Governance Quality, Financial Reporting, and Shareholder Activism: The Economic Effects of Mandatory Executive Compensation Disclosure

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Abstract

We develop a two-period model in which an active shareholder decides on whether to intervene by replacing a potentially dependent board of directors which is in charge of contracting with a CEO. The model’s key feature is that there exists information asymmetry between firm insiders and outsiders about whether firms face a board dependence issue (i.e., information asymmetry about “governance quality”). In the absence of any other information, low earnings are indicative of low governance quality, implying a high success likelihood of intervention, whereas high earnings are indicative of a good fundamental substance, implying a high value of intervention. In equilibrium, the shareholder intervenes in firms reporting intermediate performance and dependent boards distort CEO contracts to manage earnings in order to avert replacement. If CEO pay levels are jointly disclosed with earnings, the shareholder intervenes in sufficiently well-performing firms that excessively compensate CEOs and dependent boards’ incentives to manage earnings are mitigated. Our results are consistent with the argument that mandatory executive compensation disclosure facilitates shareholder monitoring of boards and also addresses the undesirable ex ante consequences of shareholder activism. The paper further provides a number of novel empirical predictions.

Keywords: Board of directors, board turnover, compensation disclosure, accounting information, monitoring.

JEL: G34, M41

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1. Introduction

“Shareholder activism is, at bottom, a response to the potential gains from addressing the agency conflict at the core of large publicly traded companies with absentee owners. […] The board of directors has a significant role in controlling such agency problems that comes with its fiduciary obligation to shareholders, which includes the responsibility to hire, fire, compensate, and monitor management. The demand for activism arises when boards fail to perform these tasks.” Gillan and Starks (2007, p. 58)

Shareholder activism is an important determinant of firms’ corporate governance. The ever growing incidence of shareholder intervention is not only driven by specialized hedge funds, but also by other institutional investors which were long believed to be “passive” (Appel et al., 2016).\(^1\) Interventions are frequently motivated by a perceived board dependence issue and typically lead to a turnover of board members (Gillan and Starks, 2000; Brav et al., 2008; Ertimur et al., 2011).\(^2\) Not only the frequency with which shareholders intervene in firms’ corporate governance is increasing but also the strategy that they employ has seemingly evolved over time. Case study and archival evidence from the late 1980s and early 1990s suggests that institutional investors seem to particularly interfere in badly performing firms (Gordon and Pound, 1993; Smith, 1996; Bethel et al., 1998; Gillan and Starks, 2000). In contrast, Brav et al. (2008), Klein and Zur (2009), and Brav et al. (2010) use data from the early to mid 2000s to show that activist hedge funds are more likely to target well-performing firms.

This seemingly contrarian evidence provides a motivation for our study which aims to address the following two research questions: Are active shareholders more likely to intervene in the corporate governance of firms if firms’ prior accounting performance was good or bad? How do boards react to the threat of being replaced? We argue and theoretically show that the answers to these questions crucially depend on the information environment of firms in general and on whether firms are required to provide executive compensation disclosures in particular.

\(^1\)Activist interventions happen both in the public space and behind closed doors and can take many forms ranging from private talks with the management and the board, to open letters, shareholder proposals, or proxy campaigns, and can even include the use of the media to put pressure on a firms’ management (Carleton et al., 1998; Gillan and Starks, 2000; Becht et al., 2009; Appel et al., 2016; McCahery et al., 2016; Levit, 2019).

\(^2\)In fact, an indication of success of an activist hedge fund campaign is whether the activist gains representation on the board of the target firm, often replacing board members.
Executive compensation disclosure is an issue of significant regulatory scrutiny around the world. In the U.S., the most important regulatory initiatives on executive compensation disclosure are the 1992 amendments requiring boards to provide more information on executive compensation (Laksmana, 2008) and the 2006 introduction of the mandated “Compensation Discussion and Analysis” (“CD&A”) in the proxy statement of public firms, which, among other information, includes estimations of total compensation levels (Robinson et al., 2011; Gipper, 2017; Bloomfield, 2018; Ferri et al., 2018).

We develop an economic model featuring a shareholder’s decision to intervene by turning over the board, and boards’ CEO compensation contract choices. We consider a two-period setting in which a long-term shareholder puts a board into place to contract with a CEO. It is a CEO’s duty to implement a productive action which codetermines the current period’s fundamental value. The productivity of the action is random and ex ante uncertain but correlated over time. Importantly, the board’s objective may not be perfectly aligned with the shareholder’s in that a board dependence issue may exist with a certain probability. Dependent boards choose contracts with too strong incentives which lead to excessive compensation of CEOs, impairing accounting performance (Core et al., 1999; Adams et al., 2005; Larcker et al. 2007; Morse et al., 2011). Whether a board depends on the CEO or, equivalently, whether the CEO exerts power over the board is private information that is known only to the board and the CEO (i.e., firm insiders), but not to the shareholder. That is, we assume, at least initially, information asymmetry about “governance quality.” At the end of each period the firm is required to disclose a financial statement. Such a statement first and foremost reports earnings, which we define consistent with the practice of financial reporting as gross earnings minus CEO compensation. In addition, a firm may be required to disclose executive compensation information. Conditional on the first-period financial statement the shareholder strategically decides on whether to initiate a costly intervention. In case of an intervention, the board is replaced by an independent board which then chooses the CEO’s compensation contract in the second period. Thus, shareholder intervention is concerned with shareholder value gains as a consequence of improving a firms’ corporate governance.

We consider two cases. The first considers a scenario in which only earnings are disclosed but any CEO compensation-related information such as compensation policies, gross earnings, or CEO pay levels is private information of firm insiders at the earnings announcement date. In this scenario,
information asymmetry about governance quality impairs the fundamental information content of earnings and earnings, despite being disclosed perfectly and truthfully, are only imperfectly informative about both governance quality and fundamental productivity shocks (i.e., the firm’s fundamental “substance”). The shareholder uses earnings to update her beliefs about the likelihood with which a board dependence issue exists and therefore the likelihood with which her intervention could create value. Assuming that a board dependence issue exists, she also updates her priors on the fundamental substance of the firm in that she derives an expectation about the value of intervention. Low earnings are an indication of poor governance quality, whereas high earnings are an indication of a strong fundamental substance. We show that the shareholder intervenes in firms reporting intermediate accounting performance since such firms show a sufficiently high likelihood of low governance quality and a sufficiently good substance to warrant exerting intervention costs.

The threat of shareholder activism further induces a dependent board to engage in a novel form of earnings management by means of incentive contracting because the board anticipates that the shareholder conditions on earnings in her intervention decision. A dependent board has the choice between two opposing strategies. It either provides flatter incentives to the CEO so that high earnings become ex ante more likely and the inferred likelihood of a board dependence issue is too low to warrant intervention; or it even further distorts CEO contracts so that too low earnings become ex ante more likely so that from the perspective of the shareholder the substance of the firm seems too weak to warrant costly intervention. We characterize conditions under which the dependent board follows the latter strategy. This is consistent with the argument that shareholder activism partially induces the inefficiencies it attempts to resolve (Burkart et al. 1997).

In order to provide inference with respect to the economic effects of mandatory executive compensation disclosure, we consider a second scenario in that we consider perfect and truthful disclosure of CEO pay levels as an example of executive compensation disclosure. In our setting, the joint disclosure of CEO pay levels and earnings, enabling the derivation of the performance-to-pay ratio (in short “ratio”), leads to unraveling of the board’s type at the announcement date, where a low ratio is indicative of a board dependence issue. Unraveling has important consequences for both the shareholder’s intervention strategy and a dependent board’s contract choice. With respect to shareholder intervention, if the ratio is high, the shareholder never intervenes as there are no benefits to replacing an independent board. In contrast, if the ratio is low, the shareholder knows that
a board dependence issue exists. Then the shareholder intervenes if the fundamental substance is sufficiently good to warrant the exertion of intervention costs. From an empirical perspective this should manifest in shareholders intervening in sufficiently well-performing firms which is generally consistent with the findings of Brav et al. (2008), Klein and Zur (2009), and Brav et al. (2010) on the targeting behavior of activist hedge funds in the early 2000s. Alternatively, shareholders may also be more likely to intervene in firms which excessively compensate their management. This is consistent with the evidence by Ertimur et al. (2011), who document that particularly pension funds target firms with excess CEO compensation.

Mandatory executive compensation disclosure further has ex ante effects on dependent boards. Dependent boards anticipate that their type as well as productivity shocks are ex post revealed. We show that mandatory compensation disclosure mitigates a dependent board’s incentives to engage in earnings management as a response to shareholder activism. Overall, we show that mandatory executive compensation disclosure ex post facilitates shareholder monitoring of boards and also mitigates the ex ante harmful incentive effects of shareholder activism. Based on our insights, we are able to derive novel empirical predictions. In particular, we predict that mandatory executive compensation disclosure leads to (i) an increase in the success likelihood of shareholder interventions, (ii) an increase in the likelihood of activists targeting well-performing firms with a low performance-to-pay ratio, (iii) an increase in expected earnings and firm value in earlier periods, and (iv) a decrease in executive compensation levels in earlier periods, where (iii) and (iv) are driven by firms with a low performance-to-pay ratio.

2. Related Literature and Contribution

In the following, we discuss the related literature and how this paper contributes to it. First, our paper is related to the general literature on shareholder monitoring, intervention, and activism. A considerable research stream in this area focuses on associations related to dispersed ownership and innate free rider problems of costly shareholder intervention (Grossman and Hart, 1980; Shleifer and Vishny, 1986; Admati et al., 1994; Huddart, 1993). Papers in this regard especially emphasize the trade off between direct intervention (“voice”) and selling blocks of shares (“exit”) to exert pressure on a firm’s management (Bolton et al., 1998; Kahn and Winton, 1998; Maug, 1998; Noe, 2002; Faure-
A second literature stream specifically focuses on the effects of voice. A notable paper in this regard is Burkart et al. (1997). They study a parsimonious model with a manager who makes an effort decision to increase shareholder value and the monitoring effort of a large shareholder. They show that shareholder monitoring is ex post efficient but may induce ex ante incentives which are suboptimal.

Our paper is related to the shareholder activism and monitoring literature as follows. First, consistent with the second literature branch our main focus is on voice and we abstract away from a shareholder’s choice to exit. Second, different to the extant literature which predominantly considers capital market and investment settings, we consider a more specific form of voice, namely shareholder monitoring of boards which are responsible for contracting with CEOs. We motivate this focus in that we believe that it more closely reflects some of the main aspects of the microfoundation of shareholder activism as highlighted by the evidence of a substantial number of empirical studies:

1. The majority of shareholder interventions revolve around corporate governance issues, most importantly a perceived board dependence issue, which induces strategic as well as operational inefficiencies that impair shareholder value (e.g., Gillan and Starks, 2000; Brav et al., 2008; Dimson et al., 2015).

2. Interventions induce changes in target firms’ corporate governance by replacing individual board members and by changing CEOs’ compensation (e.g., Smith, 1996; Ertimur et al., 2011; Bebchuk et al., 2019).

Inspired by these observations, our basic setting considers a simplified moral hazard problem in the presence of a potential board dependence issue in which an active shareholder can decide on whether to replace a board after a financial statement is publicly disclosed.

We therefore build on and extend the literature studying moral hazard problems as a result of a separation of ownership and control and their resolution through incentive compensation (Jensen and Meckling, 1976; Holmstrom, 1979). The closest branch in this vast area of academic inquiry studies the effects of board dependence and highlights potentially beneficial effects of a coalition between boards and managers (e.g., Adams and Ferreira, 2007; Laux, 2008; Kumar and Sivaramakrishnan, 2008; Baldenius et al., 2014). However, we also deviate from this literature branch in several ways. First, we do not highlight beneficial effects of board dependence but instead con-
sider it to be unambiguously detrimental to shareholder value. Second, we assume the existence of different board types, dependent and independent ones. Third, we assume that there exists, at least initially, information asymmetry between firm insiders and outsiders with respect to whether a board dependence issue exists. Overall, we consider a setting with information asymmetry about governance quality (Core, 2000) and it is this information asymmetry which provides the basis for our consideration of governance-oriented shareholder activism.

A paper that is close to ours is Drymiotes and Lin (2019). They study the consequences of shareholders’ rights to replace boards by considering a two-period setting with binary output realizations in each period which are influenced by the incumbent CEO’s ability. Importantly, boards have different abilities to assess CEOs’ abilities and boards’ main task is to replace incompetent CEOs. Their main findings are that shareholders sometimes replace boards in case first period output is low. The threat of being replaced can induce inefficiencies for both effective and ineffective boards.

There are several parallels but also differences between our paper and Drymiotes and Lin (2019). First, we also consider different board types and information asymmetry about these types, even though in our setting they arise due to a potential board dependence issue and not innate ability. Second, we also consider board turnover through shareholder intervention. However, in Drymiotes and Lin (2019) intervention is costless, whereas in our setting intervention is privately costly to the active shareholder. According to the evidence by Gantchev (2013) the intervention costs to active shareholders can be considerable. Third, as was also established by Burkart et al. (1997) we also find that the threat of being replaced may induce the inefficiencies shareholder activism is meant to address.³

Counter to Burkart et al. (1997) and Drymiotes and Lin (2019) however the rationale underlying our observations is fundamentally accounting-based in that the shareholder in our setting conditions on financial statements in her intervention decision. In our setting the active shareholder faces a novel earnings-based trade off. On the one hand, low earnings are indicative of a board dependence issue (and thus a higher likelihood with which an intervention is successful) but may also imply a weak fundamental substance. On the other hand, high earnings support the inference of a strong

³Some other notable differences are that we consider the contracting role of boards, not their monitoring role and that we consider a continuous reporting space, not a binary one.
fundamental substance, implying a high potential value of intervention, but also imply a lower likelihood with which there is a governance issue to begin with. In the absence of other information, the shareholder intervenes in firms with intermediate financial performance. Lastly, similar to Drymiotes and Lin (2019) we further show that dependent boards anticipate the shareholder’s intervention strategy. In order to avert replacement, they distort their decision. However, our observation is that a dependent board distorts the CEO’s compensation contract in an attempt to ex ante manage earnings instead of distorting the publicly observable CEO turnover decision.

Our paper therefore also contributes to the literature on earnings management and is especially related to the papers by Fischer and Verrecchia (2000) and Ewert and Wagenhofer (2005) who consider settings with uncertain objectives of corporate insiders. In a reporting game Fischer and Verrecchia (2000) show that unraveling is avoided if the reporting manager’s objectives are not perfectly known to the capital market. Ewert and Wagenhofer (2005) extend the setting of Fischer and Verrecchia (2000) and show that by increasing the costs of accrual-based earnings management, managers may resort to performing more real earnings management since the larger responsiveness of the stock price to the financial report implies a larger utility gain of information and real distortions. Similarly, we also consider a case in which corporate insiders’ incentives are uncertain and in which an earnings announcement conveys information about insiders’ incentives. However, we highlight the contracting decision of a potentially dependent board and not an ex post accrual or real earnings management decision by a manager.

In addition, we believe to be the first to show that financial reporting may lead to a real effect with regards to the compensation practices of firms. Thus, our paper also contributes to the literature on the real effects of public disclosure (Kanodia and Lee, 1998; Kanodia et al., 2005; Beyer and Guttman, 2012; Kanodia and Sapra, 2016). This literature focuses on settings with perfectly or imperfectly observable investment decisions undertaken by managers with an exogenously given interest in the short-term stock price. Further in all settings we are aware of the way rents are allocated between insiders and outside investors are implicitly or explicitly assumed. In this respect and as already stated, our considerations are more in line with an extensive literature on moral hazard and incentive compensation in that we consider a notion of rent allocation. In addition, the

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4In our model, independent boards also have an incentive to manage the threat of intervention but this incentive never becomes dominant under the assumptions made.
real effect in our setting is qualitatively different in that it is not information about the investment
decision (i.e., balance sheet information) but information about profitability (i.e., income statement
information) which induces a real distortion.

Our study is also among the first to investigate the economic effects of mandatory executive
compensation disclosure. In our setting, we establish that the perfect and truthful disclosure of
executive compensation information (CEO pay levels, performance measures, compensation policies)
jointly with accounting earnings leads to unraveling about both governance quality and fundamental
information asymmetries at the announcement date. When additionally disclosing pay information,
the shareholder is enabled to better discern whether a firm suffers from a governance issue. The
shareholder’s intervention strategy changes in that she focuses on sufficiently well-performing firms
with an apparent governance issue. We therefore provide a potential rationale for why shareholder
activism in the U.S. in the 1980s and 1990s focused on firms with bad to intermediate performance,
whereas more recently activist shareholders, especially hedge fund activists but also pension funds,
focus on well-performing firms and firms with excess CEO pay (Gordon and Pound, 1993; Smith,
1996; Bethel et al., 1998; Gillan and Starks, 2000; Brav et al., 2008; Klein and Zur, 2009; Ertimur
et al., 2011). In addition, we show that compensation disclosure also weakens a dependent board’s
incentives to manage earnings in order to reduce the likelihood with which it is turned over, and thus
the real effect induced through disclosure of accounting earnings. Thus, it mitigates the detrimental
ex ante effects of shareholder activism as first outlined by Burkart et al. (1997).

To our knowledge, the only other paper that studies the economic effects of disclosing compensa-
tion information is Bertomeu (2012). He studies a capital market setting in which the initial firm
owners and the to-be-hired manager observe fundamental information about the firm’s productivity
before an equity-based contract is offered to the manager. After contracting and exerting effort, an
investor bases her demand in the firm’s stock on private fundamental information and information
about the compensation policy (the fraction of equity which is offered to the manager). The paper
highlights the signaling value of equity compensation information. In contrast to Bertomeu (2012),
we abstract away from a capital market setting and signaling considerations. However, in our set-
ting compensation information also carries information, but it is not only fundamental information
but information about governance quality and thus the strategic incentives of the board in place
which are conveyed through compensation disclosure. Further executive compensation disclosure
and accounting earnings are jointly disclosed, whereas Bertomeu (2012) considers imperfect private
information about future earnings.

Lastly, we want to note that especially the disclosure of CEO pay levels as mandated by regu-
lations is essentially an issue of disaggregation in financial reporting in that the disclosure of CEO
pay levels in addition to accounting earnings allows for inference about the realized but from the
outset unobservable performance measure and thus the overall value creation of the firm in a given
period. This then enables investors to extract more information about the firm’s fundamentals from
financial statements. This is consistent with Ferri et al. (2018), who document an increase in price
responsiveness to earnings after mandating the disclosure of CD&A in the U.S. in 2006.

3. The Model

3.1. Model Setup

We consider a model with two periods $t \in \{1, 2\}$ and three risk neutral parties, an active shareholder
(“she”), a board of directors (“board” or “it”), and CEOs (“he”). Initially a board is set up and the
shareholder, who is the sole owner of the firm, delegates the responsibility over hiring a CEO to
the board. A CEO’s duty is to implement a productive decision that is chosen by the board. The
board that is initially hired suffers from a dependence issue with a certain probability in that it can
be one of two types indicated by subscript $i \in \{D, I\}$. With probability $1 - q \in (1/2, 1)$ a board is
of type $i = I$ and is independent in that it pursues shareholder value maximization, whereas with
probability $q$ a board is of type $i = D$ and is dependent on the CEO (or, alternatively, the CEO
has power over the board). Then the board maximizes a weighted average of the shareholder’s
and CEO’s expected payoff, where the weight on the shareholder’s (CEO’s) expected payoff is
$w \in (2/3, 1) (1 - w)$. Constraint $w < 2/3$ serves to avoid the unrealistic case in which the board
sells the entire firm to the CEO. This constraint will later be refined.

Fundamental Problem. We consider a simplified contracting problem in which the board chooses a
contract at the beginning of each period $t$ which simultaneously determines both the overall surplus
that is generated and how this surplus is allocated between the CEO and the shareholder in a given

$q$ may be interpreted with the fraction of firms in a market or an economy. We further assume this fraction is
below 1/2 to ease some of the proofs. Alternatively we may assume $q \in (0, 1)$ but refine Assumption 2 accordingly.
period. In particular, the board chooses a compensation policy by deciding on the share $\beta_{i,t}$ the CEO receives from end-of-period gross earnings $v_{i,t}$. Hence the CEO’s compensation contract is $s_{i,t} = \beta_{i,t} v_{i,t}$, where the contract is affine and linear in gross earnings. To simplify the problem and to focus on the impact of shareholder activism on board decision making, $\beta_{i,t}$ is assumed to also dictate the productive decision that should be implemented by the CEO. We assume that gross earnings in period $t$ are the product of the board’s contract decision $\beta_{i,t}$ and a random productivity shock $\eta_{t}$, i.e., $v_{i,t} = \beta_{i,t} \eta_{t}$. The periodic productivity shock $\eta_{t}$ realizes at the end of period $t$ and is assumed to be distributed over $R_{+}$. $f[\eta_{t}]$ further denotes its probability density function. For the sake of simplicity, we impose two further assumptions. First, we assume that $\eta_{t}$ follows a truncated standard normal distribution in that $f[\eta_{t}]$ if $\eta_{t} > 0$ and 0 if $\eta_{t} \leq 0$. Second, we assume that $\eta_{1}$ and $\eta_{2}$ are perfectly correlated such that $\eta_{1} = \eta_{2}$.\footnote{Perfect correlation of $\eta_{1}$ and $\eta_{2}$ is not necessary to obtain our results. One may alternatively consider a case in which productivity shocks follow the following process:}

With this basic problem we envision a board contracting problem in which the chosen slope coefficient $\beta_{i,t}$ provides enough guidance for the CEO to implement a productive decision that increases gross earnings in the current period. Much like in standard moral hazard problems the board’s contracting decision not only determines how much surplus is created but also how this surplus is allocated between the shareholder and the CEO.

Financial Reporting. Firms are required to provide information about their profitability at the end of each period. Consistent with the practice of financial reporting, earnings capture the returns that were generated for the shareholder in period $t$. That is, earnings are such that they are defined as income after CEO compensation,

$$r_{t} = (1 - \beta_{i,t}) v_{i,t}.$$ 

We consider truthful reporting of earnings $r_{t}$ and rule out any manipulation of financial reporting information, e.g., due to the presence of a sufficiently strong disciplinary environment. This facilitates our focus on the board’s contract choice.

\footnote{Perfect correlation of $\eta_{1}$ and $\eta_{2}$ is not necessary to obtain our results. One may alternatively consider a case in which productivity shocks follow the following process:}$ \eta_{1} = \varepsilon_{1},$

\footnote{Overall, as long as current productivity shocks and consequently current earnings predict future productivity shocks and consequently future earnings our results hold (Ball and Brown, 1968; Beaver, 1968).}$ \eta_{2} = \rho \varepsilon_{1} + (1 - \rho) \varepsilon_{2},$
In addition, one of the main aims of this paper is to provide inference with respect to executive compensation disclosure because of increased regulation in this regard over the course of the past three decades (Laksmana 2008; Robinson et al. 2011; Bloomfield, 2018; Ferri et al. 2018). We initially assume that the board’s type $i$, its choice of compensation policy $\beta_{i,t}$, the realized productivity shock at the end of period $t$, $\eta_t$, gross earnings $v_{i,t}$, and the CEO’s pay in period $t$, $s_{i,t}$, are private knowledge of the board and the CEO at the respective time of realization, but unobservable to the shareholder. Thus, we explicitly consider a setting featuring two information asymmetries, information asymmetry about the firm’s fundamentals ($\eta_t$) and information asymmetry about “governance quality” as represented by the board’s type ($i$). We then relax this assumption by considering the effects of a perfect and truthful disclosure of CEO pay levels, $s_t$, in Section 4.

**Shareholder Intervention.** At the end of period $t = 1$ and after earnings $r_1$ (and CEO pay levels $s_t$) are publicly disclosed, the shareholder assesses whether to initiate a costly intervention by turning over the board. In this case, the board is replaced by an independent board chosen by the shareholder and the replaced board loses its interest in the firm in that its utility in this case is assumed to be zero. This specification effectively assumes that the incumbent board has private benefits associated with its position in the firm. However, the new board subsequently chooses the CEO’s $t = 2$ contract such that shareholder value is maximized. This is realistic insofar as activist hedge funds typically seek board representation when targeting a firm (Klein and Zur, 2009). The new board is then likely less favorable when it comes to CEO compensation.\(^7\)

An intervention is privately costly to the shareholder in the amount of $k > 0$. The cost can be understood as the shareholder’s costs associated with processing information and effort costs necessary for the development of proposals on strategic changes in the firm, the costs of gathering enough support from the other shareholdings or the costs associated with establishing a new board (i.e., search costs).\(^8\)

**Equilibrium Definition.** We define an equilibrium as follows:

**Definition:** A rational expectations equilibrium consists of dependent and independent boards’ con-
tract choices in both periods $(\beta_{D,1}, \beta_{D,2}, \beta_{I,1}, \beta_{I,2})$ and the shareholder’s intervention strategy.

Each player rationally conjectures the other players’ unobservable or future strategies. We denote a rational conjecture of another player’s unobservable or future strategy with a hat (“^”). We further restrict our attention to pure strategies, neglect signaling solutions, and focus on threshold strategies for the shareholder’s intervention decision.

3.2. Model Solution and Equilibrium

We solve the game by backward induction and start with the period $t = 2$ contracting decisions of dependent and independent boards. Then we derive the shareholder’s intervention strategy followed by the solution of the $t = 1$ contracting problems of dependent and independent boards.

Period $t = 2$ Contracting. After the first period, firm insiders learned first period productivity shock $\eta_1$. Conditional upon observing $\eta_1$, a dependent board’s ($i = D$) contracting choice in $t = 2$ is such that it not only considers the shareholder’s but also the CEO’s expected utility. In particular, it solves

$$
\max_{\beta_{D,2}} \left[ w(1 - \beta_{D,2})\beta_{D,2} + (1 - w)\beta_{D,2}^2 \right] E[\eta_2|\eta_1]
$$

which yields

$$
\beta_{D,2} = \frac{1}{2} \frac{w}{2w - 1}.
$$

The contract that is chosen by a dependent board in period $t = 2$ provides excessive incentives ($\frac{1}{2} \frac{w}{2w - 1} > \frac{1}{2}$), leading to an overcompensation of the CEO and to an impairment of shareholder value. The result is lower $t = 2$ earnings $r_2$.

In contrast to a dependent board, an independent board ($i = I$) aims to maximize expected shareholder value:

$$
\max_{\beta_{I,2}} (1 - \beta_{I,2})\beta_{I,2}E[\eta_2|\eta_1]
$$

where $E[\eta_2|\eta_1] = \eta_1$. The solution to this problem simply is
\[ \beta_{1,2} = \frac{1}{2} \]

**The Shareholder’s Intervention Decision.** The shareholder in our basic setting observes only earnings \( r_1 \) but neither observes \( \eta_1 \), nor the board’s type \( i \), nor the contract choice \( \beta_{i,1} \), nor total CEO compensation \( s_1 \). Even after the earnings announcement, there exists information asymmetry between the the firm insiders and the shareholder about both the first period’s productivity shock \( \eta_1 \) and the board’s type \( i \). Conditional on \( r_1 \) the shareholder updates her beliefs in both respects. In addition to conjecturing independent and dependent boards’ contract choices in both periods \( (\hat{\beta}_{i,t}) \), she further conjectures that a dependent board induces a steeper contract than an independent board \( (1 > \hat{\beta}_{D,t} > \hat{\beta}_{I,t} \geq 1/2) \) and therefore that \((1 - \hat{\beta}_{I,1})\hat{\beta}_{I,1} > (1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1} \). The latter inequality represents the conjecture that independent boards generate higher expected earnings than dependent boards. These conjectures will later be verified to hold in equilibrium.

Overall, conditional on \( r_1 \) the active shareholder intervenes if

\[
\Pr(i = D|r_1) = \left[ (1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}|r_1 = (1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1}\eta_1; i = D \right] - k \geq 0. \tag{1}
\]

The shareholder updates her beliefs about the expected benefits of replacing the board. The expected benefit arising from more efficient contracting in period \( t = 2 \) consists of two components. First, conditional on \( r_1 \) the shareholder derives the likelihood with which the board is dependent, \( \Pr(i = D|r_1) \). \( \Pr(i = D|r_1) \) can be presented as follows:

\[
\Pr(i = D|r_1) = \left\{ 1 + \frac{1 - q}{q} \frac{f_{\frac{r_1}{(1-\hat{\beta}_{I,1})\hat{\beta}_{I,1}}} f_{\frac{r_1}{(1-\hat{\beta}_{D,1})\hat{\beta}_{D,1}}}^{-1} \right\}.
\]

The crucial component is the fraction in the denominator,

\[
\frac{f_{\frac{r_1}{(1-\hat{\beta}_{I,1})\hat{\beta}_{I,1}}} f_{\frac{r_1}{(1-\hat{\beta}_{D,1})\hat{\beta}_{D,1}}}^{-1}.
\]

It is straightforward to show that as long as \((1 - \hat{\beta}_{I,1})\hat{\beta}_{I,1} \neq (1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1} \), earnings \( r_1 \) are informative about the board’s type. Further note that since \((1 - \hat{\beta}_{I,1})\hat{\beta}_{I,1} > (1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1} \) and due to the normal distribution assumption, the Monotone Likelihood Ratio Property ("MLRP") is inherent in our structure in that \( \Pr(i = D|r_1) \) decreases in \( r_1 \). Thus, the shareholder infers from low earnings that the board is more likely to be dependent.
Second, the shareholder also formulates an expectation about the value of an intervention, given that earnings are the result of the contracting choice by a dependent board, i.e., \( r_1 = (1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1}\eta_1 \):

\[
E\left[(1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2} | r_1 = (1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1}\eta_1; i = D\right] = \\
\left[(1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\right] E\left[\eta_2 | \eta_1 = \frac{r_1}{(1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1}}; i = D\right] = \\
\left[(1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\right] \frac{r_1}{(1 - \hat{\beta}_{D,1})\hat{\beta}_{D,1}}.
\]

In particular, the shareholder estimates the gain in period \( t = 2 \) shareholder value that results from replacing a dependent board. It is straightforward to show that this value is unambiguously positive since

\[
\left[(1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\right] > 0
\]
can be shown to hold. Further the higher earnings in \( t = 1 \), the higher the productivity shock in the next period, and thus the higher the value of intervention. The intuition is that a firm reporting high earnings despite a dependent board has a good fundamental “substance.” Improving CEO contracting should then yield an especially large boost in \( t = 2 \) shareholder value.

Overall the shareholder trades off two distinct incentives that relate to earnings. On the one hand, she infers from low earnings that the board is more likely to be dependent because it allows the CEO to extract higher rents. On the other hand, due to the information content of earnings about future productivity shocks the shareholder estimates a larger value of intervention for higher earnings. Which of the two incentives dominates depends on the circumstances. Proposition 1 summarizes the shareholder’s governance intervention strategy.

**Proposition 1:** For any \( 1 > \hat{\beta}_{D,1} > \hat{\beta}_{I,1} \geq \frac{1}{2} \) and any \( 1 > \hat{\beta}_{D,2} > \hat{\beta}_{I,2} \geq \frac{1}{2} \), the shareholder’s intervention strategy is such that there exists a unique threshold \( \bar{k} > 0 \) such that:

(i) If \( k \in (0, \bar{k}) \), the shareholder intervenes if \( r_1 \in [r_1^L, r_1^H] \), where \( r_1^H > r_1^L > 0 \), and refrains from intervention otherwise.

(ii) If \( k \geq \bar{k} \), the shareholder never intervenes.

Proposition 1 states our first main result. The shareholder intervenes in firms with intermediate accounting performance and refrains from intervention in firms with either low or high accounting performance. This is the case because only firms with intermediate performance balance the two
previously discussed inferences on governance quality and fundamental substance to a sufficient degree. Too high earnings \( r_1 > r_1^H \) do not provide sufficient indication of a board dependence issue, whereas too low earnings \( r_1 < r_1^L \) suggest a too weak fundamental substance (i.e., a too low \( \eta_1 \)) to warrant the exertion of intervention cost \( k \). Figure 1 provides a visual representation of the shareholder’s intervention strategy.

[PLEASE INSERT FIGURE 1 HERE]

Before solving the \( t = 1 \) contracting decisions, we impose the following parameter restrictions.

**Assumption 1:** \( 1 > w > w^o \), where \( w^o \in (2/3, 1) \).

**Assumption 2:** \( \bar{k} > k > k^o \), where \( k^o \in (0, \bar{k}) \).

Assumptions 1 and 2 parameterize the model by introducing a lower bound on incentive weight \( w^o \) (i.e., an upper bound on the strength of board dependence) and a lower bound on the shareholder’s intervention cost \( k \). Taken together, the assumptions establish a lower bound on threshold \( r_1^L > r_1^L \) and a feasible range of \( k \) for which the shareholder intervenes. This ensures that the decision problems of both dependent and independent boards are locally concave so that their respective \( t = 1 \) contract choices are interior, avoiding corner solutions. The constraint on the cost of intervention \( k \) is further consistent with the evidence by Gantchev (2013) who documents that the costs active shareholders bear when intervening in a firm can be substantial.

**Period \( t = 1 \) Contracting.** In period \( t = 1 \), dependent and independent boards choose contracts \( \beta_{D,1} \) and \( \beta_{I,1} \), respectively. They do so by conjecturing the respective other’s \( t = 1 \) contracting choice (\( \hat{\beta}_{I,1} \) and \( \hat{\beta}_{D,1} \), respectively) as well as their own and the respective other’s future contracting strategies, \( \hat{\beta}_{D,2} \) and \( \hat{\beta}_{I,2} \), as well as \( 1 > \hat{\beta}_{D,2} > \hat{\beta}_{I,2} \geq 1/2 \). In addition, they also anticipate the shareholder’s intervention strategy in that the shareholder intervenes if \( \hat{r}_1^H > r_1 > \hat{r}_1^L > r_1^L \). Ex post if a board is replaced this eliminates its interest in the firm implying a utility of zero.

A dependent board solves the following problem:

\[
\Pr (\eta_1 > 0) \left\{ E \left[ w(1 - \beta_{D,1})\beta_{D,1} \eta_1 + (1 - w)\beta_{D,1}^2 \eta_1 | \eta_1 > 0 \right] \\
+ \Pr (\hat{r}_1^L > r_1 > 0|\eta_1 > 0) E \left[ w(1 - \beta_{D,2})\beta_{D,2} \eta_2 + (1 - w)\beta_{D,2}^2 \eta_2 | \hat{r}_1^L > r_1 > 0, \eta_1 > 0 \right] \\
+ \Pr (r_1 > \hat{r}_1^H | \eta_1 > 0) E \left[ w(1 - \beta_{D,2})\beta_{D,2} \eta_2 + (1 - w)\beta_{D,2}^2 \eta_2 | r_1 > \hat{r}_1^H, \eta_1 > 0 \right] \right\}
\]
Note that the above expected utility incorporates the assumption of a truncated standard normal distribution. The expected utility further simplifies to

\[
\begin{align*}
&\left[w(1 - \beta_{D,1})\beta_{D,1}\eta_1 + (1 - w)\beta_{D,2}^2\right] f_0^\infty \eta_1 f[\eta_1]d\eta_1 \\
&+ \left[w(1 - \beta_{D,2})\beta_{D,2} + (1 - w)\beta_{D,2}^2\right] \left\{f_0^{(1 - \beta_{D,1})^\beta_{D,1}} \eta_1 f[\eta_1]d\eta_1 + \int_0^\infty \frac{r^L_1}{(1 - \beta_{D,1})^\beta_{D,1}} \eta_1 f[\eta_1]d\eta_1\right\}.
\end{align*}
\]

Optimization yields

\[
\begin{align*}
&\left[w(1 - 2\beta_{D,1}) + (1 - w)2\beta_{D,1}\right] \frac{1}{\sqrt{2\pi}} \\
&+ \left[w(1 - \beta_{D,2})\beta_{D,2} + (1 - w)\beta_{D,2}^2\right] \left(\frac{2\beta_{D,1}}{(1 - \beta_{D,1})^\beta_{D,1}}\right)^2 f \left[\frac{r^L_1}{(1 - \beta_{D,1})^\beta_{D,1}}\right] \\
&- \left[\frac{r^H_1}{(1 - \beta_{D,1})^\beta_{D,1}}\right]^2 f \left[\frac{r^H_1}{(1 - \beta_{D,1})^\beta_{D,1}}\right] = 0.
\end{align*}
\]

This leads to a key observation of our study.

**Lemma 1:** \(1 > \beta_{D,1} > \frac{1 - w}{2 \frac{w}{2w - 1}}\).

The observation in Lemma 1 is the consequence of a novel tradeoff a dependent board faces in its contract choice \(\beta_{D,1}\). In the considered scenario, only earnings are released to the public and the active shareholder conditions its intervention strategy solely on earnings. The board is aware of this reliance and minimizes its risk of being replaced by adjusting its contract choice accordingly.

The incentive to manage earnings in order to manage the threat of shareholder intervention arises endogenously in our setting because the board assigns utility to retaining its position (i.e., a private benefit of directorship). If this incentive would be absent, the dependent board would optimally choose \(\beta_{D,1} = \frac{1 - w}{2 \frac{w}{2w - 1}}\). In particular, the board can respond in two opposing ways. On the one hand, it can lower \(\beta_{D,1}\), boosting earnings such that they are more likely in the right tail of the earnings distribution, i.e., \(r_1 > r^H_1\). In this case shareholder activism disciplines board decision making. In contrast, it can further increase \(\beta_{D,1}\) to artificially lower earnings to camouflage a good fundamental substance such that earnings are too low for the shareholder to intervene, i.e., \(r_1 < r^L_1\). Under the assumptions made, it is this latter incentive that dominates in equilibrium.

An independent board’s contract choice (\(\beta_{I,1}\)) maximizes expected shareholder value but also anticipates a risk of being replaced since there exists information asymmetry about governance quality even after the disclosure of earnings \(r_1\). In particular, an independent board optimizes
period, the shareholder intervenes and replaces the board if the firm reports intermediate financial
overcompensation reduces reported earnings. At the end of the first period, the shareholder intervenes and replaces the board if the firm reports intermediate financial performance. This observation is the result of a novel trade off in that low earnings suggest a low

\[ \Pr (\eta_1 > 0) \{ E [(1 - \beta_{I,1}) \hat{\beta}_{I,1} \eta_1 | \eta_1 > 0] \\
+ \Pr (\hat{r}_1^T > r_1 > 0 | \eta_1 > 0) E [(1 - \hat{\beta}_{I,2}) \hat{\beta}_{I,2} \eta_2 | \hat{r}_1^T > r_1 > 0, \eta_1 > 0] \\
+ \Pr (r_1 > \hat{r}_1^H | \eta_1 > 0) E [(1 - \hat{\beta}_{I,2}) \hat{\beta}_{I,2} \eta_2 | r_1 > \hat{r}_1^H, \eta_1 > 0] \} . \]

The expected utility can be rewritten to

\[
(1 - \beta_{I,1}) \beta_{I,1} \int_0^\infty \eta_1 f[\eta_1] d\eta_1 + (1 - \hat{\beta}_{I,2}) \hat{\beta}_{I,2} \left\{ \int_0^{\hat{r}_1^T} \eta_1 f[\eta_1] d\eta_1 + \int_{\hat{r}_1^H}^{\infty} \eta_1 f[\eta_1] d\eta_1 \right\} .
\]

The first order condition is

\[
(2\beta_{I,1} - 1) \left\{ -\frac{1}{\sqrt{2\pi}} + (1 - \hat{\beta}_{I,2}) \hat{\beta}_{I,2} \left\{ \frac{1}{(1 - \beta_{I,1}) \beta_{I,1}} \left[ \frac{\hat{r}_1^T}{(1 - \beta_{I,1}) \beta_{I,1}} \right]^2 f \left[ \frac{\hat{r}_1^T}{(1 - \beta_{I,1}) \beta_{I,1}} \right] \right\} \right\} = 0.
\]

An independent board chooses contract $\beta_{I,1}$ with the intend to maximize shareholder value subject to the risk of being replaced as it also assigns utility to retaining its position. However, the incentive arising from the threat of being replaced is secondary as long as $\hat{r}_1^T$ is sufficiently large such that the term in the curly bracket is unambiguously negative. Assumptions 1 and 2 assure that this is the case, implying that $\beta_{I,1} = \frac{1}{2}$. Hence the independent board chooses the shareholder value maximizing compensation policy.

After enforcing all conjectures ($\hat{\beta}_{D,1} = \beta_{D,1}, \hat{\beta}_{I,1} = \beta_{I,1}, \hat{\beta}_{D,2} = \beta_{D,2}, \hat{\beta}_{I,2} = \beta_{I,2}, \hat{r}_1^T = r_1^T, \hat{r}_1^H = r_1^H$), we can provide the following equilibrium statement.

**Proposition 2:** There exists a unique rational expectations equilibrium with the following characteristics:

(i) A dependent board chooses compensation policies $\beta_{D,1} \in (\beta_{D,2}, 1)$ in period $t = 1$ and $\beta_{D,2} = \frac{1}{2} \frac{w}{2w - 1}$ in period $t = 2$, where $\beta_{D,1}$ is implicitly defined by (2).

(ii) An independent board chooses compensation policies $\beta_{I,1} = \beta_{I,2} = \frac{1}{2}$.

(iii) The shareholder intervenes as stated under Proposition 1 (i).

Proposition 2 establishes the uniqueness of the model solution. In equilibrium, dependent boards overcompensate CEOs and this overcompensation reduces reported earnings. At the end of the first period, the shareholder intervenes and replaces the board if the firm reports intermediate financial performance. This observation is the result of a novel trade off in that low earnings suggest a low
governance quality, implying a higher likelihood of successful intervention, whereas high earnings suggest a good fundamental substance, implying a large potential value of intervention. In case of shareholder intervention, future shareholder value improves. Further in response to the threat of being replaced, dependent boards manage earnings by further distorting CEO contracting.

The economics embedded in our model can be reconciled with considerable empirical evidence of two literature streams. First, Core et al. (1999) document that firms with weak corporate governance (i.e., a dependent board) tend to overpay their CEOs and perform worse. In a similar vein, the joint evidence of Adams et al. (2005), Larcker et al. (2007) and Morse et al. (2011) is consistent with the argument that more powerful CEOs excessively extract rents—also by exerting power over the compensation process—which leads to suboptimal decision making and reduces firm performance. Our setting is also in line with Bebchuk et al. (2011). They provide evidence consistent with the argument that the CEO’s pay slice of the aggregate compensation of the top-five executive team of a firm captures the CEO’s power and ability to extract rents. They further establish a negative relation between CEO pay slice and accounting profitability. Second, a large set of papers studies the ex post consequences of shareholder activism. They show that shareholder interventions yield improvements in operational efficiency (Brav et al., 2015) and innovation efficiency (Brav et al., 2018), and are associated with long-term financial returns (Becht et al., 2009; Cunat et al., 2012; Bebchuk et al., 2015; Dimson, et al., 2015).

3.3. Comparative Statics

In the following, we provide a comparative statics analysis of the equilibrium in Proposition 2 with respect to the shareholder’s intervention cost \( k \) and the strength of the dependence issue of dependent boards \( w \). We focus on the dependent board’s \( t = 1 \) compensation policy \( \beta_{D,1} \) and the size of the interval over which the shareholder intervenes, \( r_{1}^{H} - r_{1}^{L} \). We begin with a variation of the intervention cost \( k \).

**Corollary 1:** An increase of the shareholder’s intervention cost (a higher \( k \)) has the following effects:

(i) A dependent board chooses a flatter compensation policy, i.e., \( \frac{d\beta_{D,1}}{dk} < 0 \).

(ii) The shareholder intervenes less, i.e., \( \frac{d(r_{1}^{H} - r_{1}^{L})}{dk} < 0 \).
Corollary 1 states the effects of varying the activist shareholder’s intervention costs. As is intuitive, increasing intervention costs leads the activist to require either higher or lower earnings for her to intervene, i.e., she narrows her intervention window \([r^L_1, r^H_1]\). This result is reflected in Corollary 1 (ii). As a consequence, a dependent board’s incentives to manage earnings in order to avert replacement weaken, implying a flatter compensation policy as stated in Corollary 1 (i).

Next, we consider the effects of varying the extent of the board dependence issue.

**Corollary 2:** A decrease in the extent of the board dependence issue (a higher \(w\)) has the following effects:

(i) A dependent board chooses a flatter compensation policy, i.e., \(\frac{d\beta_{D,1}}{dw} < 0\).

(ii) The shareholder may intervene more or less often, i.e., \(\frac{d(r^H_1 - r^L_1)}{dk} \geq 0\).

A decrease in the extent of the board’s dependence issue (an increase of weight parameter \(w\)) induces three effects. First, an increase of \(w\) changes the incentives of the dependent board in \(t = 1\) by putting more weight on the shareholder’s expected utility. Second, this also reduces a dependent board’s \(t = 2\) utility,

\[
[w(1 - \beta_{D,2})\beta_{D,2} + (1 - w)\beta_{D,2}^2] = \frac{w^2}{4(2w - 1)},
\]

implying that the incentives to distort contracts to manage earnings weaken. Third, the shareholder anticipates the more efficient contract in \(t = 2\) which leads to a decline in the value of intervention. For a given policy \(\beta_{D,1}\), this leads to less intervention. All three effects unambiguously discipline a dependent board’s contracting choice (Corollary 2 (i)). As for the shareholder intervention decision, there exists a direct effect associated with an anticipation of a more efficient contract choice of a dependent board in \(t = 2\). This disincentivizes intervention. However, a countervailing information effect is present in that a reduction in \(\beta_{D,1}\) leads to an increase in the expected value of intervention. The intuition behind this effect is that the shareholder discounts earnings less such that her intervention decision becomes more sensitive to earnings. The larger \(\beta_{D,1}\), the smaller is the required minimum level of earnings, \(r^L_1\). This explains the ambiguous result in Corollary 2 (ii).

4. The Effects of Mandatory Executive Compensation Disclosure
So far, we have assumed that the contract that is signed and the amount of compensation that is paid to the CEO are private information of the board and the CEO. In recent decades however, regulators increasingly require publicly listed firms to provide information about pay levels, composition of equity compensation, and information about the objectives underlying companies’ compensation policies. In this section, we study the implications of mandatory executive compensation disclosure for shareholder intervention and board decision making. We illustrate the effects of mandatory executive compensation disclosure by considering the case in which CEO pay levels \( s_t \) are jointly disclosed with earnings \( r_t \).\(^9\) Note that this disclosure is assumed to be perfect and truthful.

4.1. Equilibrium

*Period \( t = 2 \) Contracting.* We note that the \( t = 2 \) contracting decisions remain the same as under the baseline setting.

*The Shareholder’s Intervention Decision.* At the end of the first period, the shareholder observes both CEO pay level \( s_1 \) and earnings \( r_1 \) and decides on whether to intervene in the firm. Importantly, by observing both signals, unraveling regarding the board’s type occurs in our setting. This can best be seen when considering the ratio of earnings to CEO pay, or performance-to-pay ratio or “ratio” for short:

\[
\frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{i,1})\hat{\beta}_{i,1}\eta_1}{\hat{\beta}_{i,2}^2\eta_1} = \frac{1 - \hat{\beta}_{i,1}}{\hat{\beta}_{i,1}}.
\]

As is straightforward to see, the ratio is a sufficient statistic of the board’s contract choice and thus the board’s type. This is case because the ratio decreases in \( \hat{\beta}_{i,1} \), implying that if \( \hat{\beta}_{D,1} > \hat{\beta}_{I,1} \) then \( \frac{(1-\hat{\beta}_{D,1})}{\hat{\beta}_{D,1}} < \frac{(1-\hat{\beta}_{I,1})}{\beta_{I,1}} \). That is, a lower ratio is indicative of a dependent board. Therefore, the joint disclosure of CEO pay levels and earnings is informationally equivalent to the disclosure of pay policy \( \beta_{i,t} \). In addition, since the board’s type is revealed the shareholder can also back out productivity shock \( \eta_1 \), implying that a reduction in information asymmetry about governance quality also leads to a reduction in information asymmetry about firms’ fundamentals.\(^{10}\)

\(^9\) Alternatively, one may consider the supplementary disclosure of compensation policy \( \beta_{i,t} \) or realized performance measure \( v_{i,t} \). The economic effects are qualitatively identical.

\(^{10}\) That pay disclosure improves the fundamental information value of accounting earnings is corroborated by Ferri et al. (2018). They document that stock price responsiveness to earnings increased after the introduction of required disclosure of CD&A in the U.S. in 2006.
Conditional on her information, the shareholder decides on whether to intervene and replace the board. Intuitively, replacing an independent board does not have any benefits which is why the shareholder always refrains from intervention if the ratio is \( \frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{D,1})}{\beta_{D,1}} \). However, if the ratio is \( \frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{D,1})}{\beta_{D,1}} \), then the shareholder intervenes if

\[
E \left[ (1 - \hat{\beta}_{I,2}) \hat{v}_{I,2} - (1 - \hat{\beta}_{D,2}) \hat{v}_{D,2} \mid r_1 = (1 - \hat{\beta}_{D,1})\beta_{D,1}\eta_1, s_1 = \beta_{D,1}^2 \eta_1; i = D \right] - k \geq 0.
\]

This is different to the decision problem of the shareholder in the absence of executive compensation disclosure in that the probability with which a board is dependent is equal to 1 if \( \frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{D,1})}{\beta_{D,1}} \). Acknowledging that the shareholder can back out \( \eta_1 \), the shareholder’s decision problem reduces to

\[
\left[ (1 - \hat{\beta}_{I,2}) \hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2}) \hat{\beta}_{D,2} \right] \eta_1 - k \geq 0
\]

since \( \eta_2 = \eta_1 \).

The following proposition summarizes the shareholder’s intervention strategy in the presence of disclosure of CEO pay levels.

**Proposition 3:** For any \( 1 > \hat{\beta}_{D,1} > \hat{\beta}_{I,1} \geq \frac{1}{2} \) and any \( 1 > \hat{\beta}_{D,2} > \hat{\beta}_{I,2} \geq \frac{1}{2} \), the shareholder’s intervention strategy is such that:

(i) If \( \frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{I,1})}{\beta_{I,1}} \), the shareholder refrains from intervention.

(ii) If \( \frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{D,1})}{\beta_{D,1}} \), the shareholder intervenes if \( \eta_1 > \eta_1^o \), where \( \eta_1^o > 0 \).

Proposition 3 states the result that for the case in which \( \frac{r_1}{s_1} = \frac{(1 - \hat{\beta}_{D,1})}{\beta_{D,1}} \), the shareholder’s utility of intervention increases in \( \eta_1 \) which leads to the shareholder intervening if \( \eta_1 \) is sufficiently large. This corresponds to the cases in which either compensation \( s_1 \) or earnings \( r_1 \) are sufficiently large (i.e., \( s_1 > s_1^o \) or \( r_1 > r_1^o \), respectively) and in addition the performance-to-pay ratio \( \frac{r_1}{s_1} \) is small.

This also implies that even if it is apparent that a board dependence issue is present within a firm, for some firms with a relatively weak fundamental substance, costly intervention is not economical to the shareholder.

**Period \( t = 1 \) Contracting.** In period \( t = 1 \), dependent and independent boards choose contracts \( \beta_{D,1} \) and \( \beta_{I,1} \), respectively. They do so by conjecturing the respective other’s \( t = 1 \) contracting choice (\( \hat{\beta}_{I,1} \) and \( \hat{\beta}_{D,1} \), respectively) as well as their own and the respective other board type’s future
contracting strategies, $\hat{\beta}_{D,2}$ and $\hat{\beta}_{I,2}$, where $1 > \hat{\beta}_{D,2} > \hat{\beta}_{I,2} \geq 1/2$, and they also anticipate the shareholder’s intervention strategy in that the shareholder intervenes if $\eta_1 > \check{\eta}_1$.

A dependent board solves:

$$\max_{\check{\beta}_{D,1}} \Pr (\eta_1 > 0) \left\{ E \left[ w(1 - \beta_{D,1})\beta_{D,1}\eta_1 + (1 - w)\beta_{D,1}^2\eta_1 | \eta_1 > 0 \right] ight.$$ 
$$+ \Pr (\eta_1 > \check{\eta}_1 | \eta_1 > 0) E \left[ w(1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\eta_2 + (1 - w)\hat{\beta}_{D,2}^2\eta_2 | \eta_1 > \check{\eta}_1 \right] \right\}.$$

Since there exists no information asymmetry about the board’s type any longer due to executive compensation disclosure, the shareholder conditions on the inferred realized productivity shock $\eta_1$ in her decision to intervene. Boards generally anticipate this unraveling. A dependent board conjectures that it will be replaced for certain realizations of $\eta_1$. However, in contrast to the baseline setting contracting cannot be used to avert shareholder intervention. Hence, a dependent board’s optimal decision simply is $\beta_{D,1} = \frac{1}{2} \frac{w}{2w-1}$. That is, it chooses the same contracting policy as it would if there would not be any threat of replacement. This is important insofar, as it suggests that mandatory compensation disclosure has the potential to mitigate the detrimental ex ante effects of shareholder activism (Burkart et al. 1997).

An independent board chooses the $t = 1$ compensation policy $\beta_{I,1}$ which maximizes its expected utility:

$$\Pr (\eta_1 > 0) \left\{ E \left[ (1 - \beta_{I,1})\beta_{I,1}\eta_1 | \eta_1 > 0 \right] + E \left[ (1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2}\eta_2 | \eta_1 > 0 \right] \right\}.$$

Due to unraveling, an independent board is never at risk of being replaced. This implies that the expected utility of an independent board is unaffected by shareholder interventions. Hence counter to our baseline setting such a board would not even consider to manage earnings in order to avert being replaced. It optimally chooses $\beta_{I,1} = \frac{1}{2}$.

We again enforce all conjectures ($\hat{\beta}_{D,1} = \beta_{D,1}, \hat{\beta}_{I,1} = \beta_{I,1}, \hat{\beta}_{D,2} = \beta_{D,2}, \hat{\beta}_{I,2} = \beta_{I,2}, \check{\eta}_1 = \eta_1$) and can make the following equilibrium statement.

**Proposition 4:** Given perfect executive compensation disclosure, there exists a unique rational expectations equilibrium with the following characteristics:

(i) A dependent board chooses compensation policies $\beta_{D,1} = \beta_{D,2} = \frac{1}{2} \frac{w}{2w-1}$.

(ii) An independent board chooses compensation policies $\beta_{I,1} = \beta_{I,2} = \frac{1}{2}$.

(iii) The shareholder intervenes as stated under Proposition 3.
4.2. Comparative Analysis

Now that we have solved the model setup for the cases with and without executive compensation disclosure, we can provide inference with respect to the effects of executive compensation disclosure. We start with the dependent board’s $t = 1$ contracting choice.

**Proposition 5:** Mandatory executive compensation disclosure has the following effects:

(i) Dependent boards choose flatter compensation policies in period $t = 1$ (i.e., a lower $\beta_{D,1}$).

(ii) Expected CEO compensation in period $t = 1$, $\Pr(\eta_1 > 0)E[s_1|\eta_1 > 0]$, decreases.

(iii) Expected earnings in period $t = 1$, $\Pr(\eta_1 > 0)E[r_1|\eta_1 > 0]$, increase.

Proposition 5 (i) follows directly from Lemma 1 and Proposition 4. In the absence of executive compensation disclosure, information asymmetries regarding governance quality and firm fundamentals are not completely resolved through reporting of accounting earnings. Then the shareholder’s intervention decision solely relies on earnings and this reliance is internalized by dependent boards who, as we show in Lemma 1, distort CEO compensation contract policy $\beta_{D,1}$ to manage earnings in order to avert replacement. However, the joint disclosure of executive compensation information and earnings leads to unraveling in our setting and dependent boards’ incentives to manage earnings are mitigated. Therefore, executive compensation disclosure disciplines dependent boards’ contract choices. In expectation, this yields lower CEO compensation and higher earnings, as stated in Proposition 5 (ii) and (iii), respectively.

Next, we consider the impact of executive compensation disclosure on shareholder activism. Corollary 3 provides a first observation.

**Corollary 3:** Mandatory executive compensation disclosure leads to a higher success likelihood of shareholder intervention.

In our setting, executive compensation information which is jointly disclosed with earnings reveals the board’s type. In contrast to the baseline setting, this implies that an active shareholder knows in advance whether an intervention would create value. Ceteris paribus, the success likelihood of shareholder intervention increases as stated in Corollary 3.

**Proposition 6:** Mandatory executive compensation disclosure leads to:

(i) a higher ex ante likelihood of intervention for firms with a low performance-to-pay ratio,
i.e., \( \Pr(\eta_1 > \eta_1^0) > \Pr(r_1^H > r_1 > r_1^L | i = D) \) if \( \frac{r_1}{s_1} = \frac{(1 - \beta_{D,1})}{\beta_{D,1}} \)

(ii) a lower ex ante likelihood of intervention for firms with a high performance-to-pay ratio, i.e., \( 0 < \Pr(r_1^H > r_1 > r_1^L | i = I) \) if \( \frac{r_1}{s_1} = \frac{(1 - \beta_{I,1})}{\beta_{I,1}} \).

The results in Proposition 6 further emphasize the results from Proposition 3 in that we show that firms with an apparent board dependence issue are ex ante more likely to be targeted by an activists, whereas firms with independent boards are less likely to be targeted. The latter result is intuitive since the shareholder would never target a firm with an independent board. Further the result in Proposition 6 (i) appears intuitive but is less trivial as the economics are more subtle. The reason is the existence of an information effect, which can best be explained by first reconsidering the conditionally expected value of intervention, given that the board is dependent:

\[
[(1 - \beta_{I,2})\beta_{I,2} - (1 - \beta_{D,2})\beta_{D,2}] \frac{r_1}{(1 - \beta_{D,1})\beta_{D,1}}.
\]

As long as \( \beta_{D,1} > 1/2 \), a higher \( \beta_{D,1} \) leads to less discounting of earnings \( r_1 \). Under Proposition 5, we have established that \( \beta_{D,1} \) is lower with pay disclosure than without. Thus, in the absence of pay disclosure, there is less discounting. This effect then pushes down \( r_1^L \) since at \( r_1^L \) the shareholder’s intervention decision increases in \( r_1^L \). However, in the appendix we show that this countervailing effect is never dominant such that we are able to establish that \( r_1^0 < r_1^L \), where \( \eta_1^0 = \frac{r_1^0}{(1 - \frac{1}{2^{w-1}})(1 - \frac{1}{2^{w-1}})} \).

Extending the result from Proposition 6 (i), we further provide the following insight.

**Corollary 4:** Mandatory executive compensation disclosure leads shareholders to intervene in well-performing firms \( (r_1 > r_1^H) \) with a low performance-to-pay ratio \( \frac{r_1}{s_1} = \frac{(1 - \beta_{D,1})}{\beta_{D,1}} \).

Based on the observation that \( r_1^0 < r_1^L \), it must also hold true that \( r_1^0 < r_1^H \). This implies that the shareholder now also intervenes in firms which she would not target in the absence of executive compensation disclosure, namely sufficiently well-performing firms \( (r_1 > r_1^H) \).

Proposition 6 and Corollary 4 also enable us to provide the following inference.

**Corollary 5:** Mandatory executive compensation disclosure leads to a higher expected \( t = 2 \) shareholder value increase from shareholder activism, i.e.,

\[
q \Pr(r_1^H > r_1 > r_1^L)E \left[ (1 - \beta_{I,2})\beta_{I,2}\eta_1 - (1 - \beta_{D,2})\beta_{D,2}\eta_1 | r_1^H > r_1 > r_1^L \right] < q \Pr(\eta_1 > \eta_1^0)E \left[ (1 - \beta_{I,2})\beta_{I,2}\eta_1 - (1 - \beta_{D,2})\beta_{D,2}\eta_1 | \eta_1 > \eta_1^0 \right].
\]
Finally, with Corollary 5 we show that the expected value of shareholder activism based increases with mandating executive compensation disclosure. Overall, our results establish that executive compensation disclosure not only ex post facilitates shareholder monitoring (Corollary 5), but also mitigates the harmful ex ante incentive effects of shareholder activism (Proposition 5).

5. Robustness

Simplified Basic Problem. We consider a simplified basic problem in which the board’s contract choice mechanically co-determines the action choice of the CEO. However, the outlined economics are reconcilable with a standard moral hazard problem in which both principal (board) and agent (CEO) are risk neutral, the agent chooses action $a_{i,t} > 0$ and incurs a quadratic effort cost ($\frac{a_{i,t}^2}{2}$), faces limited liability, and has a reservation utility that is normalized to zero. Consistent with our setting, the compensation contract specifies no fixed component in this case.

The main difference of our model setting to a standard moral hazard problem is that the CEO’s reaction function is assumed to be exogenously given, rather than chosen by the CEO in each period. We consider this setting for two main reasons. First, it reduces the order of updating terms about future productivity shocks from two to one, facilitating some of the proofs. Second and more importantly, it helps us focus on board incentives in that it disregards CEOs’ decision making as a consequence of the board being replaced. We believe that the essence of the issue at hand is still preserved in our model. An alternative assumption which leads to the same insights would be to assume that the CEO is myopic and only focuses on his utility in the current period, whereas the board thinks more long term.

Imperfect Executive Compensation Disclosure and Endogenous Disclosure Incentives. We assume that the disclosure of executive compensation information is perfect and truthful. However, in practice this may not hold true. First, regulation does not require perfect disclosure. For example, in the derivation of the pay levels of the top five executives there is significant leeway in the measurement of the value of stock options and shares. Second and more importantly, firms and firm insiders may have incentives to withhold compensation information. Dependent boards have incentives to avoid identification but even independent boards may be reluctant to publicly disclose remuneration information due to its proprietary nature (Bloomfield 2018). That firms withhold
and obfuscate executive compensation information is supported by the evidence by Robinson et al. (2011) and Laksmana et al. (2012). In addition, that firms ex post deviate from ex ante disclosed pay plans is supported by Morse et al. (2011).

In our model, perfect and truthful disclosure of CEO pay levels jointly with earnings leads to unraveling about the board’s type. We note that unraveling may be an extreme result but is still useful for our inference. If information about executive pay would be imperfect, then (i) shareholders may still sometimes intervene in firms that do not suffer from a board dependence issue (and interventions may not always produce shareholder value increases), (ii) shareholders may not intervene in extremely well-performing firms, and (iii) dependent boards may still have an incentive to manage earnings in an attempt to avert replacement. Therefore, imperfect pay disclosure reinstates the importance of the result in Lemma 1.

Reputation Concerns of Boards. In our study, we assume that shareholder intervention leads to a replacement of boards, even when the board’s type is not perfectly known. In the absence of executive compensation disclosure, the threat of intervention then induces incentives of boards to manage earnings through distorting CEO compensation contract policies because the boards internalize their replacement through a loss in $t = 2$ utility. In addition to the loss in utility associated with a current directorship, one may consider additional costs associated with being replaced. This is suggested by Ertimur et al. (2012) and Fos and Tsoutsoura (2014). Ertimur et al. (2012) document that directors who are replaced due to shareholder interventions bear a reputational cost in that the number of their future board positions declines. Fos and Tsoutsoura (2014) further find that proxy contests significantly affect directorships at other firms in that proxy-nominated directors are 58% more likely to lose seats on other boards. Additional costs associated with being replaced would not significantly alter the outlined economics. However, a noteworthy effect would be that if these costs were sufficiently large, then independent boards would also start distorting contracts in order to manage earnings in our baseline setting. Then executive compensation disclosure would not only have ex ante benefits in that it disciplines dependent boards’ decisions but it would also have a disciplinary effect on independent boards.

Contingency of Intervention Costs on Information Environment. In our study, we assume that the shareholder’s intervention cost is a positive constant $k$ that does not vary with the information environment. The validity of this implicit assumption depends on the nature of these costs. For
example, if the costs relate to the shareholder’s efforts to persuade the other shareholders to support her campaign, then these costs may be lower with pay information than without pay information since pay information is informative of governance quality. In the most extreme case, \( k \to 0 \) in an environment in which executive compensation disclosure is perfect. Then, the active shareholder always intervenes if \( \frac{\alpha_i}{s_i} = \frac{(1-\beta_{D,1})}{\beta_{D,1}} \), refining the result in Proposition 3 (ii). However, the result that dependent boards lose their incentive to manage the threat of replacement remains unaffected, implying continued validity of the statements in Proposition 5.

6. Empirical Implications

In the main analysis, we have reconciled some of the basic associations which are featured in our model with existing empirical evidence. In the following discussion, we condense our results from our consideration of mandatory executive compensation disclosure and provide novel predictions for empirical research. First, we show that in the absence of compensation disclosure the shareholder intervenes in firms with intermediate accounting performance, whereas when pay information is disclosed shareholders target well-performing firms with excess CEO pay. Executive compensation disclosure may therefore provide an explanation for the empirically observed dichotomy in activists’ strategies. In particular, the result provided in Proposition 1 seems more consistent with the evidence on traditional institutional investors from the late 1980s and the early 1990s in that they are more likely to target firms with a relatively modest performance (Gordon and Pound, 1993; Smith, 1996; Bethel et al., 1998; Gillan and Starks, 2000). In contrast, Proposition 3 is more consistent with Brav et al. (2008), Klein and Zur (2009), Brav et al. (2010), and Ertimur et al. (2011). Brav et al. (2008), Klein and Zur (2009), and Brav et al. (2010) use data on activist hedge funds in the early 2000s and document that they are more likely to target firms with a higher ROA. In addition, Ertimur et al. (2011) document that activists, especially pension funds, target firms with excess CEO pay and that the proposals they bring forward are more likely to be successful for firms with excess CEO pay. From this it can be concluded that either the information environment has changed such that shareholders are enabled to better monitor boards or some institutional investors may neglect pay information in their targeting strategy. In either case, the following predictions can be formulated:
Prediction 1: Mandatory executive compensation disclosure leads to a higher likelihood with which activists target well-performing firms, especially when these firms show a low performance-to-pay ratio.

Prediction 2: Mandatory executive compensation disclosure leads to an increase in the success probability of shareholder interventions and to larger improvements in shareholder value.

In addition to predictions with respect to the behavior of active shareholders, our theory also offers insights on the firm-level consequences of mandatory executive compensation disclosure. In particular, in Proposition 5 we establish that executive compensation disclosure disciplines dependent boards’ contracting, which should lead to lower CEO compensation and higher firm performance and value. Hence we can offer the following predictions:

Prediction 3: Mandatory executive compensation disclosure leads to higher earnings and firm value.

Prediction 4: Mandatory executive compensation disclosure leads to lower expected CEO compensation.

From an empirical perspective, Predictions 1 through 4 may be testable using regulatory events on the disclosure of executive compensation. Notable events in the U.S. were the 1992 amendments requiring boards to provide more information on executive compensation (Laksmana, 2008) and the 2006 rule introducing mandated disclosure of “Compensation Discussion and Analysis” or “CD&A” as a part of public firms’ filings (Robinson et al., 2011; Gipper, 2017; Bloomfield, 2018; Ferri et al., 2018).

Some empirical evidence exists on Prediction 4. Mas (2017) studies a 2010 disclosure mandate which requires the disclosure of municipal salaries in California. He documents that mandatory disclosure led to a decline in salaries. A political setting like the one studied by Mas (2017) is reconcilable with our model insofar as the public (e.g., tax payers) is enabled to better scrutinize municipal decision makers when provided with compensation information. However, a paper that more closely studies the setting we have in mind is Gipper (2017). He documents that the 2006 introduction of CD&A lead to on average increases in executive compensation, which is seemingly at odds with our prediction. Additional evidence in Gipper (2017) is further consistent with the
argument that pay disclosure impacts the labor market for CEOs, explaining these increases in compensation. He also shows that powerful CEOs, the ones that are at the core of our theory, do not experience pay increases. The question that remains is whether it is the effect of executive compensation disclosure on shareholder activism which balances the labor market effects in the determination of powerful CEOs’ compensation.

7. Conclusion

In this paper, we study active shareholders’ decision to intervene in firms’ corporate governance at a cost, and how boards respond to the threat of being replaced. The key assumption we impose is that the shareholder is ex ante uncertain about the governance quality of the firm. In a baseline setting in which compensation-related information is private information of firm insiders, we show that an active shareholder has incentives to intervene in a firm reporting intermediate earnings because then earnings are sufficiently indicative of a board dependence issue while also implying a sufficiently good fundamental substance to warrant the exertion of intervention costs. Dependent boards respond by distorting CEOs’ compensation contracts to manage earnings in order to avert replacement. In addition, we study the consequences of mandatory executive compensation disclosure. Disclosing CEO pay levels jointly with earnings leads to a resolution of both the information asymmetry about governance quality and information asymmetry about fundamentals at the announcement date. We show that in such an information environment, activist shareholders focus on well-performing firms with an apparent governance issue (e.g., firms with excess CEO compensation). In addition, mandatory executive compensation disclosure weakens dependent boards’ incentives to manage earnings by distorting CEO contracts. Overall, we show that mandatory executive compensation disclosure facilitates shareholder monitoring of boards ex post and mitigates the harmful ex ante incentive effects of shareholder activism as highlighted by Burkart et al. (1997).

Our paper has a number of limitations, which may be exploited by future research. First, we compare two extreme scenarios, one in which no pay information is disclosed and a second with perfect pay information. However, boards may have incentives to distort CEO pay disclosure for various reasons. One channel through which such distortion may occur is through manipulation of estimations regarding the value of equity instruments such as employee stock options. That is, a
future study could investigate strategic pay disclosure. Second, we solely focus on the role of executive compensation disclosure in active shareholders’ decision making, which in turn influences boards’ decision making. However, preliminary empirical evidence is in line with the argument that disclosing more pay information creates externalities in that disclosure impacts both product markets (Bloomfield, 2018) and labor markets (Gipper, 2017). We leave these and other interesting issues to future research.

Appendix

Proof of Proposition 1

We first explicitly state the intervention problem of the shareholder as follows:

\[
\left\{ 1 + \frac{1-q}{q} \frac{r_1}{(1-\hat{\beta}_{D,1})} \left[ \frac{r_1}{(1-\hat{\beta}_{I,1})} \right] \right\}^{-1} \frac{r_1}{(1-\hat{\beta}_{D,1})} \left[ (1-\hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1-\hat{\beta}_{D,2})\hat{\beta}_{D,2} \right] - k \geq 0
\]

\[\Leftrightarrow \Omega \geq \frac{k}{(1-\hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1-\hat{\beta}_{D,2})\hat{\beta}_{D,2}},\]

where

\[
\Omega \equiv \left\{ 1 + \frac{1-q}{q} \frac{r_1}{(1-\hat{\beta}_{D,1})} \left[ \frac{r_1}{(1-\hat{\beta}_{I,1})} \right] \right\}^{-1} \frac{r_1}{(1-\hat{\beta}_{D,1})}\hat{\beta}_{D,1}.
\]

\(\Omega\) has the following properties with respect to \(r_1\). As long as \(1 > \hat{\beta}_{D,1} > \hat{\beta}_{I,1} \geq \frac{1}{2}\), the limits are:

\[\lim_{r_1 \to 0} \Omega = \lim_{r_1 \to \infty} \Omega = 0.\]

Further the first order condition of \(\Omega\) with respect to \(r_1\) is as follows:

\[
\frac{\partial \Omega}{\partial r_1} = \left\{ 1 + \frac{1-q}{q} \frac{r_1}{(1-\hat{\beta}_{D,1})} \left[ \frac{r_1}{(1-\hat{\beta}_{I,1})} \right] \right\}^{-2} \frac{1}{(1-\hat{\beta}_{D,1})}\hat{\beta}_{D,1}\Omega^\circ,
\]

where

\[
\Omega^\circ \equiv 1 + \left\{ 1 - r_1^2 \left[ \frac{1}{(1-\hat{\beta}_{D,1})^2\hat{\beta}_{D,1}^2} - \frac{1}{(1-\hat{\beta}_{I,1})^2\hat{\beta}_{I,1}^2} \right] \right\} \frac{1-q}{q} \frac{r_1}{(1-\hat{\beta}_{D,1})}\hat{\beta}_{D,1}\left[ \frac{r_1}{(1-\hat{\beta}_{I,1})} \right].
\]

The sign of \(\frac{\partial \Omega}{\partial r_1}\) is proportional to that of \(\Omega^\circ\). The properties of \(\Omega^\circ\) with respect to \(r_1\) are:
\[
\begin{align*}
\lim_{r_1 \to 0} \Omega^o &= \frac{1}{q} > 0, \\
\lim_{r_1 \to \infty} \Omega^o &= -\infty < 0,
\end{align*}
\]

\[
\frac{\partial \Omega^o}{\partial r_1} = -\frac{1}{q} r_1 \left[ \frac{1}{(1-\beta_{D,1})^2 \beta_{D,1}} - \frac{1}{(1-\beta_{I,1})^2 \beta_{I,1}} \right] f \left[ \frac{r_1}{(1-\beta_{D,1})^2 \beta_{D,1}} \right] \left\{ 1 + r_1^2 \left[ \frac{1}{(1-\beta_{D,1})^2 \beta_{D,1}} - \frac{1}{(1-\beta_{I,1})^2 \beta_{I,1}} \right] \right\} < 0.
\]

Overall this implies that \( \Omega \) first increases and then decreases in \( r_1 \). Further for any \( k > 0 \) and given that \( (1 - \hat{\beta}_{I,2})^2 \beta_{I,2} - (1 - \hat{\beta}_{D,2})^2 \beta_{D,2} > 0 \) (which is easily shown to hold in equilibrium) this means that there must exist a unique threshold \( \bar{k} > 0 \) which is the level of \( k \) which induces the level of \( r_1 \) where \( \frac{\partial \Omega}{\partial r_1} = 0 \) (apart from the extreme cases). If \( \bar{k} > k > 0 \), this further implies the existence of two thresholds \( r^H_1 > r^L_1 > 0 \) such that the statement in Proposition 1 (i) holds.

Lastly to facilitate the subsequent proofs we shall also derive the first order condition of \( \Omega \) with respect to \( \hat{\beta}_{D,1} \):

\[
\frac{\partial \Omega}{\partial \hat{\beta}_{D,1}} = \begin{cases}
1 + \frac{1}{q} f \left[ \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right] -2 \left[ \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right] f \left[ \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right] q \left[ \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right] \left( 2 \hat{\beta}_{D,1} -1 \right) + f \left[ \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right] \left[ \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right] q \left( \frac{r_1}{(1-\hat{\beta}_{D,1})^2 \hat{\beta}_{D,1}} \right)^2 -1 \right),
\end{cases}
\]

Given that \( 1 > \hat{\beta}_{D,1} > \hat{\beta}_{I,1} \geq 1/2, 1/2 > q > 0 \), and \( r_1 > r^L_1 \) (see Proofs of Lemma 1 and Proposition 2), \( \frac{\partial \Omega}{\partial \hat{\beta}_{D,1}} < 0 \).

Q.E.D.

Proofs of Lemma 1 and Proposition 2

First note that a dependent board’s utility can be explicitly presented by acknowledging that

\[
\Pr(\eta_1 > 0) \Pr(\hat{r}^L_1 > r_1 > 0|\eta_1 > 0) = \Pr(\eta_1 > 0) \frac{\Pr(\hat{r}^L_1 > r_1 > 0|\eta_1 > 0)}{\Pr(\eta_1 > 0)} = \Pr(\eta_1 > 0) \frac{\hat{r}^L_1}{(1-\beta_{D,1})^2 \beta_{D,1}} > \eta_1 > 0),
\]

\[
\Pr(\eta_1 > 0) \Pr(\hat{r}^H_1 > r_1 > 0|\eta_1 > 0) = \Pr(\eta_1 > 0) \frac{\Pr(\hat{r}^H_1 > r_1 > 0|\eta_1 > 0)}{\Pr(\eta_1 > 0)} = \Pr(\eta_1 > 0) \frac{\hat{r}^H_1}{(1-\beta_{D,1})^2 \beta_{D,1}} > \eta_1 > 0),
\]

\[
E \left[ w(1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\eta_2 + (1 - w)\hat{\beta}_{D,2}^2 \eta_2 | \hat{r}^L_1 > r_1 > 0, \eta_1 > 0 \right] = \frac{w(1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\eta_2 + (1 - w)\hat{\beta}_{D,2}^2 \eta_2}{\Pr(\hat{r}^L_1 > r_1 > 0|\eta_1 > 0)} \eta_1 f[\eta_1] d\eta_1,
\]

and that

31
\[
E \left[ w(1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}\eta_2 + (1 - w)\hat{\beta}_{D,2}^2\eta_2 | r_1 > \hat{r}_1^H, \eta_1 > 0 \right] \\
= \frac{\left[ \frac{w(1-\beta_{D,1})}{(1-\beta_{D,1})\beta_{D,1}} + (1-w)\beta_{D,1}^2 \right] f_{\eta_1} \eta_1 d\eta_1}{Pr \left( \eta_1 > \frac{\hat{r}_1^H}{(1-\beta_{D,1})\beta_{D,1}} \right)}.
\]

The first order condition solving a dependent board’s contracting problem further is presented in condition (2). We algebraically manipulate this condition and define the condition as follows:

\[
\Psi_D = \frac{1}{\sqrt{2\pi} \left( \frac{w(1-\beta_{D,1})}{(1-\beta_{D,1})\beta_{D,1}} + (1-w)\beta_{D,1}^2 \right)^{\frac{3}{2}}} \\
+ \frac{1}{(1-\beta_{D,1})\beta_{D,1}} \left\{ \left[ \frac{\hat{r}_1^L}{(1-\beta_{D,1})\beta_{D,1}} \right]^2 f \left[ \frac{\hat{r}_1^L}{(1-\beta_{D,1})\beta_{D,1}} \right] - \left[ \frac{\hat{r}_1^H}{(1-\beta_{D,1})\beta_{D,1}} \right]^2 f \left[ \frac{\hat{r}_1^H}{(1-\beta_{D,1})\beta_{D,1}} \right] \right\}.
\]

An important component in \( \Psi_D \) is the bracket term

\[
\left[ \frac{\hat{r}_1^L}{(1-\beta_{D,1})\beta_{D,1}} \right]^2 f \left[ \frac{\hat{r}_1^L}{(1-\beta_{D,1})\beta_{D,1}} \right] - \left[ \frac{\hat{r}_1^H}{(1-\beta_{D,1})\beta_{D,1}} \right]^2 f \left[ \frac{\hat{r}_1^H}{(1-\beta_{D,1})\beta_{D,1}} \right].
\]

In order to show whether this difference is positive or negative, it is sufficient to derive the properties of generic function \( \eta_1^2 f [\eta] \):

\[
\lim_{\eta_1 \to 0} \eta_1^2 f [\eta] = 0, \\
\lim_{\eta_1 \to \infty} \eta_1^2 f [\eta] = 0, \\
\frac{\partial \eta_1^2 f [\eta]}{\partial \eta_1} = \eta_1 (2 - \eta_1^2) f [\eta].
\]

The function first increases until \( \eta_1 = \sqrt{2} \) and subsequently decreases. This implies that given that \( \hat{r}_1^L > \sqrt{2}(1 - \beta_{D,1})\beta_{D,1} \), the difference is unambiguously positive. Assumption 1 as imposed later assures that \( \hat{r}_1^L > \sqrt{2}(1 - \beta_{D,1})\beta_{D,1} \) always holds. Further due to this property it must be the case that \( \frac{\partial \Psi_D}{\partial \hat{r}_1^L} < 0 \) and that \( \frac{\partial \Psi_D}{\partial \hat{r}_1^H} > 0 \). The limits of \( \Psi_D \) with respect to \( \beta_{D,1} \) are as follows:

\[
\lim_{\beta_{D,1} \to \frac{1}{2}} \Psi_D = \infty > 0, \\
\lim_{\beta_{D,1} \to \frac{1}{2}} \Psi_D = \frac{1}{2 \sqrt{2} \sqrt{w-1}} \left( \frac{w}{2} \right) \left( \frac{w}{2} \right) \\
\left\{ \left[ \frac{\hat{r}_1^L}{(1-\frac{1}{2} \frac{w}{2} \sqrt{w-1}) \frac{w}{2} \sqrt{w-1}} \right]^2 f \left[ \frac{\hat{r}_1^L}{(1-\frac{1}{2} \frac{w}{2} \sqrt{w-1}) \frac{w}{2} \sqrt{w-1}} \right] - \left[ \frac{\hat{r}_1^H}{(1-\frac{1}{2} \frac{w}{2} \sqrt{w-1}) \frac{w}{2} \sqrt{w-1}} \right]^2 f \left[ \frac{\hat{r}_1^H}{(1-\frac{1}{2} \frac{w}{2} \sqrt{w-1}) \frac{w}{2} \sqrt{w-1}} \right] \right\} > 0, \\
\lim_{\beta_{D,1} \to 1} \Psi_D = -2 \sqrt{2} (2 - 7 w + 6 w^2) \sqrt{w^2} < 0.
\]

The first order condition with respect to \( \beta_{D,1} \) further is
\[
\begin{align*}
\frac{\partial \Psi_D}{\partial \beta_{D,1}} &= -\frac{\sqrt{7(1-w)}}{\sqrt{w(1-\beta_{D,2})\beta_{D,2}+(1-w)\beta_{D,2}^2}}(\beta_{D,1}-1)^2 + (\beta_{D,1}-1) \\
&= \left\{ \begin{array}{ll}
\frac{r_{L_1}^2}{(1-\beta_{D,1})\beta_{D,1}} & 2 - 3 - \frac{r_{L_1}^2}{(1-\beta_{D,1})\beta_{D,1}} \\
\frac{r_{H_1}^2}{(1-\beta_{D,1})\beta_{D,1}} & 2 - 3 - \frac{r_{H_1}^2}{(1-\beta_{D,1})\beta_{D,1}} 
\end{array} \right\} f \left[ \frac{r_{L_1}}{(1-\beta_{D,1})\beta_{D,1}} \right] \\
&\quad - \left\{ \begin{array}{ll}
\frac{r_{L_1}^2}{(1-\beta_{D,1})\beta_{D,1}} & 2 - 3 - \frac{r_{L_1}^2}{(1-\beta_{D,1})\beta_{D,1}} \\
\frac{r_{H_1}^2}{(1-\beta_{D,1})\beta_{D,1}} & 2 - 3 - \frac{r_{H_1}^2}{(1-\beta_{D,1})\beta_{D,1}} 
\end{array} \right\} f \left[ \frac{r_{H_1}}{(1-\beta_{D,1})\beta_{D,1}} \right]
\end{align*}
\]

The term in the curly brackets can best be understood by deriving the properties of generic function \(\eta_1^2(3-\eta_1^2)f[\eta_1]\):

\[
\begin{align*}
\lim_{\eta_1 \to 0} \eta_1^2(3-\eta_1^2)f[\eta_1] &= 0, \\
\lim_{\eta_1 \to \infty} \eta_1^2(3-\eta_1^2)f[\eta_1] &= 0, \\
\frac{\partial \eta_1^2(3-\eta_1^2)f[\eta_1]}{\partial \eta_1} &= \eta_1(6 - 7\eta_1^2 + \eta_1^4)f[\eta_1].
\end{align*}
\]

The function is weakly positive if \(\eta_1 \leq \sqrt{3}\) and unambiguously negative if \(\eta_1 > \sqrt{3}\). Further its minimum is at \(\eta_1 = \sqrt{6}\) where \((6 - 7\eta_1^2 + \eta_1^4) = 0\). It is straightforward to show that if \(\eta_1 > \sqrt{6}\) the function increases. This implies that if \(r_{L_1}^L > \sqrt{6}(1 - \beta_{D,1})\beta_{D,1}\), the term in the curly brackets in \(\frac{\partial \Psi_D}{\partial \beta_{D,1}}\) is unambiguously negative, implying that \(\frac{\partial \Psi_D}{\partial \beta_{D,1}} < 0\). Hence we shall impose sufficient conditions such that \(r_{L_1}^L > r_{L_1}^L \equiv \frac{\sqrt{6}}{4}\) (since \(\max\{1 - \beta_{D,1}\beta_{D,1}\} = \frac{1}{4}\)). Given that \(r_{L_1}^L > r_{L_1}^L\), this further implies that that \(1 > \beta_{D,1} > \frac{1}{2} \frac{w}{2w-1}\), proving the statement in Lemma 1. Also note that given that \(r_{L_1}^L > r_{L_1}^L\), an independent board’s decision problem is also concave in \(\beta_{I,1}\) and that the term in the curly bracket of condition (3) is unambiguously negative, implying that \(\beta_{I,1} = \frac{1}{2}\).

We now enforce all conjectures. We define the following functions, which implicitly define \(r_{L_1}^L\) and \(r_{H_1}^L\), respectively, after inserting \(\beta_{I,1} = \beta_{I,2} = \frac{1}{2}\) and \(\beta_{D,2} = \frac{1}{2} \frac{w}{2w-1}\):

\[
\begin{align*}
\Psi_L &= \left\{ 1 + \frac{1-g}{q} \frac{f[4r_{L_1}^L]}{(1-\beta_{D,1})\beta_{D,1}} \right\}^{-1} \frac{r_{L_1}^L}{(1-\beta_{D,1})\beta_{D,1}} - \frac{4k(2w-1)^2}{(1-w)^2} = 0, \\
\Psi_H &= \left\{ 1 + \frac{1-g}{q} \frac{f[4r_{H_1}^L]}{(1-\beta_{D,1})\beta_{D,1}} \right\}^{-1} \frac{r_{H_1}^L}{(1-\beta_{D,1})\beta_{D,1}} - \frac{4k(2w-1)^2}{(1-w)^2} = 0.
\end{align*}
\]

Due to the properties derived in the Proof of Proposition 1, it must be the case that \(\frac{\partial \Psi_L}{\partial r_{L_1}^L} > 0\) and that \(\frac{\partial \Psi_H}{\partial r_{L_1}^L} < 0\) and that \(\frac{\partial \Psi_L}{\partial r_{L_1}^L} = \frac{\partial \Psi_H}{\partial r_{L_1}^L} = 0\). In addition, if \(r_{L_1}^L > r_{L_1}^L\), then \(\frac{\partial \Psi_L}{\partial \beta_{D,1}}, \frac{\partial \Psi_H}{\partial \beta_{D,1}} < 0\) due to the behavior of \(\Omega\) as established under the Proof of Proposition 1.

To prove uniqueness of the equilibrium, we make use of the Inverse Function Theorem by deriving the determinant of the Jacobian matrix \(J\) which is defined as follows:

33
\[ J = \begin{pmatrix} \frac{\partial \Psi_D}{\partial \beta_{D,1}} & \frac{\partial \Psi_D}{\partial r_1^L} & \frac{\partial \Psi_D}{\partial r_2^L} \\ \frac{\partial \Psi_L}{\partial \beta_{D,1}} & \frac{\partial \Psi_L}{\partial r_1^L} & 0 \\ \frac{\partial \Psi_H}{\partial \beta_{D,1}} & \frac{\partial \Psi_H}{\partial r_1^L} & 0 \end{pmatrix}. \]

The determinant of \( J \) simply is \( \text{Det}(J) = \frac{\partial \Psi_D}{\partial \beta_{D,1}} \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_D}{\partial \beta_{D,1}} \frac{\partial \Psi_H}{\partial \beta_{D,1}} \), which can be shown to be unambiguously positive. This implies the existence of a unique rational expectations equilibrium as summarizes in Proposition 1, given that \( r_1^L > l_1^L \).

In a last step, we establish the conditions under which \( r_1^L > l_1^L \) holds, which are stated in Assumptions 1 and 2. First, to ensure that \( l_1^L \) lies in the feasible range for which the shareholder intervenes we set \( r_1 = r_1^L \) in \( \Omega^L \) which gives

\[ \Omega^L_{r=r_1^L} = 1 + \left\{ 1 - 3 \frac{1}{8} \left( 1 - \beta_{D,1} \right)^2 \beta_{D,1}^2 - \frac{1}{16} \right\} \frac{1 - q}{q} f \left[ \sqrt{6} \right] \frac{\frac{\sqrt{2}}{\gamma} (1 - \left( \frac{2w}{1} \right)^{-1})^{-1} (1 - \left( \frac{2w}{1} \right)^{-1})^{-1}}{\frac{1}{16}}. \]

It can be shown that \( \Omega^L_{r=r_1^L} \) decreases in \( \beta_{D,1} \), implying that it is lowest if \( \beta_{D,1} = 1 - \frac{w}{2w-1} \). To derive a sufficient condition we insert \( \beta_{D,1} = 1 - \frac{w}{2w-1} \) which yields

\[ \Omega^L_{r=L_1^L, \beta_{D,1}=1} = 1 + \left\{ 1 - 3 \frac{1}{8} \left[ 1 - \frac{1}{2} \left( \frac{w}{2w-1} \right)^{-2} \right] \right\} \frac{1 - q}{q} f \left[ \sqrt{6} \right] \frac{\frac{\sqrt{2}}{\gamma} (1 - \left( \frac{2w}{1} \right)^{-1})^{-1} (1 - \left( \frac{2w}{1} \right)^{-1})^{-1}}{\frac{1}{16}}. \]

The properties of \( \Omega^L_{r=L_1^L, \beta_{D,1}=1} = 1 - \frac{w}{2w-1} \) with respect to \( w \) are as follows:

\[ \lim_{w \to 2/3} \Omega^L_{r=L_1^L, \beta_{D,1}=1} = \frac{1}{2w-1} = -\infty < 0, \]

\[ \lim_{w \to 1} \Omega^L_{r=L_1^L, \beta_{D,1}=1} = \frac{1}{2} = 0, \]

\[ \frac{\partial \Omega^L_{r=L_1^L, \beta_{D,1}=1}}{\partial w} = \frac{1}{q} \frac{f \left[ \sqrt{6} \right] \frac{\sqrt{2}}{\gamma} (1 - \left( \frac{2w}{1} \right)^{-1})^{-1} (1 - \left( \frac{2w}{1} \right)^{-1})^{-1}}{\frac{1}{16}} > 0. \]

From this it follows that there must exist a unique threshold \( w^* \) such that if \( w > w^* \), the maximum \( r_1 \) is above \( L_1^L \). In addition, this implies that there must also exist a level of \( k \) which induces \( r_1^L = L_1^L \), denoted by \( k^* \in (0, \bar{k}) \). Taken together, if \( w > w^* \) and if \( k > k^* \) then \( r_1^L > L_1^L \).

Q.E.D.
Proof of Corollary 1

We make use of a multivariable version of the Implicit Function Theorem. For an arbitrary exogenous variable \( z \in \{k, w\} \) we simultaneously solve

\[
\begin{pmatrix}
\frac{\partial \Psi_D}{\partial \beta_{D,1}} & \frac{\partial \Psi_D}{\partial r^L_1} & \frac{\partial \Psi_D}{\partial r^H_1} \\
\frac{\partial \Psi_L}{\partial \beta_{D,1}} & 0 & \frac{\partial \Psi_L}{\partial r^H_1} \\
\frac{\partial \Psi_H}{\partial \beta_{D,1}} & 0 & \frac{\partial \Psi_H}{\partial r^H_1}
\end{pmatrix}
\begin{pmatrix}
\frac{d \beta_{D,1}}{dz} \\
\frac{d \beta_{D,1}}{dz} \\
\frac{d \beta_{D,1}}{dz}
\end{pmatrix}
= - \begin{pmatrix}
\frac{\partial \Psi_D}{\partial z} \\
\frac{\partial \Psi_L}{\partial z} \\
\frac{\partial \Psi_H}{\partial z}
\end{pmatrix},
\]

which leads to

\[
\begin{align*}
\frac{d \beta_{D,1}}{dz} &= \frac{-\frac{\partial \Psi_D}{\partial r^L_1} \frac{\partial r^L_1}{\partial \beta_{D,1}} - \frac{\partial \Psi_D}{\partial r^H_1} \frac{\partial r^H_1}{\partial \beta_{D,1}}}{\text{Det}(J)}, \\
\frac{d r^L_1}{dz} &= \frac{-\frac{\partial \Psi_L}{\partial r^L_1} \frac{\partial r^L_1}{\partial \beta_{D,1}} - \frac{\partial \Psi_L}{\partial r^H_1} \frac{\partial r^H_1}{\partial \beta_{D,1}}}{\text{Det}(J)}, \\
\frac{d r^H_1}{dz} &= \frac{-\frac{\partial \Psi_H}{\partial r^L_1} \frac{\partial r^L_1}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial r^H_1} \frac{\partial r^H_1}{\partial \beta_{D,1}}}{\text{Det}(J)}.
\end{align*}
\]

The partials necessary to derive the comparative statics with respect to \( k \) are \( \frac{\partial \Psi_D}{\partial k} = 0 \) and

\[
\frac{\partial \Psi_L}{\partial k} = -\frac{\partial \Psi_H}{\partial k} = -\frac{4(2w-1)^2}{(1-w)^2} < 0.
\]

First, it is straightforward to show that \( \frac{d \beta_{D,1}}{dz} < 0 \) since \( \frac{\partial \Psi_D}{\partial r^L_1} \frac{\partial r^L_1}{\partial \beta_{D,1}} + \frac{\partial \Psi_D}{\partial r^H_1} \frac{\partial r^H_1}{\partial \beta_{D,1}} \) is unambiguously positive. Second, it can be shown that \( \frac{d r^L_1}{dk} > 0 \). Note that

\[
\frac{d r^L_1}{dk} \propto \left[-\frac{\partial \Psi_D}{\partial r^L_1} \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) - \frac{\partial \Psi_D}{\partial \beta_{D,1}} \frac{\partial \Psi_H}{\partial r^L_1} \right] \frac{\partial \Psi_H}{\partial k}.
\]

The sign of \( \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) \) can be shown by acknowledging that

\[
\begin{align*}
\left\{ 1 + \frac{1-q}{q} \frac{f\left[4r^L_1\right]}{(1-\beta_{D,1})\beta_{D,1}} \right\}^{-1} r^L_1 &\left\{ 1 + \frac{1-q}{q} \frac{f\left[4r^H_1\right]}{(1-\beta_{D,1})\beta_{D,1}} \right\}^{-1} \frac{r^H_1}{(1-\beta_{D,1})\beta_{D,1}}.
\end{align*}
\]

Difference \( \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) \) can be simplified to

\[
\left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) = \left\{ 1 + \frac{1-q}{q} \frac{f\left[4r^H_1\right]}{r^H_1} \right\}^{-2}
\]

\[
\frac{(2\beta_{D,1}-1)r^H_1(r^L_1-r^H_1)}{(1-\beta_{D,1})\beta_{D,1}} \left( r^L_1 + (r^H_1+r^L_1)^{-1} \frac{1-q}{q} \frac{f\left[4r^H_1\right]}{r^H_1} \right) > 0.
\]

It follows that \( \left[ -\frac{\partial \Psi_D}{\partial r^L_1} \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) - \frac{\partial \Psi_D}{\partial r^H_1} \frac{\partial \Psi_H}{\partial r^L_1} \right] \) is unambiguously negative, implying that \( \frac{d r^L_1}{dk} > \)
0. Third, \( \frac{d r_H^L}{d k} \) is ambiguous. To see this consider the following relation:

\[
\frac{d r_H^L}{d k} \propto \left[ \frac{\partial \Psi_D}{\partial r_H^L} \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) - \frac{\partial \Psi_D}{\partial \beta_{D,1}} \frac{\partial \Psi_L}{\partial r_H^L} \right] \frac{\partial \Psi_H}{\partial k}.
\]

Now note that \( \frac{\partial \Psi_D}{\partial r_H^L} \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) < 0 \) and that \( -\frac{\partial \Psi_D}{\partial \beta_{D,1}} \frac{\partial \Psi_L}{\partial r_H^L} > 0 \).

In Corollary 1 (ii) we state the effect of a change in \( k \) on difference \( r_H^L - r_H^L \). The effect is as follows:

\[
\frac{d (r_H^L - r_H^L)}{d k} = \frac{d r_H^L}{d k} - \frac{d r_H^L}{d k} \propto \left\{ \left( \frac{\partial \Psi_D}{\partial r_H^L} + \frac{\partial \Psi_D}{\partial r_H^L} \right) \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) - \frac{\partial \Psi_D}{\partial \beta_{D,1}} \left( \frac{\partial \Psi_L}{\partial r_H^L} - \frac{\partial \Psi_H}{\partial r_H^L} \right) \right\} \frac{\partial \Psi_H}{\partial k}.
\]

It is straightforward to show that \( \left( \frac{\partial \Psi_D}{\partial r_H^L} + \frac{\partial \Psi_D}{\partial r_H^L} \right) > 0 \), implying that

\[
\left\{ \left( \frac{\partial \Psi_D}{\partial r_H^L} + \frac{\partial \Psi_D}{\partial r_H^L} \right) \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) - \frac{\partial \Psi_D}{\partial \beta_{D,1}} \left( \frac{\partial \Psi_L}{\partial r_H^L} - \frac{\partial \Psi_H}{\partial r_H^L} \right) \right\} > 0.
\]

This proves that \( \frac{d (r_H^L - r_H^L)}{d k} < 0 \).

Q.E.D.

**Proof of Corollary 2**

The comparative statics with respect to \( w \) rely on the following partials:

\[
\frac{\partial \Psi_D}{\partial w} = -\sqrt{\frac{\pi}{2w}} \left( \frac{8(2w-1)}{w^2(2\beta_{D,1} - 1)} \right) < 0,
\]

\[
\frac{\partial \Psi_L}{\partial k} = \frac{\partial \Psi_H}{\partial k} = \frac{8k(2w-1)}{(1-w)^3} < 0.
\]

First, note that

\[
\frac{d \beta_{D,1}}{d w} \propto \left( \frac{\partial \Psi_D}{\partial r_H^L} + \frac{\partial \Psi_D}{\partial r_H^L} \right) \left( \frac{\partial \Psi_H}{\partial r_H^L} + \frac{\partial \Psi_H}{\partial r_H^L} \right) \frac{\partial \Psi_H}{\partial w} - \frac{\partial \Psi_L}{\partial r_H^L} \frac{\partial \Psi_H}{\partial r_H^L} \frac{\partial \Psi_D}{\partial r_H^L} < 0
\]

since \( \left( \frac{\partial \Psi_D}{\partial r_H^L} + \frac{\partial \Psi_D}{\partial r_H^L} \right) \left( \frac{\partial \Psi_H}{\partial r_H^L} + \frac{\partial \Psi_H}{\partial r_H^L} \right) > 0 \). Second,

\[
\frac{d (r_H^L - r_H^L)}{d k} \propto \left\{ \left( \frac{\partial \Psi_D}{\partial r_H^L} + \frac{\partial \Psi_D}{\partial r_H^L} \right) \left( \frac{\partial \Psi_L}{\partial \beta_{D,1}} - \frac{\partial \Psi_H}{\partial \beta_{D,1}} \right) - \frac{\partial \Psi_D}{\partial \beta_{D,1}} \left( \frac{\partial \Psi_L}{\partial r_H^L} - \frac{\partial \Psi_H}{\partial r_H^L} \right) \right\} \frac{\partial \Psi_H}{\partial w} + \frac{\partial \Psi_L}{\partial \beta_{D,1}} \frac{\partial \Psi_H}{\partial \beta_{D,1}} \frac{\partial \Psi_D}{\partial \beta_{D,1}} \frac{\partial \Psi_H}{\partial r_H^L} \frac{\partial \Psi_D}{\partial r_H^L} \frac{\partial \Psi_H}{\partial w} \leq 0.
\]

since \( \left( \frac{\partial \Psi_L}{\partial r_H^L} + \frac{\partial \Psi_H}{\partial r_H^L} \right) < 0 \).

Q.E.D.
Proof of Proposition 3

The proof is straightforward in that we derive the properties of the shareholder’s intervention problem with respect to \( \eta_1 \). For this we define the following function which follows from condition (4):

\[
\Gamma \equiv \eta_1 - \frac{k}{(1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}}.
\]

The relevant properties with respect to \( \eta_1 \) are:

\[
\lim_{\eta_1 \to 0} \Gamma = -\frac{k}{(1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2}} < 0,
\]

\[
\lim_{\eta_1 \to \infty} \Gamma = \infty > 0,
\]

\[
\frac{\partial \Gamma}{\partial \eta_1} = 1 > 0.
\]

It follows that given that \( (1 - \hat{\beta}_{I,2})\hat{\beta}_{I,2} - (1 - \hat{\beta}_{D,2})\hat{\beta}_{D,2} > 0 \) there must exist a unique threshold \( \eta_1^L > 0 \) such that the statement in Proposition 3 holds.

Q.E.D.

Proof of Proposition 5

The proof of (i) follows from Lemma 1 and Proposition 4. We further can derive the CEO’s expected compensation and expected earnings as follows, respectively:

\[
\Pr(\eta_1 > 0)E[s_1|\eta_1 > 0] = \frac{1}{\sqrt{2\pi}} \left[ q\beta_{D,1}^2 + (1 - q)\beta_{I,1}^2 \right],
\]

\[
\Pr(\eta_1 > 0)E[r_1|\eta_1 > 0] = \frac{1}{\sqrt{2\pi}} \left[ q(1 - \beta_{D,1})\beta_{D,1} + (1 - q)(1 - \beta_{I,1})\beta_{I,1} \right].
\]

It is straightforward to show that \( \frac{\partial \Pr(\eta_1 > 0)E[s_1|\eta_1 > 0]}{\partial \beta_{D,1}} > 0 \) and \( \frac{\partial \Pr(\eta_1 > 0)E[r_1|\eta_1 > 0]}{\partial \beta_{D,1}} < 0 \).

Q.E.D.

Proofs of Proposition 6 and Corollary 4

The Proof of Proposition 6 (ii) is self-evident. To prove (i) we first rewrite the shareholder’s indifference condition in the case with pay disclosure to the following:
From the above equality and \( \Psi_L = 0 \) it follows that
\[
\Psi^o \equiv \left\{ 1 + \frac{1-q}{q} \frac{f \left[ 4r_L \right]}{f \left[ \frac{r_f^1}{(1-\beta_D,1)\beta_D,1} \right]} \right\}^{-1} \frac{r_f^1}{(1-\beta_D,1)\beta_D,1} - \frac{r_f^0}{(1-\frac{1}{2}\frac{w}{2w-1})\frac{w}{2w-1}} = 0.
\]

To show that \( r_f^L > r_f^0 \), we use a proof by contradiction. Assume that \( r_f^0 = r_f^L \). \( \Psi^o_{r_f^0=r_f^L} \) behaves as follows with respect to \( \beta \):
\[
\lim_{\beta_D,1 \to 1} \Psi^o_{r_f^0=r_f^L} = -\frac{r_f^L}{(1-\frac{1}{2}\frac{w}{2w-1})\frac{w}{2w-1}} < 0,
\]
\[
\lim_{\beta_D,1 \to \frac{1}{2}\frac{w}{2w-1}} \Psi^o_{r_f^0=r_f^L} = -\frac{1-q}{q} \frac{f \left[ 4r_f^L \right]}{f \left[ \frac{r_f^1}{(1-\frac{1}{2}\frac{w}{2w-1})\frac{w}{2w-1}} \right]} \left\{ 1 + \frac{1-q}{q} \frac{f \left[ 4r_f^L \right]}{f \left[ \frac{r_f^1}{(1-\frac{1}{2}\frac{w}{2w-1})\frac{w}{2w-1}} \right]} \right\}^{-1} \frac{r_f^L}{(1-\frac{1}{2}\frac{w}{2w-1})\frac{w}{2w-1}} < 0.
\]

From the Proof of Proposition 1 it further follows that \( \frac{\partial \Psi^o_{r_f^0=r_f^L}}{\partial \beta_D,1} < 0 \). Thus, for any \( \beta_D,1 \in \left( \frac{1}{2}\frac{w}{2w-1}, 1 \right) \) it must be the case that \( \Psi^o < 0 \) implying that it cannot be that \( r_f^0 = r_f^L \). Further since \( \Psi^o \) increases in \( r_f^L \) (since \( \frac{\partial \Psi^o}{\partial r_f^L} > 0 \)), it must follow that \( r_f^L > r_f^0 \), which further implies that \( r_f^H > r_f^0 \).

Hence the interval of report realizations for which the shareholder intervenes in the absence of pay disclosure is nested in the interval of realizations for which she intervenes in the presence of pay disclosure. This proves Proposition 6 (i) and Corollary 4.

Q.E.D.

**Proof of Corollary 5**

First, we rewrite and simplify the argument in Corollary 5 to the following:
\[
\Pr \left( \frac{r_f^H}{(1-\beta_D,1)\beta_D,1} > \eta_1 > \frac{r_f^L}{(1-\beta_D,1)\beta_D,1} \right) E \left[ \eta_1 \mid \frac{r_f^H}{(1-\beta_D,1)\beta_D,1} > \eta_1 > \frac{r_f^L}{(1-\beta_D,1)\beta_D,1} \right] < \Pr(\eta_1 > \eta_0) E \left[ \eta_1 \mid \eta_1 > \eta_0 \right]
\]
and further
\[
\int_{\eta_0}^{\eta_1} \eta f[\eta] d\eta < \int_{\eta_0}^{\eta_1} \eta f[\eta] d\eta.
\]

Next it is convenient to express the right-hand side in term of \( r_f^0 \) instead of \( r_f^H \) in that \( \eta_0 = \frac{r_f^0}{(1-\frac{1}{2}\frac{w}{2w-1})\frac{w}{2w-1}} \)
\[ \int_{r_{L,1}^{H}(1-\beta_{D,1})^{\beta_{D,1}}}^{r_{L,1}^{H}(1-\beta_{D,1})^{\beta_{D,1}}} \eta f[\eta] \, d\eta < \int_{(1-\frac{w}{2w-1})\frac{w}{2w-1}}^{\infty} \eta f[\eta] \, d\eta. \]

Now it can be shown that the partial of the left-hand side with respect to \( \beta_{D,1} \) is always negative:

\[
\frac{\partial}{\partial \beta_{D,1}} \int_{r_{L,1}^{H}(1-\beta_{D,1})^{\beta_{D,1}}}^{r_{L,1}^{H}(1-\beta_{D,1})^{\beta_{D,1}}} \eta f[\eta] \, d\eta = -\frac{(2\beta_{D,1}-1)}{(1-\beta_{D,1})^{\beta_{D,1}}} \left\{ \left[ \frac{r_{L,1}^{H}}{(1-\beta_{D,1})^{\beta_{D,1}}} \right]^{2} f \left[ \frac{r_{L,1}^{H}}{(1-\beta_{D,1})^{\beta_{D,1}}} \right] - \left[ \frac{r_{L,1}^{H}}{(1-\beta_{D,1})^{\beta_{D,1}}} \right]^{2} f \left[ \frac{r_{L,1}^{H}}{(1-\beta_{D,1})^{\beta_{D,1}}} \right] \right\} < 0.
\]

Thus, the left-hand side is highest if \( \beta_{D,1} = \frac{1}{2} \frac{w}{2w-1} \). Acknowledging this leads to

\[ \int_{(1-\frac{w}{2w-1})\frac{w}{2w-1}}^{r_{L,1}^{H}} \eta f[\eta] \, d\eta < \int_{(1-\frac{w}{2w-1})\frac{w}{2w-1}}^{\infty} \eta f[\eta] \, d\eta \]

which can further be rearranged to

\[ \int_{(1-\frac{w}{2w-1})\frac{w}{2w-1}}^{r_{L,1}^{H}} \eta f[\eta] \, d\eta - \int_{(1-\frac{w}{2w-1})\frac{w}{2w-1}}^{r_{L,1}^{H}} \eta f[\eta] \, d\eta < \int_{(1-\frac{w}{2w-1})\frac{w}{2w-1}}^{\infty} \eta f[\eta] \, d\eta. \]

Under the Proof of Proposition 6 we have shown that \( r_{L,1}^{H} > r_{L}^{H} \). It therefore must be the case that the left-hand side is negative such that the inequality must always hold.

Q.E.D.
References


Figure 1: The Shareholder’s Intervention Decision in the Absence of Executive Compensation Disclosure.