\left[P_X(2)\right] + \eta, \tag{34}$$

In words, (34) states that the raider must increase the firm's expected payoff, conditional on the information available at date 1 by at least η. Using (1), (8), (12), (13), and (34), it follows that the raider succeeds in taking over the firm if and only if

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

$\Diamond$

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

$$E(P_X(2)) = E(2\tilde{\mu}_X + \sigma_X\tilde{z_1} + \sigma_X\tilde{z_2}) = 2m_X. \tag{35}$$

$$E(1_{takeover}\alpha) = \alpha E(1_{takeover}) = \alpha Prob\{m_x \geq m_x + S_X\hat{z} + \eta\} = \alpha\Phi(-\frac{\eta}{S_X}), \tag{36}$$

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

$$\begin{aligned} P_X^{raider}(2) - P_X(2) &= P_X(1) + \tilde{\mu}_X^{raider} + \sigma_X\tilde{z}_2 - (P_x(1) + \tilde{\mu}_x + \sigma_x\tilde{z}_3) \\ &= \tilde{\mu}_X^{raider} - \tilde{\mu}_X + \sigma_X(\tilde{z}_2 - \tilde{z}_3) \end{aligned} \tag{37}$$

From equation (37):

$$\begin{aligned} E[1_{takeover}(P_X^{raider}(2) - P_X(2))] &= E[1_{takeover}(\tilde{\mu}_X^{raider} - \tilde{\mu}_X)] + \sigma_X E[1_{takeover}(\tilde{z}_2 - \tilde{z}_3)] \\ &= \begin{array}{l} E[1_{takeover}\tilde{\mu}_X^{raider}] - E[1_{takeover}\tilde{\mu}_X] + \\ \sigma_X E[1_{takeover}] \cdot E(\tilde{z}_2 - \tilde{z}_3) \end{array} \\ &= E(1_{takeover})m_X - E[1_{takeover}\tilde{\mu}_X] \\ &= \Phi(-\tfrac{\eta}{S_X})[m_X - E(\tilde{\mu}_X | S_X\hat{z} \leq -\eta)]. \end{aligned} \tag{38}$$

Let

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

Then,

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

so that

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

$$\begin{aligned} E(\tilde{\mu}_X|S_X\hat{z} \leq -\eta) &= m_X + \frac{1}{\Phi(-\frac{\eta}{S_X})} \int_{-\infty}^{-\eta} f(y) E(\tilde{\mu}_X|y)\, dy \\ &= m_X + \frac{1}{\Phi(-\frac{\eta}{S_X})} \int_{-\infty}^{-\eta} f(y) y\, dy \\ &= m_X + \frac{1}{\Phi(-\frac{\eta}{S_X})} \int_{-\infty}^{-\eta} \frac{1}{\sqrt{2\pi} S_X} e^{-\frac{y^2}{2S_X^2}} y\, dy \\ &= m_X + \frac{1}{\Phi(-\frac{\eta}{S_X})} (-\frac{S_X}{\sqrt{2\pi}} e^{-\frac{y^2}{2S_X^2}} |_{-\infty}^{-\eta}) \\ &= m_X - \frac{1}{\Phi(-\frac{\eta}{S_X})} \frac{S_X}{\sqrt{2\pi}} e^{-\frac{\eta^2}{2S_X^2}}. \end{aligned} \tag{39}$$

From equation (38) and (39),

$$E[1_{takeover}(P_X^{raider}(2) - P_X(2))] = \frac{S_X}{\sqrt{2\pi}} e^{-\frac{\eta^2}{2S_X^2}}. \tag{40}$$

Proposition 2 follows from (35), (36), and (40). $\Diamond$

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,

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

where $0 < m < 1$ so that

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

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

Proof of Proposition 4

Define the expected excess payoff from the more innovative project over the less innovative project

by the function $G(\eta, \alpha)$ where

$$G(\eta, \alpha) \equiv 2m_H - 2m_L + F(\eta, \alpha)$$

and

$$F(\eta, \alpha) \equiv \frac{S_H}{\sqrt{2\pi}} exp(-\frac{\eta^2}{2S_H^2}) - \alpha\Phi(-\frac{\eta}{S_H}) - \frac{S_L}{\sqrt{2\pi}} exp(-\frac{\eta^2}{2S_L^2}) + \alpha\Phi(-\frac{\eta}{S_L}). \tag{41}$$

Note that

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

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

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

From the behavior of $\frac{\partial F(\eta,\alpha)}{\partial \eta}$ described above, it follows that:
(i) $min(\alpha, \hat{\eta})$ is a local minimum for $F(\eta, \alpha)$;
(ii) $F(\eta, \alpha)$ is weakly decreasing in η if $\alpha = \hat{\eta}$.

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

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

$$G(\hat{\eta}, \alpha) < 0 \tag{42}$$

where $G(\eta_{\min}, \alpha) = G(\eta_{\max}, \alpha) = 0$ 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 $F(\eta, \alpha)$ and rearranging terms, the necessary and sufficient condition described in (42) becomes:

$$\alpha > \alpha_{MIN} \equiv \frac{2(m_L - m_H) - \frac{S_H}{\sqrt{2\pi}} exp[-\frac{S_L(lnS_H - lnS_L)}{S_H - S_L}] + \frac{S_L}{\sqrt{2\pi}} exp[-\frac{S_H(lnS_H - lnS_L)}{S_H - S_L}]}{\Phi[-S_H\sqrt{\frac{2(lnS_H - lnS_L)}{S_H - S_L}}] - \Phi[-S_L\sqrt{\frac{2(lnS_H - lnS_L)}{S_H - S_L}}]} > 0. \tag{43}$$

$\Diamond$

Proof of Proposition 5

Let $\bar{\eta}$ satisfy $G(\bar{\eta}, \alpha) = 0$, so that $\bar{\eta} = \eta_{\min}$ or $\eta_{\max}$ are the thresholds defined above that satisfy $G(\eta_{\min}, \alpha) = G(\eta_{\max}, \alpha) = 0$ for all $\alpha > \alpha_{MIN}$ defined in (43). Using the Implicit Function theorem:

$$\frac{d\bar{\eta}}{d\alpha} = \frac{-\frac{\partial G}{\partial \alpha}}{\frac{\partial G}{\partial \eta}}|_{\eta=\bar{\eta}} = \frac{\Phi(\frac{-\eta}{S_H}) - \Phi(-\frac{\eta}{S_L})}{\frac{\partial F(\eta)}{\partial \eta}}|_{\eta=\bar{\eta}}. \tag{44}$$

The numerator of (44) is positive. From the proof of proposition 4, the denominator of (44) is

negative for $\bar{\eta} = \eta_{min}$, and positive for $\bar{\eta} = \eta_{max}$. This completes the proof. $\Diamond$

Proof of Proposition 6

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

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. $\Diamond$

Appendix B–Difference-in-Difference Implementation

We begin with the model specification for the cross-sectional tests

$$y_{ist} = \beta_i + \beta_t + \beta_1 TI_{s,t} + \beta_2 TI_{s,t}^2 + \beta_3 MI_{i,t-1} + \beta_4 \left(TI_{s,t}^2 * MI_{i,t-1}\right) + \beta \cdot X_{ist} + \varepsilon_{ist} \tag{45}$$

The difference-in-difference tests are designed to weaken the identifying assumption underlying the cross-sectional tests, i.e., the error term ε_{ist} is uncorrelated with each of the regressors in (45).

Suppose state s passes n anti-takeover laws in years $t_1, ..., t_n$ where $1 < ... < n$ and t_l denotes the year in which state s passes the lth law. We assume that a law takes effect at the beginning of the succeeding year in which it is passed. In other words, even though the lth law is passed in year t_l, it only becomes effective at the beginning of year $t_l + 1$. We denote the time period from year $t_l + 1$ to year t_{l+1}, i.e., the period during which all the l laws are effective in state s, as m_l. Equivalently, $m_l = [t_l + 1, t_{l+1}]$. Let $TI_s(m_l)$ denote the value of the anti-takeover index during the period m_l. The variable $TI_s(m_l)$ therefore denotes the value of the anti-takeover index in state s when all the l anti-takeover laws are effective. Note that $TI_{s,t} = TI_s(m_l)$ for any $t \in m_l$.

Summing (45) over all $t \in m_l$ and dividing by the length $t_{l+1} - t_l$ of the interval m_l, we obtain:

$$\begin{aligned} \overline{y}_{is}(m_l) &= \beta_i + \overline{\beta}(m_l) + \beta_1 TI_s(m_l) + \beta_2 TI_s^2(m_l) + \beta_3 \overline{MI}_i(m_l) + \beta_4 \overline{MI}_i(m_l) * TI_s^2(m_l) \\ &\quad + \beta \cdot \overline{X}_{is}(m_l) + \overline{\varepsilon}_{is}(m_l) \end{aligned} \tag{46}$$

where $\overline{y}_{is}(m_l)$ denotes the average level of innovation, and $\overline{X}_{is}(m_l)$ denotes the average values of the control variables, for all firms i incorporated in state s over the time period $m_l = [t_l + 1, t_{l+1})$. The variable $\overline{MI}_i(m_l)$ denotes the average level of monitoring intensity of firm i over the time period $[t_l, t_{l+1} - 1)$. Note that because we examine the effects of lagged monitoring intensity on innovation (see 45), the average of the monitoring intensity is taken over the period $[t_l, t_{l+1} - 1]$ and not over the period $[t_l + 1, t_{l+1}]$. The variable $\overline{\varepsilon}_{is}(m_l)$ denotes the average of the error terms ε_{ist} in (45) over the period m_l.

Subtracting (46) from (45), we obtain

$$\begin{aligned} y_{ist} - \overline{y}_{is}(m_l) &= \beta_t - \overline{\beta}(m_l) + \beta_1 [TI_{s,t} - TI_s(m_l] + \beta_2 \left[TI_{s,t}^2 - TI_s^2(m_l)\right] + \beta_3 [MI_{i,t-1} - \overline{MI}_i(m_l] \\ &\quad + \beta \cdot \left(X_{ist} - \overline{X}_{is}(m_l)\right) + \beta_4 \left[MI_{i,t-1} * TI_{s,t}^2 - \overline{MI}_i(m_l) * TI_s^2(m_l)\right] \\ &\quad + \underbrace{\varepsilon_{ist} - \overline{\varepsilon}_{is}(m_l)}_{\nu_{ist}} \end{aligned} \tag{47}$$

where $t \in m_{l+1}$.

The term $y_{ist} - \overline{y}_{is}(m_l)$ therefore captures the *change in innovation* in year $t \in m_{l+1}$ for firm i in state s as a result of the passage of $(l+1)^{th}$ law in state s where the change is calculated relative to

the average level of innovation for the same firm during the period m_l preceding the passage of the law when l laws were effective.

Let c denote a state that *never passed a law* during the *entire time period* of our sample (e.g., the state of California in our sample). We index the set of firms incorporated in such states by j. These firms constitute our *control group*. Because the anti-takeover index is a constant equal to TI_c for the entire sample period for this group of firms so that $TI_{c,t} = TI_c$ for all t, (47) for these firms reduces to

$$\begin{aligned} y_{jct} - \overline{y}_{jc}(m_l) &= \beta_t - \overline{\beta}(m_l) + \beta \cdot \left(X_{jct} - \overline{X}_{jc}(m_l)\right) \\ &+ \left[\beta_3 + \beta_4 (TI_{c,t})^2\right] \left[MI_{j,t-1} - \overline{MI}_j\,(m_l)\right] + \underbrace{\varepsilon_{jct} - \overline{\varepsilon}_{jc}(m_l)}_{\nu_{jct}} \end{aligned} \tag{48}$$

Subtracting (48) from (47), we obtain

$$\begin{aligned} & \left[y_{ist} - \overline{y}_{is}(m_l)\right] - \left[y_{jct} - \overline{y}_{jc}(m_l)\right] \\ = \; & \beta_1 \left[(TI_{s,t} - TI_s(m_l)) - \overbrace{(TI_{c,t} - TI_c)}^{=0} \right] + \beta_2 \left[\left(TI_{s,t}^2 - TI_s^2(m_l)\right) - \overbrace{\left(TI_{c,t}^2 - TI_c^2\right)}^{=0} \right] \\ & + \beta_3 \cdot \left[\left(MI_{i,t-1} - \overline{MI}_i\,(m_l)\right) - \left(MI_{j,t-1} - \overline{MI}_j\,(m_l)\right)\right] \\ & + \beta_4 \left[\left(MI_{i,t-1} * TI_{s,t}^2 - \overline{MI}_i(m_l) * TI_s^2(m_l)\right) - \left(MI_{j,t-1} * TI_{c,t}^2 - \overline{MI}_j(m_l) * TI_c^2\right)\right] \\ & + \beta \cdot \left[\left(X_{ist} - \overline{X}_{is}(m_l)\right) - \left(X_{jct} - \overline{X}_{jc}(m_l)\right)\right] - \nu_{ist} - \nu_{jct} \end{aligned} \tag{49}$$

Comparing (49) with (28), $\beta_1, \beta_2, \beta_3, \beta_4$ are identified as *difference-in-difference* coefficients where the treatment group of firms that experience a law are compared with the control group that does not. The identifying assumptions are that the error term $\nu_{ist} - \nu_{jct}$ should be uncorrelated with the regressors in (49). In other words, around a particular law change, *unexplained variation* in the change in innovation for the treatment group *relative* to the control group is uncorrelated with the regressors.

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Table 1: Summary Statistics and Correlations

This table displays the summary statistics for the proxies for Innovation and the proxy for Monitoring Intensity. The variables are winsorized at the 1% and 99% levels. Since the unit of observation is a firm-year, all the summary statistics are computed at the firm-year level of aggregation.

Number of firm-year observations = 10377

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
R&D/Sales	0.18	0.04	0.75	0	6.65
Number of Patents	19.5	3.0	66.5	1	1127
Number of Citations	197.8	15.0	752.6	0	15006
Total Blockholder ownership %	13.8%	13.4%	10.6%	0	79.7%

Table 2: State of Incorporation of Firms in our Sample

The top panel shows the number of observations and the number of firms by the state of incorporation. The bottom panel shows the year(s) in which anti-takeover laws were passed in each state, the value of the index before the change and the change in the index. We compile this list of changes by combining the anti-takeover index from Bebchuk and Cohen (2003) together the list of law passages compiled by Bertrand and Mulainathan (2003) and Karpoff and Malatesta (1989). While we rely primarily on Bebchuk and Cohen (2003) for the list of law passages, we cross-checked the year of passage of these laws using the list provided in Bertrand and Mulainathan (2003) and Karpoff and Malatesta (1989). In those instances where the year of passage of the law did not coincide across these three studies, we cross-checked the year using Lexis-Nexis' annotated state statutes.

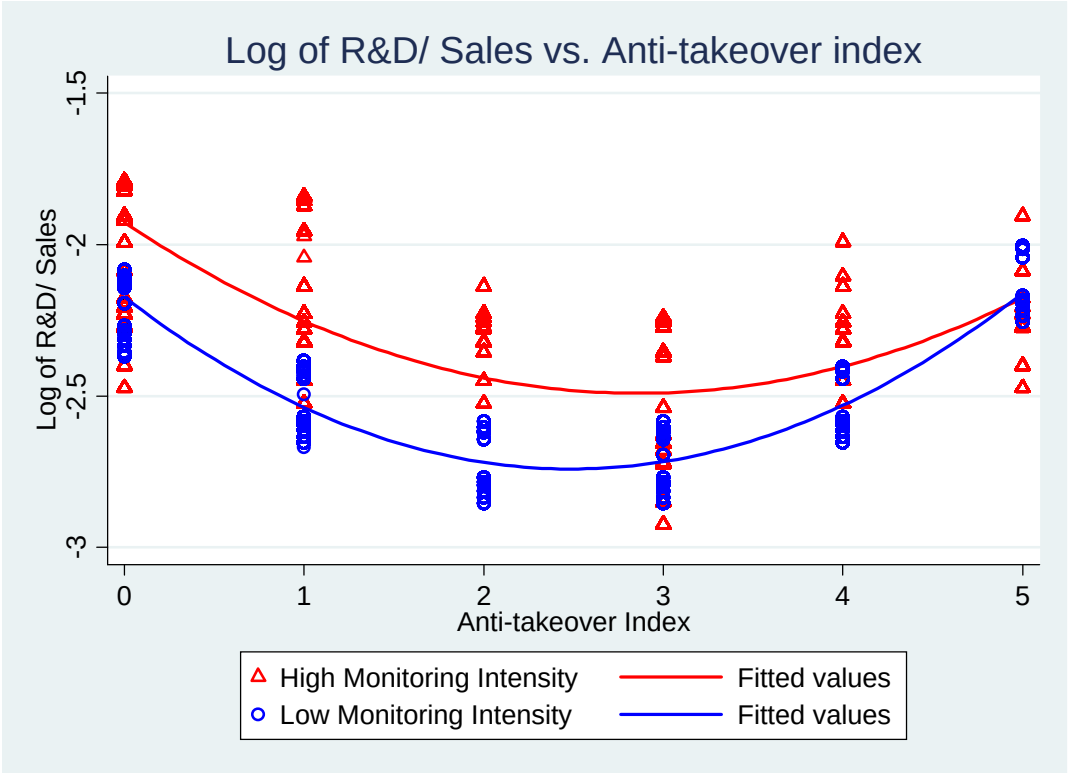
Number of firm-year observations = 10377

State	# obns	State	# obns
Delaware	4,888	Pennsylvania	392
California	1,029	Minnesota	307
New York	651	New jersey	264
Ohio	487	Others	1930
Massachusetts	429		

State	Year	Index before	Change	State	Year	Index before	Change
Colorado	1989	0	1	North Carolina	1987	0	2
Connecticut	1984	0	1	North Carolina	1990	2	1
Connecticut	1989	1	1	Nebraska	1988	0	2
Delaware	1988	0	1	New jersey	1986	0	2
Florida	1987	0	2	New jersey	1989	2	2
Florida	1989	2	2	Nevada	1987	0	1
Georgia	1985	0	1	Nevada	1989	1	1
Georgia	1988	1	1	Nevada	1991	2	3
Georgia	1989	2	2	New York	1985	0	3
Iowa	1989	0	2	New York	1989	3	1
Illinois	1984	0	2	Ohio	1982	0	3
Illinois	1989	2	2	Ohio	1990	3	2
Indiana	1986	0	4	Oklahoma	1987	0	1
Indiana	1989	4	1	Oregon	1987	0	1
Kansas	1988	0	1	Oregon	1989	1	2
Massachusetts	1987	0	1	Oregon	1991	3	1
Massachusetts	1989	1	3	Pennsylvania	1988	0	1
Maryland	1983	0	1	Pennsylvania	1989	1	3
Maryland	1988	1	1	Pennsylvania	1993	4	1
Maryland	1989	2	1	Rhode island	1990	0	4
Michigan	1984	0	1	South Carolina	1988	0	3
Michigan	1988	1	1	Tennessee	1988	0	4
Michigan	1989	2	1	Tennessee	1989	4	1
Minnesota	1984	0	1	Utah	1987	0	1
Minnesota	1987	1	2	Utah	1989	1	1
Minnesota	1991	3	1	Virginia	1985	0	1
Missouri	1984	0	1	Virginia	1988	1	2
Missouri	1986	1	3	Virginia	1992	3	1
Mississippi	1985	0	1	Washington	1987	0	2
Mississippi	1990	1	1	Wisconsin	1984	0	2
Mississippi	1991	2	1	Wisconsin	1987	2	3

Figure 3: Scatter and Quadratic Fit Plots

The top (bottom) figure plots the *residuals* of a regression of logarithm of R&D/Sales (number of patents) on firm and application year dummies versus the anti-takeover index for high (i.e. above median) and low (i.e. below median) values of the proxy for monitoring intensity. The hollow triangles (hollow circles) correspond to high (low) monitoring intensity. The smoothed line fits a quadratic function to the raw data.



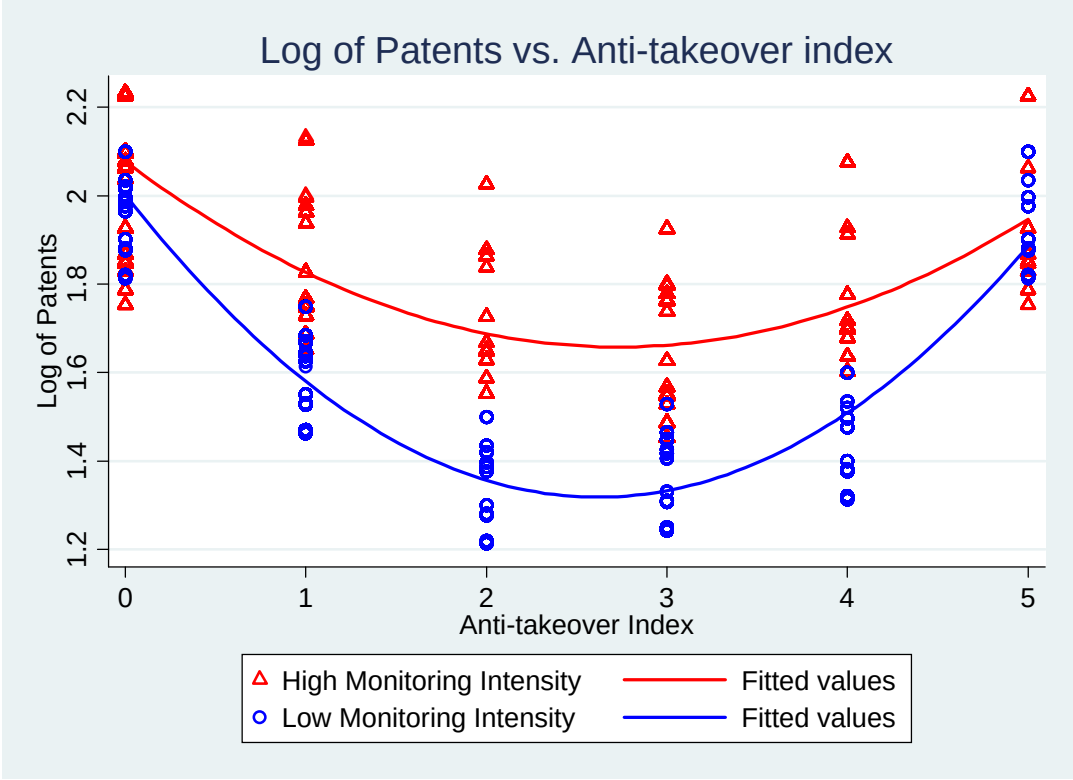


Table 3: Cross-sectional Regressions

$$y_{ist} = \beta_i + \beta_t + \beta_1 \cdot TI_{st} + \beta_2 \cdot \left(TI_{st}\right)^2 + \beta_3 \cdot MI_{i,t-1} + \beta_4 \cdot \left\{MI_{i,t-1} * \left(TI_{st}\right)^2\right\} + \beta \cdot X_{ist} + \varepsilon_{ist}$$

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 ratio of R&D expenditures to Sales in year *t* (Columns 1-3) (b) the number of patents applied for (and eventually granted) in year t (Columns 4-6), (b) the number of subsequent citations to these patents (Columns 7-9). All regressions are estimated using OLS. The sample consists of firms that applied for a patent over the period 1981-1995 (and the patent was eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. The variable $TI_{s,t}$ equals the value of the anti-takeover index in state s at the end of year t. The variable $MI_{i,t-1}$ denotes the Monitoring Intensity in firm *i* in year *t-1*. The variables β_i and β_t denote firm & year fixed effects. 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 logarithm of:	(1) R&D/ Sales	(2) R&D/ Sales	(3) R&D/ Sales	(4) Patents	(5) Patents	(6) Patents	(7) Citations	(8) Citations	(9) Citations
Anti-takeover Index (H1)	-0.467***	-0.404***	-0.450***	-0.315***	-0.298***	-0.281***	-0.335***	-0.314***	-0.283***
	(6.80)	(6.37)	(5.93)	(6.98)	(6.72)	(5.54)	(6.76)	(6.39)	(5.10)
Square of Anti-takeover Index (H1)	0.086***	0.074***	0.073***	0.051***	0.048***	0.038***	0.058***	0.054***	0.040***
	(6.91)	(6.45)	(4.69)	(5.72)	(5.44)	(3.59)	(5.98)	(5.65)	(3.48)
Minimum ($-\beta_1/ 2*\beta_2$)	2.715	2.730	3.082	3.088	3.104	3.697	2.888	2.907	3.538
Proxy for Monitoring Intensity (H2)	1.962***	1.698***	2.266***	1.337***	1.260***	1.430***	1.412***	1.333***	1.542***
	(6.49)	(6.22)	(5.07)	(7.90)	(7.65)	(5.54)	(7.58)	(7.37)	(5.66)
Square of Anti-takeover Index *	-0.082***	-0.069***	-0.093***	-0.051***	-0.047***	-0.055***	-0.053***	-0.050**	-0.057**
Proxy for Monitoring Intensity (H3)	(2.91)	(2.63)	(3.05)	(2.85)	(2.71)	(2.76)	(2.59)	(2.49)	(2.49)
Current Log of Assets		0.101***	0.106***		0.046***	0.041***		0.049***	0.042***
		(4.00)	(2.80)		(5.54)	(3.93)		(5.08)	(3.22)
Lagged R&D/ Sales		0.001	0.003		0.001***	0.002***		0.000	0.001*
		(1.00)	(1.25)		(2.71)	(4.00)		(0.90)	(1.95)
Lagged Tobin's Q		-0.034**	-0.009		-0.011	0.007		-0.004	0.023
		(2.30)	(0.36)		(1.54)	(0.57)		(0.52)	(1.16)
Lagged Herfindahl Index		1.802***	2.011***		0.375***	0.548***		0.615***	0.720***
		(6.38)	(4.94)		(2.96)	(3.04)		(4.64)	(3.76)
Square of Lagged Herfindahl Index		-1.663***	-1.825***		-0.629***	-0.764***		-0.502***	-0.727***
		(5.95)	(4.62)		(4.74)	(4.08)		(3.92)	(4.23)
Firm age		0.021	0.014		-0.068***	-0.074***		-0.080***	-0.087***
		(1.52)	(0.61)		(7.45)	(5.88)		(7.93)	(6.50)
Observations	10377	10377	5489	10377	10377	5489	10377	10377	5489
Adjusted R-squared	0.05	0.11	0.12	0.06	0.09	0.09	0.11	0.13	0.13
Sample	All	All	No Delaware	All	All	No Delaware	All	All	No Delaware
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Difference-in-Difference Regressions Exploiting the Sequential passage of Anti-takeover Laws

$$y_{ist}-\overline{y}_{is}(m_l)=\beta_0+\beta_t+\beta_1\cdot\left[TI_{st}-TI_s(m_l)\right]+\beta_2\cdot\left[TI_{st}^2-TI_s^2(m_l)\right]+\beta_3\cdot\left[MI_{i,t-1}-\overline{MI}_i(m_l)\right]+\beta_4\cdot\left[MI_{i,t-1}\cdot TI_{st}^2-\overline{MI}_i(m_l)\cdot TI_s^2(m_l)\right]+\beta\cdot\left(X_{ist}-\overline{X}_{is}(m_l)\right)+\varepsilon_{ist}$$

The variables t_l and t_{l+1} respectively denote the years in which state s passed the lth and $(l+1)^{th}$ laws. Denote the time period during which state s passed the lth law but not the $(l+1)^{th}$ as m_l. The variable y_{ist} denotes a measure of innovation in year $t \in m_{l+1}$ for firm i incorporated in state s while $\overline{y}_{is}(m_l)$ is the average of y_{ist} over the time period m_l. The variable TI_{st} denotes the value of the anti-takeover index in state s at the end of year t while $TI_s(m_l)$ denotes the constant value of the anti-takeover index during the period m_l. The variable $MI_{i,t-1}$ denotes the monitoring intensity for firm i in year $t-1$ while $\overline{MI}_i(m_l)$ is the average value of monitoring intensity for firm i over the time period $[t_l, t_{l+1}-1]$. The vector X_{ist} denotes the set of control variables for firm i in year t while the vector $\overline{X}_{is}(m_l)$ is the average of X_{ist} over the time period m_l. The variable β_t denotes year fixed effects. All regressions are estimated using OLS. The sample consists of firms that applied for a patent over the period 1981-1995 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. The standard errors are robust to heteroskedasticity and autocorrelation and are clustered by state of incorporation. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable is logarithm of:	R&D/ Sales	R&D/ Sales	R&D/ Sales	Patents	Patents	Patents	Citations	Citations	Citations
Δ Anti-takeover Index	-0.294***	-0.263***	-0.255*	-0.243***	-0.225***	-0.226***	-0.258***	-0.237***	-0.229***
	(2.97)	(2.92)	(1.94)	(4.96)	(4.58)	(3.56)	(4.68)	(4.07)	(3.48)
Δ Square of Anti-takeover Index	0.062***	0.054***	0.053**	0.040***	0.037***	0.042***	0.045***	0.041***	0.045***
	(3.24)	(3.05)	(2.24)	(3.89)	(3.34)	(3.20)	(3.66)	(2.95)	(2.86)
Minimum ($-\beta_1/2*\beta_2$)	2.371	2.435	2.406	3.038	3.041	2.690	2.867	2.890	2.544
Δ Proxy for Monitoring Intensity	1.702**	1.067**	2.194***	2.725***	2.186***	3.085***	2.870***	2.272***	3.198***
	(2.41)	(2.58)	(6.74)	(6.55)	(5.34)	(6.61)	(6.34)	(5.53)	(5.67)
Δ Interaction of Square of Anti-takeover	-0.195***	-0.084**	-0.155***	-0.104***	-0.121***	-0.162***	-0.137***	-0.134***	-0.180***
Index with Proxy for Monitoring Intensity	(3.24)	(2.05)	(2.96)	(4.00)	(4.00)	(3.53)	(4.21)	(3.60)	(3.08)
Δ Current Log of Assets		0.279***	0.269***		0.164***	0.145***		0.201***	0.174***
		(7.69)	(4.28)		(13.58)	(9.93)		(13.10)	(10.87)
Δ Lagged R&D/ Sales		0.005***	0.007**		0.001***	0.001		-0.000**	-0.001
		(10.95)	(2.68)		(5.88)	(1.37)		(2.44)	(0.87)
Δ Lagged Tobin's Q		0.073***	0.046		0.021***	0.038**		0.051***	0.089***
		(5.17)	(1.23)		(3.25)	(2.27)		(4.73)	(5.11)
Δ Lagged Herfindahl Index		1.646**	2.248**		0.470	0.100		0.575	-0.093
		(2.69)	(2.07)		(1.47)	(0.19)		(1.32)	(0.16)
Δ Square of Lagged Herfindahl Index		-1.627**	-2.568**		-0.351	-0.030		-0.372	0.118
		(2.30)	(2.23)		(1.13)	(0.05)		(0.91)	(0.16)
Δ Firm age		-0.049***	-0.050***		0.040***	0.039***		0.031***	0.032***
		(25.09)	(11.73)		(16.31)	(7.77)		(11.57)	(5.45)
Observations	10377	10377	5489	10377	10377	5489	10377	10377	5489
Adjusted R-squared	0.02	0.21	0.22	0.05	0.33	0.32	0.07	0.29	0.27
Sample	All	All	No Delaware	All	All	No Delaware	All	All	No Delaware
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: Difference-in-Difference Regressions Exploiting the Sequential passage of Anti-takeover Laws using Innovation outside State of Incorporation for the Treatment Sample

$$y_{kist} - \overline{y}_{kis}(m_l) = \beta_0 + \beta_t + \beta_1 \cdot \left[TI_{st} - TI_s(m_l)\right] + \beta_2 \cdot \left[TI_{st}^2 - TI_s^2(m_l)\right] + \beta_3 \cdot \left[MI_{i,t-1} - \overline{MI}_i(m_l)\right]$$
$$+\beta_4 \cdot \left[MI_{i,t-1} \cdot TI_{st}^2 - \overline{MI}_i(m_l) \cdot TI_s^2(m_l)\right] + \beta \cdot \left[X_{ist} - \overline{X}_{is}(m_l)\right] + \varepsilon_{kist}$$

The variables t_l and t_{l+1} denote the years in which state s passed the lth and $(l+1)^{th}$ laws. Denote the time period when state s passed the lth law but not the $(l+1)^{th}$ as m_l. The variable y_{kist} is a measure of innovation in year $t \in m_{l+1}$ for a division/ subsidiary k of firm i where division/subsidiary k is located outside the state of incorporation of s of firm i while $\overline{y}_{kis}(m_l)$ is the average of y_{kist} over the time period m_l. The variable TI_{st} denotes the value of the anti-takeover index in state s at the end of year t while $TI_s(m_l)$ denotes the constant value of the anti-takeover index during the period m_l. The variable $MI_{i,t-1}$ denotes the monitoring intensity for firm i in time $t-1$ while $\overline{MI}_i(m_l)$ is the average value of monitoring intensity for firm i over the time period $[t_l, t_{l+1} - 1]$. The vector X_{ist} denotes the set of control variables for firm i in year t while the vector $\overline{X}_{is}(m_l)$ is the average of X_{ist} over the time period m_l. The variable β_t denotes year fixed effects. All regressions are estimated using OLS. The sample consists of firms that applied for a patent over the period 1981-1995 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. For firms incorporated in states that passed the anti-takeover law, y includes only those patents applied for (and eventually granted) by subsidiaries/ divisions outside the state of incorporation and citations to these patents. The standard errors are robust to heteroskedasticity and autocorrelation and are clustered by state of incorporation. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

Dependent Variable is logarithm of:	(1) Patents	(2) Patents	(3) Patents	(4) Citations	(5) Citations	(6) Citations
Δ Anti-takeover Index	-0.066**	-0.048**	-0.050*	-0.090**	-0.061*	-0.061*
	(2.60)	(2.46)	(1.96)	(2.62)	(1.71)	(1.70)
Δ Square of Anti-takeover Index	0.020***	0.017***	0.021***	0.026**	0.020*	0.022**
	(3.30)	(2.77)	(3.20)	(2.54)	(1.91)	(2.29)
Δ Proxy for Monitoring Intensity	3.465***	3.725***	4.688***	3.830***	3.995***	5.184***
	(8.24)	(9.01)	(12.93)	(7.71)	(8.43)	(12.64)
Δ Interaction of Square of Anti-takeover	-0.113***	-0.111***	-0.156***	-0.134***	-0.111***	-0.177***
Index with Proxy for Monitoring Intensity	(6.96)	(6.09)	(6.30)	(4.88)	(3.81)	(5.39)
Δ Current Log of Assets		0.075***	0.063***		0.118***	0.104***
		(10.16)	(8.26)		(10.97)	(7.51)
Δ Lagged R&D/ Sales		0.001***	0.001***		-0.000***	-0.000
		(9.08)	(3.00)		(3.78)	(0.38)
Δ Lagged Tobin's Q		0.026***	0.041***		0.068***	0.117***
		(5.40)	(4.27)		(4.77)	(6.19)
Δ Lagged Herfindahl Index		-0.288	0.003		-0.603	-0.145
		(1.29)	(0.01)		(1.61)	(0.30)
Δ Square of Lagged Herfindahl Index		0.335**	0.286		0.656**	0.781
		(2.24)	(0.81)		(2.09)	(0.99)
Δ Firm age		0.012***	0.014***		-0.000	0.005*
		(12.79)	(11.08)		(0.00)	(1.91)
Observations	25341	25341	13179	25341	25341	13179
Adjusted R-squared	0.08	0.17	0.21	0.07	0.13	0.17
Sample	All	All	No Delaware	All	All	No Delaware
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Difference-in-Difference Regressions Exploiting the Sequential passage of Anti-takeover laws using S&P 500 index Entry and Exit as an Instrument for Changes in Blockholder Ownership

$$y_{ist} - \overline{y}_{is}(m_l) = \beta_0 + \beta_t + \beta_1 \cdot \left[TI_{st} - TI_s(m_l)\right] + \beta_2 \cdot \left[TI_{st}^2 - TI_s^2(m_l)\right] + \beta_3 \cdot SP_{i,t-1} + \beta_4 \cdot SP_{i,t-1}\left[TI_{st}^2 - TI_s^2(m_l)\right] + \beta \cdot \left[X_{ist} - \overline{X}_{is}(m_l)\right] + \varepsilon_{ist}$$

The variables t_l and t_{l+1} denote the years in which state s passed the lth and $(l+1)^{th}$ laws. Denote the time period when state s passed the lth law but not the $(l+1)^{th}$ as m_l. The variable y_{ist} denotes a measure of innovation in year $t \in m_{l+1}$ for firm i incorporated in state s while $\overline{y}_{is}(m_l)$ is the average of y_{ist} over the time period m_l. The variable TI_{st} denotes the value of the anti-takeover index in state s in year t while $TI_s(m_l)$ denotes the constant value of the anti-takeover index during the period m_l. 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, the variable $SP_{i,t}$ 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 vector X_{ist} denotes the set of control variables for firm i in year t while the vector $\overline{X}_{is}(m_l)$ is the average of X_{ist} over the time period m_l. The variable β_t denotes year fixed effects. All regressions are estimated using OLS. The sample consists of firms that applied for a patent over the period 1981-1995 (and eventually granted by the U.S. Patent Office) matched to Compustat and CDA Spectrum. The standard errors are robust to heteroskedasticity and autocorrelation and are clustered by state of incorporation. ***, **, * denote significance at 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	Sample using entry into S&P 500			Sample using exit into S&P 500		
Dependent variable is the logarithm of:	R&D/ Sales	Patents	Citations	R&D/ Sales	Patents	Citations
Δ Anti-takeover Index	-0.277***	-0.248***	-0.252***	-0.263***	-0.235***	-0.235***
	(4.24)	(4.69)	(3.95)	(3.74)	(4.35)	(3.58)
Δ Square of Anti-takeover Index	0.033**	0.025**	0.025*	0.032**	0.026**	0.026*
	(2.03)	(2.66)	(1.77)	(2.07)	(2.49)	(1.70)
Entry into/ Exit from S&P	0.450***	0.716***	0.905***	0.458***	0.595***	0.695***
	(5.22)	(6.02)	(6.67)	(4.52)	(4.67)	(4.21)
Entry into/ Exit from S&P *	-0.068***	-0.072***	-0.090***	-0.061***	-0.072***	-0.091***
Δ Square of Anti-takeover Index	(2.72)	(2.88)	(3.40)	(3.57)	(3.17)	(3.12)
Δ Current Log of Assets	-0.212***	0.240***	0.256***	-0.215***	0.241***	0.259***
	(5.36)	(7.28)	(8.14)	(5.54)	(7.10)	(8.23)
Δ Lagged R&D/ Sales	0.005***	0.001***	-0.000	0.005***	0.001***	-0.000
	(9.54)	(6.22)	(0.38)	(9.57)	(5.45)	(0.78)
Δ Lagged Tobin's Q	0.047***	0.033***	0.063***	0.049***	0.036***	0.067***
	(4.63)	(3.53)	(5.09)	(5.17)	(3.78)	(4.92)
Δ Lagged Herfindahl Index	-3.037***	-1.406***	-1.622***	-2.956***	-1.329***	-1.549***
	(3.71)	(4.45)	(3.70)	(3.66)	(4.66)	(3.87)
Δ Square of Lagged Herfindahl Index	3.183***	1.270***	1.410***	3.123***	1.219***	1.366***
	(3.05)	(3.67)	(3.03)	(2.94)	(3.95)	(3.19)
Δ Firm age	-0.010***	0.026***	0.017***	-0.011***	0.024***	0.015***
	(2.77)	(10.92)	(8.30)	(3.22)	(10.70)	(7.29)
Observations	10377	10377	10377	10377	10377	10377
Adjusted R-squared	0.11	0.34	0.28	0.11	0.34	0.28
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes