# Corporate Governance and Innovation: Theory and Evidence

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**Abstract**

We develop a 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) for a given level of monitoring intensity, there is a U–shaped relationship between innovation and the takeover pressure the firm faces; (ii) for a given level of takeover pressure, the likelihood that a firm innovates increases as monitoring intensity increases, and (iii) the marginal positive effect of monitoring intensity on innovation is smaller the lower the takeover pressure the firm faces.

Our empirical analysis provides strong support for our predictions using both cross-sectional and time-series tests. We employ patents and citations to proxy for innovation. Our time-series tests address potential endogeneity concerns by exploiting the passage of antitakeover laws as a natural experiment for changes in takeover pressure.

Our study highlights the complementary role of external governance mechanisms, such as anti-takeover statutes, and internal governance mechanisms that influence shareholders' monitoring intensity in encouraging innovation.

JEL: G31, G34, K22

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# 1 Introduction

The spate of highly publicized corporate scandals in recent years has provided a lot of fodder for the debate about the appropriate features of corporate governance. Given the intensity of this debate, the academic literature has investigated the impact of corporate governance on shareholder value by investigating the effects of corporate governance on equity prices and/or executive compensation. Somewhat surprisingly, however, academic work that explores the *real* effects of corporate governance is relatively sparse. In this study, we address a more *primitive* question: how do various corporate governance mechanisms influence a firm's incentives to undertake value-enhancing innovative projects?

We develop a parsimonious model to study how a manager's incentives to undertake an innovative project is affected by the internal *monitoring intensity* she faces from shareholders, and the external *takeover pressure* the firm faces. The model predicts that innovation varies non-monotonically in a U-shaped manner with the extent of takeover pressure that a firm faces. Monitoring intensity has a positive effect on innovation, but this positive effect declines at the margin as takeovers become more difficult. We test the main predictions of the theory in our empirical analysis. Using both cross-sectional and time-series tests, we find strong empirical support for our predictions. From a normative standpoint, our study suggests that, to optimally foster value-increasing innovative activity, laws and regulations influencing takeover pressure should either be non-existent, or be strong enough to significantly deter takeovers. External governance mechanisms, such as anti-takeover laws, and internal governance mechanisms, such as monitoring intensity, complement each other to encourage innovation.

We construct a one-period model in which the manager of a firm chooses between a *routine* project and an *innovative* project at date zero. We call a project routine if it contains tasks involving a low level of uncertainty. In contrast, an innovative project involves highly uncertain activities that therefore generate a higher expected payoff than the routine project. The manager derives private control benefits that are pecuniary in nature; these private benefits increase proportionally with the project's payoff. The manager's expected private control benefits are affected by the monitoring intensity and the takeover pressure that she faces. The lower the shareholders' monitoring intensity, the easier it is for the manager to extract private benefits. The greater the takeover pressure the firm faces, the lower is the likelihood that the manager is able to successfully retain control over the firm and, thereby, extract the control benefits.

While the manager's project choice and her private control benefits are non-contractible, the project's payoff is contractible. The shareholders can, therefore, influence the manager's project choice through a compensation contract that could be explicitly contingent on the project's payoff. We assume that the private benefits accrue to the agent who has control over the firm. Therefore, the manager cedes these control benefits to the raider if the takeover materializes. Consequently, in designing the optimal compensation contract, the shareholders rationally anticipate that the manager would lose pecuniary control benefits to the raider if the takeover is successful. Assuming that shareholders and the manager are risk-neutral, the manager's objective is to maximize the expected payoff from the project less the expected loss of private control benefits in the event of a takeover. In a first–best environment, where private control benefits are absent, the manager always chooses the innovative project since it maximizes the expected total surplus. However, in our second–best environment where the manager derives private control benefits, choosing the riskier innovative project has the additional effect of increasing the likelihood of takeover and thereby decreasing the manager's expected private benefits. Consequently, the manager faces a tradeoff between maximizing the expected payoff of the firm (shareholders + manager) versus maximizing her expected control benefits. Since the magnitude of private benefits depends upon the shareholders' monitoring intensity, this tradeoff is moderated by the interaction between shareholders' monitoring intensity and the takeover pressure the firm faces.

In our model, we avoid technical complexities but incorporate enough richness to capture the tradeoff described above. The analysis of the model generates the following three testable predictions:

1. For a given level of monitoring intensity, there is a U–shaped relationship between the likelihood of innovation and the takeover pressure the firm faces. Equivalently, when a firm faces no takeover pressure or extreme takeover pressure, it is more likely to innovate. However, if the takeover pressure is moderate, the firm is more likely not to innovate.

2. For a given level of takeover pressure, the likelihood that a firm innovates increases with the monitoring intensity.

3. The marginal positive effect of monitoring intensity on innovation described in (2) is smaller the lower the takeover pressure the firm faces.

The intuition behind the U–shaped relationship between innovation and takeover pressure described in (1) is as follows. When the firm faces no takeover pressure, the likelihood that the manager loses her control benefits is quite low. She, therefore, chooses the innovative project because it maximizes the expected payoff to the firm. In other words, the distortions created by the potential loss of the manager's control benefits are minor when a takeover is less likely so that the first best choice of the innovative project is also optimal in the second-best setting. Conversely, when the takeover pressure is extremely high, the likelihood of losing control benefits is very high. In this case, the manager has "little to lose" and therefore speculates by choosing the innovative project for its higher expected payoff. When takeover pressure is moderate, the manager chooses the less risky routine project since it lowers the likelihood of a takeover and the associated loss of control benefits. The intuition behind result (2) is quite straightforward. For any given level of takeover pressure, as monitoring intensity increases, the manager has less to lose from giving up control so that the region of moderate takeover pressure where the manager does not innovate shrinks. The intuition behind result (3) is more subtle. As takeover pressure decreases, the likelihood that firms innovate increases. For such firms, the expected loss of control benefits are generally lower and therefore the marginal gains from increased monitoring are also lower. Thus, monitoring intensity and takeover pressure play *complementary* roles in motivating innovation.

We test the predictions of the theory by using data on the patents issued by the US Patent Office to US firms over the period 1987 to 2002, and the trail of citations to these patents. These data were first constructed and used by Hall, Jaffe and Trajtenberg (2001) as a measure of the extent of innovative activity. To measure monitoring intensity, we employ the presence of institutional blockholder ownership and public pension fund ownership as in Cremers and Nair (2005). Instead of employing firm level measures of anti-takeover defenses, which could be driven by factors that may be correlated to innovation too, we employ state level anti-takeover statutes as our proxy for takeover pressure. For our cross-sectional analysis, we employ the state level anti–takeover index as constructed by Bebchuk and Cohen (2003). Through our time series analysis, we further address endogeneity concerns by exploiting the passage of these anti-takeover statutes as a natural experiment for change in takeover pressures.

The results of our empirical analysis support our theoretical predictions. We find strong evidence of a U–shaped relationship between our measure of takeover pressure and our measure of innovation. When the value of the anti–takeover index in a state is zero (so that takeover pressure is high), as it is in California, a one point increase in the value of the index on average *decreases* annual patents and citations for firms incorporated in the state by 12.3% and 15.2% respectively. In contrast, if the value of the index is four (so that takeover pressure is low), as it was in Pennsylvania in 1992, a one point increase in the value of the index on average *increases* annual patents and citations for firms incorporated in the state by 2.9% and 7.2% respectively. Second, we find that stronger monitoring intensity is associated with greater innovation. Firms having an institutional blockholder receive on average 7.6% more patents and 9.7% more citations annually than firms without an institutional blockholder. An additional institutional blockholder is associated on average with 3.6% more annual patents and 5.3% more annual citations while the presence of an additional public pension fund is associated on average with a 6.8% increase in annual patents and 6.2% increase in annual citations. Finally, we find that an increase in the number of anti–takeover provisions in a state dampens the marginal positive impact of monitoring. A one point increase in the value of the anti–takeover index on average decreases the marginal positive impact of monitoring intensity on annual patents and citations by about 30%. Our results are qualitatively similar when we conduct time–series analyses using exogenous changes in anti–takeover laws to proxy for differences in laws affecting takeovers.

Apart from its positive implications for the effects of monitoring intensity and external takeover pressure on firm-level innovation, our study also suggests insights that are potentially interesting from a normative standpoint. The prediction of a U-shaped relation between the severity of anti-takeover statutes and innovation suggests that, in environments for which our model is a reasonable abstraction, anti-takeover laws should either be practically non-existent or be very severe. Indeed, anecdotal evidence provides some support to this key insight derived from our theory. The state of California has essentially no laws preventing takeovers (its anti-takeover index is zero), but firms incorporated in California have engaged in, and continue to engage in, a significant amount of innovative activity. On the other hand, the state of Massachusetts has very strong anti-takeover laws (its anti-takeover index is 4)[1], but also supports extensive innovation by firms. The prediction of the theory that the marginal positive effect of internal monitoring on innovation declines with the severity of anti-takeover laws suggests that internal and external governance mechanisms such as monitoring and takeover intensity play complementary roles in fostering innovation.

Our paper is related to two strands of the literature, namely the literature on corporate governance and the literature on innovation. Most of the prior literature has investigated the impact of corporate governance on either firm performance or CEO performance (for some recent examples, see e.g., Bertrand and Mulainathan (2003), Core, Holthausen, and Larcker (1999), Hermalin and Weisbach (1998), Gompers, Ishii, and Metrick (2003) and Cremers and Nair (2005)). Similarly, there is a growing literature that investigates the incentives of firms' to undertake innovative activities (see e.g, Acharya and Subramanian (2007), Manso (2007) and Rayo and Sapra (2007)). Our paper differs from prior work in that we model the link between two specific features of corporate governance, namely monitoring intensity and takeover pressure and a manager's incentives to engage in innovation. Our model generates some testable implications. Using the same proxies for monitoring intensity, takeover pressure, and innovation from prior empirical work, we find strong economic and statistical significance for our theoretical predictions. To our knowledge, this is the first paper to empirically document the real effects of corporate governance, particularly the effect of the interaction between internal and external governance mechanisms on innovation.

The rest of the paper is organized as follows. In section 2, we investigate how monitoring intensity and takeover pressure affect a manager's incentives to choose between a routine project versus an innovative project to generate three testable predictions. In section 3, we discuss data collection procedures, our empirical proxies for our measures of innovation, monitoring intensity and takeover pressure. Furthermore, we discuss our control variables as well as provide some descriptive statistics. In Section 4, we provide empirical evidence for our model's predictions using both cross–sectional and time series tests. Section 5 concludes. The appendix contains the proofs of the propositions.

[1]Apart from its anti-takeover index being 4 based on the standard anti-takeover statutes, Massachusetts adopted an unusual and more restrictive statute that was labeled "notorious" by Corporate Governance scholars and observers (Bebchuk and Cohen, 2003). It passed a statute that mandated a staggered board, which has a strong antitakeover force, even for firms that did not have a provision to this effect in their charter.

# 2 The Model

We consider a single–period framework with two dates $0, 1$. At date 0, the manager of an all-equity firm faces a choice between a "tried and tested" or "routine" project and a riskier "innovative" project. The initial investment for either project is $I$. All payoffs are realized at date 1. The manager and the firm's shareholders are risk-neutral with a common discount rate that is normalized to zero.

## 2.1 Projects' Payoffs

The payoffs from the routine project ($R$) and the innovative project ($I$) are lognormally distributed as follows:

$$\begin{aligned} \text{Routine Project Payoff} = \widetilde{P}_R &= P_0 \exp\left[(\mu_R - \frac{1}{2}\sigma_R^2) + \sigma_R \widetilde{z}\right], \\ \text{Innovative Project Payoff} = \widetilde{P}_I &= P_0 \exp\left[(\mu_I - \frac{1}{2}\sigma_I^2) + \sigma_I \widetilde{z}\right]. \end{aligned} \tag{1}$$

In the above formulation, $\widetilde{z}$ is a standard normal random variable. The random variables $z$ in the two preceding equations could, of course, differ from each other, but for notational simplicity, we denote them by the same letter. The variable $P_0 > I$ represents the *scale* of the firm, and determines the *level* of the payoff from either project. From (1), the expected payoffs of the routine and innovative projects are therefore $P_0 \exp(\mu_R)$ and $P_0 \exp(\mu_I)$, respectively and the variances of the payoffs of the routine and innovative projects are $P_0^2 \exp(2\mu_R)[\exp(\sigma_R^2) - 1]$ and $P_0^2 \exp(2\mu_I)[\exp(\sigma_I^2) - 1]$. We assume that

$$\mu_I > \mu_R, \ \sigma_I > \sigma_R, \tag{2}$$

so that the innovative project has higher risk and a higher expected payoff than the routine project.

## 2.2 Monitoring Intensity and Takeover Pressure

The manager derives private control pecuniary benefits that are a proportion $\alpha \in (0, 1)$ of the payoff $P$ of the project at date 1 *provided* she still controls the firm. However, if the project's payoff $P$ falls below the level $\eta > 0$, the firm is taken over by a raider with probability $p \in (0, 1)$ at date 1. The manager's private control benefits parameter $\alpha$ reflects the monitoring intensity that the manager faces with a higher (lower) value of $\alpha$ corresponding to weaker (stronger) monitoring intensity. For example, if the firm has a high proportion of ownership by outside block-holders, then the manager will be better monitored so that her private control benefits are likely to be lower. The parameter $\eta$ captures the takeover pressure that the manager faces with a lower (higher) value of $\eta$ corresponding to the scenario in which takeovers are more difficult (less difficult). Thus, a higher (lower) value of $\alpha$ corresponds to greater (lower) level of monitoring intensity on the manager.

Equivalently, a lower (greater) level of $\eta$ corresponds to lower (greater) takeover pressure on the manager.

## 2.3 The Manager's Objective Function

The manager's project choice is non-verifiable and, therefore, non-contractible. However, the date 1 cash flows to the firm (manager + shareholders) *net* of the manager's private control benefits are observable and verifiable and, therefore, contractible. At date 0, the shareholders can therefore write a compensation contract as a function of date 1 cash flows net of the manager's control benefits. Denote this compensation contract by $w(Q_X)$ where $Q_X$ denotes the total payoff to the firm (manager + shareholders) net of the manager's control benefits at date 1 given that the project chosen is $X \in \{R, I\}$.

If the firm is not taken over at date 1, then the manager extracts pecuniary benefits of $\alpha P_X$ so that the date 1 contractible cash flow is $Q_X = (1-\alpha)P_X$. If the firm is taken over date 1, the manager cedes her private control benefits to the raider who takes control of the firm. The date 1 contractible cash flows to the manager and the existing shareholders are, therefore, still given by $Q_X = (1-\alpha)P_X$. Thus, regardless of whether or not the firm is taken over, the date 1 contractible cash flow is the same, i.e., $Q_X = (1-\alpha)P_X$. However, if the firm is taken over, the manager loses all the private control benefits to the raider.

At date 0, the shareholders design an optimal contract $w(Q_X)$ to maximize their expected payoff. Therefore the choice of the project $X \in \{R, I\}$ and compensation contract $w(Q_X)$ must solve:

$$\max_{X,\, w(Q_X)} E[(1-\alpha)\widetilde{P}_X - w(\widetilde{Q}_X)] \tag{3}$$

subject to the manager's participation constraint:

$$E[(1 - p\,\Pr(P_X \leq \eta)) \cdot \alpha \widetilde{P}_X) + w(\widetilde{Q}_X)] \geq U \tag{4}$$

where $U$ denotes the manager's reservation utility. Note that in designing the optimal contract, the shareholders anticipate that the manager would lose pecuniary control benefits with probability $p\,\Pr(P_X \leq \eta)$ so that the expected amount of pecuniary benefits they would extract is $[1 - p\,\Pr(P_X \leq \eta)] \cdot \alpha E(\widetilde{P}_X)$ which is the first term in the manager's participation constraint (4).

Because the constraint (4) must hold with equality, we can solve for

$$E(w(\widetilde{Q}_X)) = U - [1 - p\,\Pr(P_X \leq \eta)] \cdot \alpha E(\widetilde{P}_X).$$

Substituting for $E(w(\widetilde{Q}_X))$ in the expected net cash flows of the firm described in (3) and simplifying yields:

$$\max_{X} E(\widetilde{P}_X) - p\Pr(P_X \leq \eta) \cdot \alpha E(\widetilde{P}_X) - \ U \tag{5}$$

The expression described in (5) implies that the manager's project choice under the optimal contract must maximize the expected value $E(\widetilde{P}_X)$ of the project less the expected private control benefits $\alpha E(\widetilde{P}_X)$ that are lost in the event of a takeover which occurs with probability $p\Pr(P_X \leq \eta)$. Note that given the friction created by the existence of private control benefits, the manager's project choice

$$X^* = \arg \max_{X \in \{R,I\}} \underbrace{E(\widetilde{P}_X)}_{\text{expected payoff}} - \underbrace{p\Pr(P_X \leq \eta) \cdot \alpha E(\widetilde{P}_X)}_{\text{expected loss in private control benefits}} \tag{6}$$

is *constrained efficient*. In a first–best environment in which private control benefits issues are moot, the manager always chooses the innovative project. However, in our second–best environment, in choosing the project, the manager has to weigh the expected payoff of the project against the expected loss in control benefits due to the takeover at date 1. Note that the expected loss in control benefits not only depends on the takeover pressure $\eta$ and monitoring intensity $\alpha$ but also on the nature of the project itself via the term $\Pr(P_X \leq \eta)$. In other words, whether project chosen is routine or innovative affects the very likelihood that the firm is taken over at date 1.

From (1), the manager's objective function can be rewritten as follows:

$$\max_{X \in \{R,I\}} P_0 e^{\mu_X} - \alpha p P_0 e^{\mu_X} \Phi\left(\frac{\log(\eta/P_0) - \mu_X - \frac{1}{2}\sigma_X^2}{\sigma_X}\right), \tag{7}$$

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

## 3 Results and Empirical Predictions

The first proposition describes the effects of takeover pressure on innovation.

**Proposition 1 (Effect of Takeover Pressure on Innovation)**
*There exists an interval $[\eta_{min}, \eta_{max}]$ such that the manager chooses the innovative project if $\eta \notin [\eta_{min}, \eta_{max}]$ and the routine project if $\eta \in [\eta_{min}, \eta_{max}]$.*

The intuition for the above result follows directly from equation (6). The manager chooses whether or not to innovate by trading off the expected payoff of the project with the expected loss of control benefits due to a takeover at date 1. Consider first the case where $\eta$ is very low, so that the manager faces almost no takeover pressure. In this case, the manager's expected loss of control benefits at date 1 are relatively small compared to the expected payoff of the project. It is, therefore, optimal for her to choose the innovative project because it has a higher total expected payoff. As $\eta$ increases, so that the takeover pressure on the firm increases, the expected loss of control benefits on her project choice increases. Above a threshold level, $\eta_{min}$ of $\eta$, it is optimal for the manager to choose the lower risk, routine project to lower the probability of takeover and the associated loss of control benefits. As $\eta$ increases above a higher trigger $\eta_{max}$, however, the likelihood of a takeover is very high. In this scenario, the manager has "little to lose" and, therefore, gambles by choosing the innovative project, which increases the total expected payoff (recall that the manager's control benefits are proportional).

Proposition 1 leads to the following testable implication.

**Testable Implication 1**
*For a given level of monitoring intensity, there is a U–shaped relation between innovation and the takeover pressure the firm faces.*

The intuition underlying Proposition 1 suggests that the manager's loss of control benefits due to a takeover plays a key role in generating a region where the manager chooses not to innovate. As mentioned earlier, the control benefits the manager extracts (and, therefore, loses due to a takeover) depend on the monitoring intensity of the firm. The following proposition describes the effects of monitoring intensity on innovation.

**Proposition 2 (Effect of Monitoring Intensity on Innovation)**
*The interval $[\eta_{min}(\alpha), \eta_{max}(\alpha)]$ for which the manager does not choose the innovative project increases as the private control benefits parameter $\alpha$ increases. More precisely,*

$$[\eta_{min}(\alpha_1), \eta_{max}(\alpha_1)] \subset [\eta_{min}(\alpha_2), \eta_{max}(\alpha_2)], \text{ for } \alpha_1 < \alpha_2, \tag{8}$$

*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 effect of the manager's expected loss of control benefits on her project choice due to a takeover dominates the expected payoff of the project so that she chooses the project with the lower expected payoff, i.e., the routine project. As the manager's control benefits increase, the potential losses she incurs due to a takeover also increase so that the interval over which she chooses the routine project increases.

So far, the variable $P_0$ determining the scale of the firm's payoff has been fixed. We now expand the model to consider the *population* of firms that might differ in the value of $P_0$. We assume that the distribution of $P_0$ across the population of firms has a lognormal distribution with mean $\Pi$.

The following proposition, which is related to Proposition 1, describes innovation for any firm in this population for *given* levels of takeover pressure $\eta$ and monitoring intensity $\alpha$.

**Proposition 3 (Innovation by an Arbitrary Firm)**
*(i) For given $\eta$ and $\alpha$, there exist $P_{min}$ and $P_{max}$ with $P_{min}(\eta, \alpha) < P_{max}(\eta, \alpha)$ such that a firm innovates if and only if $P_0 \notin [P_{min}(\eta, \alpha), P_{max}(\eta, \alpha)]$.*
*(ii) $[P_{min}(\eta, \alpha_1), P_{max}(\eta, \alpha_1)] \subseteq [P_{min}(\eta, \alpha_2), P_{max}(\eta, \alpha_2)]$ for $\alpha_1 < \alpha_2$.*

The intuition for result (i) hinges on the same tradeoff that underlies the intuition for Proposition 1. For fixed values of $\eta$ and $\alpha$, when $P_0$ is very high, the probability of takeover at date 1 is very low so that it is optimal for the manager to choose the innovative project. As $P_0$ decreases, the effect of the manager's future control benefit loss from a takeover increases. Below a threshold $P_{max}$, it is optimal for the manager to lower risk by choosing the routine project. Below a lower threshold $P_{min}$, however, the probability of takeover is so high that the manager gambles by again choosing the innovative project.

Result (ii) follows from the fact that the intermediate region in which firms do not innovate is driven by the expected loss of future control benefits for the manager. As monitoring intensity improves, the manager's control benefits and, therefore, her expected loss decline so that the intermediate region over which innovation is not chosen shrinks.

Proposition 3 leads to the following empirical implication.

**Testable Implication 2**
*For a given level of takeover pressure, the likelihood that a firm innovates increases as the manager faces greater monitoring intensity.*

We now investigate the effect of takeover pressure on innovation.

**Proposition 4 (Effect of Takeover Pressure on Innovation by an Arbitrary Firm)**
*The interval $[P_{min}(\eta, \alpha), P_{max}(\eta, \alpha)]$ defined in Proposition 3 "moves to the left" as $\eta$ decreases, i.e.,*

$$P_{min}(\eta_1, \alpha) < P_{min}(\eta_2, \alpha) \text{ and } P_{max}(\eta_1, \alpha) < P_{max}(\eta_2, \alpha) \text{ for } \eta_1 < \eta_2 \tag{9}$$

The intuition for the above proposition is straightforward. The intermediate interval

$$[P_{min}(\eta, \alpha), P_{max}(\eta, \alpha)]$$

over which the routine project is chosen depends crucially on the trigger point $\eta$ below which takeovers are possible. As $\eta$ decreases, the interval itself "moves to the left".

Propositions 3 (*ii*) and 4 together suggest that the positive effect of monitoring intensity on innovation declines as $\eta$ decreases, that is, as takeover pressure goes down. Because the distribution of $P_0$ across firms in the population is lognormal, Proposition 4 implies that, as $\eta$ increases, the proportion of firms that do not innovate declines.[2]. As a result, the *marginal* effect of monitoring intensity on innovation also declines. In other words, as takeovers become more difficult so that takeover pressure goes down, more firms are likely to innovate. For such firms, the expected loss

[2] We assume here that the "initial" value of $\eta$ is approximately equal to the mean value of $P_0$ across the population.

of control benefits are generally lower and therefore the incremental effect of monitoring intensity declines. We, therefore, have the following implication.

**Testable Implication 3**

*The marginal positive effect of monitoring intensity on innovation declines as takeover pressure is lower.*

# 4 Data and Proxies

We use patents from the NBER Patents File (Hall, Jaffe and Trajtenberg, 2001) to measure innovation. Our data on the state-level index of anti-takeover statutes comes from Bebchuk and Cohen (2003). Although the patent data is available from 1963 onwards, the information on the state-level index of anti-takeover statutes provided by Bebchuk and Cohen (2003) starts only in 1987. Therefore, the time period of our sample is 1987–2002. We first describe the patents data and our measures of innovation. We then describe our state level data on the anti-takeover statutes. Finally, we describe our firm level proxies for monitoring intensity and the various control variables.

## 4.1 Proxies for Innovation

Patents have long been used as an indicator of innovative activity and technological change in both the micro-economic and macro-economic studies (Griliches, 1990). Although patents provide an imperfect measure of innovation, there is no other widely accepted method that can be applied to capture technological advances. R&D expenditures constitute a reasonable proxy for innovation. However, R&D expenditures are an input to innovation along with physical and human capital, managerial/employee effort, and creativity. Moreover, R&D expenditures include investments made by firms to generate new innovations as well as the outlays for developing and commercializing these innovations. Further, R&D expenditures may be affected by whether they are capitalized or expensed in a company's financial statements. For these reasons, R&D expenditures may be a very noisy proxy for innovation.

Nevertheless, we are aware that using patents has its drawbacks. Not all firms patent their innovations, because some inventions do not meet the patentability criteria and because the inventor might rely on secrecy or other means to protect its innovation. In addition, patents measure only successful innovations. To that extent, our results are subject to the same criticisms as previous studies that have used patents to measure innovation (e.g., Griliches, 1990; Cockburn and Henderson, 1998; Kortum and Lerner, 1999).

The NBER patent dataset provides among other items, annual information on patent assignee names, the number of patents, the number of citations received by each patent, and the year that the patent application is filed. The dataset covers all patents filed with the US Patents Office

(USPTO) by firms from around 70 countries. However, for our empirical analysis, we focus on the patents granted to US Corporations.[3] Since the year of application captures the relevant date of the innovation for which a patent is filed, we date our patents according to the year in which they were applied for. This also avoids anomalies that may be created due to the time lag between the date of application and the date of grant of the patent (Griliches, Pakes, and Hall, 1987). Note that although we use the application year as the relevant year for our analysis, the patents appear in the database only after they are granted. Hence, we use the patents actually granted (rather than the patent applications) for our analysis.[4]

To obtain financial information on the innovating firms, we match the NBER sample to Compustat. We use the set of firms in Compustat till the year 2002 to match based on firm names. We obtain more than 12,000 firm-year observations over the sample period 1987-2002 through this matching process.

We use two broad metrics to measure innovation. The first is a simple patent count of the number of patents that were filed in a particular year in a specific patent class and sub-class. The second metric of innovative activity that we use in most of the analysis measures the importance and drastic nature of innovation by examining the citations that are made to patents. This measure is motivated by the recognition that the simple count of patents has its limitations. One of the biggest problems is that it does not distinguish breakthrough innovations from less significant or incremental technological discoveries. Pakes and Shankerman (1984) and Griliches, Pakes, and Hall (1987) show that the distribution of the importance of patents is extremely skewed, i.e., most of the value is concentrated in a small number of patents. Trajtenberg (1990), Albert et al. (1991), and Hall et al. (2005) among others demonstrate that patent citations are a good measure of the value of innovations. Intuitively, the rationale behind using patent citations to identify important innovations is that if firms are willing to further invest in a project that is building upon a previous patent, it implies that the cited patent is influential and economically significant. In addition, patent citations tend to arrive over time, suggesting that the importance of a patent may be revealed over a period of time and may be difficult to evaluate at the time the innovation occurred. And, finally, citations also help control for country-level differences arising in the number of patents due to differences in the number and size of firms, and, in turn, of innovations.

Patent citations, however, suffer from a severe truncation bias because patent citations are received for many years after the patent is applied for and granted. Another potential concern with using citations is that different industries might have different propensities to cite patents. We

[3] The NBER Patent data includes the field asscode to identify the category of the inventor. Asscode equal to 2 identifies US Corporations.

[4] Readers may query 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 3,333,701 patents in our sample, we identify 21489 patents (0.6%) issued to US subsidiaries of foreign companies. Not surprisingly, excluding these patents does not change our results.

correct for these biases by employing fixed effects for each application year and for each 2-digit SIC industry, which account for intertemporal variations and inter-industry differences in the citations respectively.

## 4.2 Proxies for Takeover Pressure

We employ both cross-sectional and time-series proxies for takeover pressures.

### 4.2.1 Cross-sectional Proxy: State level anti-takeover Provisions

The anti-takeover protection index, compiled by Bebchuk and Cohen (2003), attaches to each state a score from 0 to 5 that is equal to its number of standard anti-takeover statutes. These statutes are as follows:

1. Control Share, which is equal to one if the state has a control share acquisition statute and to zero otherwise. A control share acquisition statute essentially requires a hostile bidder to put its offer to a vote of the shareholders before proceeding with it. If a bidder does not do so and purchases a large block of shares, it runs a very serious risk of not being able to vote these shares at all and thus will not be able to gain control despite its large holdings.

2. Fair Price, which is equal to one if the state has a fair-price statute and to zero otherwise. A fair-price statute requires a bidder who succeeds in gaining control and then proceeds with a second-step freeze-out (a transaction removing remaining shareholders) to pay the remaining minority shareholders the same price it paid for shares acquired through its bid. This prevents bidders from using the threat of a second-step freeze-out at a low price as a mechanism for pressuring the shareholders into tendering.

3. No Freeze-outs, which is equal to one if the state has a business combination statute that prevents a freeze-out for up to 3 years or longer after a takeover and to zero otherwise. Business combination statutes prevent a bidder that gains control from merging the target with its own assets for a specified period of time (unless certain difficult-to-meet conditions are satisfied). Such a constraint might make it more difficult for successful bidders to realize gains from synergy following a takeover, and this, by reducing the potential profits from a takeover, might discourage potential buyers from bidding.

4. Poison Pill Endorsement, which is equal to one if the state has a statute endorsing the use of a poison pill and to zero otherwise. Poison pills are warrants or rights issued by the company that are triggered and entitle their holders to get significant value in the event that any buyer obtains a significant block without the approval of the board. As long as they are not redeemed, poison pills make a takeover prohibitively costly. Delaware courts have

approved the use of pills in a series of well-known cases, starting with Moran v. Household International in 1985. Other states have found it necessary to ground the use of poison pills in legislation either because of the absence of such cases or in a few instances to reverse court rulings against poison pills.

5. Constituencies, which is equal to one if the state has a statute allowing managers to take into account interests of nonshareholders in defending against a takeover and to zero otherwise. Such statutes are regarded as anti-takeover statutes because allowing the managers to take into account how a takeover would affect, say, employees or debt holders provides managers with extra reasons for opposing the takeover and makes it more difficult for courts to scrutinize such decisions.

All together, control share acquisition statutes were passed in 27 states, fair-price statutes in 27 states, business combination statutes (of both types) in 33 states, pill endorsement statutes in 25 states, and constituencies statutes in 31 states. Of these 143 statutes, 135 statutes were adopted in the period 1985–91.

Anti-takeover statutes are possibly important not only in what they actually do but also in what they signal. They send an anti-takeover message and signal that the state is likely to provide in future anti-takeover protections that will be valuable for firms. Adopting the full arsenal of standard anti-takeover statutes sends a clear anti-takeover message to state courts and to potential and existing incorporators. Many studies argue that these laws have been effective in deterring takeovers, thus increasing the power and entrenchment of existing managers [Jensen (1988) , Karpoff and Malatesta (1989) , Shleifer and Vishny (1990) , Romano (1992) , Szewczyk and Tsetsekos (1992) , Bertrand and Mullainathan (2003)].

#### 4.2.2 Time-series proxy: Exogenous Changes in anti-takeover laws

Bertrand and Mullainathan (2003) argue that business combination laws were the most stringent of the three laws, and focus on only on their passage. They rely on Karpoff and Malatesta (1989), who find that investor reaction was the most negative to the announcement of the passage of BC laws. However, the passages of various anti-takeover laws were likely triggered by one another. Such correlation means that a law with lower investor reaction may not be necessarily weaker – investors may have anticipated the passage of this law upon observing the passage of a previous law. Consistent with this, a priori we take no stand on the effectiveness of the different forms of laws. Instead, we focus on the changes in innovation around the time of passage of the first piece of second-generation anti-takeover legislation in the firm's state of incorporation. To the extent the passage of subsequent laws in a given state is eased by the enactment of the first law, we believe it is the first law that represents a truly exogenous shock. Accordingly, we define a dummy variable

"State Level anti-takeover Change Dummy" for each firm that takes a value of unity in the years after the year of the passage of the corresponding state's first anti-takeover law.

### 4.3 Proxy for Monitoring Intensity: Active Shareholders

Our proxies for monitoring intensity are similar to those used in Cremers and Nair (2005). To construct our proxies for monitoring intensity, we use data on institutional share holdings from CDA Spectrum, which collects information on institutional shareholdings from the SEC 13f filings. CDA reports holdings over a quarterly frequency. However, since the patent data is available at an annual frequency, we use the institutional shareholdings at the end of December of each year.

We consider several proxies to measure the extent of monitoring intensity in a firm. First, we use a dummy for the presence of large institutional blockholder. We define a blockholder as a shareholder with greater than 5% ownership of the firm's outstanding shares. By using institutional blockholding rather than institutional holdings, we mitigate the problem that institutions with minor stakes may have little incentive to monitor. In addition, a blockholder also has substantial voting control to pressure the management (see, e.g., Shleifer and Vishny (1986)). We also employ other variations of institutional blockholder ownership such as the number of institutional blockholders, the maximum share owned by the blockholder, and the total percentage of shares owned by the blockholder.

While blockholder ownership enables us to proxy monitoring intensity in a firm, different institutions may have different objectives and different incentives to monitor. For example, it has been argued that hedge funds avoid any direct management interaction to steer clear of any insider trading violations. Institutions such as corporate pension funds and bank trust departments are often written off as strong advocates of shareholder interests because they may suffer from strong conflicts of interest due to the commercial network of firms in which they own stock and debt. Pound (1988) documents that institutions such as banks and insurance companies are more likely to side with management in proxy contests due to conflicts of interest. Such criticism leads to our next proxy. We use the number of public pension fund owners in the firm. Public pension funds are generally more free from conflicts of interest and corporate pressure than other institutional shareholders. They are known to be aggressive shareholder activists (Guercio and Hawkins (1999)).

### 4.4 Control Variables

To control for other determinants of innovation, we include the logarithm of sales as a proxy for firm size, firm age and square of the firm age, and lagged values of (i) ratio of Cash to Assets, (ii) ratio of EBITDA to Assets, (iii) Kaplan-Zingales measure of Cash Flow constraints, (iv) ratio of Net PPE to Assets, (v) Tobin's Q, (vi) ratio of book value of Equity to Assets, (vii) ratio of R&D expenditure to sales, (viii) sales based Herfindahl measure for the 4-digit SIC industry, and

(ix) square of the Herfindahl measure.

The data on total assets, sales, industry SIC, R&D expenditures, book equity, debt, net property plant and equipment, cash, and operating profits (EBIDTA) come from Compustat. We construct the age of the firm as the number of years since the IPO as reported in CRSP.

### 4.5 Descriptive Statistics

Panel A of Table 1 shows the summary statistics for our various proxies. From our proxies for innovation, we observe that the average firm in our sample applies for and is granted 16 patents per year, each of which receive on average over 100 citations subsequently. The anti-takeover index varies from 0 to 5 with the average level of the index being 2.3. As for our proxies for monitoring intensity, we observe that 70% of the firms in our sample had an institutional blockholder, the average number of blockholders in our sample was 1.3. Across our sample, the largest blockowner owned 10% shares in the firm while all blockowners together owned 10% on average. The number of public pension funds owning share in our sample was 3.4.

In Panel B, we examine the correlations between logarithm of firm size and our proxies for monitoring intensity. Using all our proxies for monitoring intensity, we find that the intensity of monitoring is higher in larger firms. We also find a lack of correlation between the number of public pension funds and the other proxies for monitoring intensity.

## 5 Empirical Analysis

An empirical analysis of the effects of corporate governance is complicated by the fact that firms with varying levels of governance may also differ along other, often unobservable, dimensions. These unobservable characteristics could also influence the outcome of interest, be it equity returns or the nature of firm investments. As a result, it is quite possible that differences between firm level outcomes are due more to these unobserved differences rather than the effect of the corporate governance variable being studied.

We adopt a two pronged empirical strategy to tackle the above-mentioned "endogeneity" problem.

First, we examine the effects of state level anti-takeover laws on innovation in the *cross-section*. Since these laws exist at the state level, they are unlikely to be driven endogenously by firm level unobserved factors. Unlike the firm-specific anti-takeover provisions such as poison pills, staggered boards, which are captured by governance indices developed by Gompers, Ishii, Metrick (2003) and Bebchuk, Ferrel and Cohen (200x), the state level anti-takeover provisions are not adopted on a firm-by-firm basis.

Second, we use the passage of anti-takeover laws in various states as a natural source of exogenous variation and a “difference in differences" approach to identify the causal link between anti-takeover statutes and innovation. To infer the effects of the passage of these laws on firm level innovation, we compare changes in innovation around the time of the passage of the law for firms incorporated in the state where the law was passed to changes for firms that are unaffected by the law. To illustrate this methodology, let's consider the following example. Suppose we want to estimate the effect on innovation of the passage of the *business combination law* in the state of Massachusetts in 1989. We estimate the difference in innovations before and after the law was passed for firms incorporated in Massachusetts. To control for economy wide factors that might affect this difference in innovation after 1989, we also estimate this difference for those states that did not pass an anti-takeover statute in 1989. The difference of these two differences captures the marginal effect of the change in the law on innovation.

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 record the location of the innovation through the state where a patent was filed. Thus, while Xerox may be headquartered in Rochester, NY, its research labs are located in Rochester, NY as well as in Palo Alto, CA. The NBER patent data enable us to distinguish between patents filed by Xerox's Palo Alto Research Center and its Rochester laboratories. Now, if NY passed an anti-takeover law, the passage of the law would have an effect on innovation at its Palo Alto Research Center and its Rochester laboratories. However, any state wide economic changes accompanying the change in the law would affect only the innovation done by Xerox's Rochester laboratories. The change in innovation at Xerox's Palo Alto research center when compared to changes in innovation for other companies located in CA but headquartered in a state other than NY measures only the impact of the law change. Therefore, to separate the effect of the change in anti-takeover law from the effect of state wide economic changes accompanying the law change, we examine the impact on innovation outside the state of incorporation for firms that are incorporated in the state of change and compare the change to innovation done by firms unaffected by the law change.

## 5.1 Cross-sectional Tests

We begin by testing the main implications of the theory using cross-sectional tests. In our first set of tests, we investigate Implication 1 of the theory, which predicts a U-shaped relationship between innovation and the level of anti-takeover provisions. We use the model described below to examine this relationship.

$$y_{is,t} = \beta_i + \beta_s + \beta_t + \boldsymbol{\beta}_1 \text{TakeoverPressure}_{s,t-1} + \boldsymbol{\beta}_2 \left(\text{TakeoverPressure}_{s,t-1}\right)^2 + \beta X + \varepsilon_{ict}, \quad (10)$$

where $y$ is the natural logarithm of a measure of innovation for firm $i$, incorporated in state $(s)$, and the year when the patent was applied for $(t)$. $\beta_i, \beta_s$ and $\beta_t$ respectively denote fixed effects for firm $(i)$, state of incorporation $(s)$ and application year $(t)$, where $t \in [1987, 2002]$. To examine the effect of the anti-takeover provisions in a current year on the level of innovation next year, we employ our proxies for innovation for year $t$ while our index of anti-takeover provisions are measured in year $t-1$.

In the above specification, the "firm" and "state of incorporation" fixed effects enable us to control for *time-invariant* unobserved determinants of innovation at the level of the firm and at the level of the state of incorporation, respectively. The "application year" fixed effects control for intertemporal differences in innovation. The principal coefficients of interest are $\beta_1$ and $\beta_2$ because these capture the non-monotonic impact of the anti-takeover provisions. Based on Testable Implication 1, the hypothesis is that $\beta_1 < 0$ and $\beta_2 > 0$.

Table 2 shows the results of our analysis. In each of our regressions, we estimate standard errors that are robust to heteroskedasticity and autocorrelation. The dependent variable in Columns (1) and (2) of this table is the logarithm of the number of patents while it is the logarithm of the number of citations in Columns (3) and (4). In Columns (1) and (3), we include all the control variables that we described in Section 4.4. In Columns (2) and (4), we add the Gompers, Ishii and Metrick (2003) index of firm-level anti-takeover provisions. We also include the Entrenchment Index developed in Bebchuk, Ferrell, and Cohen (2007). We include these firm level measures of anti-takeover provisions to check if these firm level measures subsume the effect of our state level anti-takeover index. Across Columns (1)–(4), we find that $\beta_1 < 0$ and $\beta_2 > 0$.. All the coefficients are statistically significant. An examination of the values of $\beta_1$ and $\beta_2$ in the four models reveals that the value, $|\beta_1| / (2 * \beta_2)$ at which innovation attains its minimum lies in the range 0-5 of possible values of the anti-takeover index.

Thus, we find strong evidence of a U-shaped relationship between innovation and the level of the anti-takeover index. These effects are also economically significant. When the value of the index in a state is zero, as it is in California, a one point increase in the value of the index decreases annual patents and citations for firms incorporated in the state by 12.3% and 15.2% respectively. In contrast, if the value of the index is four, as it was in Pennsylvania in 1992, a one point increase in the value of the index *increases* annual patents and citations for firms incorporated in the state by 2.9% and 7.2% respectively.

We now analyze Testable Implications 2 and 3 of the theory that highlight the effects of monitoring intensity, and the interaction between monitoring intensity and takeover pressure, on innovation.

We use the empirical specification described below:

$$\begin{aligned} y_{is,t} &= \beta_i + \beta_s + \beta_t + \boldsymbol{\beta}_1 \left(\text{TakeoverPressure}_{s,t-1} * \text{MonitoringIntensity}_{i,t-1}\right) \\ &+ \boldsymbol{\beta}_2 \text{MonitoringIntensity}_{i,t-1} \\ &+ \beta_3 \text{TakeoverPressure}_{s,t-1} + \beta_4 \left(\text{TakeoverPressure}_{s,t-1}\right)^2 + \beta X + \varepsilon_{ict} \end{aligned} \tag{11}$$

where $y_{is,t}$ is the measure of innovation as in (10) and $\beta_i, \beta_s, \beta_t$ denote fixed effects for firm $(i)$ , state of incorporation $(s)$ and application year $(t)$ , $t \in [1986, 2001]$ . As in (10) above, the "firm" and "state of incorporation" fixed effects enable us to control for *time-invariant* unobserved determinants of innovation at the level of the firm and at the level of the state of incorporation, respectively while the "application year" fixed effects control for intertemporal differences in innovation.

The empirical model specified in (11) measures *how innovation is affected by the interaction between monitoring intensity and takeover pressure.* The principal coefficients of interest are $\beta_1$, $\beta_2$, $\beta_3$, and $\beta_4$. Based on Testable Implications 1, 2, and 3, we hypothesize that $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 < 0$ and $\beta_4 > 0$.

Table 3 shows the results of our analysis. In each regression, we estimate standard errors that are robust to heteroskedasticity and autocorrelation. In Panel A of this table, the dependent variable is the logarithm of the number of patents while it is the logarithm of the number of citations in Panel B. Columns (1)–(5) employ the five different proxies for monitoring intensity that we described in section 4.3. In each of these regressions, we include all the control variables that we described in section 4.4. We first note that $\beta_1 < 0$ and $\beta_2 > 0$. Except for Column (1) in Panel A, each of these coefficients is statistically significant at either the 5% or 1% levels.

Consistent with Implication 2, higher monitoring intensity is associated with greater innovation and this effect is economically quite significant. From Column (1) of Panels A and B, we estimate that firms having an institutional blockholder receive 7.6% more patents and 9.7% more citations annually than firms without an institutional blockholder. From Column (2) of Panels A and B, we can infer that an additional institutional blockholder is associated with 3.6% more annual patents and 5.3% more annual citations. Similarly, Column (5) of Panels A and B shows that the presence of an additional public pension fund is associated with a 6.8% increase in annual patents and 6.2% increase in annual citations.

The fact that $\beta_1 < 0$ implies that the effect of a decrease in takeover pressure is disproportionately higher in those firms where monitoring intensity is stronger. In other words, takeover pressure, as captured by the state level anti-takeover provisions, and monitoring intensity, as captured by the incidence of active shareholders, are complementary to each other in encouraging innovation. This is because a decrease in the value of the anti-takeover index, which corresponds to an increase in takeover pressure, amplifies the positive effect of monitoring intensity. Across Columns (1)–(5), we see that a one point decrease in the value of the anti-takeover index increases the marginal impact of monitoring intensity on annual patents and citations from anywhere between 5% to 38% (depending upon our proxy for monitoring intensity).

Next, we note that $\beta_3 < 0$ and $\beta_4 > 0$ across all specifications and are statistically significant. Further, the magnitudes of the coefficients suggest that innovation attains an interior minimum within the range 0-5 of possible values of the state-level anti-takeover index. Consistent with Testable Implication 1, and with the results of Table 2, therefore, there is a U-shaped relation between innovation and takeover pressure.

## 5.2 Time-series Tests

We now examine the testable implications of the theory using time-series tests and a "difference in differences" approach. We focus a "treatment" sample of states, where anti-takeover laws underwent a change during our sample period, and a "control" sample of other states where no such change occurred. We, therefore, use the changes in anti-takeover laws in various states over the period 1987-1999 as a *natural experiment* to perform a difference-in-differences test for the causal impact of anti-takeover laws and monitoring intensity on innovation. Table 4 documents the list of states that passed an anti-takeover law along with the year in which the law was passed.

The model we test is described below:

$$\begin{aligned} y_{is,t} &= \beta_i + \beta_s + \beta_t + \boldsymbol{\beta}_1 \left(\delta_{s,t-1} * \text{MonitoringIntensity}_{i,t-1}\right) + \beta_2 \text{MonitoringIntensity}_{i,t-1} \quad (12) \\ &\quad + \boldsymbol{\beta}_3 \cdot \delta_{s,t-1} + \boldsymbol{\beta}_4 \cdot (\delta_{s,t-1} * \text{TakeoverPressure}_{s,t-2}) + \beta X + \varepsilon_{ict} \ , \end{aligned}$$

where, as in the cross-sectional test, $y$ is the natural logarithm of a measure of innovation for firm $(i)$, incorporated in state $(s)$, and the year when the patent was applied for $(t)$. $\delta_{s,t-1}$ measures the change in the takeover pressure in year $(t-1)$. To capture the quadratic term, we interact the change variable with the level of Takeover pressure in the year prior to the passage of the law, which is captured by $\text{TakeoverPressure}_{s,t-2}$.

As in Bertrand and Mulainathan (2003), we include application year, state and firm level dummies. Notice that compared to the usual difference-in-difference specification which contains dummies for treatment groups and treatment periods, including dummies for all the states and all the years leads to a much stronger test since we are able to control for time-invariant state-specific effects as well as time-varying effects that are common to all states.

Based on our Testable Implications 1, 2, and 3, we hypothesize that $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 < 0$, and $\beta_4 > 0$. Table 5 shows the results of our analysis. In each regression, we estimate standard errors that are robust to heteroskedasticity and autocorrelation. In Panel A of this table, the dependent variable is the logarithm of the number of patents while it is the logarithm of the number of citations in Panel B. Columns (1) - (5) employ the five different proxies for monitoring intensity that we described in Section 4.3. In each regression, we include all the control variables that we described in Section 4.4.

We first note that $\beta_1 < 0$ and $\beta_2 > 0$. Except for Column (1) in Panel A where $\beta_1$ is statistically significant at the 10% level, each of these coefficients is statistically significant at either the 5% or 1% levels. Next, we note in Table 4 that $\beta_3$ is consistently negative and always statistically significant at the 1% level while $\beta_4$ is consistently positive and always statistically significant at the 1% level.

Consistent with the inferences derived from our cross-sectional tests, the time-series results show that innovation varies in a U-shaped manner with the takeover pressure and increases with the monitoring intensity. Further, the marginal positive effect of monitoring intensity on innovation increases as the takeover pressure increases.

#### 5.2.1 Causal Effect of Passage of anti-takeover Laws

Are the effects obtained in Table 4 truly a causal effect of changes in takeover pressure, as captured by the passage of the anti-takeover laws, on innovation? Or, was it the case that the firms incorporated in the states that passed the law lobbied for the law with the express objective of enhancing their private control benefits, so that the evidence above exhibits some reverse causality. Note that in *either* of these cases, the evidence lends support to our basic premise that takeover pressure affects innovation.

We investigate the issue of reverse causality in Table 6 by examining the dynamic effect of the passage of these anti-takeover laws. For the evidence to be consistent with reverse causality, we would expect an "effect" of the change even prior to the change itself. To examine this, we follow Bertrand and Mulainathan (2003) in decomposing our Change Dummy variable into three separate time periods – Change Dummy (-2,-1) captures any effects from two years before to a year before the passage of the law, Change Dummy (0) captures the effect in the year of the law being passes, and Change Dummy ($\geq$1) captures the effect one year and beyond. If the coefficient of Change Dummy (-2,-1) or its interaction with monitoring intensity is economically and statistically significant, that may be symptomatic of reverse causation. In fact, both in Panel A and Panel B of Table 6, we find that the coefficient of Change Dummy (-2,-1) and Change Dummy (0) and their interaction with Monitoring Intensity are statistically insignificant. In contrast, Change Dummy ($\geq$1), its interaction with Monitoring Intensity and its interaction with the index value before the change are all strongly statistically significant. Therefore, the results in Table 6 provide confidence for the causal impact of change in takeover pressure on innovation.

### 5.2.2 Separating out the Effects of Other Statewide Changes Accompanying the Passage of anti-takeover Laws

As we described in the last paragraph of Section 5, the NBER patent data provides information about the location of the innovation. We use this unique feature of the data to separate out the effect of other statewide economic changes that may have accompanied the passage of the law in various states.

The model we test here is described below:

$$\begin{aligned} y_{is,t} &= \beta_i + \beta_s + \beta_t + \boldsymbol{\beta}_1 \left(\delta_{s,t-1} * \text{MonitoringIntensity}_{i,t-1}\right) + \beta_2 \text{MonitoringIntensity}_{i,t-1} \quad (13) \\ &\quad + \boldsymbol{\beta}_3 \cdot \delta_{s,t-1} + \boldsymbol{\beta}_4 \cdot (\delta_{s,t-1} * \text{TakeoverPressure}_{s,t-2}) + \beta X + \varepsilon_{ict} \ , \end{aligned}$$

where $y$ is the natural logarithm of a measure of innovation for firm $(i)$, incorporated in state $(s)$, and the year when the patent was applied for $(t)$. For the "treatment" sample of firms that are incorporated in the state that underwent a change, y is the innovation done by the firm in a state outside where it is incorporated. For other firms, which form the "control" sample, y remains same as in earlier specifications.

The coefficient $\delta_{s,t-1}$ measures the change in the takeover pressure in year $(t-1)$. To capture the quadratic term, we interact the change variable with the level of Takeover pressure in the year prior to the passage of the law, which we denote by $\text{TakeoverPressure}_{s,t-2}$.

The rationale for using these out-of-state innovations for the "treatment" sample of firms is described earlier in the last paragraph before Section 5.1.

Table 7 presents the results of our analysis. We use the number of institutional blockholders and the number of public pension funds as our proxies for monitoring intensity. Except for the lack of statistical significance on the coefficients of monitoring intensity in Columns (1) and (3), the results are identical to those in Table 5.

## 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) for a given level of monitoring intensity, there is a U–shaped relationship between innovation and the takeover pressure the firm faces; (ii) for a given level of takeover pressure, the likelihood that a firm innovates increases as monitoring intensity increases, and (iii) the marginal positive effect of monitoring intensity on innovation is smaller the lower the takeover pressure the firm faces. Our empirical tests provide strong support for our model's predictions and the results are economically significant.

## References


[1] Acharya, Viral V., and Krishnamurthy Subramanian, 2007, "Bankruptcy Codes and Innovation," Working Paper, London Business School.

[2] Albert, M., D. Avery, F. Narin, and P. McAllister, 1991, "Direct validation of citation counts as indicators of industrially important patent," *Research Policy* 20, 251–259.

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

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

[5] Cockburn, I., and R. Henderson, 1998, "Absorptive Capacity, Coauthoring behavior, and the organization of research in drug discovery," *Journal of Industrial Economics* 46, 157–182.

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

[7] Core, J., R. Holthausen, and D. Larcker, 1999, "Corporate Governance, Chief Executive Officer Compensation, and Firm Performance," *Journal of Financial Economics* , 371–406.

[8] Gompers, P., J. Ishii, A. Metrick, 2003, "Corporate governance and equity prices," *Quarterly Journal of Economics*, 118,107-155.

[9] Griliches, Z., A. Pakes, and B. Hall, 1987, "The value of patents as indicators of inventive activity," in P. Dasgupta and P. Stoneman, eds., *Economic Policy and Technological Performance*, Gambridge England: Cambridge University Press.

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

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

[12] Hermalin, B.E., Weisbach, M.S. (1998), "Endogenously chosen boards of directors and their monitoring of the CEO", *American Economic Review*, 88, 96-118.

[13] Jensen, M., 1988, "Takeovers: Their Causes and Consequences," *Journal of Economic Perspectives*, 2, 21–48.

[14] Karpoff, J., and P. Malatesta, 1989, "The Wealth Effects of Second Generation State Takeover Legislation," *Journal of Financial Economics*, 25, 291–322.

[15] King, Robert and Ross Levine, “Finance and Growth: Schumpeter Might be Right,” 1993, *Quarterly Journal of Economics*, CVIII, 3, 717-738.

[16] Kortum, Samuel and Josh Lerner, “What is behind the recent surge in patenting?” 1999, *Research Policy*, 28, 1-22.

[17] Manso, Gustavo, 2007, “Motivating Innovation,” Working Paper, MIT.

[18] North, D. C. (1990). Institutions, Institutional Change and Economic Performance. New York: Cambridge University Press.

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

[20] Romano, R., 1992, “Rethinking Takeover Regulation,” *Journal of Applied Corporate Finance*, 5, 47–57.

[21] Rayo, L., and H. Sapra, 2007, “Optimal Takeover Mechanisms and Innovation,” Working paper, University of Chicago–GSB.

[22] Shleifer, A., and R. Vishny, 1990, “The Takeover Wave of the 1980s,” *Science*, 249, 745–749.

[23] Szewczyk, S., and G. Tsetsekos, 1992, “State Intervention in the Market for Corporate Control: The Case of Pennsylvania Senate Bill 1310,” *Journal of Financial Economics*, 31, 3–24.

[24] Trajtenberg, M., 1990, “A penny for your quotes: Patent citations and the value of information,” *RAND Journal of Economics*, 21, 325–342.

# Appendix: Proofs

**Proof of Proposition 1**

From (7), the manager chooses the innovative project if and only if:

$$P_0 e^{\mu_I} - \alpha p P_0 e^{\mu_I} \Phi\Big(\frac{\log(\eta/P_0) - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\Big) > P_0 e^{\mu_R} - \alpha p P_0 e^{\mu_R} \Phi\Big(\frac{\log(\eta/P_0) - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\Big). \quad (14)$$

Rearranging the above, the manager chooses the innovative project if and only if

$$e^{\mu_I} - e^{\mu_R} > \alpha p e^{\mu_I} \Phi\Big(\frac{\log(\eta/P_0) - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\Big) - \alpha p e^{\mu_R} \Phi\Big(\frac{\log(\eta/P_0) - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\Big). \quad (15)$$

Define

$$\delta = log(\eta/P_0). \quad (16)$$

Denote the right hand side of (15) as a function, $F(\delta)$ of $\delta$. Note that the left hand side of (15) does not depend on $\delta$.

We now show that the graph of $F(\delta)$ intersects the horizontal line $e^{\mu_I} - e^{\mu_R}$ at most twice. First, note that

$$\begin{aligned} e^{\mu_I} - e^{\mu_R} &> F(-\infty) = 0, \\ e^{\mu_I} - e^{\mu_R} &> F(\infty) = \alpha p[e^{\mu_I} - e^{\mu_R}], \end{aligned} \tag{17}$$

where the first inequality follows from the fact that $\mu_I > \mu_R$, and the second follows from $\mu_I > \mu_R$ and $\alpha p < 1$. We see that

$$F'(\delta) = \frac{\alpha p e^{\mu_I}}{\sigma_I}\Phi'\big(\frac{\delta - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\big) - \frac{\alpha p e^{\mu_R}}{\sigma_R}\Phi'\big(\frac{\delta - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\big). \tag{18}$$

From equation (18), $F'(\delta^*) = 0$ when

$$e^{\mu_I - \mu_R}\frac{\sigma_R}{\sigma_I} = \exp\Big[-\big(\frac{\delta^* - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\big)^2 + \big(\frac{\delta^* - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\big)^2\Big], \tag{19}$$

or

$$\mu_I - \mu_R + log(\sigma_R) - \log(\sigma_I) = \big(\frac{\delta^* - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\big)^2 - \big(\frac{\delta^* - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\big)^2 \tag{20}$$

The right hand side of (20) is a parabola that intersects the left hand side at most twice. Therefore, $F'(\delta) = 0$ has at most two roots. Further, we can check that one of these roots corresponds to a local maximum and the other to a local minimum. By (17), it then follows that the graph of $F(\delta)$ intersects the horizontal line $e^{\mu_I} - e^{\mu_R}$ at most twice at the points, $\delta_{min}$ and $\delta_{max}$.

From (15), the manager chooses the innovative project for $\delta < \delta_{min}$ and for $\delta > \delta_{max}$, while she chooses the routine project for $\delta_{min} < \delta < \delta_{max}$. Setting

$$\gamma_{min} = e^{\delta_{min}}; \;\; \gamma_{max} = e^{\delta_{max}}, \tag{21}$$

we now see that the manager chooses the routine project when

$$\gamma_{min} < \frac{\eta}{P_0} < \gamma_{max}, \tag{22}$$

and the innovative project when

$$\frac{\eta}{P_0} < \gamma_{min} \text{ or } \frac{\eta}{P_0} > \gamma_{max}. \tag{23}$$

The result of the proposition follows from (22) and (23) setting $\eta_{min} = P_0\gamma_{min}$ and $\eta_{max} = P_0\gamma_{max}$. Q.E.D.

**Proof of Proposition 2**

For $\alpha = \alpha_1$, it follows from (15) that the manager chooses the routine project if and only if:

$$e^{\mu_I} - e^{\mu_R} < \alpha_1 p e^{\mu_I}\Phi\Big(\frac{\log(\eta/P_0) - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\Big) - \alpha_1 p e^{\mu_R}\Phi\Big(\frac{\log(\eta/P_0) - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\Big). \qquad (24)$$

Because the left hand side of (24) is strictly positive, the right hand side of (24) is also strictly positive for $\eta_{min}(\alpha_1) < \eta < \eta_{max}(\alpha_1)$. Since $\alpha_1 < \alpha_2$,

$$\begin{aligned} & \alpha_1 p e^{\mu_I}\Phi\Big(\frac{\log(\eta/P_0) - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\Big) - \alpha_1 p e^{\mu_R}\Phi\Big(\frac{\log(\eta/P_0) - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\Big) \\ < \quad & \alpha_2 p e^{\mu_I}\Phi\Big(\frac{\log(\eta/P_0) - \mu_I - \frac{1}{2}\sigma_I^2}{\sigma_I}\Big) - \alpha_2 p e^{\mu_R}\Phi\Big(\frac{\log(\eta/P_0) - \mu_R - \frac{1}{2}\sigma_R^2}{\sigma_R}\Big). \qquad (25) \end{aligned}$$

From (24) and (25) it follows that, *for a fixed* $\eta$, whenever the manager chooses the routine project for $\alpha = \alpha_1$, she also chooses the routine project for $\alpha = \alpha_2$. It follows that (8) must be true. Q.E.D.

**Proof of Proposition 3**

(i) From (22) and (23), the manager chooses the routine project if and only if:

$$\frac{\eta}{\gamma_{max}(\alpha)} < P_0 < \frac{\eta}{\gamma_{min}(\alpha)}, \qquad (26)$$

where we explicitly indicate the dependence of $\gamma_{min}(.)$ and $\gamma_{max}(.)$ on $\alpha$. The result follows by setting:

$$\begin{aligned} P_{min}(\eta, \alpha) &= \frac{\eta}{\gamma_{max}(\alpha)}, \\ P_{max}(\eta, \alpha_1) &= \frac{\eta}{\gamma_{min}(\alpha)}. \qquad (27) \end{aligned}$$

(ii) By the arguments in the proof of Proposition 2, we have

$$\begin{aligned} \gamma_{min}(\alpha_2) &< \gamma_{min}(\alpha_1), \\ \gamma_{max}(\alpha_1) &< \gamma_{max}(\alpha_2). \qquad (28) \end{aligned}$$

The result follows from (26) and (28). Q.E.D.

**Proof of Proposition 4** This result follows directly from (26) and (27). Q.E.D.

# Table 1: Summary Statistics and Correlations

## Panel A: Summary Statistics

| Variable | # of Obns. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Proxies for Innovation:** | | | | | |
| Number of Patents | 12510 | 16.0 | 75.7 | 1 | 3072 |
| Number of Citations | 12510 | 104.4 | 571.7 | 0 | 21042 |
| **State Antitakeover Provisions:** | | | | | |
| Antitakeover Index | 12510 | 2.3 | 1.9 | 0 | 5 |
| **Proxies for Monitoring Intensity:** | | | | | |
| Dummy for Blockholder ownership | 12510 | 0.7 | 0.5 | 0 | 1 |
| Number of Blockholders | 12510 | 1.3 | 1.3 | 0 | 9 |
| Maximum % ownership of Blockholder | 12510 | 0.1 | 0.1 | 0 | 0.7 |
| Total Blockholder ownership % | 12510 | 0.1 | 0.1 | 0 | 0.8 |
| Number of Public Pension Funds | 12510 | 3.4 | 3.6 | 0 | 14 |

## Panel B: Correlation between various proxies of Monitoring Intensity

| | Dummy for Blockholder ownership | Number of Blockholders | Maximum % ownership of Blockholder | Total Blockholder ownership % | Number of Public Pension Funds |
|---|---|---|---|---|---|
| Number of Blockholders | 0.72 | | | | |
| Maximum % ownership of Blockholder | 0.59 | 0.54 | | | |
| Total Blockholder ownership % | 0.66 | 0.90 | 0.81 | | |
| Number of Public Pension Funds | 0.01 | -0.01 | 0.00 | -0.02 | |
| Logarithm of Firm Size | 0.08 | 0.06 | 0.08 | 0.06 | 0.75 |

## Table 2: Effect of Takeover Pressure on Innovation

The dependent variable in the OLS regressions below is either the *logarithm of the number of patents or number of citations to these patents* granted to firms over the period 1987-2002 by the U.S. Patent Office, as constructed by Hall, Jaffe and Trajtenberg (2001). We employ the State level Anti Takeover Index, constructed by Bebchuk and Cohen (2003) as our proxy for takeover pressure: a higher level of the index indicates stronger laws preventing takeover of firms incorporated in that state, and consequently lower takeover pressure. The control variables include the logarithm of sales for firm i in year t, and lagged values of (i) ratio of Cash to Assets, (ii) ratio of EBITDA to Assets, (iii) Kaplan-Zingales measure of Cash Flow constraints, (iv) ratio of Net PPE to Assets, (v) Tobin's Q, (vi) ratio of book value of Equity to Assets, (vii) ratio of R&D expenditure to sales, (viii) sales based Herfindahl measure for the 4-digit SIC industry, and (ix) square of the Herfindahl measure. The standard errors are robust to heteroskedasticity and autocorrelation. *** and ** denote significance at the 1% and 5% levels respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable is: | Log of Patents | | Log of Citations | |
| State Anti-takeover Index | -0.145*** | -0.143*** | -0.184*** | -0.183*** |
| | (3.92) | (3.89) | (3.81) | (3.79) |
| Square of State Anti-takeover Index | 0.019*** | 0.019*** | 0.029*** | 0.028*** |
| | (2.83) | (2.82) | (3.18) | (3.17) |
| Log of Sales | 0.204*** | 0.200*** | 0.172*** | 0.169*** |
| | (12.71) | (12.58) | (7.22) | (7.12) |
| Kaplan-Zingales measure of Cash | 0.002 | 0.002 | 0.005 | 0.005 |
| Flow constraints | (0.38) | (0.39) | (0.50) | (0.50) |
| Tobin's Q | -0.004 | -0.004 | 0.001 | 0.001 |
| | (1.62) | (1.63) | (0.25) | (0.24) |
| R&D/ Sales | 0.001*** | 0.001*** | 0.001** | 0.001** |
| | (3.17) | (3.19) | (2.17) | (2.19) |
| Herfindahl Index | 0.524 | 0.517 | 1.064** | 1.054** |
| | (1.64) | (1.62) | (2.12) | (2.09) |
| Square of Herfindahl Index | -0.435 | -0.426 | -0.564 | -0.556 |
| | (1.41) | (1.38) | (1.20) | (1.19) |
| GIM Index | | 0.029*** | | 0.025*** |
| | | (4.14) | | (2.73) |
| Entrenchment Index | | -0.062** | | -0.047 |
| | | (2.54) | | (1.49) |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | No | Yes |
| Observations | 12510 | 12502 | 10757 | 10757 |
| Adjusted R-squared | 0.24 | 0.24 | 0.53 | 0.53 |

## Table 3: Effect of Monitoring Intensity and Takeover Pressure on Innovation

The dependent variable in the OLS regressions below is the *logarithm of the number of patents* in Panel A and *number of citations to these patents* in Panel B. The sample consists of patents granted to firms over the period 1987-2002 by the U.S. Patent Office, as constructed by Hall, Jaffe and Trajtenberg (2001). We employ the State level Anti Takeover Index, constructed by Bebchuk and Cohen (2003) as our proxy for takeover pressure: a higher level of the index indicates stronger laws preventing takeover of firms incorporated in that state, and consequently lower takeover pressure. The control variables include the logarithm of sales for firm i in year t, and lagged values of (i) ratio of Cash to Assets, (ii) ratio of EBITDxcA to Assets, (iii) Kaplan-Zingales measure of Cash Flow constraints, (iv) ratio of Net PPE to Assets, (v) Tobin's Q, (vi) ratio of book value of Equity to Assets, (vii) ratio of R&D expenditure to sales, (viii) sales based Herfindahl measure for the 4-digit SIC industry, and (ix) square of the Herfindahl measure. The standard errors are robust to heteroskedasticity and autocorrelation. *** and ** denote significance at the 1% and 5% levels respectively.

### Panel A: Dependent Variable is Log of Patents

| Which Proxy for Monitoring Intensity? | (1) Dummy for Blockholder ownership | (2) Number of Blockholders | (3) Maximum % ownership of Blockholder | (4) Total blockholder ownership % | (5) Number of Public Pension Funds |
|---|---|---|---|---|---|
| State Anti-takeover Index * Monitoring Intensity | -0.023* | -0.014*** | -0.356*** | -0.181*** | -0.009*** |
| | (1.91) | (3.08) | (2.91) | (3.45) | (4.18) |
| Monitoring Intensity | 0.078** | 0.039*** | 0.938** | 0.536*** | 0.088*** |
| | (2.06) | (2.63) | (2.36) | (3.07) | (9.92) |
| State Anti-takeover Index | -0.111** | -0.114*** | -0.102** | -0.113*** | -0.122*** |
| | (2.56) | (2.67) | (2.33) | (2.65) | (2.88) |
| Square of State Anti-takeover Index | 0.016** | 0.017** | 0.016** | 0.017** | 0.023*** |
| | (2.07) | (2.21) | (2.14) | (2.23) | (2.87) |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 9573 | 9573 | 9573 | 9573 | 9573 |
| Adjusted R-squared | 0.27 | 0.27 | 0.27 | 0.27 | 0.28 |

### Panel B: Dependent Variable is Log of Citations

| Which Proxy for Monitoring Intensity? | (1) Dummy for Blockholder ownership | (2) Number of Blockholders | (3) Maximum % ownership of Blockholder | (4) Total blockholder ownership % | (5) Number of Public Pension Funds |
|---|---|---|---|---|---|
| State Anti-takeover Index * Monitoring Intensity | -0.033* | -0.017*** | -0.312* | -0.205*** | -0.009*** |
| | (1.92) | (2.67) | (1.81) | (2.70) | (3.03) |
| Monitoring Intensity | 0.092* | 0.053** | 0.919 | 0.637** | 0.074*** |
| | (1.76) | (2.51) | (1.64) | (2.46) | (6.44) |
| State Anti-takeover Index | -0.188*** | -0.194*** | -0.187*** | -0.194*** | -0.202*** |
| | (3.30) | (3.46) | (3.26) | (3.46) | (3.63) |
| Square of State Anti-takeover Index | 0.033*** | 0.034*** | 0.033*** | 0.034*** | 0.039*** |
| | (3.21) | (3.32) | (3.21) | (3.32) | (3.66) |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 8136 | 8136 | 8136 | 8136 | 8136 |
| Adjusted R-squared | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |

## Table 4: List of State Level Changes in Anti-Takeover Laws

This table shows the list of states that underwent a change in the laws preventing takeover of firms incorporated in that state. This list is based on Bebchuk and Cohen (2003). "Year" indicates the year in which the change in the law occurred while "Value Before" lists the value of the aggregate state level anti-takeover index before the change.

| STATE NAME | YEAR | VALUE BEFORE | STATE NAME | YEAR | VALUE BEFORE |
|---|---|---|---|---|---|
| ARIZONA | 1987 | 4 | NEBRASKA | 1988 | 2 |
| FLORIDA | 1987 | 2 | PENNSYLVANIA | 1988 | 3 |
| LOUISIANA | 1987 | 2 | SOUTH CAROLINA | 1988 | 3 |
| MASSACHUSETTS | 1987 | 1 | TENNESSEE | 1988 | 4 |
| MINNESOTA | 1987 | 3 | VIRGINIA | 1988 | 2 |
| MISSOURI | 1987 | 4 | COLORADO | 1989 | 1 |
| NEVADA | 1987 | 1 | HAWAII | 1989 | 3 |
| NEW MEXICO | 1987 | 1 | ILLINOIS | 1989 | 4 |
| NORTH CAROLINA | 1987 | 2 | INDIANA | 1989 | 5 |
| OKLAHOMA | 1987 | 1 | IOWA | 1989 | 2 |
| OREGON | 1987 | 1 | MARYLAND | 1989 | 3 |
| UTAH | 1987 | 1 | NEW JERSEY | 1989 | 4 |
| WASHINGTON | 1987 | 2 | NEW YORK | 1989 | 4 |
| WISCONSIN | 1987 | 5 | WYOMING | 1989 | 1 |
| CONNECTICUT | 1988 | 2 | MISSISSIPPI | 1990 | 2 |
| DELAWARE | 1988 | 1 | OHIO | 1990 | 5 |
| GEORGIA | 1988 | 2 | RHODE ISLAND | 1990 | 4 |
| IDAHO | 1988 | 5 | SOUTH DAKOTA | 1990 | 5 |
| KANSAS | 1988 | 1 | NORTH DAKOTA | 1993 | 1 |
| KENTUCKY | 1988 | 3 | TEXAS | 1997 | 1 |
| MICHIGAN | 1988 | 3 | VERMONT | 1998 | 1 |

## Table 5: Effect of Monitoring Intensity and Changes in Takeover Pressure on Innovation

The dependent variable in the OLS regressions below is the *logarithm of the number of patents* in Panel A and *number of citations to these patents* in Panel B. The sample consists of patents granted to firms over the period 1987-2002 by the U.S. Patent Office, as constructed by Hall, Jaffe and Trajtenberg (2001). The change in the State level Anti Takeover laws is from Bebchuk and Cohen (2003) – a change in the law in a state increased the hurdles for potential acquirers to takeover firms incorporated in that state and therefore reduced takeover pressure. The control variables include the logarithm of sales for firm i in year t, and lagged values of (i) ratio of Cash to Assets, (ii) ratio of EBITDA to Assets, (iii) Kaplan-Zingales measure of Cash Flow constraints, (iv) ratio of Net PPE to Assets, (v) Tobin's Q, (vi) ratio of book value of Equity to Assets, (vii) ratio of R&D expenditure to sales, (viii) sales based Herfindahl measure for the 4-digit SIC industry, and (ix) square of the Herfindahl measure. The standard errors are robust to heteroskedasticity and autocorrelation. *** and ** denote significance at the 1% and 5% levels respectively.

### Panel A: Dependent Variable is Log of Patents

| Which Proxy for Monitoring Intensity? | (1) Dummy for Blockholder ownership | (2) Number of Blockholders | (3) Maximum % ownership of Blockholder | (4) Total blockholder ownership % | (5) Number of Public Pension Funds |
|---|---|---|---|---|---|
| State Anti-takeover Index Change * Monitoring Intensity | -0.069* | -0.051** | -0.979** | -0.634*** | -0.029* |
| | (1.66) | (2.59) | (2.27) | (2.82) | (1.91) |
| Monitoring Intensity | 0.064** | 0.037*** | 0.657** | 0.480*** | 0.083*** |
| | (2.57) | (3.98) | (2.17) | (4.06) | (5.04) |
| State Anti-takeover Index Change | -0.332*** | -0.313*** | -0.311*** | -0.312*** | -0.289*** |
| | (3.51) | (3.47) | (3.45) | (3.45) | (3.49) |
| State Anti-takeover Index Change * Index Value Before Change | 0.083*** | 0.082*** | 0.085*** | 0.082*** | 0.100*** |
| | (4.37) | (4.29) | (4.35) | (4.23) | (5.98) |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 9573 | 9573 | 9573 | 9573 | 9573 |
| Adjusted R-squared | 0.26 | 0.26 | 0.26 | 0.26 | 0.27 |

### Panel B: Dependent Variable is Log of Citations

| Which Proxy for Monitoring Intensity? | (1) Dummy for Blockholder ownership | (2) Number of Blockholders | (3) Maximum % ownership of Blockholder | (4) Total blockholder ownership % | (5) Number of Public Pension Funds |
|---|---|---|---|---|---|
| State Anti-takeover Index Change * Monitoring Intensity | -0.117** | -0.056* | -1.119*** | -0.681** | -0.028** |
| | (2.25) | (1.88) | (2.84) | (2.30) | (2.02) |
| Monitoring Intensity | 0.084** | 0.046** | 0.823** | 0.542** | 0.070*** |
| | (2.46) | (2.29) | (2.32) | (2.64) | (5.13) |
| State Anti-takeover Index Change | -0.495*** | -0.501*** | -0.495*** | -0.504*** | -0.478*** |
| | (3.62) | (3.81) | (3.74) | (3.91) | (4.62) |
| State Anti-takeover Index Change * Index Value Before Change | 0.142*** | 0.141*** | 0.144*** | 0.142*** | 0.157*** |
| | (4.40) | (4.31) | (4.49) | (4.37) | (5.33) |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 8136 | 8136 | 8136 | 8136 | 8136 |
| Adjusted R-squared | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |

## Table 6: Test of Reverse Causality in the Effect of Monitoring Intensity and Changes in Anti-takeover laws on Innovation

The dependent variable in the OLS regressions below is the *logarithm of the number of patents* in Panel A and *number of citations to these patents* in Panel B. The sample consists of patents granted to firms over the period 1987-2002 by the U.S. Patent Office, as constructed by Hall, Jaffe and Trajtenberg (2001). The change in the State level Anti Takeover laws is from Bebchuk and Cohen (2003) – a change in the law in a state increased the hurdles for potential acquirers to takeover firms incorporated in that state and therefore reduced takeover pressure. Change Dummy (-2,-1), Change Dummy (0) and Change Dummy (≥1) equal 1 for state that underwent the change and for time periods t ε (m-2,m-1), t = m and t ≥ m+1 respectively, where m is the year of the change in the law. The value of these change dummies is 0 otherwise. The control variables include the logarithm of sales for firm i in year t, and lagged values of (i) ratio of Cash to Assets, (ii) ratio of EBITDA to Assets, (iii) Kaplan-Zingales measure of Cash Flow constraints, (iv) ratio of Net PPE to Assets, (v) Tobin's Q, (vi) ratio of book value of Equity to Assets, (vii) ratio of R&D expenditure to sales, (viii) sales based Herfindahl measure for the 4-digit SIC industry, and (ix) square of the Herfindahl measure. The standard errors are robust to heteroskedasticity and autocorrelation. *** and ** denote significance at the 1% and 5% levels respectively.

### Panel A: Dependent Variable is Log of Patents

| | (1) Dummy for Block-holder ownership | (2) No. of Block-holders | (3) Max. % owned by Block-holder | (4) Total % owned by block-holders | (5) No. of Public Pension Funds |
|---|---|---|---|---|---|
| State Anti-takeover Change Dummy (-2,-1) * Monitoring Intensity | -0.093 | -0.038 | -0.612 | -0.444 | -0.039** |
| | (1.11) | (0.92) | (1.04) | (1.41) | (2.29) |
| State Anti-takeover Change Dummy (0) * Monitoring Intensity | -0.025 | -0.062 | -0.531 | -0.477 | 0.000 |
| | (0.20) | (0.95) | (0.59) | (0.86) | (0.01) |
| State Anti-takeover Change Dummy (>=1) * Monitoring Intensity | -0.102*** | -0.068*** | -1.319*** | -0.815*** | -0.048*** |
| | (3.15) | (4.30) | (3.04) | (4.37) | (2.96) |
| Monitoring Intensity | 0.092*** | 0.050*** | 0.945*** | 0.628*** | 0.097*** |
| | (6.73) | (5.71) | (6.04) | (6.99) | (6.97) |
| State Anti-takeover Change Dummy (-2,-1) | 0.035 | 0.020 | 0.018 | 0.016 | 0.132 |
| | (0.47) | (0.26) | (0.22) | (0.22) | (1.52) |
| State Anti-takeover Change Dummy (0) | -0.032 | 0.015 | -0.010 | -0.005 | -0.030 |
| | (0.33) | (0.15) | (0.12) | (0.07) | (0.37) |
| State Anti-takeover Change Dummy (>=1) | -0.371** | -0.351** | -0.347** | -0.351** | -0.225** |
| | (2.53) | (2.41) | (2.51) | (2.46) | (2.15) |
| State Anti-takeover Change Dummy (>=1) * Index Value Before Change | 0.089*** | 0.088*** | 0.089*** | 0.087*** | 0.097*** |
| | (4.93) | (4.84) | (4.95) | (4.87) | (5.37) |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 9573 | 9573 | 9573 | 9573 | 9573 |
| Adjusted R-squared | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |

**Panel B: Dependent Variable is Log of Citations**

| | (1) Dummy for Block-holder ownership | (2) No. of Block-holders | (3) Max. % owned by Block-holder | (4) Total % owned by block-holders | (5) No. of Public Pension Funds |
|---|---|---|---|---|---|
| State Anti-takeover Change Dummy (-2,-1) * Monitoring Intensity | -0.037 | -0.001 | 0.057 | -0.182 | -0.041** |
| | (0.25) | (0.01) | (0.07) | (0.31) | (2.27) |
| State Anti-takeover Change Dummy (0) * Monitoring Intensity | 0.056 | -0.048 | 0.353 | -0.005 | -0.001 |
| | (0.33) | (0.48) | (0.29) | (0.01) | (0.03) |
| State Anti-takeover Change Dummy (>=1) * Monitoring Intensity | -0.119* | -0.064* | -1.016* | -0.732** | -0.049*** |
| | (1.97) | (1.91) | (1.80) | (2.04) | (3.85) |
| Monitoring Intensity | 0.085** | 0.051** | 0.731** | 0.581** | 0.085*** |
| | (2.48) | (2.49) | (2.36) | (2.64) | (8.32) |
| State Anti-takeover Change Dummy (-2,-1) | 0.032 | 0.013 | 0.005 | 0.026 | 0.177 |
| | (0.33) | (0.15) | (0.05) | (0.33) | (1.62) |
| State Anti-takeover Change Dummy (0) | -0.111 | -0.028 | -0.102 | -0.074 | -0.055 |
| | (1.07) | (0.23) | (0.87) | (0.66) | (0.45) |
| State Anti-takeover Change Dummy (>=1) | -0.553*** | -0.549*** | -0.566*** | -0.554*** | -0.390** |
| | (2.98) | (3.06) | (3.14) | (3.12) | (2.46) |
| State Anti-takeover Change Dummy (>=1) * Index Value Before Change | 0.149*** | 0.148*** | 0.151*** | 0.148*** | 0.153*** |
| | (4.67) | (4.62) | (4.75) | (4.61) | (4.69) |
| Control Variables | Yes | Yes | Yes | Yes | Yes |
| Application Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 8136 | 8136 | 8136 | 8136 | 8136 |
| Adjusted R-squared | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 |

## Table 7: Effect of Monitoring Intensity and Changes in Anti-takeover laws on Innovation using innovation done outside state of incorporation

The dependent variable in the OLS regressions below is the *logarithm of the number of patents* in Panel A and *number of citations to these patents* in Panel B. The sample consists of patents granted to firms over the period 1987-2002 by the U.S. Patent Office, as constructed by Hall, Jaffe and Trajtenberg (2001). The change in the State level Anti Takeover laws is from Bebchuk and Cohen (2003) – a change in the law in a state increased the hurdles for potential acquirers to takeover firms incorporated in that state and therefore reduced takeover pressure. For our treatment sample, i.e., the states that underwent a change in the antitakeover law, we consider only those firm patents that were filed by divisions or subsidiaries located outside the state of incorporation of the firm. The control variables include the logarithm of sales for firm i in year t, and lagged values of (i) ratio of Cash to Assets, (ii) ratio of EBITDA to Assets, (iii) Kaplan-Zingales measure of Cash Flow constraints, (iv) ratio of Net PPE to Assets, (v) Tobin's Q, (vi) ratio of book value of Equity to Assets, (vii) ratio of R&D expenditure to sales, (viii) sales based Herfindahl measure for the 4-digit SIC industry, and (ix) square of the Herfindahl measure. The standard errors are robust to heteroskedasticity and autocorrelation. *** and ** denote significance at the 1% and 5% levels respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable is: | Log of Patents | | Log of Citations | |
| Which Proxy for Monitoring Intensity? | Number of Blockholders | Number of Public Pension Funds | Number of Blockholders | Number of Public Pension Funds |
| State Anti-takeover Change * | -0.045** | -0.004 | -0.100*** | -0.027** |
| Monitoring Intensity | (2.31) | (0.45) | (3.18) | (2.37) |
| Monitoring Intensity | 0.020 | 0.048*** | -0.036 | 0.021* |
| | (1.34) | (5.69) | (1.54) | (1.67) |
| State Anti-takeover Change | -0.566*** | -0.656*** | -1.075*** | -1.127*** |
| | (5.50) | (6.52) | (6.83) | (7.38) |
| State Anti-takeover Change * | 0.127*** | 0.135*** | 0.147*** | 0.165*** |
| Index Value Before Change | -0.045** | (4.76) | (3.52) | (3.94) |
| Control Variables | Yes | Yes | Yes | Yes |
| Time Period Dummies | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes |
| State of Incorporation Dummies | Yes | Yes | Yes | Yes |
| State of Innovation Dummies | Yes | Yes | Yes | Yes |
| Firm Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 8594 | 8594 | 7294 | 7294 |
| Adjusted R-squared | 0.13 | 0.13 | 0.25 | 0.25 |