Corporate Governance and Innovation: Theory and Evidence

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Abstract

We develop a theory of the effects of external and internal corporate governance mechanisms on innovation. Our theory generates the following testable predictions: (i) innovation varies non-monotonically in a U-shaped manner with takeover pressure; (ii) innovation increases with monitoring intensity; and (iii) the sensitivity of innovation to changes in takeover pressure declines with monitoring intensity. We show strong empirical support for these predictions using both ex ante and ex post measures of innovation. Our empirical analysis exploits cross-sectional as well as time-series variations in takeover pressure created by the sequential passage of anti-takeover laws across different states. Our study highlights the incentive effects of the interplay between expected takeover premia and private benefits that lead to a non-monotonic relation between innovation and takeover pressure. Innovation is therefore fostered either by an unhindered market for corporate control, or by anti-takeover laws that are severe enough to effectively deter takeovers.
A growing body of empirical evidence shows that laws and institutions that influence corporate governance impact economic growth (e.g., La Porta et al., 2000). An independent strand of the literature demonstrates that innovation by firms is a key driver of economic growth (e.g., Aghion and Howitt, 2006). There is, however, relatively limited micro evidence of how laws and institutions affect innovation by firms through the channel of corporate governance. In this study, we theoretically and empirically show how external governance mechanisms — such as anti-takeover laws that affect the market for corporate control — and internal governance mechanisms — such as monitoring and compensation contracts — interact to affect innovation.

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

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

We formalize the essence of the above example in a two-period model in which the manager of a firm chooses to invest in one of two projects: a “more innovative” project or a “less innovative”
project. The projects’ payoffs are uncertain and occur at the end of the second period. There is imperfect, but symmetric, information about the true expected payoffs (hereafter, the qualities) of the projects. The more innovative project has higher mean quality and higher payoff uncertainty than the less innovative one. Furthermore, consistent with the fact that innovation entails significantly more uncertainty with respect to exploration, a larger proportion of the total uncertainty of the more innovative project stems from uncertainty about its quality.

The manager’s project choice is observable. At the end of the first period, agents observe a public signal about the payoff of the chosen project. The signal partially resolves the uncertainty associated with the project’s terminal payoff. Based on this signal, all agents update their prior assessments of the project’s quality. The distinctions between the projects described above imply that the posterior assessments of the quality of the more innovative project are more variable.

The firm could potentially be acquired by another firm through a tender offer at the end of the first period. There is imperfect, but symmetric, information about the value generated by the raider. The severity of external anti-takeover laws influences the takeover pressure the firm faces and, in turn, the firm’s bargaining power when it negotiates with the raider (see Comment and Schwert, 1995, Bebchuk and Cohen, 2003). The firm’s bargaining power is reflected in the minimum takeover premium the firm must be guaranteed by the raider.

We accommodate the possibility that the raider could add or destroy firm value. In equilibrium, however, the firm is taken over only if the raider adds value based on the information available to agents in the market. Further, the firm is taken over only if the intermediate signal is sufficiently bad that the posterior assessment of the quality of the firm’s project is below a threshold. In other words, the firm is taken over if the project under-performs at the intermediate date. The threshold level below which the firm could be taken over falls with an increase in the severity of anti-takeover laws so that the likelihood of a takeover decreases with an increase in the severity of anti-takeover laws. Furthermore, because posterior quality assessments are more variable for the more innovative project, it is more likely to be taken over.

The prediction that highly innovative firms could be taken over if intermediate signals of their project outcomes are poor is consistent with empirical evidence. Desyllas and Hughes (2009) examine the characteristics of publicly traded innovative firms that get acquired. They find evidence that highly innovative firms are taken over because of short-term weaknesses in their innovation outcomes.
Our focus on “disciplinary” takeovers in the basic model in which under-performing firms are taken over is also consistent with the perspectives of studies such as Jensen (1988), Scharfstein (1988) and Stein (1988). Nevertheless, in Appendix C, we show that our main testable implications are robust to a setting that also accommodates “synergistic” takeovers in which firms with high intermediate signals could be taken over because of potential synergies with an acquiring firm. In other words, in the extended model, both significantly under–performing and over–performing firms could be taken over.

We capture two frictions in our environment. First, even though the manager’s project choice is observable, it is non-verifiable and, therefore, non-contractible. Second, as in Bebchuk and Jolls (1999), the manager derives pecuniary private control benefits that are observable, but non-contractible. The manager’s private benefits decline with the intensity with which shareholders monitor the manager. If the firm is taken over at the end of the first period, the manager cedes her control benefits to the raider. The project’s payoff net of the manager’s control benefits (the project’s net payoff) as well as the payoff conditional on the firm being taken over are contractible. The shareholders can influence the manager’s project choice through a compensation contract contingent on the project’s contractible payoffs.

We derive the manager’s optimal compensation contract and show that it can be implemented through an equity stake in the firm along with a payment that resembles a golden parachute in the event of a takeover. The golden parachute aligns the interests of the manager and shareholders by effectively compensating the manager for her loss of control benefits in the event of a takeover. The manager’s optimal project choice maximizes the firm’s unconditional expected payoff (expected payoff in the absence of a takeover) plus the expected takeover premium less the expected loss of private benefits in the event of a takeover.

In choosing the degree of innovation, the manager faces the following trade-off. Choosing the more innovative project increases the firm’s likelihood of being taken over and, therefore, increases the manager’s expected loss of control benefits. The higher likelihood of a takeover for the more innovative project, however, also results in a larger expected takeover premium. The manager trades off the positive effect of greater innovation on the expected takeover premium against its negative effect on the expected loss of control benefits. Because private benefits decline with monitoring intensity, this trade-off is influenced by the interaction between the intensity of monitoring of the manager and
the takeover pressure the firm faces.

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

The above intuition implies that the manager chooses lower innovation for moderate levels of takeover pressure because the effect of her expected loss of control benefits dominates. As monitoring intensity increases, the manager’s private benefits decline so that their relative importance in influencing the degree of innovation declines. Hence, the manager chooses greater innovation over a larger range of values of the takeover pressure. Furthermore, because the U-shaped relation between innovation and takeover pressure is driven by the manager’s potential loss of control benefits, an increase in the monitoring intensity also lowers the sensitivity of the degree of innovation to changes in takeover pressure, that is, the U-shaped relation becomes flatter.

We test the predictions of the model using \textit{ex ante} and \textit{ex post} measures of the degree of innovation. We use R&D intensity as our \textit{ex ante} measure, and patents filed with the US Patent Office as well as citations to these patents as our \textit{ex post} measures. We use the state-level index of the severity of anti-takeover statutes (hereafter “anti-takeover index”) from Bebchuk and Cohen (2003) as our proxy for the external takeover pressure a firm faces. We employ levels of ownership by institutional blockholders to proxy for internal monitoring intensity. Our empirical analysis, which exploits the substantial cross-sectional and time-series variations in takeover pressure created by the sequential passage of anti-takeover laws in different states, proceeds in three steps.

First, we test our hypotheses using panel regressions with firm and year fixed effects. As Imbens and Wooldridge (2007) show, the inclusion of firm and year fixed effects implies that these regressions are equivalent to “difference-in-difference” regressions in a general setting with multiple treatments and
multiple time periods. We show that innovation varies in a U-shaped manner with the anti-takeover index. Second, we find a strong positive relation between innovation and our proxies for monitoring intensity. Finally, we show that the curvature of the U-shaped relationship between innovation and the anti-takeover index declines with monitoring intensity, that is, the U-shaped relationship becomes flatter.

A potential concern with the above tests is that the results could be distorted by other unobserved state-specific and industry-specific changes that affect innovation. To examine such alternative interpretations, we employ two different sets of tests. First, we regress annual changes in our innovation proxies on changes in our explanatory variables after including state of incorporation, industry and year fixed effects. In these “triple-difference” tests (see Imbens and Wooldridge, 2007), identification comes from the potential effects of changes in the key explanatory variables on firm-level deviations from state- and industry-specific trends in innovation.

The above tests account for linear trends specific to each state. However, unobserved state-wide changes accompanying the passage of anti-takeover laws may have non-linear effects on innovation. To investigate such concerns, we exploit the fact that our dataset contains data on innovation performed by subsidiaries/divisions of firms. For these tests, we use the NBER patents database to identify the specific division/subsidiary of a firm that filed a patent. State-wide changes accompanying law passages would affect innovation done by subsidiaries/divisions located in the state of incorporation. They are, however, less likely to affect innovation by subsidiaries/divisions located outside the state in which the firm is incorporated. Therefore, for firms incorporated in states that passed anti-takeover laws, we exclude all innovation done by subsidiaries and divisions located in the state of incorporation. Thus, by examining innovation done outside the state of incorporation for states that passed anti-takeover laws, we potentially isolate the pure effects of the anti-takeover law passages. We find strong empirical support for all our predictions in these tests.

The economic magnitudes of the predicted effects are significant. When the value of the anti-takeover index before a law passage was zero (four), as it was is in the case of Delaware (Indiana), a one point increase in the value of the index decreases (increases) R&D intensity, patents and citations for firms incorporated in the state, respectively, by 19%, 17%, and 18% (25%, 11%, and 14%) more than for those firms incorporated in states that did not pass a law. Thus, when the takeover pressure was very low (Indiana), a decrease in takeover pressure increased the degree of innovation. When the
takeover pressure was very high (Delaware), the decrease in takeover pressure decreased the degree of innovation. The empirical evidence therefore supports a statistically and economically significant U-shaped relationship between the degree of innovation and takeover pressure. Second, higher monitoring is associated with greater innovation – a one standard deviation increase in blockholder ownership is associated with 12% higher R&D/ sales, 26% more annual patents, and 27% more annual citations. Finally, higher monitoring leads to a flatter U-shaped relationship between takeover pressure and innovation. A one standard deviation increase in blockholder ownership flattens the curvature of annual R&D/ Sales, patents, and citations by 8%, 6%, and 6% respectively.

We also carry out a number of additional tests to examine the robustness of our results. First, we rule out the existence of a “reverse causal” relationship between takeover laws and innovation. Second, we examine the long-run effects of takeover law passages on innovation. Our earlier tests examine the effects of changes in takeover pressure on our innovation proxies one year after the changes and beyond. We would expect changes in takeover pressure to have short-term effects on R&D investment because it is an input to innovation, and long-term effects on patents and citations because they are outputs. Consistent with this intuition, we find that changes in takeover pressure have the predicted effects on R&D intensity within a year, while the effects on patents and citations persist even three years after the changes. Third, we carry out tests that incorporate inter-industry differences in innovation intensities, and show that our results are not driven by more innovation-intensive industries. Fourth, we offer several arguments to demonstrate that the results of our tests are not affected by the possibility that firms could re-incorporate to other states in response to anti-takeover law passages.

From a theoretical standpoint, we contribute to the literature that examines the effects of corporate governance mechanisms on innovation. Stein (1988) shows that the threat of a takeover induces managers to behave myopically. Manso (2007) shows that the compensation contracts that provide incentives to a CEO to innovate exhibit the twin features of tolerance for failure in the short term, and reward for long-term performance. Aghion et al (2008) predict and find that higher institutional ownership is positively associated with greater innovation. The existing studies thus examine how innovation is affected by either internal mechanisms such as managerial compensation contracts and large shareholder monitoring, or by external mechanisms such as takeover pressure. Innovation is potentially driven by the interactions among the market for corporate control, contracts, and monitoring. By integrating external and internal governance mechanisms, we demonstrate how the interactions be-
tween takeover premia and private control benefits lead to the novel prediction that innovation varies in a U-shaped manner with takeover pressure.

Our results are especially pertinent to the ongoing debate on the importance of the market for corporate control in fostering innovation. One strand of the literature (the “quiet life” view) argues that laws that hinder the market for corporate control encourage managerial slack and cause managers to refrain from investing in innovative activities (Jensen, 1988). In contrast, another strand of the literature (the “managerial myopia” view) argues that strong anti-takeover laws may foster innovation by facilitating long-term contracting (Shleifer and Summers, 1988) or by encouraging long-term investments in innovation by managers (Stein, 1988).

Our theory, which integrates long-term contracting and an external market for corporate control, shows that both perspectives are “locally” correct. When takeover pressure is above a threshold, a decrease in takeover pressure decreases innovation, which is consistent with the “quiet life” view. When takeover pressure is below the threshold, a decline in takeover pressure increases innovation, which is consistent with the “managerial myopia” view. An unhindered market for corporate control fosters innovation through the incentives provided by takeover premia. Severe anti-takeover laws may, however, also induce innovation by mitigating the adverse effects of private control benefit losses on managers’ incentives to engage in innovative activities. The interplay between the magnitudes of these conflicting forces causes innovation to vary non-monotonically with takeover pressure.

From an empirical standpoint, our paper is related to studies that examine the real effects of corporate governance. Atanassov (2007) empirically examines the “quiet life” view versus “managerial myopia” view using the passage of business combination laws. While Atanassov (2007) tests for a monotonic relationship between takeover pressure and innovation, we show that the relationship between takeover pressure and innovation is, in fact, non-monotonic. Bertrand and Mullainathan (2003) examine the effect of passage of business combination statutes on plant-level productivity. Bebchuk and Cohen (2005) show that the presence of staggered boards has a detrimental effect on firm value. Giroud and Mueller (2008) examine the differential effects of business combination laws on competitive and non-competitive industries. We complement these studies by investigating the sequential effects of every anti-takeover law.

Section 1 describes the model. Section 2 derives the main testable implications of the model. Section 3 contains the empirical analysis. Section 4 concludes the paper. Appendix A provides the
proofs of the propositions. Appendix B shows that our theoretical implications are robust to a model with more general payoff distributions. Appendix C shows that our testable implications are robust to a model that incorporates disciplinary as well as synergistic takeovers. Finally, in Appendix D, we provide a formal justification for our empirical strategy and illustrate how the panel regressions that we employ in the empirical analysis are equivalent to difference-in-difference regressions.

1 The Model

We consider a two-period model with dates 0, 1, 2. At date 0, the manager of an all-equity firm chooses between two projects that differ in their degrees of innovation. We denote the “more innovative” project by $H$ and the “less innovative” project by $L$. Payoffs occur at date 2. All agents are risk-neutral with a common discount rate that is normalized to zero. The manager is wealth-constrained, which precludes the possibility of “selling the firm” to the manager at date 0.

1.1 Project Characteristics

The project $X \in \{H, L\}$ requires an initial investment $C$ and generates a payoff of $P_X(2)$ at date 2.\footnote{The assumption that the projects require the same initial investment is made purely to simplify the notation. We only require that the more innovative project have a higher net present value than the less innovative one.} To simplify the analysis and clarify the main economic mechanisms underlying our results, we deliberately make specific distributional assumptions on the projects’ payoffs in the analysis below. Appendix B shows that all our results hold for more general distributions.

The true expected returns of the projects (the expected returns from the perspective of a hypothetical omniscient agent) are unobservable to all agents, including the manager. As in Holmstrom (1999), there is imperfect, but symmetric, information about the true expected returns. The projects differ from each other as follows. First, the more innovative project has a higher risk and a higher expected return than the less innovative one. Second, the more innovative project involves greater “exploration” relative to the less innovative one so that there is more uncertainty about its expected return.

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

$$P_X(2) = 2\bar{\mu}_X + \sigma_X \tilde{z}_1 + \sigma_X \tilde{z}_2.$$  

\footnote{The assumption that the projects require the same initial investment is made purely to simplify the notation. We only require that the more innovative project have a higher net present value than the less innovative one.}
The parameter $\tilde{\mu}_X$ in (1) determines the true expected return of the project, which we refer to as the project’s quality. All agents have symmetric, normally distributed prior beliefs about the project’s quality. Formally,

$$\tilde{\mu}_X \sim N(m_X, s^2_X),$$

(2)

where $m_X$ is the mean quality of the project. The parameter $s^2_X$ is the variance in agents’ beliefs about the project’s quality, which we refer to as the quality uncertainty of the project.

In (1), $z_1$ and $z_2$ are independent standard normal random variables, which respectively capture the first and second period intrinsic uncertainties associated with the project. The parameter $\sigma_X$, which is common knowledge, captures the level of intrinsic uncertainty of project $X$.

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

$$m_H > m_L \text{ and } \sigma_H > \sigma_L.$$  

(3)

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

$$s_H > s_L.$$  

(4)

Furthermore, we assume that

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

(5)

which implies that, compared to the less innovative project $L$, a relatively greater proportion of the total uncertainty associated with the more innovative project $H$ stems from uncertainty about its quality. For instance, in our example of the pharmaceutical company, while a significant portion of the uncertainty associated with manufacturing and launching a generic substitute lies in the marketing stage, a relatively greater proportion of the uncertainty associated with inventing a new drug occurs in the exploration stage, when the very existence of the drug is in question.
1.2 Intermediate Signals and Posterior Assessments of Project Quality

The manager’s project choice at date 0 is observable. If the manager chooses project $X \in \{H, L\}$ at date 0, then all agents observe a signal $P_X(1)$ at date 1 that is given by

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

From (1), it follows that:

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

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

Given the signal, all agents update their assessments about the quality of the project chosen by the manager. Using Bayes’ rule, the posterior distribution of the quality of project $X$ is also normally distributed with mean $\hat{m}_X$ and standard deviation $\hat{s}_X$ given by:

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

$$\hat{s}_X^2 \equiv \frac{s_X^2 \sigma_X^2}{s_X^2 + \sigma_X^2}. \quad (9)$$

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

$$\hat{m}_X = m_X + S_X \tilde{z} \quad (10)$$

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

$$S_X \equiv \frac{s_X^2}{\sqrt{s_X^2 + \sigma_X^2}} \quad (11)$$

It follows from (4), (5) and (11) that

$$S_H > S_L \quad (12)$$

Equation (12) captures an additional salient aspect of innovation that goes beyond the usual risk–return trade-off; the uncertainty in the posterior assessments of project quality are more variable for the more innovative project.
1.3 Private Control Benefits and Monitoring Intensity

Similar to studies such as Bebchuk and Jolls (1999), the manager extracts observable, but non-verifiable (and, therefore, non-contractible) pecuniary private control benefits $\alpha \in (0, \infty)$ provided she still controls the firm in the second period. The private benefits, which represent the portion of the firm’s earnings that the manager can costlessly extract, decline with the intensity of monitoring of the manager by the shareholders. For example, if the firm has a higher proportion of ownership by outside block-holders, then the manager will be better monitored so that the private benefits that she can extract are likely to be lower (Tirole, 2006). In other words, better monitoring of the manager increases the verifiable portion of the firm’s total earnings thereby limiting the manager’s private benefits. In Appendix B, we show that our results are unaltered if the manager’s private benefits differ for the two projects.

1.4 Takeover Pressure

At date 1, the firm can be acquired by another firm through a tender offer. If the tender offer is successful, the raider acquires the firm and alters the project’s quality and intrinsic uncertainty in the second period. The project’s terminal payoff at date 2 under the raider’s control is

$$P_{X}^{\text{raider}} (2) = P_{X} (1) + \tilde{\mu}_{X}^{\text{raider}} + \sigma_{X} \tilde{z}_{3}, \quad (13)$$

where $\tilde{z}_{3}$ is a standard normal random variable independent of $\tilde{z}_{1}, \tilde{\mu}_{X},$ and $\tilde{\mu}_{X}^{\text{raider}}$. As is the case for the project’s true expected return $\tilde{\mu}_{X}$ under the firm’s incumbent management, the true expected return $\tilde{\mu}_{X}^{\text{raider}}$ of the project under the raider, is also unobservable to all agents in the economy. The true expected return generated by the raider is

$$\tilde{\mu}_{X}^{\text{raider}} = (1 - \Theta) \tilde{\mu}_{X} + \Theta \tilde{\nu}_{X}^{\text{raider}} = \tilde{\mu}_{X} + \Theta \left( \tilde{\nu}_{X}^{\text{raider}} - \tilde{\mu}_{X} \right) \quad (14)$$

where $\Theta \in (0, 1]$ is a deterministic constant, and $\tilde{\nu}_{X}^{\text{raider}}$ is a random variable that could be viewed as the intrinsic quality of the raider. Equation (14) implies that the true expected return generated by the raider is a convex combination of the project’s intrinsic quality $\tilde{\mu}_{X}$ and the intrinsic quality of the
raider $\bar{\nu}_X^{\text{raider}}$. The parameter $\Theta$ could thus be viewed as the “degree of substitutability” between the assets of the firm and those of the raider.

As in the case of the project’s intrinsic quality $\bar{\mu}_X$, there is imperfect but symmetric information about the raider’s intrinsic quality $\bar{\nu}_X^{\text{raider}}$. Consistent with (2),

$$\bar{\nu}_X^{\text{raider}} \sim N(m_X, s_X^2),$$

(15)

which captures the intuitive notion that the raider’s project is drawn from the same pool of projects as that of the incumbent manager. For simplicity, we assume that $\bar{\nu}_X^{\text{raider}}$ is independent of $\bar{\mu}_X$.

Since the raider’s intrinsic quality $\bar{\nu}_X^{\text{raider}}$ could be above or below the project’s intrinsic quality $\bar{\mu}_X$, equation (14) implies that the additional return generated by the raider could be positive or negative. In other words, we allow for the raider to add or destroy value. However, as we see shortly, in equilibrium, a takeover is successful only if the expected return generated by the raider, conditional on the information available to market participants at date 1, is positive.

If the raider takes over the firm, the incumbent manager loses her control benefits $\alpha$ to the raider. Anti-takeover laws take various forms, but all have the common feature that they affect the firm’s bargaining power in its negotiations with the raider (see Comment and Schwert, 1995). The more severe the anti-takeover laws, the more difficult it is for the raider to take over the firm. We capture the severity of anti-takeover laws through the minimum takeover premium that the raider must offer the firm. More precisely, in the absence of a takeover, the payoff to the firm (shareholders + manager) at date 2 net of the private benefits extracted by the manager is $P_X(2) - \alpha$. Hence, the expected payoff to the firm at date 1 net of the manager’s private benefits is $E_1 [P_X(2) - \alpha]$. Let $P_X^{\text{takeover}}$ be the total payoff that the raider offers the firm. The takeover is successful if and only if

$$P_X^{\text{takeover}} \geq E_1 [P_X(2) - \alpha] + \eta,$$

(16)

where $\eta > 0$ denotes the minimum takeover premium the raider has to offer. As anti-takeover laws become more severe, the parameter $\eta$ increases so that takeover pressure decreases. The positive relationship between the minimum takeover premium and the severity of anti-takeover laws is consistent with the evidence in Comment and Schwert (1995) that the passage of anti-takeover laws resulted in significant increases in takeover premia.
The following proposition shows that, for a successful takeover, the value added by the raider must exceed a threshold that depends on the severity of anti-takeover laws.

**Proposition 1 (Likelihood of Takeover and Takeover Payoff)**

a) The firm is successfully acquired if and only if

$$\Theta(m_X - \hat{m}_X) \geq \eta.$$  

(17)

where $\hat{m}_X$ is the mean posterior project quality at date 1 (see 8).

b) The total payoff that the firm receives from the raider is

$$P^\text{takeover}_X = E_1[P^\text{raider}_X(2) - \alpha] = \hat{m}_X + \Theta(m_X - \hat{m}_X) - \alpha,$$  

(18)

c) The likelihood of a takeover is higher for the more innovative project.

Condition (17) implies that, conditional on the information available to all market participants at date 1, the takeover is successful if and only if the additional expected return generated by the raider is sufficiently high to compensate for the takeover premium that it must pay the firm. The condition holds if and only if the posterior mean assessment of project quality $\hat{m}_X$ is sufficiently low, that is, if the firm receives a sufficiently low intermediate signal at date 1. In other words, as in studies such as Jensen (1988), Scharfstein (1988) and Stein (1988), a takeover is successful only if the project under-performs at the intermediate date.

Since the minimum takeover premium $\eta$ that the raider has to offer increases with the severity of anti-takeover laws, the threshold project quality (below which a takeover occurs) decreases as anti-takeover laws become more severe. Therefore, an increase in the severity of anti-takeover laws lowers the takeover pressure faced by a firm.

Condition (c) of Proposition 1 implies that the likelihood of a takeover is higher for the more innovative project. Because the payoff distribution of the more innovative project has fatter tails, it is more likely to generate significantly bad signals in the interim, which increases the likelihood of a takeover.

The prediction of Proposition 1 that more innovative firms are more likely to underperform in the interim and are consequently more likely to be taken over is consistent with empirical evidence. Desyllas and Hughes (2009) analyze the acquisitions of publicly traded high technology firms over the
period 1984-1998. They find that, compared to non-acquired firms, acquired firms are more innovative but they experience poor profitability and low liquidity prior to being taken over.

Our focus on “disciplinary” takeovers in the basic model, in which under-performing firms are taken over, is consistent with the perspectives of studies such as Jensen (1988), Scharfstein (1988) and Stein (1988). Nevertheless, in Appendix C we show that our key results are robust to a setting that accommodates both disciplinary as well as “synergistic” takeovers. In that setting, the acquiring firm’s project could either “substitute” the incumbent firm’s project, which is characteristic of disciplinary takeovers, or “complement” the incumbent firm’s project, which is characteristic of synergistic takeovers (see Auerbach, 1988). In a synergistic takeover, over-performing firms are taken over because of potential synergies with an acquiring firm. In the extended model, therefore, both significantly under-performing and over-performing firms could be taken over.

1.5 Contracting between the Manager and Shareholders

At date 0, the manager and the shareholders enter into a long-term contract. The contract cannot prevent the pool of shareholders at date 1 from tendering their shares to an raider if it is in their interests to do so. However, the contract can specify a severance payment to the manager in the event of a takeover at date 1.

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

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

2 Equilibrium

In this section, we characterize the equilibrium of the model. We then derive the main results of the paper and generate the empirical implications.
2.1 Benchmark Environment

It is useful to analyze the benchmark environment in which there are no frictions, that is, the project choice \( X \) is contractible, and the manager derives no private control benefits. In this environment, the manager chooses the project that maximizes the total expected payoffs of the firm. The project choice therefore maximizes

\[
X^{\text{benchmark}} = \arg \max_{X \in \{H, L\}} \left[ E\left[ \left( 1 - 1_X^{\text{takeover}} \right) P_X(2) \right] + E\left[ 1_X^{\text{takeover}} \cdot P_X(2) \right] \right],
\]

where the indicator variable \( 1_X^{\text{takeover}} \) represents the event that the firm that has undertaken project \( X \) is taken over at date 1 (the subscript indicates that the event of being taken over depends on the project \( X \)). In the benchmark environment, the shareholders maximize their expected payoffs by extracting all the surplus from the raider at date 1 and the raider earns zero profits. Therefore, \( P_X^{\text{takeover}} = E_1[P_X^{\text{raider}}(2)] \) where \( E_1[\cdot] \) denotes the expectation operator with respect to date 1 information. Substituting for \( P_X^{\text{takeover}} = E_1[P_X^{\text{raider}}(2)] \) in (20) and using the law of iterated expectations, we get

\[
X^{\text{benchmark}} = \arg \max_{X \in \{H, L\}} \left[ E\left[ P_X(2) \right] + E\left[ 1_X^{\text{takeover}} \cdot \left( P_X^{\text{raider}}(2) - P_X(2) \right) \right] \right],
\]

Equation (21) implies that, in the benchmark environment, the manager chooses the project that maximizes the total expected surplus of the firm, which is equal to the expected unconditional payoff of the project plus the expected takeover premium from selling the firm. Note that, because the firm can only be taken over if the raider offers a positive premium, the expected takeover premium term is strictly positive. The following proposition shows that the manager always chooses greater innovation in the first-best benchmark.

**Proposition 2 (The Benchmark Project Choice)** In the benchmark environment with no frictions, the manager always chooses the more innovative project.

The more innovative project has a higher unconditional expected payoff than the less innovative one. Furthermore, by (12), the likelihood of a takeover is higher when the manager chooses the more innovative project, implying that the expected takeover premium in the right-hand side of (21) is also higher. It is therefore optimal for the manager to choose the more innovative project.
2.2 Optimal Project Choice

We now analyze the environment in which the manager’s project choice is non-contractible and she derives private benefits. At date 0, in order to maximize their expected payoffs, the shareholders design an optimal compensation contract $w^*(Q_X)$ for the manager, where $Q_X$ is the contractible payoff defined in (19). The optimal project choice $X^* \in \{H, L\}$ and the manager’s compensation contract $w^*(Q_X)$ solve the following optimization problem:

$$\max_{X, w(Q_X)} \mathbb{E}[Q_X - w(Q_X)]$$

subject to the manager’s participation constraint,

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

and the incentive compatibility constraint,

$$X = \arg \max_{X' \in \{H, L\}} E[(1 - 1_{\text{takeover} \cap X'}) \cdot \alpha + w(Q_{X'})].$$

In constraint (23), the variable $U$ denotes the manager’s reservation payoff. Constraint (24) ensures that the manager’s project choice is incentive compatible.

It is easy to see that the participation constraint (23) must be binding in the optimal contract, which implies that\footnote{Otherwise, the manager’s compensation can be reduced by a constant amount that does not affect the incentive compatibility constraint (24) but strictly increases the shareholders’ expected payoff.}

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

Substituting for $E(w^*(Q_X))$ in (22) and using (19) as well as the law of iterated expectations, we obtain

$$X^* = \arg \max_{X \in \{H, L\}} \left( \mathbb{E}(P_{X}(2)) + \mathbb{E} \left[ 1_{\text{takeover} \cap X} \cdot (P_{X}^{\text{raider}}(2) - P_X(2)) \right] - \mathbb{E}[1_{\text{takeover} \cap X} \cdot \alpha] \right).$$

Note that in deriving the optimal project choice $X^*$, we have ignored the incentive compatibility constraint (24). We show later in Proposition 4 that, under the optimal contract, the constraint is
indeed satisfied and the manager’s optimal project choice solves (25). By (25), in the presence of private control benefits, the manager’s optimal project choice maximizes the expected total unconditional payoff $E(P_X(2))$ of the project plus the expected takeover premium less the expected control benefits that are lost in the event of a takeover. Recall that, in the benchmark environment with no frictions, equation (21) implies that the manager maximizes the total expected surplus of the firm given by the first two terms of (25). However, in our second-best environment, in which the project choice is not contractible and private control benefits are present, the manager maximizes the total expected surplus of the firm minus the expected loss in control benefits due to a possible takeover at date 1.

The following proposition describes the optimal project choice of the manager.

**Proposition 3 (Optimal Project Choice)** The manager’s optimal project choice solves

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

(26)

where $\Phi(\cdot)$ is the cumulative standard normal distribution and $S_X$ is defined in (11).

The objective function in (26) illustrates the basic trade-off that the manager faces in choosing the degree of innovation. From Proposition 1(c), the likelihood of being taken over is higher for the more innovative project. Hence the manager’s expected loss of control benefits is also higher. However, the higher likelihood of being taken over also results in a larger expected takeover premium for the more innovative project. The manager’s project choice trades off the positive effect of greater innovation on the expected takeover premium against its negative effect on the expected loss of control benefits. Furthermore, note that the expected takeover premium depends on the level of takeover pressure $\eta$ that the firm faces while the expected loss in control benefits depends on both the level of takeover pressure $\eta$ and the magnitude of the private control benefits $\alpha$. Therefore, the above trade–off between the expected takeover premium and the expected loss in control benefits is itself influenced by the interaction between the shareholders’ monitoring intensity (which affects $\alpha$) and the extent of external takeover pressure the firm faces.
Optimal Compensation Contract

Proposition 4 (Optimal Contract) An optimal contract for the manager is one in which she receives a fraction \( \lambda \) of the firm’s terminal payoffs (i.e., \( \lambda Q_{X^*} \)) and an additional payment, \( \beta \), if the firm is taken over where

\[
\beta = (1 - \lambda) \alpha, \tag{27}
\]

and \( \lambda \) is chosen to satisfy the manager’s participation constraint at equality:

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

where \( X^* \) is the optimal project choice that satisfies (26).

The optimal allocation of payoffs to the agents—shareholders and the manager—can be implemented in different ways. In the above implementation, the manager receives a (restricted) equity stake of \( \lambda \) in the firm along with a severance payment of \( \beta > 0 \) if the firm is taken over at date 1. Since the manager loses her control benefits in the event of a takeover, the severance payment partially compensates for this loss of control benefits by providing a proportion \( (1 - \lambda) \) of the control benefits. From an ex ante perspective, both the equity stake \( \lambda \) and the severance payment \( \beta \) are optimal contractual devices that align the manager’s incentives with those of the shareholders. The severance payment resembles a firm-level anti-takeover device, such as a golden parachute or a poison pill, in the sense that it makes it costlier for the raider to take over the firm.

Note that, as is standard in incomplete contracting models in which private benefits are observable but non-contractible (e.g., Bebchuk and Jolls, 1999, Chapter 3 of Tirole, 2006), the contractual parameters—the equity stake \( \lambda \) and the severance payment \( \beta \)—depend on \( \alpha \). This reflects the fact that shareholders incorporate their knowledge of the value of \( \alpha \) in designing the manager’s contract. The contractual compensation \( w^*(\cdot) \) is, however, directly contingent on the contractible variable \( Q_X \) and not on the manager’s private benefits. If private benefits were observable and contractible, then \( w^*(\cdot) \) could be made directly contingent on the amount of private benefits that the manager extracts. In this case, the first best outcome could be achieved via a wage contract that imposes a severe penalty on the manager if she extracts nonzero private benefits.
2.4 Innovation, External Takeover Pressure, and Monitoring

We now describe the effects of takeover pressure on the degree of innovation.

Proposition 5 (Effect of Takeover Pressure on Innovation) There exists an (possibly degenerate) interval $[\eta_{\text{min}}, \eta_{\text{max}}]$ of the external takeover pressure parameter $\eta$ such that the manager chooses the more innovative project for $\eta \not\in [\eta_{\text{min}}, \eta_{\text{max}}]$ and the less innovative project for $\eta \in [\eta_{\text{min}}, \eta_{\text{max}}]$. The interval $[\eta_{\text{min}}, \eta_{\text{max}}]$ is non-degenerate if and only if the private control benefits $\alpha$ are large enough.

To understand the intuition behind this result, consider first the case where the external takeover pressure is very low ($\eta > \eta_{\text{max}}$). In this case, a takeover is very unlikely, so the expected takeover premium as well as the expected loss in control benefits are insignificant (i.e., the second and third terms in (26) are relatively small). Therefore, the manager’s optimal project choice is driven by the unconditional expected project payoff (the first term in (26)). The manager, therefore, chooses the more innovative project due to its higher unconditional expected payoff. Conversely, when takeover pressure is very high ($\eta < \eta_{\text{min}}$), regardless of the project choice, the expected loss in control benefits is very high. Because the more innovative project generates a higher expected takeover premium, it is again optimal to choose the more innovative project. For moderate levels of takeover pressure, the effect of the expected loss of control benefits dominates so that the manager chooses the less innovative project, thereby lowering the likelihood of a takeover.

The intuition underlying Proposition 5 suggests that the loss of control benefits due to a takeover plays a key role in generating the intermediate region within which lower innovation is chosen. As mentioned earlier, the control benefits the manager extracts (and, therefore, the control benefits she loses due to a takeover) depend on shareholders’ monitoring intensity. The following proposition describes the effects of monitoring intensity on the degree of innovation.

Proposition 6 (Effect of Monitoring Intensity on Innovation)

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

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

for $0 < \alpha_1 < \alpha_2,$

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

To explore how the external takeover pressure and the internal monitoring intensity interact to affect the degree of innovation, we define the expected excess payoff from higher innovation \(G(\eta, \alpha)\), as the expected payoff from the more innovative project \(H\) less the expected payoff from the less innovative project \(L\). From Proposition 3, the expected excess payoff is given by

\[
G(\eta, \alpha) = 2m_H + \frac{\Theta S_H}{\sqrt{2\pi}} \exp\left(-\frac{1}{2} \left(\frac{\eta}{\Theta S_H}\right)^2\right) - \alpha \Phi\left(-\frac{\eta}{\Theta S_H}\right) - 2m_L - \frac{\Theta S_L}{\sqrt{2\pi}} \exp\left(-\frac{1}{2} \left(\frac{\eta}{\Theta S_L}\right)^2\right) + \alpha \Phi\left(-\frac{\eta}{\Theta S_L}\right)
\]

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

**Proposition 7 (Takeover Pressure, Monitoring Intensity, and Innovation)** There exists an \(\eta^* > 0\) such that

\[
\frac{\partial^2 G}{\partial (\alpha) \partial \eta} > 0 \text{ for } \eta < \eta^*, \quad (29)
\]

\[
\frac{\partial^2 G}{\partial (\alpha) \partial \eta} < 0 \text{ for } \eta > \eta^*
\]

Figure 1 illustrates the result of Proposition 7 by showing the variation of the expected excess payoff from higher innovation with takeover pressure for different values of the manager’s private control benefits. Proposition 5 and Figure 1 show that the U-shaped relation between the degree of innovation and takeover pressure becomes “flatter” as monitoring intensity increases — that is, as \(\alpha\) declines. The intuition is that, as the manager’s private control benefits decline, so does the relative impact of the manager’s expected loss of control benefits on the expected excess payoff from higher innovation. As a result, the expected excess payoff from higher innovation becomes less sensitive to changes in takeover pressure as the monitoring intensity increases. Hence, as illustrated by Figure 1, the U-shaped relation between the degree of innovation and takeover pressure becomes flatter as
monitoring intensity increases.

In Appendix B, we show that all the implications derived above hold in a setting in which the underlying random variables are drawn from general distributions. In this general setting, we describe the necessary and sufficient conditions on the distributions of project payoffs and qualities to obtain the main testable implications described by Propositions 5, 6, and 7. In Appendix C, we show that all the above implications are also robust to a setting that incorporates disciplinary and synergistic takeovers.

2.5 Testable Hypotheses

The preceding theoretical predictions generate the following empirically testable hypotheses.

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

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

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

In the model, the degree of innovation and the manager’s compensation contract are simultaneously and endogenously determined by the takeover pressure, $\eta$, and the private benefits, $\alpha$. In other words, the parameters $\eta$ and $\alpha$ are inputs to the model, whereas the compensation contract and the degree of innovation are outputs. In particular, our predictions relating innovation to takeover pressure and monitoring intensity incorporate the fact that the manager’s compensation contract responds optimally to the takeover pressure and monitoring intensity that she faces. Moreover, as discussed in Section 2.3, the manager’s contract can be implemented in different ways through combinations of financial securities and additional payoffs contingent on a takeover. Hence, our testable hypotheses also reflect the possibility that the firm could alter its financial structure and takeover provisions in response to changes in the external takeover pressure (for example, through anti-takeover laws) to implement the optimal payoffs of agents as described by Proposition 4. Further, from an econometric standpoint, the
inclusion of endogenous variables as additional explanatory variables is incorrect because they distort coefficient estimates and standard errors of the exogenous variables as well. To closely tie our empirical analysis to the theory, and to avoid “endogeneity” problems in our empirical analysis, we examine the relationship between innovation and proxies for external takeover pressure and monitoring intensity without including endogenous firm-level variables such as compensation contracts, insider ownership, firm-level anti-takeover provisions, and capital structure.

3 Empirical Analysis

3.1 Proxies for Innovation

We employ both \textit{ex ante} and \textit{ex post} measures to proxy for innovation by firms. We use R&D intensity—the ratio of a firm’s R&D expenditures to sales—as our \textit{ex ante} measure of innovation. We use two broad metrics for our \textit{ex post} measures of innovation. First, using data on patents filed by US firms with the US Patent Office (USPTO) constructed by Hall, Jaffe, and Trajtenberg (2001), we employ a simple count of the number of patents that were filed by a firm in a particular year. Second, to capture the economic importance of innovation, we measure all subsequent citations (until 2002) made to these patents (see Griliches, Pakes, and Hall, 1987). Because the year of application for a patent captures the relevant date of the innovation for which a patent is filed, we date our patents according to the year in which they were applied for. This also avoids any anomalies that may be caused by the time lag between the application date versus the grant date of a patent. Note that although we use the application year as the relevant year for our analysis, the patents appear in the database only after they are granted. Hence, for our analysis, we use the patents actually granted.\footnote{We identify patents filed by U.S. subsidiaries of foreign firms as those where the country of the “assignee” is non-US but the country of the “inventor” is the US. Of the 331,014 patents in our sample, there are 6689 patents (~2.0%) issued to US subsidiaries of foreign companies. Not surprisingly, excluding these patents does not change our results.}

3.2 Proxies for External Takeover Pressure

As discussed in Section 1.4, the external takeover pressure parameter $\eta$ in our model captures the severity of anti-takeover laws. Accordingly, we use the state-level index of anti-takeover laws compiled by Bebchuk and Cohen (2003) as the empirical proxy for external takeover pressure. The index attaches to each state a score from 0 to 5 that is equal to its number of standard anti-takeover
statutes. They are called the Control Share Acquisition, Fair-price, Business Combination, Poison Pill Endorsement, and Constituencies Statutes. (See Bebchuk and Cohen (2003) for detailed descriptions of these statutes.) Given our discussion in Section 2.5, the state-level anti-takeover index serves as a viable exogenous proxy for takeover pressure.

Figure 2 shows the evolution of the anti-takeover index for the various states in which firms in our sample are incorporated. The top panel of Figure 2 shows the evolution of the anti-takeover index due to the passage of anti-takeover laws in Delaware, New York, Ohio, Massachusetts, Pennsylvania, Minnesota, and New Jersey. These states collectively account for over three-quarters of our observations. The panel shows that the anti-takeover index is zero for California because it never passed an anti-takeover law. The bottom panel shows the evolution of the anti-takeover index for all the states in our sample.

Table 1 shows the states that form part of our sample and had passed anti-takeover laws during the period 1980-1995. This panel also lists the year in which the law was passed, the value of the state anti-takeover index before the passage of the law, and the change in the value of the index (which equals the number of anti-takeover statutes passed in that year).^4 Figure 2 and Table 1 display two patterns that are important for our empirical strategy: both the levels and changes of the anti-takeover index exhibit considerable variation across time and across the different states. These variations occur for two reasons. First, many states passed anti-takeover laws sequentially over time. Second, states chose to pass a variable number of anti-takeover laws in different years. For example, Indiana passed four anti-takeover laws in 1986 and another anti-takeover law in 1989.

3.3 Proxy for Monitoring Intensity: Active Shareholders

Our proxies for monitoring intensity are constructed using block ownership data from CDA Spectrum. Because the NBER patent data is available at an annual frequency, we employ the institutional shareholdings at the end of December of each year. We define a blockholder as a shareholder owning greater than 5% of the firm’s outstanding shares and employ three different proxies for monitoring

^4We compiled this list of changes by combining the anti-takeover index from Bebchuk and Cohen (2003) together the list of law passages compiled by Bertrand and Mullainathan (2003) and Karpo¤ and Malatesta (1989). While we rely primarily on Bebchuk and Cohen (2003) for the list of law passages, we cross-checked the year of passage of these laws using the list provided in Bertrand and Mullainathan (2003) and Karpo¤ and Malatesta (1989). In those instances where the year of passage of the law did not coincide across these three studies, we cross-checked the year using Lexis-Nexis’ annotated state statutes.
intensity: (i) the number of institutional blockholders, (ii) the total percentage of shares owned by blockholders, and (iii) the number of public pension fund blockholders. We run our tests using all of the above proxies. Because the results are similar using each of the three proxies, we only report the results using the total percentage of shares owned by blockholders for brevity.

### 3.4 Sample Construction and Descriptive Statistics

Our sample period ranges from 1980 to 1995. We begin our sample in 1980 because blockholder ownership data are available from 1980 onwards. We terminate the sample in 1995 for two reasons. First, patents applied for in later years may not have been granted and therefore would not be present in the NBER dataset. Furthermore, because the NBER dataset extends only until 2002, citations to recent patents are not present in the data, which further exacerbates the problems stemming from “truncation bias.” Second, as Table 1 shows, the last anti-takeover law was passed in 1992. Because the effects of law passages on innovation may decay over time, innovation undertaken several years after the laws are passed are more likely to be affected by other factors. We therefore follow Bertrand and Mullainathan (2003) and Giroud and Mueller (2008) in ending our sample in 1995. Our results remain unchanged if we extend the sample to 2002.

To be included in the sample, a firm must have filed at least one patent during our sample period. For our empirical analysis, we focus on the patents granted to US Corporations in the NBER patent dataset. Each assignee in the NBER dataset is assigned a unique and time-invariant identifier (an assignee code equal to 2 identifies US non-government assignees, which are mainly US Corporations.) First, we match the assignee names in the NBER patent dataset to the names of divisions/subsidiaries belonging to a Corporate family from the Directory of Corporate Affiliations. We then match the name of the Corporate parent to Compustat. This matching process is done using name matching algorithms together with manual verification of 5% of the matched pairs. To remove the effects of outliers, we winsorize our sample at the 1% and 99% levels. Our final sample consists of 10,377 firm-year observations.

Table 2 shows the summary statistics for our various proxies. Because our unit of observation is a firm-year, all these summary statistics are calculated at the firm-year level of aggregation. The average (median) firm invests 18% (4%) of its annual sales revenue in R&D, applies for and is granted 19.5 (3) patents per year, and receives about 197.8 (15) citations per year subsequently. Thus, compared
to the median firm, the average firm in our sample invests 4.5 times more in R&D, applies for and is granted 6.5 times more patents and receives about 13.2 times more citations. The average and median percentage of shares owned by all blockholders together are 13.8% and 13.4% respectively. Table 3 lists the states in which firms in our sample are incorporated as well as the number of firm-year observations contributed by the various states.

### 3.5 Univariate Analysis

Before we proceed to our empirical analysis, we undertake univariate analyses of the raw data. Figure 3 shows a scatter plot, a quadratic fit, and a flexible piecewise spline fit for our *ex ante* and *ex post* measures of innovation against the anti-takeover index. The y-axis plots the average value of the logarithm of R&D/ Sales, the logarithm of patents and the logarithm of citations, where the average is computed over all firms incorporated in a state for each state of incorporation and for each value of the anti-takeover index in that state over the time period 1981-1995. The quadratic and the spline fits provide preliminary evidence that the relationship between the ex ante and ex post innovation proxies and the anti-takeover index is non-monotonic and U-shaped.

### 3.6 Empirical Strategy

As noted in Figure 2 and Table 1, the levels as well as changes in the anti-takeover index exhibit substantial cross-sectional and time-series variation. We exploit these sources of variation to conduct our empirical analysis in four steps. First, we conduct fixed effects panel regressions. Second, to weaken the identifying assumptions underlying these tests, we exploit the variation in the *changes* in the anti-takeover index to undertake fixed effects panel regressions of annual changes in our innovation proxies on changes in the explanatory variables. Third, to alleviate any residual endogeneity concerns, we exploit the fact that our data include patents and citations filed by subsidiaries and divisions of firms. Because other state-wide unobserved changes accompanying the passage of anti-takeover laws may distort our results, we run “change on change” regressions by excluding all innovation done by subsidiaries and divisions located in the state of incorporation. Finally, we carry out additional robustness tests that (i) examine whether our results are driven by reverse causality; (ii) investigate the long-term effects of innovation; and (iii) analyze whether our results hold across a broad spectrum of industries, or are driven by a narrow group of industries.
3.7 Fixed Effects Panel Regressions

To investigate Hypotheses 1, 2, and 3, we run the following fixed effects panel regression:

\[ y_{is,t+1} = \beta_i + \beta_{t+1} + \beta_1 TI_{st} + \beta_2 TI_{st}^2 + \beta_3 MI_{it} + \beta_4 (TI_{st}^2 * MI_{it}) + \beta \cdot X_{ist} + \varepsilon_{is,t+1} \]  

where \( y_{is,t+1} \) is the measure of innovation of firm \( i \) incorporated in state \( s \) in year \( t + 1 \). The variable \( TI_{st} \) denotes the anti-takeover index for state \( s \) at the end of year \( t \), while the variable \( MI_{it} \) denotes the monitoring intensity for firm \( i \) at the end of year \( t \). We examine the effects of monitoring intensity and the anti-takeover index with a time lag of one year because states may pass anti-takeover laws in any month of the year, and institutional shareholdings may change throughout the year. Since we include firm fixed effects in these regressions, we estimate robust standard errors that are clustered by the state of incorporation to account for correlation in the errors within a state (Petersen, 2009).

The variables \( \beta_i \) and \( \beta_{t+1} \) denote firm and year fixed effects respectively. The firm fixed effects control for time-invariant unobserved determinants of innovation at the firm level. Since most firms do not change their state of incorporation or their primary industry, the firm fixed effects capture time-invariant unobserved determinants at the state and industry levels as well. The year fixed effects control for inter-temporal differences in innovation that are constant across states and industries as well as problems stemming from the truncation bias in citations. By including fixed effects for the firm and year, we estimate a “difference-in-difference” specification in a generalized setting with multiple treatment groups and multiple time periods (see Bertrand, Duflo and Mullainathan, 2004 and Imbens and Wooldridge, 2007). Appendix D provides a formal proof of the same (in particular see equations (82) and (83)).

In the above specification, \( X \) denotes a vector of control variables that are potential determinants of innovation. To control for the potential dependence of innovation on firm size, we include the logarithm of assets. Because innovation may be more likely when investment opportunities are greater, we include Tobin’s Q to control for a firm’s investment opportunities. Aghion et al (2005) show that innovation varies in an inverted U-shaped manner with industry competition. Accordingly, we include

\footnote{We employ OLS regressions using log-linear specifications for two reasons. First, the identifying assumptions required in non-linear models such as the negative binomial model or the poisson model are quite restrictive in practice (Wooldridge, 2002 page 675). Second, interpreting the interaction coefficient \( \beta_4 \) is problematic in these non-linear models (see Lel and Miller, 2008 and Ai and Norton, 2003).}
a sales-based Herfindahl measure for the 4-digit SIC industry and its square as additional controls. Finally, we also control for the potential dependence of innovation on the age of the firm.

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

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

Across columns 1-9 of Table 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 these models reveals that the value at which innovation attains its minimum, $-\beta_1/(2 \times \beta_2)$, lies in the range 0-5 of possible values of the anti-takeover index. Using the coefficients in columns 2, 5, and 8, we find that when the value of the index in a state is zero (four), as it is in California (Pennsylvania in 1992), a one point increase in the value of the index decreases (increases) R&D/ sales, patents, citations for firms incorporated in the state respectively by 28%, 22%, and 23% (30%, 14%, and 19%) annually. Thus, consistent with Hypothesis 1, we find strong evidence of an economically significant U-shaped relationship between innovation and the level of the anti-takeover index.

Table 4 also shows that $\beta_3 > 0$. Across columns 1-9, the coefficients are statistically significant. A one standard deviation increase in total blockholder ownership is associated with 20% higher R&D/ Sales, 14% more annual patents, 15% more annual citations. These results are consistent with Hypothesis 2 that higher monitoring intensity is associated with greater innovation.

Finally, we find that $\beta_4 < 0$ across columns 1-9. A one standard deviation increase in the total blockholder ownership flattens the curvature of annual patents, citations, and R&D/ Sales by 4.1%, 3.7%, and 3.8% respectively. Thus, consistent with Hypothesis 3, we find that higher monitoring leads to a flattening of the U-shaped relationship between takeover pressure and innovation.
Among our control variables, we find that firm size is positively associated with our innovation proxies. Furthermore, consistent with Aghion et al. (2005), we find evidence of an inverted U-shaped relationship between innovation and competition. Finally, we find that younger firms patent and receive citations relatively more than older firms.

**Discussion of the Fixed Effects Panel Regressions**

By identifying the predicted effects as a “difference-in-difference,” the above tests alleviate concerns about other alternative interpretations. A simple cross-sectional analysis that exploits differences in innovation across the different U.S. states would have to contend with the criticism that these results are driven by comparative advantages of firms located in some specific states. First, the presence of elite universities may enable recruitment of quality scientific personnel and may increase collaborations with these universities; these effects could lead to greater innovation. Second, geographical clusters such as the Silicon valley and Route 128 may offer significant advantages to innovative firms. Since we identify the predicted effects using changes in some states (treatment) vis-a-vis the changes in the other states (control), such state-specific effects cannot account for our results.

However, our results could be distorted by time-varying, unobserved factors that influence innovation. In other words, while we have accounted for the time-invariant, unobserved determinants in the tests above, time-varying, state or industry specific factors may be accounting for our results. For example, firms located in California or Massachusetts may be able to better equipped to respond to technological advances such as the advent of the Internet. Such effects may manifest as California and Massachusetts displaying a steeper upward trend in innovation when compared to other states. The incorporation of such state-specific and industry-specific time trends leads to “triple-difference” tests in which the identifying assumptions are weaker.

### 3.8 Change-on-Change Panel Regressions

As noted in Section 3.2, changes in the anti-takeover index vary both within a state and across states. Because firm-level blockholder ownership changes vary across time in our sample too, we exploit these rich variations to conduct fixed effects panel regressions of changes in our explanatory variables on changes in innovation (see Imbens and Wooldridge (2007), Section 4). Motivated by the possibility of state-specific and industry-specific time trends discussed above, we consider the following
equation-of-motion for our innovation-proxies:

\[ y_{is,t+1} = \beta_i + (t + 1) \beta_s + (t + 1) \beta_{industry} + \gamma_{t+1} + \beta_1 TI_{st} + \beta_2 TI_{st}^2 + \beta_3 MI_{it} + \beta_4 (TI_{st}^2 \cdot MI_{it}) + \beta \cdot X_{ist} + \eta_{is,t+1} \]  

(31)

Thus, we allow for (i) state-specific time trends \((t + 1) \beta_s\) as in Besley and Burgess (2004); (ii) industry-specific time trends \((t + 1) \beta_{industry}\); and (iii) time and firm-specific factors \(\beta_i\) and \(\gamma_t\), respectively.

First-differencing (31) yields

\[ \Delta y_{is,t+1} = \beta_s + \beta_{industry} + \beta_{t+1} + \beta_1 \Delta TI_{st} + \beta_2 \Delta TI_{st}^2 + \beta_3 \Delta MI_{it} \]

(32)

\[ + \beta_4 \Delta (TI_{st}^2 \cdot MI_{it}) + \beta \cdot \Delta X_{ist} + \varepsilon_{is,t+1}; \]

where

\[ \Delta y_{is,t+1} = y_{is,t+1} - y_{is,t}; \beta_{t+1} = \gamma_{t+1} - \gamma_t; \Delta TI_{st} = TI_{st} - TI_{s,t-1}; \]

\[ \Delta TI_{st}^2 = TI_{st}^2 - TI_{s,t-1}^2; \Delta MI_{it} = MI_{it} - MI_{i,t-1}; \]

\[ \Delta (TI_{st}^2 \cdot MI_{it}) = TI_{st}^2 \cdot MI_{it} - TI_{s,t-1}^2 \cdot MI_{i,t-1}; \]

\[ \Delta X_{ist} = X_{ist} - X_{is,t-1}; \varepsilon_{is,t+1} = \eta_{is,t+1} - \eta_{ist}. \]

The time fixed effects \(\beta_{t+1}\) in equation (32) control for shocks to changes in innovation that are common to all firms. Identification in (32) comes from the potential effects of changes in the explanatory variables on firm-level deviations from state- and industry-specific trends in innovation. Given the state and time fixed effects in a panel regression of changes-on-changes, using arguments similar to those used in Appendix D, it can be shown that the coefficients \(\beta_1 - \beta_4\) are estimated as “triple-differences”. Following Petersen (2009) who recommends clustering on the dimension in which fixed effects are not included in a panel regression, we estimate robust standard errors that are clustered by firm given the state of incorporation fixed effects.

Hypotheses 1, 2, and 3 predict that

\[ \beta_1 < 0, \ \beta_2 > 0, \ \beta_3 > 0, \ \beta_4 < 0 \]  

(33)
Table 5 presents the results. The specifications we employ in Table 5 mirror those employed in Table 4. Consistent with our hypotheses we find that $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$, and $\beta_4 < 0$ across all the specifications. By examining the values of $\beta_1$ and $\beta_2$ in columns 1-9, we find that the value at which innovation attains its minimum, $-\beta_1/(2 \times \beta_2)$, lies in the range 0 – 5 of possible values of the anti-takeover index. Across Columns 1-9, the coefficient estimates are very similar to those obtained in Table 4. Hence, the economic magnitudes of the effects are close to those described in Section 3.7.

Discussion of the Change-on-Change Panel Regressions

Since these tests control for linear state-specific time-trends (see 31), they largely account for the effects of state-specific factors coinciding with the passage of anti-takeover laws. However, if these state-specific factors lead to non-linear effects on innovation, such non-linear trends will not be captured by the above tests. Our next set of tests is designed to address such alternative interpretations.

3.9 Subsidiary/Division-Level Change-on-Change Regressions

To control for the effects of changing economic conditions that accompany the passage of an anti-takeover law in a state, we exploit a unique feature of our data. The NBER patents data records the location of the innovation through the state where a patent was filed. Thus, while Xerox may be headquartered and incorporated in Rochester, NY, its research labs are located in Rochester, NY as well as in Palo Alto, CA. The NBER patent data enable us to distinguish between patents filed by Xerox’s Palo Alto Research Center and those of its Rochester laboratories. Anti-takeover laws passed by New York would likely affect innovation at its Palo Alto Research Center and its Rochester laboratories. However, any state-wide economic changes accompanying the law are more likely to affect the innovation at Xerox’s Rochester laboratories. Therefore, if we exclude changes in innovation at Xerox’s Rochester laboratories and estimate only using changes in innovation at Xerox’s Palo Alto research center, then such an estimation potentially isolates the pure effect of the law passage. In other words, to separate the effect of changes in the anti-takeover index from the effect of other accompanying state-wide changes, we examine the impact on innovation in divisions/subsidiaries outside the state of incorporation for firms incorporated in the state.
We implement the tests using the following specification:

$$
\Delta y_{kis,t+1} = \beta_{location} + \beta_s + \beta_{t+1} + \beta_1 \Delta TI_{st} + \beta_2 \Delta TI_{st}^2 + \beta_3 \Delta MI_{st} + \beta_4 \Delta \left(TI_{st}^2 \times MI_{st}\right) + \beta \cdot \Delta X_{ist} + \varepsilon_{kis,t+1}
$$

(34)

where $y_{kis,t}$ denotes the level of innovation in year $t$ for subsidiary/division $k$ of firm $i$ incorporated in state $s$ and subsidiary/division $k$ of firm $i$ is located outside state $s$. For firms incorporated in states in which the anti-takeover index changed during the time-period 1980-1995, $y$ includes only those patents applied for (and eventually granted) by subsidiaries/divisions outside the state of incorporation and citations to these patents. The variable $\beta_{location}$ denote fixed effects for the state in which subsidiary/division $k$ is located. Because different subsidiaries/divisions of a firm could be located in different states, we are able to include these fixed effects for the location of the subsidiary apart from fixed effects for the state in which the firm is incorporated ($\beta_s$). The other variables are defined similarly as in (32).

Table 6 reports the results of the tests. Because subsidiary level information is not available for R&D intensity, we only test for patents and citations. The specifications employed for these are identical to those in Columns 4-9 of Table 5. We note that the coefficients $\beta_1$ to $\beta_4$ retain their predicted signs and are statistically significant.

We estimate the economic magnitudes of the predicted effects using the coefficients in columns 2 and 5. First, when the value of the index in a state is zero (four), as it is in California (Pennsylvania in 1992), a one point increase in the value of the index decreases (increases) R&D/sales, patents, citations for firms incorporated in the state respectively by 11% and 16% (32% and 26%) annually. This effect is consistent with the U-shaped relationship between innovation and the level of the anti-takeover index. Second, a one standard deviation increase in total blockholder ownership is associated with 11% more annual patents and 14% more annual citations. Finally, a one standard deviation increase in the total blockholder ownership flattens the curvature of annual patents and citations by 31% and 34% respectively.

Our tests have progressively addressed concerns relating to identification: while the identifying assumptions were the strongest in our “difference-in-difference” tests, they are the weakest in the division-level “difference in difference” tests. In fact, by completely shutting out any state-specific
factor that may have coincided with the passage of the anti-takeover laws and by identifying the effects using triple-differences, these tests exploit primarily exogenous variations to identify the predicted effects. It is also worth noting here that even if there were any distortions created by the exclusion of firm-level endogenous variables as additional controls (recall the discussion in Section 2.5), they would be considerably mitigated because identification in our tests described in Sections 3.8 and 3.9 comes from “triple-differences” (differences-in-changes for the treated firms vis-à-vis the differences-in-changes for the control firms).

3.10 Robustness Tests

3.10.1 Reverse Causality

The earlier tests do not address the possibility of a “reverse causal” relationship between innovation and takeover laws. If the anti-takeover laws were passed in response to innovation already occurring due to other factors in the economy, then we might see an “effect” of the change in anti-takeover laws prior to the change itself. We explore this possibility by examining the effects of anti-takeover laws on our innovation proxies before the year of the actual law passage using the following lag specification:

$$
\Delta y_{is,t-l} = \beta_s + \beta_{industry} + \beta_{t-1} + \beta_1 \Delta TI_{st} + \beta_2 \Delta \hat{I}_{st}^2 + \beta_3 \Delta MI_{it} + \beta_4 \Delta (TI_{st}^2 \ast MI_{it}) + \beta \cdot \Delta X_{ist} + \varepsilon_{is,t-l}
$$

(35)

where $l$ captures the number of years before the passage of an anti-takeover law.

Table 7 displays the results. In Columns 1-3, we examine whether there were changes in innovative activity one year prior to the passage of an anti-takeover law. We find that while the coefficients $\beta_1$ and $\beta_2$ are insignificant for our ex-post proxies, they are negative and positive respectively and statistically significant for our ex-ante proxy. Thus, while we find no evidence of changes in innovative activity for our ex post proxies, we find some evidence for our ex ante proxy. These findings are consistent with the fact that R&D investment is an input to innovation, while patents and citations are outputs. Firms could potentially anticipate an impending law passage in the near future and alter their investments in R&D. It is, however, less likely that firms can anticipate law passages in the more distant future so that we would not expect a relationship between R&D investments and takeover pressure changes in the more distant future. In Column 4, we re-run regression (35) for $l = 2$ using R&D intensity as the dependent variable. Consistent with the above intuition, we find no relationship
between R&D intensity and law passages two years later. Our results, therefore, do not indicate that firm-level changes in innovation significantly preceded changes in takeover pressure, which alleviate concerns of reverse causality.

3.10.2 Long-Term Effects of Innovation

In our main tests, we examined the effects of changes in takeover pressure and monitoring intensity a year after the changes and beyond. We would expect changes in takeover pressure to have short term effects on R&D investment because it is an input to innovation, and long term effects on patents and citations because they are outputs. For example, Kondo (1999) finds that there is a one-and-a-half year lag between R&D investments and patent applications. To examine the differential effects on inputs and outputs of innovation, we investigate the effects of changes in takeover pressure on our innovation proxies at least three years after the changes:

\[
\Delta y_{is,t+3} = \beta_s + \beta_{\text{industry}} + \beta_{t-1} + \beta_1 \Delta TI_{st} + \beta_2 \Delta TI_{st}^2 + \beta_3 \Delta MI_{it} + \beta_4 \Delta (T^2_{st} \ast MI_{it}) + \beta \cdot \Delta X_{ist} + \epsilon_{is,t+3}
\]

(36)

Columns 5-7 of Table 7 report the results. While we find no statistically significant effects on R&D intensity, the effects on patents and citations are statistically and economically significant. These results together with our earlier ones support the intuition that changes in takeover pressure have short term effects on R&D intensity and long term effects on patents and citations.

3.10.3 Inter-Industry Differences

Could the more innovation-intensive industries be driving our results? We investigate this possibility by examining inter-industry differences in the effect of takeover pressure and monitoring intensity based on the industry’s propensity to innovate. We classify industries as high or low innovation-intensive using the average number of patents filed by firms in the 4-digit SIC industry in a particular year vis-a-vis the median number of patents filed by firms in all industries in that year. We run the following regression:

\[
y_{is,t+1} = \beta_1 + \beta_{t+1} + [\beta_1 TI_{st} + \beta_2 TI_{st}^2 + \beta_3 MI_{it} + \beta_4 (T^2_{st} \ast MI_{it})] \cdot [High_{ind,t} + Low_{ind,t}] + \beta \cdot X_{ist} + \epsilon_{is,t+1}
\]

33
where \( \text{High}_{ind,t} \) (\( \text{Low}_{ind,t} \)) equals 1 if the average number of patents filed by a firm in 4-digit SIC industry in year \( t \) is above (below) the median and 0 otherwise, where the median is calculated over all industries for the year \( t \).

Table 8 shows the results of these tests, where we note that the predicted effects of takeover pressure and monitoring intensity are observed both in the High and Low innovation-intensive industries. Thus, the more innovation-intensive industries are not necessarily driving our results.

### 3.11 Discussion

A firm can choose to reincorporate to another state if its original state of incorporation passes anti-takeover laws. We believe that this possibility does not affect the inferences obtained from our tests for the following reasons.

First, anti-takeover laws are not the sole determinant of incorporation decisions. For example, a state’s corporate legal environment such as its bankruptcy laws, tax code and pro-management tilt (in aspects other than anti-takeover laws)\(^6\) may be important considerations that affect incorporation choices. Bebchuk and Cohen (2003) also find “home-state preference” to be a very important determinant of firms’ incorporation decisions. They find that firms are more likely to be incorporated in states where they are located due to (i) the higher costs of out-of-state incorporations; (ii) the desire of firms to benefit from local favoritism; and (iii) the influence of local lawyers. For several firms, the above factors could well outweigh the effects of anti-takeover laws in determining their incorporation decisions.

Second, because the above essentially constitute state-level factors, they are captured by our various empirical tests. Our “difference-in-difference” and “triple-difference” regressions control respectively for time-invariant state level factors and state-specific time trends that may affect such re-incorporation choices. More importantly, our “division-level change-on-change” regressions control for the effects of any other state-level factors that accompanied the law passage and that may have affected firms’ incorporation choices.

Third, in all cases without any exception, states passed laws that lowered takeover pressure. If the decision to reincorporate is motivated by entrenched managers, then it is clearly not in the interests

---

\(^6\)One example is a state statute that gives management greater ability to eliminate dissident shareholders in a merger. Another example is a state statute that authorizes companies to limit or eliminate the liability of directors for all but disloyalty and other intentional bad acts.
of such managers to reincorporate in order to avoid laws that lower takeover pressure.

Consistent with all the preceding arguments, we find that only 1% of our sample (or 134 firm-year observations out of 10377) is accounted for by firms that re-incorporated after the passage of anti-takeover laws. Not surprisingly, our results are unaltered by excluding these 134 observations. Thus, our results are robust to firms’ reincorporation decisions after anti-takeover law passages.

4 Conclusion

We develop a parsimonious model to investigate how corporate governance mechanisms affect a firm’s incentives to engage in innovation. Our model generates three testable predictions: (i) there is a U–shaped relationship between innovation and the takeover pressure the firm faces, (ii) the likelihood that a firm innovates increases with monitoring intensity, and (iii) the sensitivity of innovation to takeover pressure declines with monitoring intensity. Using *ex ante* and *ex post* measures of innovative activity, we show strong empirical support for the model’s predictions.

By integrating long-term contracting and a market for corporate control, our theory shows how the interplay between takeover premia and private benefits leads to a *non-monotonic* relation between innovation and takeover pressure. From a policy standpoint, our results show that innovative activity is fostered by anti-takeover laws that are either practically non-existent or are strong enough to significantly deter takeovers. Effective monitoring not only enhances innovation, but also lowers the sensitivity of innovation to variations in takeover pressure created by the passage of anti-takeover laws. Monitoring is most effective at intermediate levels of takeover pressure.

Our study is relevant to the ongoing debate among lawyers and economists on whether anti-takeover laws matter. A popular argument offered by scholars in support of the claim that anti-takeover laws are irrelevant is that firms adopt anti-takeover provisions and/or choose compensation contracts for managers that negate the effects of laws. However, the very fact that firms respond to anti-takeover laws itself means that these laws must matter. Second, our testable hypotheses for the relations among innovation and takeover pressure are derived incorporating the possibility that firms respond to changes in the external takeover pressure through managerial contract choices. Our empirical findings show that anti-takeover laws do, indeed, affect innovation.

From a normative standpoint, anti-takeover laws potentially matter because they have the force of commitment. Firm-level anti-takeover provisions can, and often are, *renegotiated* *ex post*. In
this case, the law can provide firms with a commitment device that affects \textit{ex ante} incentives for innovation. Further, it is well-known that equilibria of games depend, in general, on off-equilibrium threats. Therefore, even if one were to hypothetically observe no effects of laws on innovation (which is not true given our empirical findings) along the equilibrium path, the equilibrium itself could be \textit{supported} by the existence of laws.

Appendix A – Proofs of Propositions

Proof of Proposition 1

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

$$E_1 [P_X(2)] - \alpha + \eta, \text{ where } \eta > 0. \tag{37}$$

It follows directly from (1), (13), and (37) that the raider must generate a surplus for the firm. From the discussion in Sections 11.5.1 and 11.5.2 of Tirole (2006), free-riding by shareholders coupled with the fact that the raider obtains private control benefits, together ensure that it is optimal for the raider to make a tender offer that cedes the surplus he generates (less the control benefits he captures) to the firm. After the takeover, the firm’s current stakeholders (shareholders + manager) therefore receive a total payoff at date 1 of

$$P_X^{\text{takeover}} = E_1 \left[ P_X^{\text{raider}}(2) \right] - \alpha, \tag{38}$$

where the expectation in (38) is with respect to the information available at date 1. It follows from (37) and (38) that the takeover is successful if and only if

$$E_1 \left[ P_X^{\text{raider}}(2) \right] \geq E_1 [P_X(2)] + \eta, \tag{39}$$

In words, (39) states that the raider must increase the firm’s expected payoff, conditional on the information available at date 1 by at least $\eta$. Using (1), (8), (13), (14), and (39), it follows that the raider succeeds in taking over the firm if and only if

$$\hat{m}_X + \Theta(m_X - \hat{m}_X) \geq \hat{m}_X + \eta,$$

$$\Leftrightarrow \Theta(m_X - \hat{m}_X) \geq \eta$$

b) The payoff to the firm upon a takeover follows directly from (38) and the fact that $E_1 \left[ P_X^{\text{raider}}(2) \right] = \hat{m}_X + \Theta(m_X - \hat{m}_X)$. 

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c), From (a), the firm is taken over if and only if \( \Theta(m_X - \hat{m}_X) \geq \eta \). Using (10), to rewrite the mean posterior quality in the preceding inequality, implies that the firm is taken over if and only if 
\[
\tilde{z} \leq -\frac{\eta}{S_X \Theta}.
\]
Therefore the probability of a takeover if the manager chooses project \( X \in \{H, L\} \) is 
\[
1 - \Phi\left(\frac{\eta}{S_X \Theta}\right)
\]
where \( \Phi(\cdot) \) is the cumulative standard normal distribution. Because \( S_H > S_L \) by (12), it follows that the probability of a takeover is higher for the more innovative project.

**Proof of Proposition 2**

In an environment with no frictions, the manager maximizes the sum of the first two terms in (26). Because the expected takeover premium \( \Theta \frac{S_X \eta}{\sqrt{2\pi}} \exp\left[-\frac{1}{2} \left(\frac{\eta}{S_X \Theta}\right)^2\right] \) is increasing in \( S_X \), (12) implies that the more innovative project results in a higher takeover premium than the less innovative project. This result coupled with the assumption \( m_H > m_L \), imply that the first two terms in (26) are greater for the more innovative project making the more innovative project optimal in the benchmark environment.

**Proof of Proposition 3**

\[
E(P_X(2)) = E(2\mu_X + \sigma_X \tilde{z}_1 + \sigma_X \tilde{z}_2) = 2m_X.
\]

\[
E(1_{X_{\text{takeover}}} \cdot \alpha) = \alpha E(1_{X_{\text{takeover}}}) = \alpha \left[ 1 - \Phi\left(\frac{\eta}{S_X \Theta}\right) \right],
\]

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

\[
P_{X_{\text{takeover}}}(2) - P_X(2) = P_X(1) + \tilde{\mu}_X^{\text{raider}} + \sigma_X \tilde{z}_3 - (P_X(1) + \tilde{\mu}_X + \sigma_X \tilde{z}_2)
= \tilde{\mu}_X^{\text{raider}} - \tilde{\mu}_X + \sigma_X (\tilde{z}_3 - \tilde{z}_2)
\]

From equation (42):

\[
E[1_{X_{\text{takeover}}} \cdot (P_{X_{\text{takeover}}}(2) - P_X(2))] = E[1_{X_{\text{takeover}}} \cdot (\tilde{\mu}_X^{\text{raider}} - \tilde{\mu}_X)] + \sigma_X E[1_{X_{\text{takeover}}} \cdot (\tilde{z}_2 - \tilde{z}_3)]
= \Theta E[1_{X_{\text{takeover}}} \cdot (\tilde{\mu}_X - m_X)]
\]

By the result of Proposition 1 and (10),

\[
\Theta E\left[1_{X_{\text{takeover}}} \cdot E_1(\tilde{\mu}_X - m_X)\right] = \Theta E\left[1_{X_{\text{takeover}}} \cdot (\tilde{\mu}_X - m_X)\right]
= \frac{\Theta}{\sqrt{2\pi} S_X} \int_{-\infty}^{\infty} xe^{-\frac{1}{2} \left(\frac{x}{S_X \Theta}\right)^2} dx
= \frac{\Theta S_X}{\sqrt{2\pi}} \exp\left[-\frac{1}{2} \left(\frac{\eta}{S_X \Theta}\right)^2\right]
\]

Proposition 3 follows from (40), (41), and (44).

**Proof of Proposition 4**

The manager’s objective function is

\[
\alpha + E[w(Q_X) - 1_{X_{\text{takeover}}} \cdot \alpha], \text{ or equivalently}
\]

\[
37
\]
\[ E[w(Q_x) - 1_{\text{takeover}} \alpha]. \]

The shareholder’s objective function is \( E[Q_X - w(Q_X)] \). One way to make the project choice incentive compatible is to make the manager’s objective function proportional to the shareholder’s objective function, that is,

\[ w(Q_x) = m \frac{Q_x}{m+1} + \frac{\alpha}{m+1} 1_{\text{takeover}}, \]

where \( 0 < m < 1 \) so that

\[ w(Q_x) = \frac{m}{m+1} Q_x + \frac{\alpha}{m+1} 1_{\text{takeover}}, \]

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

\[ w(Q_x) = \lambda Q_x + (1 - \lambda) \alpha 1_{\text{takeover}}. \]

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

**Proof of Proposition 5**

Define the expected excess payoff from the more innovative project over the less innovative project by the function \( G(\eta, \alpha) \) where

\[ G(\eta, \alpha) \equiv 2m_H - 2m_L + F(\eta, \alpha); \tag{45} \]

and

\[ F(\eta, \alpha) = \frac{\Theta S_H}{\sqrt{2\pi}} \exp[-\frac{1}{2} \left( \frac{\eta}{S_H} \Theta \right)^2] - \alpha \Phi(-\frac{\eta}{S_H} \Theta) - \frac{\Theta S_L}{\sqrt{2\pi}} \exp[-\frac{1}{2} \left( \frac{\eta}{S_L} \Theta \right)^2] + \alpha \Phi(-\frac{\eta}{S_L} \Theta). \tag{46} \]

Note that as \( \eta \to \infty \), \( \lim F(\infty, \alpha) = 0 \) so that the expected excess payoff \( G(\infty, \alpha) = 2m_H - 2m_L > 0 \). Conversely, as \( \eta \to -\infty \), \( \Phi(-\frac{\eta}{S_X \Theta}) \to 1 \) so that \( \lim F(0, \alpha) = \frac{\Theta S_H}{\sqrt{2\pi}} - \frac{\Theta S_L}{\sqrt{2\pi}} > 0 \). This, in turn, implies that \( G(0, \alpha) = 2m_H - 2m_L + \frac{\theta (S_H - S_L)}{\sqrt{2\pi}} > 0 \). Thus, the manager chooses the more innovative project for relatively low and relatively high levels of takeover pressure.

We will now show that if the private control benefits parameter is sufficiently high, lower innovation may be optimal for moderate levels of takeover pressure.

Differentiate (46) with respect to \( \eta \), to get:

\[
\frac{\partial F(\eta, \alpha)}{\partial \eta} = \frac{1}{\sqrt{2\pi}} \exp(-\frac{1}{2} \left( \frac{\eta}{S_H} \Theta \right)^2) (-\frac{\eta}{S_H} \Theta)^2) - \frac{1}{\sqrt{2\pi}} \exp(-\frac{1}{2} \left( \frac{\eta}{S_L} \Theta \right)^2) (-\frac{\eta}{S_L} \Theta)
\]

\[ + \alpha \frac{1}{\sqrt{2\pi}} \exp(-\frac{1}{2} \left( \frac{\eta}{S_X \Theta} \right)^2) \Theta S_X \exp(-\frac{1}{2} \left( \frac{\eta}{S_X \Theta} \right)^2) \Theta S_X \Theta \]

\[ - \alpha \frac{1}{\sqrt{2\pi}} \exp(-\frac{1}{2} \left( \frac{\eta}{S_X \Theta} \right)^2) \Theta S_X \exp(-\frac{1}{2} \left( \frac{\eta}{S_X \Theta} \right)^2) \Theta S_X \Theta \]

\[ = \frac{1}{\sqrt{2\pi} S_H} \exp(-\frac{1}{2} \left( \frac{\eta}{S_H} \Theta \right)^2) - \frac{1}{\sqrt{2\pi} S_L} \exp(-\frac{1}{2} \left( \frac{\eta}{S_L} \Theta \right)^2) \Theta \Theta \]

The properties of the normal distribution imply that \( f_{S_H}(\frac{\eta}{\Theta}) \) and \( f_{S_L}(\frac{\eta}{\Theta}) \) cross only once for some \( \eta \geq 0 \). Let \( \hat{\eta} \) satisfy \( f_{S_H}(\frac{\eta}{\Theta}) = f_{S_L}(\frac{\eta}{\Theta}) \). Then \( f_{S_H}(\frac{\eta}{\Theta}) < f_{S_L}(\frac{\eta}{\Theta}) \) for \( \eta \in [0, \hat{\eta}] \) and \( f_{S_H}(\frac{\eta}{\Theta}) > f_{S_L}(\frac{\eta}{\Theta}) \) for \( \eta \)
for \( \eta \in (\tilde{\eta}, +\infty) \) so that

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

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

(i) \( \min(\tilde{\eta}, \frac{b}{\Theta}) \) is a local minimum for \( F(\eta, \alpha) \);

(ii) \( F(\eta, \alpha) \) is weakly decreasing in \( \eta \) if \( \frac{b}{\Theta} = \tilde{\eta} \).

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

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

\[
G(\eta, \alpha) < 0
\]  

where \( G(\eta_{\text{min}}, \alpha) = G(\eta_{\text{max}}, \alpha) = 0 \) and \( \tilde{\eta} = S_H S_L \Theta \sqrt{\frac{2(\ln S_H - \ln S_L)}{S_H^2 - S_L^2}} > 0 \) given by \( f_{S_H}(\eta) = f_{S_L}(\eta) \).

Using (45) and (46), the necessary and sufficient condition described in (47) becomes:

\[
\alpha > \alpha_{\text{MIN}} = \frac{2(m_L - m_H) - \left( \frac{\Theta S_H}{\sqrt{2\pi}} \exp(-\frac{1}{2} \left( \frac{\tilde{\eta}}{S_H} \right)^2) - \frac{\Theta S_L}{\sqrt{2\pi}} \exp(-\frac{1}{2} \left( \frac{\tilde{\eta}}{S_L} \right)^2) \right)}{\Phi(-\frac{\tilde{\eta}}{S_L \Theta}) - \Phi(-\frac{\tilde{\eta}}{S_H \Theta})} > 0.
\]  

where \( \tilde{\eta} = S_H S_L \Theta \sqrt{\frac{2(\ln S_H - \ln S_L)}{S_H^2 - S_L^2}} \).

**Proof of Proposition 6**

Let \( \tilde{\eta} \) satisfy \( G(\tilde{\eta}, \alpha) = 0 \), so that \( \tilde{\eta} = \eta_{\text{min}} \) or \( \eta_{\text{max}} \) are the thresholds defined above that satisfy \( G(\eta_{\text{min}}, \alpha) = G(\eta_{\text{max}}, \alpha) = 0 \) for all \( \alpha > \alpha_{\text{MIN}} \) defined in (48). Using the Implicit Function theorem:

\[
\frac{d\tilde{\eta}}{d\alpha} = -\frac{\partial G}{\partial \alpha} \bigg|_{\eta=\tilde{\eta}} = \frac{\Phi(-\frac{-\tilde{\eta}}{S_H \Theta}) - \Phi(-\frac{\eta}{S_L \Theta})}{\frac{\partial F(\eta, \alpha)}{\partial \eta}} \bigg|_{\eta=\tilde{\eta}}.
\]  

The numerator of (49) is positive. From the proof of proposition 5, the denominator of (49) is negative for \( \tilde{\eta} = \eta_{\text{min}} \), and positive for \( \tilde{\eta} = \eta_{\text{max}} \). This completes the proof.

**Proof of Proposition 7**

\[
\frac{\partial^2 G}{\partial (-\alpha) \partial \eta} = \frac{1}{\Theta} \left( -\frac{1}{\sqrt{2\pi}} \exp\left[-\frac{1}{2} \left( \frac{\eta}{S_H \Theta} \right)^2 \right] \frac{1}{S_H} + \frac{1}{\sqrt{2\pi}} \exp\left[-\frac{1}{2} \left( \frac{\eta}{S_L \Theta} \right)^2 \right] \frac{1}{S_L} \right)
\]

\[\approx \frac{1}{\Theta} \left( f_{S_L}(\frac{\eta}{\Theta}) - f_{S_H}(\frac{\eta}{\Theta}) \right).
\]

The properties of the normal distribution imply that \( f_{S_H}(\frac{\eta}{\Theta}) \) and \( f_{S_L}(\frac{\eta}{\Theta}) \) cross only once for some \( \eta^* \geq 0 \) such that \( f_{S_L}(\frac{\eta}{\Theta}) - f_{S_H}(\frac{\eta}{\Theta}) > 0 \) for \( \eta < \eta^* \), and \( f_{S_L}(\frac{\eta}{\Theta}) - f_{S_H}(\frac{\eta}{\Theta}) < 0 \) otherwise.
Appendix B: A Model With General Payoff Distributions and Differing Private Benefits

In this Appendix, we show that the main testable implications of the theory are robust to a generalization of the model presented in Section 1 in which (i) the projects’ payoffs are drawn from more general distributions; and (ii) the manager’s private benefits differ for the two projects. As in the basic model, the manager chooses between a more innovative project $H$ and a less innovative project $L$ at date 0. The payoff of project $X \in \{H, L\}$ at date 2 is

$$P_X(2) = 2\bar{\mu}_X + r_{X1} + r_{X2},$$  \hspace{1cm} (50)

where $r_{X1}$ and $r_{X2}$ are independent and identically distributed random variables drawn from a distribution $R_X$ with mean 0.

Consistent with the basic model, there is imperfect, but symmetric, information about the project’s quality $\bar{\mu}_X$. Agents’ prior assessment of $\bar{\mu}_X$ is drawn from a distribution $M_X$ that has mean $m_X$. We assume that

$$m_H > m_L.$$  \hspace{1cm} (51)

By (50) and (51), the more innovative project has a higher expected payoff.

At date 1, all agents observe a common signal given by

$$P_X(1) = \bar{\mu}_X + r_{X1}.$$  \hspace{1cm} (52)

Let $\hat{m}_X$ denote agents’ mean posterior assessment of the project’s quality based on their observation of the signal $P_X(1)$. We have

$$\hat{m}_X = m_X + s_X,$$  \hspace{1cm} (53)

where $s_X$ is a random variable drawn from a distribution $F_X$ with mean 0. The distribution $F_X$ depends on the distributions $M_X$ and $R_X$.

We assume that the distribution $F_X$ is absolutely continuous so that it has a density $f_X$ a.e. We also assume that the likelihood ratio

$$\frac{f_H(u)}{f_L(u)}$$  \hspace{1cm} (54)

is monotonically increasing in $u$. The above condition implies that

$$F_H(u) \leq F_L(u), \text{ for } u \geq 0.$$  \hspace{1cm} (55)

Finally, we assume that

$$\int_0^\infty uf_H(u)du \geq \int_0^\infty uf_L(u)du,$$  \hspace{1cm} (56)

which implies that, conditional on a positive change in the project’s mean quality, the expected change is also higher for the more innovative project. Conditions (54), (55) and (56) capture the intuitive
requirements that the payoff of the more innovative project is more skewed so that it is more likely to generate high signals and payoffs.

As in the basic model, the firm can be taken over by an raider through a tender offer. The project’s terminal payoff could be altered through synergies between the firm and the raider. The terminal payoff of project $X$ under the raider is

$$P_{X}^{\text{raider}}(2) = P_{X}(1) + \bar{r}_{X}^{\text{raider}} + r_{X2},$$

(57)

where

$$\bar{r}_{X}^{\text{raider}} = \bar{r}_{X} + \Theta \left( \nu_{X}^{\text{raider}} - \bar{r}_{X} \right).$$

(58)

As with the project’s intrinsic quality $\nu_{X}$, $\nu_{X}^{\text{raider}}$ is drawn from the distribution $M_X$ and is independent of $\bar{r}_{X}$.

In contrast with the basic model, we now allow for the manager’s private benefits to differ for the two projects and are given by $\alpha_H$ and $\alpha_L$, respectively. We assume that

$$\alpha_H > \alpha_L,$$

(59)

which captures the intuitive notion that the more innovative project is harder to define and therefore monitor so that the manager is able to extract greater private benefits. We assume that

$$m_H - m_L > \alpha_H - \alpha_L,$$

(60)

that is, the difference between the mean project qualities exceeds the difference between the private benefits the manager derives from the projects. The condition ensures that, in the hypothetical absence of the possibility of a takeover, the firm’s shareholders obtain a greater expected payoff from the more innovative project.

Proposition 1 a) and b) are valid for the more general model using exactly the same arguments, while part c) follows from condition (54). By arguments similar to those used in the main body of the paper, we can show that the manager’s optimal project choice solves

$$\max_{X \in \{H, L\}} \left( \begin{array}{c} 2m_X \\ \text{expected unconditional payoffs} \end{array} + \int_{\hat{\theta}}^{\infty} \Theta u f_X(u) du - \alpha_X \left[ 1 - F_X \left( \frac{\eta}{\theta} \right) \right] \right),$$

(61)

which is the expected excess payoff from higher innovation. By (60), $G(\infty) > 0$. By (55) and (56),

$$G(\eta) \equiv 2(m_H - m_L) - (\alpha_H - \alpha_L) + \int_{\hat{\theta}}^{\infty} \Theta u (f_H(u) - f_L(u)) du + \alpha_H F_H \left( \frac{\eta}{\theta} \right) - \alpha_L F_L \left( \frac{\eta}{\theta} \right),$$

(62)

Define

$$G(\eta) \equiv 2(m_H - m_L) - (\alpha_H - \alpha_L) + \int_{\hat{\theta}}^{\infty} \Theta u (f_H(u) - f_L(u)) du + \alpha_H F_H \left( \frac{\eta}{\theta} \right) - \alpha_L F_L \left( \frac{\eta}{\theta} \right),$$

(62)
\( G(0) > 0 \). Next, we note that

\[
\frac{\partial G(\eta)}{\partial \eta} = \left[ \frac{\alpha_H - \eta}{\Theta} \right] f_H(\eta) - \left[ \frac{\alpha_L - \eta}{\Theta} \right] f_L(\eta) \tag{63}
\]

We note that \( \frac{\partial G(\eta)}{\partial \eta} = 0 \) when

\[
\frac{f_H(\hat{\eta})}{f_L(\hat{\eta})} = \frac{\alpha_L - \eta}{\alpha_H - \eta} \tag{64}
\]

By (54), the left hand side is an increasing function of \( \eta \). Because \( \alpha_L < \alpha_H \), the right hand side above is a decreasing function of \( \eta \). By (54), the equation \( \frac{\partial G(\eta)}{\partial \eta} = 0 \) has a unique solution at \( \eta = \hat{\eta} \). Furthermore, it follows from (63) that \( G(\eta, \alpha) \) is decreasing for \( \eta < \hat{\eta} \), and is increasing for \( \eta > \hat{\eta} \). It follows that there exists an interval \([\eta_{\text{min}}, \eta_{\text{max}}]\) (that could be degenerate) such that the manager chooses greater innovation for \( \eta < \eta_{\text{min}} \) or \( \eta > \eta_{\text{max}} \), and lower innovation for \( \eta \in [\eta_{\text{min}}, \eta_{\text{max}}] \).

To explore the effects of monitoring intensity, let us write

\[
\alpha_X = \alpha + \beta_X; \quad X \in \{L, H\},
\]

where \( \alpha \) represents the "common" component of the manager’s private benefits from the two projects, which declines with the shareholders’ monitoring intensity. It follows directly from (55) and (62) that

\[
\frac{\partial G}{\partial (-\alpha)} > 0,
\]

which implies that higher monitoring has a positive effect on innovation. Finally, we note that

\[
\frac{\partial^2 G}{\partial (-\alpha) \partial \eta} = \frac{1}{\Theta} \left[ f_L \left( \frac{\eta}{\Theta} \right) - f_H \left( \frac{\eta}{\Theta} \right) \right].
\]

By (54), the result of Proposition 7 also holds for the more general model.

**Appendix C: A Model of Disciplinary and Synergistic Takeovers**

In this Appendix, we extend the basic model to allow for both disciplinary and synergistic takeovers and show that our main implications are unchanged. As in the basic model, the project’s terminal payoff at date 2 under the raider’s control is

\[
P_X^{\text{raider}}(2) = P_X(1) + \bar{\mu}_X^{\text{raider}} + \sigma_X \tilde{z}_3, \tag{66}
\]

where \( \tilde{z}_3 \) is a standard normal random variable independent of \( \tilde{z}_1, \tilde{\mu}_X, \) and \( \bar{\mu}_X^{\text{raider}} \). We now define a potential raider by its “complementarity/substitutability” parameter \( \chi \in [-\Theta, \Theta] \) where \( \Theta > 0 \). The true expected return \( \bar{\mu}_X^{\text{raider}}(\chi) \) generated by a raider with parameter \( \chi \) is

\[
\bar{\mu}_X^{\text{raider}}(\chi) = (1 - \chi)\bar{\mu}_X + \chi \tilde{\mu}_X^{\text{raider}} = \bar{\mu}_X + \chi (\tilde{\mu}_X^{\text{raider}} - \bar{\mu}_X). \tag{67}
\]
The true expected return generated by the raider is therefore a linear combination of the project’s intrinsic quality and the raider’s intrinsic quality \( \bar{\nu}_{\text{raider}} \). In Section 1.4, we had set \( \chi = \Theta \), which implies that the raider adds value when the intrinsic quality of its project is greater than that of the incumbent project. Consequently, only under-performing firms are taken over, that is, takeovers are disciplinary in nature. This could be viewed as a scenario in which the raider’s project “substitutes” the firm’s project if it is acquired, which is consistent with the general perspective on disciplinary takeovers (Auerbach, 1988). In contrast, because the parameter \( \chi \) can also take negative values, it follows directly from (67) that a raider with a negative value of \( \chi \) adds value if and only if \( \bar{\mu}_X > \bar{\nu}_{\text{raider}} \).

We could view this scenario as one in which the raider possesses assets that are complementary to those of the incumbent firm so that the payoff of a high quality project is further enhanced through synergies with the acquiring firm, that is, the raider’s project “complements” the firm’s project. This is consistent with the general perspective on synergistic takeovers that exploit complementarities between a firm and an acquirer (Auerbach, 1988). A raider with a positive (negative) value of \( \chi \) could be viewed as a “disciplinary” (“synergistic”) raider who adds value when the project’s quality is low (high) relative to the pool of potential projects. The parameter \( \chi \), therefore, captures the degree of substitutability between the firm’s and raider’s projects if it is positive and the degree of complementarity between the firm’s and raider’s projects if it is negative.

As in the basic model, the severity of anti-takeover laws determines the bargaining power of the firm vis-a-vis the raider, which manifests in the minimum takeover premium that the raider must offer the firm. Even though anti-takeover laws are primarily relevant for hostile takeovers, the targets in hostile takeovers could also be out-performing firms, that is, hostile takeovers could comprise of disciplinary as well as synergistic takeovers. Further, anti-takeover laws represent important “signals” of the general level of takeover pressure in the state that could influence the bargaining power of targets of all types of takeovers.

The following proposition generalizes Proposition 1 to accommodate both disciplinary and synergistic takeovers. Further, as is intuitively obvious, from the pool of potential raiders described by the set of possible synergy parameters \([-\Theta, \Theta]\), the raider that succeeds in taking over the firm is the one that generates the maximum additional value.

**Proposition 8 (Likelihood of Takeover and Takeover Payoff)**

a) The firm is successfully acquired if and only if

\[
\Theta |\hat{m}_X - m_X| \geq \eta. \tag{68}
\]

where \( \hat{m}_X \) is the mean posterior project quality at date 1 (see 8).

b) If \( \hat{m}_X > m_X \), and condition (68) is satisfied, the raider with synergy parameter \(-\Theta\) takes over the firm. If \( \hat{m}_X < m_X \), and condition (68) is satisfied, the raider with synergy parameter \( \Theta \) takes over the firm.

c) The total payoff that the firm receives from the raider is

\[
P^\text{takeover}_X = E_1[P^\text{raider}_X(2) - \alpha] = \hat{m}_X + \Theta |\hat{m}_X - m_X| - \alpha, \tag{69}
\]
The likelihood of a takeover is higher for the more innovative project.

Condition (a) implies that the takeover is successful if and only if the expected synergies generated by the raider are sufficiently high to compensate for the takeover premium that it must pay the firm. Conditions (a) and (b) together imply that the firm is taken over if the posterior mean assessment of project quality is either sufficiently high or sufficiently low, that is, if it receives either a sufficiently positive or a sufficiently negative intermediate signal at date 1. The prediction that significantly over-performing or under-performing firms are taken over is consistent with evidence on the takeover market. In reality, takeovers can be synergistic in the sense that “good” firms are taken over or disciplinary in which “bad” firms are taken over. Our analysis accommodates both types of takeovers. Condition (d) implies that the likelihood of a takeover—synergistic or disciplinary—is higher for the more innovative project. Because the payoff distribution of the more innovative project has fatter tails, it is more likely to generate significantly positive or significantly negative signals, that is, higher innovation is more likely to succeed as well as fail.

The following proposition generalizes Proposition 3.

**Proposition 9 (Optimal Project Choice)** The manager’s optimal project choice solves

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

Our testable implications described by Propositions 5, 6 and 7 also extend directly to this setting. We omit the details for brevity.


Our theory predicts the following relationship between innovation, takeover pressure, and monitoring intensity:

\[
y = b_0 + b_1 \cdot TI + b_2 \cdot TI^2 + b_3 \cdot MI + b_4 \cdot (MI \ast TI^2),
\]

where

\[
b_1 < 0; b_2 > 0, b_3 > 0, b_4 < 0
\]

We identify the coefficients \( \beta_1, \beta_2 \) and \( \beta_4 \) using the staggered state-level changes in anti-takeover laws. Our first set of regressions employ the following specification:

\[
y_{is,t+1} = \beta_i + \beta_{t+1} + \beta_1 \cdot TI_{st} + \beta_2 \cdot TI_{st}^2 + \beta_3 \cdot MI_{it} + \beta_4 \cdot (TI_{st}^2 \ast MI_{it}) + \varepsilon_{is,t+1}
\]

where \( i \) and \( s \) respectively denote firm \( i \) incorporated in state \( s \). The coefficients \( \beta_i, \beta_{t+1} \) respectively estimate firm and application year fixed effects, and the vector \( X \) represents the set of firm-level control variables.
During the sample period 1980-1995, suppose the anti-takeover index for state \( s \), \( TI_{st} \), changes \( n \) times in years \( t_1, ..., t_n \) where \( 1 < ... < n \) and \( t_l \) denotes the year in which the \( l \)th change occurred for state \( s \). Denote \( m_l = [t_l + 1, t_{l+1}] \) as the time interval during which the \( l \)th law change has occurred but not the \( (l+1) \)th. Let \( TI_s(m_l) \) denote the value of the anti-takeover index during the period \( m_l \). Thus, \( TI_{st} = TI_s(m_l) \) for any \( t \in m_l \).

Therefore, for \( t \in m_l \) and \( t' \in m_{l+1} \)

\[
y_{is,t+1} = \beta_1 + \beta_{t+1} + \beta_1 \cdot TI_s(m_l) + \beta_2 \cdot TI_s^2(m_l) + \beta_3 \cdot MI_{it} + \varepsilon_{is,t+1}
\]

\[
y_{is,t'+1} = \beta_1 + \beta_{t'+1} + \beta_1 \cdot TI_s(m_{l+1}) + \beta_2 \cdot TI_s^2(m_{l+1}) + \beta_3 \cdot MI_{it'} + \varepsilon_{is,t'+1}
\]

Subtracting (73) from (74), we obtain

\[
\Delta y_{is} = \left( \beta_{t'+1} - \beta_{t+1} \right) + \beta_1 \cdot \Delta TI_{s,t} + \beta_2 \cdot \Delta TI_{s,t}^2 + \beta_3 \cdot \Delta MI_i + \beta_4 \cdot \Delta (TI_{s,t}^2 MI_i) + \Delta \varepsilon_{is} \tag{75}
\]

where

\[
\Delta y_{is} \equiv y_{is,t'+1} - y_{is,t+1}
\]

\[
\Delta TI_{s,t} \equiv TI_s(m_{l+1}) - TI_s(m_l)
\]

\[
\Delta TI_{s,t}^2 \equiv TI_s^2(m_{l+1}) - TI_s^2(m_l)
\]

\[
\Delta MI_i \equiv MI_{it'} - MI_{it}
\]

\[
\Delta (TI_{s,t}^2 MI_i) \equiv TI_s^2(m_{l+1})MI_{it} - TI_s^2(m_l)MI_{it}
\]

\[
\Delta \varepsilon_{is} \equiv \varepsilon_{is,t'+1} - \varepsilon_{is,t+1}
\]

Let \( s' \) denote a state that did not change its anti-takeover laws over the time intervals \( m_l \) and \( m_{l+1} \) or equivalently the time period \( [t_l + 1, t_{l+2}] \). Let \( j \) index a firm incorporated in state \( s' \)

\[
y_{js',t+1} = \beta_j + \beta_{t+1} + \beta_1 \cdot TI_{s'}(m_l) + \beta_2 \cdot TI_{s'}^2(m_l) + \beta_3 \cdot MI_{jt} + \varepsilon_{js',t+1}
\]

\[
y_{js',t'+1} = \beta_j + \beta_{t'+1} + \beta_1 \cdot TI_{s'}(m_{l+1}) + \beta_2 \cdot TI_{s'}^2(m_{l+1}) + \beta_3 \cdot MI_{jt'} + \varepsilon_{js',t'+1}
\]

Because the anti-takeover index is unchanged over the time period \( [t_l + 1, t_{l+2}] \) for state \( s' \),

\[
TI_{s'}(m_l) = TI_{s'}(m_{l+1}) \tag{78}
\]

Subtracting (76) from (77) and using (78), we obtain

\[
y_{js',t'+1} - y_{js',t+1} = \left( \beta_{t'+1} - \beta_{t+1} \right) + \beta_3 \cdot \Delta MI_j + \beta_4 \cdot TI_{s,t}^2 \ast \Delta MI_j + \Delta \varepsilon_{js'} \tag{79}
\]
where
\[
\Delta y_{js,t'} \equiv y_{js,t'+1} - y_{js',t+1} \\
\Delta MI_j \equiv MI_{jt'} - MI_{jt} \\
\Delta \varepsilon_{js,t'} \equiv \varepsilon_{js,t'+1} - \varepsilon_{js',t+1}
\]

Subtracting (79) from (75), we obtain
\[
\Delta y_{is} - \Delta y_{js'} = \beta_1 \cdot \Delta T I_{s,l} + \beta_2 \cdot \Delta T I^2_{s,l} + \beta_3 \cdot [\Delta MI_i - \Delta MI_j] + \beta_4 \cdot \{\Delta (T I^2_{s,l} MI_i) - T I^2_{s',l} * \Delta MI_j\} + \Delta \varepsilon_{is} - \Delta \varepsilon_{js'}
\]  
(80)

To simplify this expression further, we examine the correlation of $\Delta MI$ with $\Delta T I$ and $\Delta (T I^2)$ and find that unconditionally, changes in our proxy for monitoring intensity are uncorrelated with $\Delta T I$ and $\Delta (T I^2)$, with the correlations being 0.0014 and 0.00017 respectively. Therefore, we can easily assume that
\[
E [\Delta MI|\Delta T I, \Delta (T I^2)] = 0
\]  
(81)

Therefore
\[
\Delta E (y_{is}) - \Delta E (y_{js'}) = \beta_1 \cdot \Delta T I_{s,l} + (\beta_2 + \beta_4 \cdot MI_i) \cdot \Delta T I^2_{s,l}
\]  
(82)

Therefore, each of the coefficients is estimated as the slope of a generalized “difference-in-difference” specification, i.e. the before-after difference for the treatment group of firms minus the same difference for the control group of firms. Formally,
\[
\beta_1 = \frac{\partial \left[ E (\Delta y_{is}) - E (\Delta y_{js'}) \right]}{\partial (\Delta T I_{s,l})}
\]
\[
\beta_2 = \frac{\partial \left[ E (\Delta y_{is}) - E (\Delta y_{js'}) \right]}{\partial (\Delta T I^2_{s,l})}
\]
\[
\beta_4 = \frac{\partial \left[ E (\Delta y_{is}) - E (\Delta y_{js'}) \right]}{\partial (MI_i \cdot \Delta T I^2_{s,l})}
\]

The identifying assumption is that
\[
E [\Delta \varepsilon_{is} - \Delta \varepsilon_{js'}|Y] = 0
\]  
(84)
where $Y$ denotes the set of explanatory variables in (82). In other words, the identifying assumption for the “difference-in-difference” (equation (84)) is that the error term $[\Delta \varepsilon_{is} - \Delta \varepsilon_{js'}]$, which captures unexplained factors influencing changes in innovation in the treatment state vis-à-vis the unexplained factors influencing changes in innovation in the control state, should be uncorrelated with the levels and changes in the anti-takeover laws and with monitoring intensity. This identifying assumption is weaker than one that assumes that the variable $\varepsilon_{is,t+1}$ in (72) which represents unexplained factors influencing levels of innovation, is uncorrelated with the level of the anti-takeover index and monitoring intensity.
References


