

Board Reputation, CEO Pay, and Camouflaged Compensation*

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Abstract

Reputational concerns are arguably the single most powerful incentive for board directors to act in the interest of shareholders. We propose a model to investigate the impact of boards' reputational concerns on the level and structure of executive compensation, the use of camouflaged pay, and the relation between board independence and compensation decisions. We show that, in order to be perceived as independent, boards lower managers' pay, but may also pay managers in hidden ways or structure compensation inefficiently. Interestingly, independent boards, not manager-friendly boards, are more likely to make use of hidden compensation. We apply our model to study the costs and benefits of greater pay transparency and of measures, such as say-on-pay initiatives, that increase boards' accountability to shareholders.

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In the ongoing debate about executive pay, critics of current compensation practices argue that pay packages are designed to facilitate rent extraction by managers rather than to provide those managers incentives to maximize shareholder wealth. In this debate, particular attention has been directed to the use of hidden or “camouflaged” forms of pay, which appear to be inconsistent with the maximization of shareholder value (Bebchuk and Fried, 2004; Bebchuk and Jackson, 2005; Weisbach, 2007). Since boards of directors set executive compensation and monitor management, the debate about executive pay has brought to the fore the unresolved question of board incentives: What determines the incentives of board directors? And how do those incentives affect directors’ choice of executive compensation packages?

Despite the key role played by boards of directors, the theoretical analysis of director incentives has been limited. In particular, while executive pay is not set by shareholders but by board directors, the agency problem between shareholders and the board in the determination of executive compensation is often ignored, at least as a first approximation, with the argument (Fama, 1980; Fama and Jensen, 1983) that reputational concerns by board directors align their incentives with those of shareholders. The debate about executive compensation, however, highlights the need to investigate how these reputational concerns shape director incentives and their choice of compensation policies for managers.

In this paper, we propose a model to analyze how boards’ incentives affect their decisions regarding the level and structure of executive compensation and the use of hidden forms of pay. In the model, we analyze a standard managerial agency problem in which a compensation contract is used to provide incentives to a risk-averse manager to exert effort. We depart from the conventional treatment of the managerial agency problem in that in our model board directors, not shareholders, design the manager’s compensation contract and we explicitly analyze reputational concerns as a major determinant of director incentives. The model has four key ingredients. First, directors that are perceived as more independent from management are more likely to keep their board seats or be elected to serve at other boards. Second, we distinguish between formal and true independence: While shareholders can observe the former, they can only infer the latter from directors’ actions. Third, following on the

perception that executive compensation is the “acid test” of corporate governance, shareholders use executive compensation decisions as a metric to assess boards’ true independence.¹ Finally, the board has the ability to pay the manager in hidden but inefficient ways. With this last assumption we aim to shed light on the reasons why boards may pay managers in camouflaged ways, such as difficult to observe perks, poorly disclosed pension plans, option backdating, strategically timed option grants, the manipulation of performance measures, or the use of stock options, to the extent that shareholders underestimate the cost of these options for the firm.

We show that if boards are not concerned about investors’ perceptions of their independence, all boards choose efficient compensation contracts regardless of their degree of independence. Manager-friendly boards pay managers more than relatively independent boards, but do so by increasing the non-contingent portion of executive compensation rather than by tinkering with the pay-performance sensitivity of the compensation contract or by paying managers in hidden ways.

If directors can benefit from being perceived as independent, independent boards will lower executive pay to signal their independence to investors. However, if independent boards have to lower executive pay below their preferred level to signal their independence, they will allow the manager to “claw back” some rents in costly undisclosed ways. Therefore, although reputational motives generally lower managerial pay, they may also lead boards to use inefficient hidden pay. Further, as long as independent boards succeed in signaling their independence to investors, manager-friendly boards will not make use of hidden pay in equilibrium: If they cannot pass as independent, manager-friendly will not deviate from their preferred compensation contract nor pay the manager in costly hidden ways. Thus, the model explains hidden pay not as a way by manager-friendly boards to deceive shareholders, but, rather, as part of a strategy that allows independent boards to signal their independence to investors.

Further, we show that reputational concerns may also lead independent boards to set inefficiently structured compensation contracts. If independent boards cannot signal their independence even if

¹The statement that “executive compensation is the acid test of corporate governance” is attributed to Warren Buffet, Chairman and CEO of Berkshire Hathaway.

they keep the manager at his reservation utility level, they may preclude imitation by management-friendly boards by choosing inefficient compensation contracts, which effectively reduce shareholder wealth.² As with hidden pay, the model implies that independent boards, rather than manager-friendly boards, are the ones that engage in inefficient pay practices. Although we focus on compensation decisions, these predictions potentially apply to other board decisions. For example, Fisman et al. (2005) argue that boards sensitive to shareholder pressure may inefficiently terminate their CEO's in response to such pressure.

We apply the model to analyze the potential impact of recent regulatory changes and corporate governance trends. We show that pay disclosure requirements that seek to make executive compensation more transparent will generally have the intended effect of discouraging the use of hidden pay.³ Interestingly, however, greater transparency may have the effect of reducing shareholder wealth. The reason is that greater transparency makes it harder for manager-friendly boards to compensate managers in undisclosed ways for a reduction in disclosed pay and, thus, makes it more costly for these boards to imitate the compensation policies of independent boards. Therefore, greater transparency reduces the pressure on independent boards to lower executive compensation to signal their independence and, as a result, may lead to higher managerial pay and lower shareholder profits. Indeed, we show that some pay opacity is optimal for shareholders.

We also study the impact of corporate governance trends, such as the increase in institutional ownership, the adoption of voting rules that increase the influence of investors over the election of board directors (such as replacing plurality rules by majority rules in board elections), or the passage of "say-on-pay" legislation.⁴ We show that greater influence by investors will generally reduce executive compensation, but may have the unintended effect of increasing the use of hidden pay. In fact,

²Jensen and Murphy (1990) make a related point when they conjecture that "political forces" together with disclosure requirements create distortions in the structure of compensation schemes.

³In 2006, the SEC introduced a major revision of the disclosure of executive compensation. In response to the 2007-2009 financial crisis, in July of 2009 the SEC proposed new rules that require firms to disclose information about how the company's overall compensation policies for employees create incentives that can affect the company's risk and management of that risk.

⁴The Dodd-Frank Wall Street Reform Act, signed into law in 2010, requires U.S. firms to conduct periodic, non-binding, advisory votes on executive pay. Similar measures have been introduced in other countries, such as the U.K. or Germany. See Yermack (2010) for a review of the literature on shareholder voting.

when investor pressure is strong enough, the distortions induced by greater director accountability to shareholders may reduce shareholder wealth.

A key assumption of our model is that boards' executive compensation decisions have reputational consequences. At least in recent years, directors indeed risk being singled out for their compensation decisions. Corporate governance watchdogs, such as Institutional Investor Services or the Corporate Library, or activist institutional investors, such as CalPERS, publish corporate governance ratings and watch lists, and boards' compensation decisions are a key factor determining those ratings. Moreover, executive compensation often receives negative coverage by the media. Thus, Core et al. (2008) find that excess CEO pay leads to negative press coverage of firms' compensation practices. Kuhnen and Niessen (2010) document that CEO pay is responsive to the negativity of the average media coverage of executive compensation. In particular, they find that firms reduced stock option compensation (the form of compensation receiving the greatest attention by the press in the period 1997-2004) following generally negative press coverage of executive pay. Kuhnen and Niessen's findings, thus, support the hypothesis that CEO pay is responsive to reputational concerns.⁵

The predictions of the model shed new light on empirical results relating corporate governance and pay-performance sensitivity. For example, Bertrand and Mullainathan (2000) and Hartzell and Starks (2003) find that pay-performance sensitivity is greater in firms with a large shareholder or high institutional ownership concentration. Our theory suggests that the higher pay-performance sensitivity in firms with higher institutional ownership may not be optimal—and thus, may not be considered as a standard of good practice—, but rather a way for the boards of these firms to signal their independence to investors. A caveat of this interpretation is that our model does not pin down the particular form in which independent boards will distort pay, so independent boards could have opted to reduce, rather than increase, pay-performance sensitivity. However, we expect independent boards to exaggerate policies that are perceived at a given moment of time to be favorable to investors

⁵Kuhnen and Niessen (2010) also report that the response of pay composition to press negativity is stronger for firms that are more in the public eye (larger firms, those with more analyst coverage, and those with more recent product safety concerns), and for firms that have less entrenched and younger CEOs. They interpret these findings as evidence that reputational concerns drive firms' responses to press negativity. Dyck et al. (2008) and Joe et al. (2009) also provide evidence that media coverage affects firms' corporate governance decisions.

and shun those that have a negative press, as suggested by Kuhnen and Niessen's (2010) results.

Several authors have argued that the widespread increase in the use of stock options in compensation plans during the 1990s, may not have been efficient.⁶ Although there are alternative explanations for the proposed overuse of stock options, our results may also help explain this phenomenon. If investors were not really aware of the cost of stock options, our model would explain the excessive use of stock options as a form of hidden compensation, as proposed by Bebchuk and Fried (2004). However, while Bebchuk and Fried's (2004) explanation of the use of stock options as a rent extraction mechanism has been criticized on the grounds that the increase in the use of stock options in the 1990s coincided with a perceived reduction in the power of top executives (Holmstrom, 2005), our model would predict this very pattern: The increase in the use of hidden pay would have been a response to directors' greater accountability to shareholders. Another critique of the hidden-pay explanation of option compensation is that the grant value of executive stock options is disclosed to investors. Further, the disclosed value of option grants is commonly their Black-Scholes value, which arguably significantly overstates their value to risk-averse executives (Hall and Murphy, 2002). Thus, if investors understand the true cost of stock options, the use of options cannot be explained as hidden compensation. Our model, however, provides an alternative explanation to the increase in stock option compensation. To the extent that the amount of stock options granted to executives was indeed inefficient, the excessive use of options could have been part of a strategy by independent boards to signal their independence to investors. We remark again that, according to either explanation, independent boards, rather than captured boards, are the ones more likely to use inefficient forms of disclosed or undisclosed compensation.

It is worth emphasizing that our predictions do not relate directly to formal independence (observable by shareholders) but to true independence (which shareholders cannot observe). However, the model can shed light on the relation between observable measures of board independence and executive pay. Outside directors in boards with a low fraction of formally independent directors may be

⁶See, e.g., Hall and Murphy (2003), Bebchuk and Fried (2004), Oyer and Schaefer (2005), and Dittmann and Maug (2007)—although see also Dittmann and Yu (2009) for the opposite view.

perceived as having little influence over executive pay decisions (even if the compensation committee is comprised mostly of independent directors), and, thus, those decisions may have a relatively weak impact on their future career prospects.⁷ A higher fraction of (formally) independent directors could then be associated with lower expected pay, but also with a greater incidence of hidden or distorted pay.

Although most of the theoretical literature on executive compensation abstracts from the role of boards, a few articles investigate this role. In an influential article, Hermalin and Weisbach (1998) propose a model in which the board decides whether to retain or fire the CEO, and the board and the CEO bargain over the CEO's pay and the composition of the board. However, the focus of Hermalin and Weisbach's article is not the determination of CEO pay contracts. In their model, there is no need to provide incentives to the CEO, who receives a flat salary. Almazan and Suarez (2003) develop a model in which the CEO's incentives to take a cash-flow increasing action are determined by a compensation contract designed by the board and by the board's bargaining power when negotiating with the CEO the latter's potential replacement. Almazan and Suarez (2003) show that the optimal pay-performance sensitivity is higher when the board is strong and that severance pay will tend to be higher in weak boards. They also show that in some circumstances it is optimal for shareholders to have a weak board. Hermalin (2005) analyzes a model in which the board decides whether to replace a CEO of unknown ability. He shows that more diligent boards may lead to higher CEO pay, because they implement a higher level of CEO effort, which has to be compensated. Kumar and Sivaramakrishnan (2008) propose a model in which the board both invests in acquiring information about the firm and selects a compensation contract for the CEO. They find that the equilibrium relation between director independence and equity compensation is ambiguous. None of these articles consider the impact of director reputation on their choice of CEO compensation.

⁷Coles and Hoi (2003) and Ertimur et al. (2010) support this hypothesis. Coles and Hoi (2003) find that rejecting antitakeover provisions affects positively the careers of nonexecutive directors, but only when nonexecutive directors control the board. Similarly, Ertimur et al. (2010) find that the career prospects of independent directors are affected more positively by the implementation of shareholder proposals in boards with a high fraction of independent directors. However the estimated difference is small and only significant in some specifications.

Several articles have recently provided models of the board as monitor or adviser of the manager.⁸ However, none of these models investigates the role of the board in determining CEO compensation contracts. Further, only Fisman et al. (2005) and Song and Thakor (2006) explicitly analyze board reputation. Fisman et al. (2005) consider a model in which the board decides on the replacement of the CEO and bears a cost for taking a decision contrary to shareholders' desires. If shareholders mistakenly attribute random shocks to firm performance as signals of the manager's ability, they will incorrectly pressure to retain (fire) the manager when the firm is hit by a positive (negative) shock. In this context, some managerial entrenchment may lead to better firing decisions. In Song and Thakor's model, boards take into account the impact that their decision whether to accept or reject a project proposed by the CEO will have on their reputation as experts. Interestingly, Song and Thakor (2006) allow the board to be concerned either by their reputation with shareholders (as in this paper) or by their reputation with the CEO.

The theoretical literature on executive compensation has, for the most part, ignored hidden compensation, since it has proven difficult to rationalize as part of a compensation contract that maximizes shareholder value. An exception is the model proposed by Kuhnen and Zwiebel (2008) in which the CEO is assumed to effectively set his own compensation, both disclosed and hidden, with the constraint that excessive compensation may lead to shareholder intervention. Kuhnen and Zwiebel (2008) effectively assume no role for the board, however, so their model cannot shed light on the role played by the board in determining executive pay.

The article is organized as follows. In Section 1 we describe the model. Section 2 analyzes the determination of the level of hidden pay by the board. Section 3 analyzes the benchmark case in which the board's independence is known by shareholders, so the board has no reputational concerns. In Section 4, we analyze the full model, in which board independence is not observable by shareholders. We study the impact on compensation decisions of pay transparency and shareholder influence over the board in sections 5 and 6, respectively. Section 7 concludes.

⁸For a review, see Adams et al. (2010).

1 Setup

We consider a one-period model of a firm that consists of a professional manager, a board of directors, and shareholders. Apart from these actors, there is a labor market for board directors, which allocates board seats to directors. At the beginning of the period, the board of directors sets and discloses publicly a compensation contract for the manager. The board may also offer additional pay to the manager that is not observed by shareholders (hidden pay). Upon observing the disclosed contract and the hidden pay offer, the manager decides whether to stay with the firm. If the manager stays, he chooses an action e , which determines the firm's expected revenues and is not observed by any other party. After revenues r are realized, the manager is paid according to the contract and receives the hidden compensation offered by the board, and the firm's shareholders receive the resulting profits. Finally, the labor market for board directors observes the disclosed contract and determines the number of board seats that the board will hold at the end of the period.

1.1 Technology, managerial preferences, and the compensation contract

The firm's revenues are determined by the manager's action $e \in \mathbb{R}$ and a random shock ϵ : $r(e, \epsilon)$, with $r_e > 0$. We assume that the manager is risk averse with exponential utility:

$$u(t, e) = -e^{-\rho(t-g(e))}, \quad (1)$$

where t is the manager's first-period pay and $g(e)$, with $g' > 0$ and $g'' > 0$, is the personal cost to the manager of taking action e . Thus, there is a conflict of interest with respect to action e since expected revenues are increasing in e . We will refer to e as effort, but other interpretations are possible.

To address the conflict of interest between shareholders and the manager, the board offers the

manager a linear compensation contract:⁹

$$t(r) = \alpha + \beta r. \quad (2)$$

We let $\gamma = (\alpha, \beta)$ represent a compensation contract and refer to α as the base salary and to β as the level of incentives. We define $w(\gamma)$ and $\pi(\gamma)$ as the manager's certainty equivalent and the firm's expected profits, respectively, if the disclosed contract is γ , the manager picks his optimal effort level given the contract, and the manager is compensated exclusively according to the disclosed contract. We will refer to $(w(\gamma), \pi(\gamma))$ as the disclosed payoff pair, and, abusing the term, we will refer to w simply as the manager's pay. The manager has a reservation utility level \underline{w} , which we express in certainty equivalent terms.

The assumption that the manager's utility is exponential implies that there are no wealth effects. Therefore, the manager's choice of effort given (α, β) , is independent of α . Moreover, the total surplus s that would be generated by contract γ in the absence of hidden pay does not depend on α : $s(\beta) = w(\alpha, \beta) + \pi(\alpha, \beta)$ for any α .¹⁰ We denote by β^* be the level of β that maximizes $s(\beta)$ and let $s^* \equiv s(\beta^*)$ the maximum level of the aggregate surplus of shareholders and the manager. We assume that $s^* > \underline{w}$, so that it is not optimal to dissolve the firm.

The revenues earned by the firm and its ability to obtain financing could, in principle, limit managerial compensation. To simplify the analysis, we do not incorporate this constraint and, thus, implicitly assume that the firm's cash flows or access to finance are not binding constraints in the determination of executive compensation.

⁹We focus on a linear contract for ease of exposition. All our results go through for any contract of the form $t(r) = \alpha + f(r; \beta)$, with $\beta \in \mathfrak{R}$ and f a possibly nonlinear function in some family of functions parameterized by β .

¹⁰Consider as an example the textbook setup with exponential utility, cost of effort given by $c(e) = \frac{e^2}{2}$, and revenues given by $r(e, \epsilon) = e + \epsilon$, where ϵ is normally distributed with $E(\epsilon) = 0$ and $Var(\epsilon) = \sigma^2$. In this case, the manager's certainty equivalent to (α, β, e) is simply $w = \alpha + \beta e - \frac{\rho\beta^2\sigma^2}{2} - \frac{e^2}{2}$ and the manager's choice of effort is $e(\alpha, \beta) = \beta$, so $w(\alpha, \beta) = \alpha + \frac{\beta^2}{2}(1 - \rho\sigma^2)$. If expected costs other than the manager's pay are c , then $\pi(\alpha, \beta) = (1 - \beta)\beta - \alpha - c$ and $s(\beta) = \beta - \frac{\beta^2}{2}(1 + \rho\sigma^2) - c$.

1.2 Hidden pay

To model the board's ability to transfer rents to the manager in hidden ways, we assume that in addition to the pay specified in the disclosed compensation contract, the board can transfer an additional amount y to the manager that is not observed by shareholders. The cost, in terms of reduced profits, of hidden pay y is $z(y)$, with $z(0) = 0$, $z' > 1$ and $z'' \geq 0$. The assumption $z' > 1$ implies that camouflaged pay is inefficient. This inefficiency may emerge because of the costs of hiding monetary payments or because the value of, say, hidden perks or related party transactions to the manager is lower than their cost to the firm. We acknowledge that certain forms of hidden pay may also have incentive effects. However, we abstract from this consideration and assume that the hidden pay does not affect the manager's effort decision.¹¹

Publicly available information other than the disclosed contract may, in principle, offer information about the amount of hidden pay. Thus, the observation of relatively low profits given a disclosed contract and realization of revenues may provide some information to investors about the amount of hidden compensation paid by the firm. In turn, if different board types chose different amounts of hidden pay, the information about hidden pay may allow the labor market for directors to update their expectation about the board's type beyond the updating that stems from the observation of the disclosed contract. However, in practice, publicly available information will typically provide only limited information about the amount of hidden compensation, since many other factors other than the manager's pay determine profits, and investors observe only accounting measures (which the board could manipulate) of those factors.¹² Moreover, the full impact of today's contracts may take place gradually over time, while the labor market for board directors has to allocate directors to boards on the basis of the information currently available. Therefore, for tractability, we assume that the

¹¹To the extent that hidden pay is also hidden from tax authorities and allows the firm to save on taxes, there could be instances of hidden pay that is less costly for the firm than disclosed pay. If such forms of hidden pay existed, all boards (independent or not) would make use of them to the maximum extent possible, which would be optimal for shareholders.

¹²Suppose that realized profits are given by $\Pi = r - t - c - z$, where c are costs other than the manager's compensation. Suppose also that there is uncertainty about c , that c is privately observed by the board, and that the board discloses an accounting measure $\hat{c} = c + z$ of c . Thus, if the labor market for directors observes a difference between profits and revenues net of the manager's compensation, it cannot tell with certainty whether the difference is due to c or z .

only piece of information used by the labor market when it attempts to infer the board's type is the disclosed contract γ :¹³

Assumption 1 *The labor market for board directors cannot infer any information about y from realized values of observable variables other than γ .*

1.3 The board's preferences

We consider the board as a single decision maker with preferences that can be represented by a discounted utility function:

$$u(\bar{w}, \bar{\pi}) + u_R, \tag{3}$$

where $\bar{w} \equiv w + y$ and $\bar{\pi} \equiv \pi - z(y)$ are the manager's certainty equivalent and expected profits, respectively, net of hidden pay, and u_R is the board's discounted expected utility from the board seats awarded by the labor market for directors.

For expositional simplicity we assume that the board's preferences over profits ($\bar{\pi}$) and managerial utility (\bar{w}) are given by:

$$u(\bar{w}, \bar{\pi}) = \tau \bar{\pi} + \theta v(\bar{w}), \tag{4}$$

where $\tau > 0, \theta > 0, v' > 0$, and $v'' \leq 0$.

Boards differ in the weight they place on the manager's welfare relative to profits. We assume that there are two types of boards: manager-friendly (M) boards and independent (I) boards, with

¹³One could relax this assumption and let the labor market for board directors observe a noisy signal of hidden pay. Continuing with the example in the previous footnote, suppose that the labor market for board directors observes r , γ (and, thus, t as well), and \hat{c} . If the labor market for directors observes a contract γ that is offered with positive probability by both board types and if it expects each board type to offer a different amount of hidden pay, then it would be able to update its expectation of the board's type not only from the observation of γ but also of the other publicly available information. If the prior distribution of c has a large variance, however, the information provided by this additional information would be limited. For tractability we do not model this possibility, since, as it will become apparent below, doing so would require considering both disclosed and hidden pay as potential signals, greatly complicating the analysis. We note, however, that whether noisy signals of hidden pay exist is immaterial for our results concerning separating equilibria. Moreover, the pooling equilibria obtained in the model would also survive in the presence of such noisy signals, since at these equilibria both boards set the same level of hidden pay.

$\theta_I < \theta_M$. The probability that a board is independent is common knowledge and equal to $q \in (0, 1)$.

We make an additional technical assumption about θ_M :

Assumption 2 $\frac{1}{v'(s^*)} > \frac{\theta_M}{\tau} > \frac{z'(0)}{v'(\underline{w})}$.

The first inequality ensures that the manager-friendly board does not want to transfer all the surplus to the manager. The second inequality guarantees the cost of hidden pay is low enough that a manager-friendly board would choose to pay some hidden compensation to the manager if the disclosed contract left the manager at his reservation level.¹⁴ We make this assumption to avoid discussing uninteresting corner cases and cases in which both board types would behave identically in the absence of reputational concerns.

1.3.1 Discussion

We assume that u is increasing in expected profits. The board will prefer higher profits if directors' pay is tied to firm performance or if, irrespectively of their pay, directors derive utility from, for example, fulfilling their fiduciary duty towards investors.¹⁵ Importantly, the preference for higher profits is not due to potential reputational benefits that those higher profits may confer to the board. We model those reputational concerns explicitly through the impact of the board's decisions on u_R .

We also assume that u is increasing in the manager's utility. Directors may care about the manager's utility, on top of the impact that it has on profits through the manager's effort provision and expected pay, for several reasons. First, they may have other-regarding preferences and care about the well-being of a person—the manager—with whom they meet often and with whom they are likely to identify (many directors being or having been top executives at other firms). Second, directors may care about the manager's well-being because it determines how conflictive the relation with the manager is. In other words, directors may, other things equal, prefer a higher pay for the manager if it buys them a quiet life in their relation with the manager. Finally, directors may care about the

¹⁴We prove this assertion in Lemma 1.

¹⁵Yermack (2004) shows that directors' pay is significantly sensitive to firm performance. Adams and Ferreira (2008) show that directors are responsive to monetary incentives.

manager's utility because it may influence the manager's willingness to favor the board. For example, board directors may prefer a higher pay if with that higher pay they can influence the manager to channel the firm's charitable donations to charities favored by them.

The distinction between independent and manager-friendly boards may stem from different personality traits. Thus, directors may be relatively manager-friendly if they tend to care more about people they work with or if they are more averse to boardroom conflict. However, directors may differ in their degree of independence even if there are no personality differences among them. In particular, the degree of board independence may be determined by the extent to which the manager can provide private benefits to the board in ways not easily observable by shareholders. For example, consider two directors: I and M . Director I has no material relation with the firm whatsoever. However, director M , while satisfying formal tests of independence, may sit at the board of a charitable organization. Thus, while director I may not gain anything by increasing the manager's compensation, director M may be willing to increase the manager's pay in exchange for having the manager direct the firm's charitable contributions to the charitable organization at whose board M sits. At the same time, the relation of M with the charitable organization may be poorly, or not at all, disclosed, so investors may not be aware of M 's potential conflict of interest. This interpretation of independence corresponds to the notion of independence based on the materiality of the director's relation to the firm that is used by the SEC, NYSE and Nasdaq.

It is important to remark that throughout the paper we assume that boards are identical in terms of all characteristics that can be observed by shareholders. Therefore, when we distinguish between independent and manager-friendly boards we do not refer to boards that differ in observable characteristics, such as size, the fraction of formally independent directors, or whether the CEO serves as chairman of the board. Rather, we focus on the differences that persist after controlling for all observable board characteristics.¹⁶

¹⁶In particular, we are interested in differences in independence between directors that would satisfy formal tests of independence. In this regard, the NYSE's *Listed Company Manual* states that: "It is not possible to anticipate, or explicitly to provide for, all circumstances that might signal potential conflicts of interest, or that might bear on the materiality of a director's relationship to a listed company." (NYSE, 2010; section 303.A.02). Consistently with these limitations, satisfying the NYSE independence tests is considered by the NYSE a necessary, but not sufficient condition

1.4 The board's reputational concerns

Since independent boards give a smaller weight to the manager's utility, their preferred compensation contracts will lead to lower managerial pay and higher profits than those preferred by manager-friendly boards.¹⁷ Therefore, the labor market for board directors will prefer boards known to be independent over boards known to be manager-friendly. Instead of explicitly modeling the labor market for directors, we build on this observation and assume that directors' discounted utility u_R from future board appointments is an increasing function of shareholders' belief $\mu \in [0, 1]$ that the board is independent.¹⁸ To facilitate the derivations and interpretation of the model, we assume a simple functional form for u_R :

$$u_R(\mu) = \eta\mu, \tag{5}$$

where $\eta > 0$ is a parameter that captures both the sensitivity of hiring or replacement decisions to directors' reputation and the value of board seats for directors. Thus, η represents the value of a reputation for independence.

With this specification for u_R , the board's discounted utility can be written as:

$$U(\bar{w}, \bar{\pi}, \mu; \theta) \equiv u(\bar{w}, \bar{\pi}) + u_R(\mu) = \tau\bar{\pi} + \theta v(\bar{w}) + \eta\mu. \tag{6}$$

Throughout the article we use the letter T to refer to either both type. For $T = I, M$, we define $U_T(\bar{w}, \bar{\pi}, \mu) \equiv U(\bar{w}, \bar{\pi}, \mu; \theta_T)$.

We note that, except for the term u_R reflecting the value of a reputation for independence, the preferences represented by (6) are similar to the ones considered in previous models of board behavior.

Most of these models (Hermalin and Weisbach, 1998; Almazán and Suarez, 2003; Raheja, 2005; Adams

for independence. See, for example, Lochner (2009) for a discussion of hypothetical directors that would meet the NYSE independence test, but would be otherwise probably considered not to be independent.

¹⁷We prove this assertion in Section 3.

¹⁸See Ottaviani and Sørensen (2006) for a similar reduced form modeling of reputation in the context of the labor market for forecasters.

and Ferreira, 2007; Harris and Raviv, 2008) assume that, either because of performance-contingent compensation or reputational concerns, boards (or, at least, outside directors) have an interest in maximizing firm profits. Some of these models introduce a conflict of interest between shareholders and the board because it is costly for boards to monitor the manager and interpret differences in that cost as reflecting the board's independence (Hermalin and Weisbach, 1998; Adams and Ferreira, 2007). Kumar and Sivaramakrishnan (2008) explicitly assume that the board may also care about the manager's welfare, and Harris and Raviv (2008) allow for inside board members who have an interest in increasing the firm's scale beyond the profit-maximizing level. In all models, the monitoring costs or the utility of the manager enter in an additive form as in (6). The key difference between our specification and the ones in previous papers is, thus, that we separate the direct impact of profits and pay on director welfare from the impact of having a reputation for independence. As noted above, the preferences over profits and managerial utility represented by u do not reflect potential reputational effects of the board's choice of compensation contracts. The reputational impact of the board's contract choice takes place through the effect that that choice has on shareholders' belief (μ) that the board is independence. This separation allows us to analyze the role of reputation as a source of incentives for board directors.

Importantly, Assumption 1 implies that the market evaluates the board's independence on the basis of the disclosed compensation contract only: the market's updated belief that the board is independent is, thus, a function $\mu(\gamma)$.

2 The Board's Choice of Hidden Pay

The board cannot contractually commit to pay the manager a certain level of hidden pay. Moreover, hidden pay is not observed by the labor market for directors and Assumption 1 ensure that it does not indirectly affect the board's reputation either. Therefore, if the board picks a disclosed contract γ , the only possible level of hidden pay in equilibrium, irrespectively of whether the board has reputational concerns, is the one that maximizes the board's utility given the disclosed contract γ . In this section,

we characterize the board's choice of hidden pay for a given disclosed contract.

For a board of type T , we denote by $y_T(w, \pi)$ the optimal level of camouflaged compensation for any disclosed contract that leads to payoff pair (w, π) . For any (w, π) , $y_T(w, \pi)$ is the solution to:

$$(Y) \begin{cases} \max_y & \tau(\pi - z(y)) + \theta_T v(w + y) + \eta(\theta)\mu \\ \text{s.t.} & y \geq 0 \\ & w + y \geq \underline{w} \end{cases}$$

Inspection of this maximization problem shows that the level of profits π does not affect the board's choice of y .¹⁹ We thus, write the optimal level of hidden pay simply as $y_T(w)$. The optimal level of hidden pay for a given pay w has the following properties (all proofs are in the appendix except otherwise noted):

Lemma 1

1. For any w , $y_M(w) \geq y_I(w)$.
2. Let $w > w'$. Then, $y_T(w) \leq y_T(w')$. Further, if $y_T(w') > 0$, then $y_T(w) < y_T(w')$.
3. Let $w > w'$. Then, $w + y_T(w) \geq w' + y_T(w')$, and if $w + y_T(w) > \underline{w}$, then $w + y_T(w) > w' + y_T(w')$.
4. For each $T \in \{I, M\}$, there exists a disclosed pay w_T^y such that:

(a) $y_T(w) = 0$ if $w \geq w_T^y$, and $y_T(w) > 0$ if $w < w_T^y$.

(b) $w_M^y > w_I^y$.

Thus, for any disclosed payoff pair (w, π) , a manager-friendly board pays at least as much camouflaged compensation as an independent board. Further, the amount of hidden compensation is nonincreasing in the manager's pay and is strictly increasing for pay levels that lead to positive hidden pay. Even if hidden pay is nonincreasing in the disclosed pay, the manager's total compensation

¹⁹This follows from the fact that the board's preferences are linear in profits. Although it simplifies the derivations, this linearity is not essential for obtaining our results.

(including both disclosed and hidden pay) is nondecreasing in the level of disclosed pay. If disclosed pay is low enough so that the manager's total compensation is equal to his reservation salary, then marginal changes in the disclosed pay translate into equivalent compensating changes in hidden pay, leaving the manager's total pay unchanged. However, if the manager's total pay is above his reservation value, then increases in disclosed pay translate into increases in total compensation. Part 4 of the lemma shows that there is a threshold level of the disclosed pay w_T^y such that a type- T board pays no hidden compensation if $w \geq w_T^y$ and pays hidden compensation if $w < w_T^y$.

3 CEO Pay in the Absence of Reputational Concerns

We consider as a benchmark the behavior of the board when there are no reputational concerns (μ is fixed and assumed to be 0). Given our definition of s^* as the maximum surplus attainable, it follows that for any contract γ , $w(\gamma) + \pi(\gamma) \leq s^*$. Further, the continuity of the problem ensures that any level of surplus $s \leq s^*$ can be achieved by selecting a contract with β such that $s(\beta) = s$. Finally, for a given level of surplus s , the manager's base salary α can be set to achieve any combination of payoffs (w, π) such that $\pi + w = s$. Therefore, the problem of selecting an optimal contract γ can be alternatively formulated as the problem of finding the optimal payoff pair (w, π) among the feasible ones, that is, the payoff pairs such that $\pi + w \leq s^*$, and then choosing a contract that implements the optimal payoff pair. The optimal payoff pair for a type- T board is the solution to:

$$\begin{aligned} \max_{w, \pi} \quad & \tau [\pi - z(y_T(w))] + \theta_T v(w + y_T(w)) \\ \text{s.t.} \quad & w + y_T(w) \geq \underline{w} \end{aligned} \tag{7}$$

$$\pi + w \leq s^*. \tag{8}$$

The board will pay in hidden ways whenever the manager's disclosed pay is too low given the board's preferences. Since hidden pay is costlier than disclosed pay, however, in the absence of reputational concerns boards will achieve their desired payoff pair solely by means of disclosed compensation

and will not make use of costly hidden pay. Moreover, since the board's objective is increasing in both π and w , it follows that, regardless of its type, the board will choose a level of incentives that maximizes surplus, i.e., a level of incentives that ensures that $w_T^* + \pi^* = s^*$. The assumption that there are no wealth effects implies that total surplus s depends on the level of incentives β and not on the base salary α . Therefore, both board types will choose the level of incentives that maximizes total surplus. Finally, it follows from the fact that the manager-friendly board gives a larger weight to the manager's utility ($\theta_M > \theta_I$) that the manager friendly board will choose to give a larger fraction of the value generated to the manager by selecting a larger base salary. These results are stated formally in Proposition 1.

Proposition 1 *Let $\gamma_T^* = (\alpha_T^*, \beta_T^*)$ be the compensation contract chosen by a board of type T in the absence of reputational concerns, and let $w_T^* \equiv w(\gamma_T^*)$ and $\pi_T^* \equiv \pi(\gamma_T^*)$ denote the corresponding disclosed payoffs. Then:*

1. *Both board types choose the efficient level of incentives: $\beta_I^* = \beta_M^* = \beta^*$.*
2. *The manager-friendly board offers a larger base salary than the independent board: $\alpha_M^* > \alpha_I^*$.*
3. *Neither board type pays any hidden compensation: $y_M(w_M^*) = y_I(w_I^*) = 0$.*
4. *$w_M^* > w_I^*$ and $\pi_M^* < \pi_I^*$.*
5. *The contract chosen by each board type and the resulting payoffs are the same that each board type would have chosen if hidden pay were not possible.*

We note that the result that both board types choose the same level of incentives β^* follows from our assumption of an exponential utility for the manager (which ensures that there are no wealth effects and, thus, that only the level of incentives β determines total surplus). Therefore, this result does not generalize to other specifications of the manager's preferences. The message from Proposition 1 is, on the one hand, that we might expect the main difference between independent and manager-friendly boards to lie in their choice of base salary. On the other hand, Proposition 1 shows that, at

least for a standard choice of preferences, there is no a priori reason why a manager-friendly board would choose a lower level of incentives.

4 The Board's Reputational Concerns and CEO Pay

In the presence of reputational concerns, the board must take into account the information about the board's independence that its choice of compensation policy conveys to the labor market for directors. To study the impact on the board's compensation policy of these reputational concerns, we analyze hereafter the equilibria of the model when labor market for directors does not know the board's type, only that the board can be either independent or manager-friendly. We focus on (Perfect Bayesian) equilibria that satisfy the Intuitive Criterion (Cho and Kreps, 1987). In the appendix, we provide a formal definition of the equilibrium concept.

We defined the board's utility as a function of the manager's and shareholders' payoffs net of hidden pay. However, it is more convenient for the analysis below to redefine the board's preferences as a function of the disclosed payoffs, that is, the payoffs that would be generated by a contract if no hidden pay were used. Therefore, we define:

$$\bar{U}(w, \pi, \mu; \theta) \equiv U(w + y(w, \theta), \pi - z(y(w, \theta)), \mu, \theta). \quad (9)$$

Thus, $\bar{U}(w, \pi, \mu; \theta)$ is the board's utility when the disclosed contract yields (w, π) , the investor's belief is μ , and the board sets its preferred level of camouflaged compensation given (w, π) . We also define:

$$\bar{U}_T(w, \pi, \mu) \equiv U_T(w + y_T(w), \pi - z(y_T(w)), \mu) \quad (10)$$

Our assumptions about the board's preferences ensure that the following Lemma holds:

Lemma 2 *Let $w' > w$, then for any π, π', μ, μ' :*

1. If $w' + y_M(w') > \underline{w}$, then :

$$\bar{U}_I(w', \pi', \mu') \geq \bar{U}_I(w, \pi, \mu) \Rightarrow \bar{U}_M(w', \pi', \mu') > \bar{U}_M(w, \pi, \mu) \quad (11)$$

2. If $w' + y_M(w') = \underline{w}$, then $\bar{U}_I(w', \pi', \mu') - \bar{U}_I(w, \pi, \mu) = \bar{U}_M(w', \pi', \mu') - \bar{U}_M(w, \pi, \mu)$.

The first part of Lemma 2 has several implications. First note that Lemma 1 implies that if $w' > w$ and $w' + y_M(\pi', w') > \underline{w}$, then $w' + y_M(w') > w + y_M(w)$. Therefore, the condition $w' + y_M(\pi', w') > \underline{w}$ is equivalent to stating that the manager's total compensation is higher under w' than under w . Thus, if we let $\pi' < \pi$, the first part of the Lemma shows that if an independent board is willing to accept a reduction in profits in exchange for an increase in the manager's total compensation, the manager-friendly board will also want to accept such an exchange. Expression (11) can equivalently be interpreted as stating that if a manager-friendly board is willing to reduce the manager's total compensation in exchange for an increase in profits, an independent board will also accept such an exchange. Similarly, if $\mu' < \mu$, and $\pi' = \pi$, (11) implies that if an independent board is willing to accept a reduction in reputation in exchange for an increase in the manager's total compensation, then the manager-friendly board also wants to accept such an exchange. Therefore, (11) subsumes two single-crossing conditions, one concerning the trade-off between pay and profits and the other the trade-off between pay and reputation.

To understand the second part of the Lemma, recall that Lemma 1 implies that if $w' > w$ and $w' + y_M(\pi', w') = \underline{w}$, then $w' + y_M(w') = w + y_M(w)$. Therefore, Lemma 2 states that if two pairs of disclosed payoffs $((w', \pi')$ and $(w, \pi))$ lead to the same total compensation, then for any μ, μ' , both board types have the same preferences over (w', π', μ') and (w, π, μ) . This implication follows immediately from the definition of \bar{U} , since if $w' + y_M(w') = w + y_M(w)$:

$$\bar{U}_I(w, \pi, \mu) - \bar{U}_I(\pi', w', \mu') = \tau(\pi - \pi') + \eta(\mu - \mu') = \bar{U}_M(w, \pi, \mu) - \bar{U}_M(\pi', w', \mu'). \quad (12)$$

To analyze the model's equilibria, we define \tilde{w} as the disclosed pay such that $\tilde{w} < w_M^*$ and

$$\bar{U}_M(w_M^*, \pi_M^*, 0) = \bar{U}_M(\tilde{w}, s^* - \tilde{w}, 1) \quad (13)$$

Therefore, \tilde{w} is the level of disclosed pay that makes a manager-friendly board indifferent between (i) being perceived as manager-friendly and offering its preferred contract and (ii) offering an efficient disclosed contract with salary \tilde{w} and being perceived as independent. By efficient disclosed contract we refer to any disclosed contract (w, π) such that $s^* = \pi + w$, so that the contract would maximize surplus in the absence of hidden pay.

We also define:

$$\underline{w}_T \equiv \max\{w : w + y_T(w) = \underline{w}\}, \quad \text{for } T \in \{I, M\}. \quad (14)$$

Therefore, \underline{w}_T is a threshold salary such that a board of type T chooses a total compensation for the manager equal to his reservation salary if $w \leq \underline{w}_T$ and greater than his reservation salary if $w > \underline{w}_T$. It follows immediately from Lemma 1 that $\underline{w}_M < \underline{w}_I$. Further, the second inequality in Assumption 2 ($\theta_M v'(\underline{w}) > \tau z'(0)$) immediately implies that $\underline{w}_M < \underline{w}$.

4.1 Efficient reputational concerns

If a reputation for independence is valuable, manager-friendly boards will try to pass as independent, and independent boards will strive to signal their independence to shareholders. We label an equilibrium separating if the manager-friendly and the independent boards choose different disclosed contracts. We label an equilibrium pooling if there is some disclosed contract that is played with positive probability by both boards.

At a separating equilibrium the manager-friendly board will choose the compensation contract and level of hidden pay that it would have chosen in the absence of reputational concerns. Otherwise, since at a separating equilibrium $\mu(\gamma_M) = 0$, deviating to the board's preferred contract would be a

profitable deviation. It follows from Proposition 1 that at any separating equilibrium the manager-friendly board will pay no hidden compensation. Recalling that the preferred contract for the manager-friendly board (γ_M^*) is efficient ($\beta_M^* = \beta^*$) we obtain the following result:

Proposition 2 *At any separating equilibrium, the manager-friendly board sets the same efficient contract, γ_M^* , that it would have set in the absence of reputational concerns and pays no hidden compensation.*

Thus, Proposition 2 shows that if independent boards succeed in signaling their independence to shareholders, reputational concerns have no impact in equilibrium on the compensation decisions of manager-friendly boards. Importantly, this implies that if there is separation in equilibrium manager-friendly boards do not pay the manager in hidden ways.²⁰

If the independent board can avoid imitation while setting its preferred contract γ_I^* , it will do so. Therefore, if \tilde{w} is large enough ($\tilde{w} > w_I^*$), reputational concerns will have no impact on compensation decisions. If, however, the independent board would trigger imitation by the manager-friendly board if it set its preferred contract, the independent board will lower the manager's compensation to signal its independence to shareholders. The independent board will do this in the least costly way possible. Therefore, it will lower the base salary while keeping the manager's incentives at the efficient level β^* . Further, if the reduction in base pay necessary to dissuade imitation by the manager-friendly board is small enough ($\tilde{w} \geq w_I^y$), the independent board will not compensate the manager in hidden ways for the reduction in disclosed pay:

Proposition 3 *If $\tilde{w} \geq w_I^y$, there are no pooling equilibria, and at the unique separating equilibrium:²¹*

1. *If $\tilde{w} \geq w_I^*$, then $(\alpha_I, \beta_I) = (\alpha_I^*, \beta^*)$, $w_I = w_I^*$, $\pi_I = \pi_I^*$, and $y_I(w_I) = 0$.*
2. *If $\tilde{w} < w_I^*$, then $\beta_I = \beta^*$, $\alpha_I < \alpha_I^*$, $w_I < w_I^*$, $\pi_I > \pi_I^*$, and $y_I(w_I) = 0$.*

²⁰Core et al. (2008) report that, after controlling for mean reversion, firms that receive negative press coverage do not significantly alter their compensation practices. This finding is consistent with Proposition 2, which shows that manager-friendly boards (which would be the ones receiving negative coverage at a separating equilibrium) choose their preferred compensation contracts.

²¹We use the word unique to refer to the board's strategies. There may be different equilibrium beliefs consistent with the unique equilibrium strategies.

Therefore, Proposition 3 shows that if the independent board can signal its independence to shareholders by setting its preferred disclosed contract or a contract with a disclosed pay not much lower than the preferred one, then the board's reputational concerns have the effect of lowering the disclosed pay that the independent board pays relative to its preferred level. Further, since the reduction in salary is not large enough, the independent board pays no hidden compensation. Thus, it follows from propositions 2 and 3 that for parameter values such that the reduction in pay needed to avoid imitation by manager-friendly boards is not too large ($\tilde{w} \geq w_I^y$), reputational concerns induce independent boards to efficiently transfer rents from the manager to shareholders and have no effect in equilibrium on the compensation decisions of manager-friendly boards.

We note that if $\tilde{w} \geq w_I^y$, then there are no pooling equilibria, so that the separating equilibrium described in Proposition 3 is unique. In fact, we show in the appendix that as long as $\tilde{w} > \underline{w}_M$ (where $\underline{w}_M < \underline{w} \leq w_I^y$) there are no pooling equilibria. The reason is that if $w > \underline{w}_M$, then it is possible to lower the manager's total compensation by setting a disclosed pay $w' < w$. Since deviating to this disclosed pay is more costly for the management oriented board, independent boards would be able to convince shareholders about their independence by deviating to w' .

It is worth clarifying that separating equilibria are robust to the critique that if shareholders learn the board type, manager-friendly boards will be fired. The impact of reputation on the board's prospects is already included in the model, although in reduced form, through the second-period expected utility u_R . In other words, even though we do not explicitly model how shareholders react in the second period to information about the board type, our assumption that $\eta > 0$ implies that at separating equilibria manager-friendly directors are indeed more likely to be fired or less likely to be hired for other boards.

4.2 Reputational concerns and hidden pay

If the disclosed pay necessary to dissuade the manager-friendly board from imitating the independent board is low enough ($\tilde{w} < w_I^y$), the independent board will further lower the base salary to signal its

independence to the investor, but will compensate the manager for the reduced pay with camouflaged compensation.

Proposition 4 *If $\underline{w}_M \leq \tilde{w} < w_I^y$, then there are no pooling equilibria and separating equilibria are such that $\beta_I = \beta^*$, $\alpha_I < \alpha_I^*$, $w(\alpha_I, \beta_I) = \tilde{w}$, and $y_I(\tilde{w}) > 0$.*

Since hidden pay is inefficient, Proposition 4 implies that the board's reputation-seeking behavior may become an agency problem. Further, Proposition 4 shows that the independent board, not the manager-friendly one, is the one that pays in inefficient hidden ways.

4.3 Reputational concerns and inefficient compensation structures

In the equilibria described in propositions 3 and 4, both board types structure disclosed compensation efficiently ($\beta_M = \beta_I = \beta^*$), although the independent board may make use of inefficient hidden pay if the disclosed pay necessary to signal its independence (\tilde{w}) is low enough. If \tilde{w} is so low that even the manager-friendly board would leave the manager at his reservation utility level ($\tilde{w} \leq \underline{w}_M < \underline{w}$), equilibria such as the ones described in Proposition 4 are still possible. However, for $\tilde{w} \leq \underline{w}_M$, in the effort to signal its independence the independent board may not only pay in hidden ways but also inefficiently distort the disclosed compensation contract by offering the manager a disclosed compensation contract with $\beta_I \neq \beta^*$:

Proposition 5 *If $\tilde{w} < \underline{w}_M$, then there is a continuum of separating equilibria with $w_I \in [\tilde{w}, \underline{w}_M]$ and $y_I(w_I) = \underline{w} - w_I > 0$. If $w_I > \tilde{w}$, then $\beta_I \neq \beta^*$, so the disclosed contract is inefficient ($\pi_I < s^* - w_I$).*

Separating equilibria with $w_I = \tilde{w}$ are identical to those described in Proposition 4. However, if $\tilde{w} < \underline{w}_M$ there are other separating equilibria at which the independent board pays a relatively higher salary ($w_I > \tilde{w}$) and achieves separation by designing an inefficient compensation structure (with $\beta_I \neq \beta^*$ and, thus, $\pi_I < s^* - w_I$) that effectively reduces expected profits. To understand this sort of equilibrium, suppose that the manager-friendly board is willing to set $(\underline{w}_M, s^* - \underline{w}_M)$ to

be perceived as an independent board. To achieve separation, the independent board could reduce the disclosed pay efficiently below \underline{w}_M . However, by definition of \underline{w}_M any further salary reduction is fully compensated with hidden pay (to satisfy the manager's participation constraint) and, thus, has no impact on the manager's total compensation. Therefore, a marginal pay reduction from \underline{w}_M to $w < \underline{w}_M$ would have the same marginal impact on both types of boards: no reduction in the manager's total compensation and a reduction in profits equal to $[z(\underline{w} - w) - z(\underline{w} - \underline{w}_M)] - [\underline{w}_M - w]$, which has the same effect on the utility of both board types since the marginal utility of profits is the same for both. Therefore, if separation can be achieved by such a choice, it can also be achieved by keeping the manager's disclosed pay at \underline{w}_M and reducing disclosed profits by $[z(\underline{w} - w) - z(\underline{w} - \underline{w}_M)] - [\underline{w}_M - w]$ through an inefficient compensation contract. For $\tilde{w} > \underline{w}_M$ the cheapest way for the independent board to signal independence is to lower pay, since for $\tilde{w} > \underline{w}_M$ reductions in disclosed pay translate into reductions in total compensation for the manager-friendly board and thus have a greater impact on the utility of the manager-friendly board. For $\tilde{w} \leq \underline{w}_M$ reducing disclosed pay or keeping the level of disclosed pay constant while distorting the compensation contract have the same impact.

Two remarks are in order. First, for given parameter values all the separating equilibria described in Proposition 5 are payoff equivalent. Since $y_I(w_I) = \underline{w} - w_I$, the manager's total compensation is \underline{w} . Further, for any equilibrium w_I , $\pi_I - z(y_I(w_I)) = s^* - \tilde{w} - z(y_I(\tilde{w}))$, so expected profits are also the same in any separating equilibrium. Second, while in signaling models separation is usually achieved by choices that have different costs for different types, here separation is achieved partly by distorting as well a variable (profits) that is equally valued by both types.

When $\tilde{w} < \underline{w}_M$, Proposition 5 shows that there is a continuum of separating equilibria. As the following proposition shows, when $\tilde{w} < \underline{w}_M$ there exists a continuum of pooling equilibria as well:

Proposition 6 *If $\tilde{w} < \underline{w}_M$, then:*

1. *For each $w \in (\tilde{w}, \underline{w}_M]$, there are pooling equilibria at which $w_I = w$, $y_I(w_I) = \underline{w} - w_I > 0$, and $\pi_I \leq s^* - w_I$.*
2. *At these pooling equilibria, the manager-friendly board randomizes between $(w_M^*, s^* - w_M^*)$ with*

$y_M(w_M^*, s^* - w_M^*) = 0$ and (w_I, π_I) with $y_M(w_I) = y_I(w_I) = \underline{w} - w_I > 0$.

3. *The probability with which the manager-friendly board plays (w_I, π_I) is highest at the pooling equilibrium with $w_I = \underline{w}_M$ and $\pi_I = s^* - \underline{w}_M$.*

The reason for this multiplicity of equilibria is that, as we show in Lemma 2, any two disclosed payoff pairs $(w, \pi), (w', \pi')$ with $w, w' \leq \underline{w}_M$ lead to the same total compensation for the manager irrespectively of the board type, since both board types pay the manager in hidden ways exactly the amount needed to keep him at his reservation utility. Therefore, (w, π) and (w', π') only differ in the profits net of hidden pay that they yield to shareholders. Since both board types prefer higher profits other things equal, it follows that either board type will prefer (w, π) over (w', π') if and only if $\pi + z(w) > w' + z(w')$. Therefore, for payoff pairs with $w, w' \leq \underline{w}_M$, the two boards have exactly the same preferences and the single-crossing condition that ensures separation does not apply. It follows that if shareholders expected both board types to choose (w, π) with $w < \underline{w}_M$, an independent board would not be able to “convince” shareholders of its independence by choosing a contract such that $w' < w$. Thus, an equilibrium in which both boards (partly) pool at $(\underline{w}_M, s^* - \underline{w}_M)$ becomes possible.

It is important to remark that, as described in part 2. of the proposition, even though both boards set the same disclosed pay in equilibrium with positive probability, it does not follow that the manager-friendly board pays more hidden compensation for that level of disclosed pay than the independent board. Pooling equilibria are only possible at disclosed pay levels such that both boards pay the same amount of hidden compensation, namely the level just necessary to satisfy the manager’s participation constraint. Therefore, it is still the case that for all pooling equilibria the expected level of hidden pay is weakly greater for the independent board and strictly greater whenever equilibria are only partly pooling (i.e., when the manager-friendly board sets its preferred contract with positive probability).

4.4 Discussion

Agency costs of board’s reputational concerns. Propositions 2–3 show that the board’s reputational concerns can help alleviate the agency problem that exists because the board, not shareholders, set the manager’s compensation: When it is relatively easy to avoid imitation by manager-friendly boards, reputational concerns lead independent boards to lower the manager’s pay with no efficiency loss, effectively transferring wealth from the manager to shareholders. However, Propositions 4–6 highlight the agency costs of the board’s reputational concerns: When the reduction in the manager’s pay that is necessary to signal the board’s independence is large enough, independent boards will lower the manager’s disclosed pay and compensate the manager with costly hidden pay, and may even inefficiently distort the disclosed compensation contract.

Board independence, hidden pay, and inefficient compensation contracts. Propositions 2–6 imply that independent boards will be more likely than manager-friendly boards to pay the managers by means of perks, hard-to-identify pension plans, option back-dating and other forms of undisclosed compensation. In fact, for most parameter values, the manager-friendly board pays no hidden compensation, and if it does (at pooling equilibria), it never pays more hidden compensation than the independent board. Therefore, our model identifies hidden pay not as a strategy by manager-friendly boards to mislead investors, but as a side effect of independent boards’ efforts to signal their independence to shareholders.

We note, however, that the implication that more independent boards make greater use of camouflaged compensation is compatible with a different explanation from the one we propose here. Rather than a strategic decision by independent directors, camouflaged compensation could be the result of actions taken by captured directors or the manager himself to keep independent directors unaware of his true compensation.

Empirical implications. Since true independence is not observable and, by its very nature, camouflaged compensation is not easy to measure, the prediction that more independent boards will be

more likely to pay in hidden ways is not directly testable. However, Proposition 4 implies that hidden compensation will be more likely in firms that pay relatively low disclosed salaries. This implication is potentially testable if reasonable proxies of camouflaged pay (such as ex post measures, like the frequency of scandals or litigation related to executive pay) can be found. In sections 5 and 6 we derive comparative statics results that provide further potentially testable implications of the model.

Implications concerning the use of stock options. The model offers two potential explanations for the increase in the use of stock options during the 1990s. To the extent that shareholders underestimated the value of stock options, as proposed by Bebchuk and Fried (2004), Proposition 4 would imply that stock options may have been used as a camouflaged form of compensation. However, our model predicts that truly independent boards, rather than those captured by the manager, would have been the ones more prone to pay the manager in this way. This explanation of stock option compensation as a form of camouflaged pay hinges on the assumption that the market was not fully aware of the true cost of executive compensation, either because this form of compensation was initially disclosed in the footnotes to the financial statements or because shareholders did not fully understand the cost of option compensation for the firm. Hall and Murphy (2003) have indeed argued that shareholders and boards perceived the cost of stock options to be lower than their true cost to the firm and that, as a result, stock options may have been overused inefficiently, even if, when doing so, boards may have thought they were acting in the best interest of shareholders.

To the extent that stock options were indeed overused inefficiently, as proposed by Hall and Murphy (2003), Proposition 5 provides an alternative explanation for the excessive use of stock option compensation: Stock options may have been an inefficient form of compensation adopted by independent boards in their effort to distinguish themselves from manager-friendly boards. We must highlight, however, that the model is neutral as to the exact form of the distortion in compensation practices introduced by independent boards. Our preferred interpretation is that the distortion will take the form of an inefficient overuse of the accepted set of best practices at any given point of time. Thus, at a time when options were considered a desirable means of aligning the interests of managers with

those of investors, independent boards may have lowered executive pay relative to manager-friendly board and substituted inefficient stock option compensation for other forms of compensation.

Welfare implications. Although our results yield implications about the manager's pay and shareholders' wealth, one has to be cautious when deriving welfare implications from them. The reason for this caution is that we do not model the impact that the revelation of information about the board's independence has for future shareholder wealth. In the model, we consider a single period and subsume the welfare effects that the choice of manager pay has for the board in the function u_R . However, we do not explicitly derive the implications that different contracts have for the manager's and shareholders' future wealth.

To analyze these implications, suppose that after the period we consider in the model there is one additional period after which the firm is liquidated and directors retire. If directors retire after the second period, they will have no reputational concerns in that period and will choose their preferred contracts described in Proposition 1. Therefore, expected profits will be higher in the second period in those firms whose second-period boards are more likely to be independent. One can also assume that, with some probability, the manager presents a proposal to the board for its approval, which has a large negative impact on firm value, yet yields the manager a large private benefit (such as an inefficient acquisition if the manager has empire-building concerns). Since an independent board would be less likely to approve such proposal, expected second-period profits would also be higher with an independent board for this reason.

At a fully separating equilibrium, manager-friendly boards are identified as such and, thus, are likely to be replaced in the second period by a board whose probability of being independent is not lower than the prior probability q (it may be higher than q if information revelation at other firms in the first period would allow shareholders to pick directors from other firms that are more likely to be independent). Therefore, at a separating equilibrium the probability that the board is independent in the second period is higher than the prior probability q . At the other extreme, if there is complete pooling at equilibrium, shareholders do not obtain any information from the board's

contract choice and, thus, are unlikely to replace the board (assuming potential replacements have a similar prior probability of being independent). Therefore, the probability that the second-period board is independent at a pooling equilibrium is unlikely to be higher than q .

It follows that we can directly compare the welfare implications of different separating equilibria, since they all lead to the same amount of information revelation. However, comparing the welfare implications of equilibria with different amounts of information revelation requires considering potential future effects on shareholder wealth. Since equilibria are separating for a wide range of parameter values this limitation is not highly restrictive, but one should keep it in mind when interpreting the welfare implications of the changes in disclosure requirements and reputational pressures that we analyze in the next two sections.

5 The Impact of Disclosure Requirements and Monitoring

Regulation may alter the cost of hidden compensation by imposing stricter disclosure requirements or by providing stronger incentives to accountants and auditors to disclose all forms of managerial compensation. In this section, we investigate the impact of disclosure requirements and auditors' incentives by analyzing the impact of changes in z , the function describing the costs of hidden compensation, on equilibrium outcomes. To do so, we assume that z belongs to a parametric family of functions with a parameter $\kappa \in (0, K)$ such that: $z(0; \kappa) = 0$ for any κ , and $z_{y\kappa} = \frac{\partial^2 z}{\partial \kappa \partial y}(y; \kappa) > 0$. Therefore, a larger κ translates into larger marginal and total costs of hiding compensation.

What is the effect of stricter disclosure requirements on disclosed compensation and profits? As hidden compensation becomes more expensive, it becomes more costly for manager-friendly boards to compensate the manager in hidden ways if they reduce the manager's pay to imitate independent boards. Therefore, the maximum salary that dissuades manager-friendly boards from imitating independent boards increases and, thus, the equilibrium disclosed pay chosen by independent boards increases as well. This increase, together with the greater cost of hiding compensation, leads to a reduction in equilibrium hidden pay:

Proposition 7 *The independent board's equilibrium disclosed pay is nondecreasing in κ and the equilibrium level of hidden compensation paid by the independent board is nonincreasing in κ .*

Therefore, there is substitution between disclosed and undisclosed compensation in equilibrium. This substitution implies that the directly observable effect of a change that makes hidden compensation more costly is an increase in the (disclosed) salary paid by independent boards.²² Therefore, the cost of stricter transparency requirements is that the pressure on independent boards to reduce pay to signal their independence is reduced and, as a consequence, disclosed pay goes up.

Interestingly, an increase in the cost of hidden compensation may make the manager better off and shareholders worse off. To see this consider, for example, the scenario described in Proposition 3. In that scenario the independent board is forced to pay in equilibrium a disclosed pay \tilde{w} , which is lower than its preferred salary. At the same time, the separating salary \tilde{w} is high enough that the independent board pays no hidden compensation. If the manager-friendly board would pay hidden compensation if it set disclosed pay \tilde{w} , then a marginal increase in the cost of hidden compensation, by making imitation more costly for the manager-friendly board, will allow the independent board to increase its disclosed pay and still achieve separation. Since the independent board was already paying no hidden compensation, the increase in the cost of camouflage will not reduce hidden compensation. Therefore, the total effect of an increase in the cost of hiding pay will be an increase in the manager's total pay and a corresponding reduction in expected profits. Moreover, if separation is still achieved, the same amount of information about the board's independence is revealed, so future profits would remain unchanged. Since \tilde{w} (the salary paid by the independent board at a separating equilibrium) is increasing in κ , a direct implication of this argument is that making the cost of hiding information very large is not optimal from the point of view of shareholders. In the following proposition we give a sufficient condition that ensures that there is such a thing as excessive transparency from the point

²²We note that for the region with multiple equilibria, we say that the equilibrium disclosed pay is increasing in κ if the minimum salary possible in equilibrium (\tilde{w}) and the maximum salary (other than w_M^* , which is the same for all values of κ) possible in equilibrium (\underline{w}_M) are both increasing in κ . This definition can be restated more formally as saying that the set of equilibrium salaries other than w_M^* is increasing in κ in the strong set order (Milgrom and Shannon, 1994). The definition of nonincreasing for the level of hidden pay is analogous.

of view of shareholders. Before doing so, we make an assumption about the family of functions z that guarantees that for κ large enough, $y_M \rightarrow 0$, and for κ low enough imitating the independent board becomes cheap enough for the manager-friendly board:

Assumption 3

1. $z_y(0) \rightarrow \frac{\theta_M v'(\underline{w})}{\tau}$ when $\kappa \rightarrow K$.
2. For κ low enough: $\bar{U}_M(\underline{w}, s^* - \underline{w}, 1) > \bar{U}_M(w_M^*, \pi_M^*, 0)$.

The first part of the assumption ensures that for any w , $y_M(w) \rightarrow 0$ as $\kappa \rightarrow K$, while, at the same time for any $\kappa \in (0, K)$, $y_M(\underline{w}) > 0$, which ensures that Assumption 2 holds for any κ . The second part of the assumption states that when the cost of hiding pay is low enough, the manager-friendly board would be willing to set a disclosed pay of \underline{w} (and compensate the manager with cheap hidden pay) to pass as independent.

Proposition 8 *Suppose that Assumption 3 holds and:*

$$U_M(\underline{w}, s^* - \underline{w}, 1) < U_M(w_M^*, \pi_M^*, 0). \tag{15}$$

Then, equilibrium expected profits are decreasing in κ for $\kappa > \bar{\kappa}$ and the profit maximizing κ^ is such that $\kappa^* \leq \bar{\kappa}$.²³*

Therefore, if the manager-friendly board would prefer, if hidden pay were not possible, setting its optimal contract and being recognized as manager-friendly over keeping the manager at his reservation salary and passing as independent (that is, if inequality (15) holds), then making camouflage too costly is harmful for shareholders.

²³Notice the difference between the second part of Assumption 3, where the utility function is \bar{U} , net of hidden pay, and expression, (15), where the utility function is the primitive U .

6 Reputational Pressure and CEO Pay

In Section 1 we define u_R as the board's discounted future expected utility and assume that u_R takes the simple form $u_R = \eta\mu$, where η measures the sensitivity of the board's expected utility to shareholders' perception of its independence. In this section, we analyze how changes in η influence equilibrium outcomes.

An increase in η , by making imitation of independent boards more attractive for manager-friendly boards, lowers the equilibrium level of managerial compensation paid by independent boards, since these boards are forced to reduce the manager's pay to signal their independence. However, greater reputational pressure on boards has the potential cost of leading to a higher level of inefficient hidden pay, as independent boards partly compensate the manager for the reduction in disclosed pay needed to signal independence. The following proposition formally states these results:

Proposition 9

1. *The separating level of pay, \tilde{w} , is decreasing in η , and the maximum pay for which the manager-friendly board would keep the manager at his reservation level, \underline{w}_M , is not affected by η .*
2. *$y_I(\tilde{w})$ is nondecreasing in η (and increasing in η whenever $y_I(\tilde{w}) > 0$) and $y_I(\underline{w}_M), y_M(\underline{w}_M)$ are not affected by η .*
3. *The maximum probability with which the manager-friendly board pays hidden compensation in equilibrium is increasing in η .*

Whenever there are only separating equilibria, then $w_I = \tilde{w}$. Therefore, part 1 implies that the equilibrium disclosed pay paid by independent boards is decreasing in η . When $\tilde{w} \leq \underline{w}_M$, propositions 5 and 6 show that there are multiple equilibria. In this case, part 1 of the Lemma ensures that the minimum disclosed pay possible in equilibrium (\tilde{w}) is decreasing in η , while \underline{w}_M , which is the maximum disclosed pay possible in equilibrium (other than w_M^*), is unchanged. Therefore, disclosed pay tends to decrease when η increases.

Part 2. of Proposition 9 shows that, whenever there are only separating equilibria, the level of equilibrium hidden compensation paid by the independent board ($y_I(\tilde{w})$) is nondecreasing in η . When there are multiple equilibria, the maximum level of hidden compensation possible in equilibrium ($y_I(\tilde{w})$) is nondecreasing in η and the minimum level ($y_I(\underline{w}_M)$) is not affected by changes in η . Therefore, even when there are multiple equilibria we still obtain the same comparative statics result (although in weaker form due to equilibrium multiplicity). Finally, part 3. shows that when there are multiple equilibria (so that the independent board pays hidden compensation with probability one at any equilibrium), the maximum probability with which the manager-friendly board pays hidden compensation, is also increasing in η . Therefore, Proposition 9 shows that hidden compensation will tend to increase when η increases.

Since hidden pay is inefficient, we immediately obtain the result that any η that leads to hidden pay in equilibrium is inefficient. Let η_T^y be such that for $\eta = \eta_T^y$, $w_T^y = \tilde{w}$. Therefore, since hidden pay is paid in equilibrium for $\tilde{w} < w_I^y$, and $\frac{d\tilde{w}}{d\eta} \leq 0$, it follows that:

Corollary 1 *Any $\eta \leq \eta_I^y$ is efficient, and any $\eta > \eta_I^y$ is inefficient.*

High levels of η lead to lower disclosed pay in equilibrium but also induce greater pay distortions that reduce profits for any level of disclosed managerial pay. To ascertain the net impact on profits of greater shareholder influence over the board we restrict the analysis to values of η for which there are only separating equilibria. For these values of η , we can obtain precise comparative statics results and unambiguous welfare implications, as discussed in Section 4.4. For values of η for which multiple equilibria are possible, in contrast, we can obtain only weak comparative results about profits and, as discussed in Section 4.4, the impact on total future profits will depend on unmodeled factors. Let η_T be defined as the level of η such that $\tilde{w} = \underline{w}_T$. Recalling that $\frac{d\tilde{w}}{d\eta} < 0$, it follows that $\eta_M > \eta_I \geq \eta_I^y$ for η_I^y defined above. It also follows from propositions 3-6 that for $\eta < \eta_M$ there exists a unique separating equilibrium.

Proposition 10 *Assume that $\eta < \eta_M$. Then:*

1. *If $\eta < \eta_I^y$, then expected equilibrium profits are increasing in η .*

2. If $\eta > \eta_I$, then expected equilibrium profits are decreasing in η .

Proposition 10 shows that too weak reputational pressure ($\eta < \eta_I^y$) is not optimal for shareholders. For such low values of η , a higher η unambiguously increases profits, since a higher η forces the independent board to lower disclosed pay to separate from the manager-friendly board yet the reduction in pay is not large enough to induce the independent board to compensate the manager in hidden ways. At the other extreme, when reputational pressures are strong enough to make the independent board keep the manager at the reservation level ($\eta > \eta_I$), further increases in η reduce disclosed pay and increase hidden pay so that total managerial compensation is unchanged. However, profits fall since hidden pay is costly. Therefore, the optimal level of shareholder influence for $\eta < \underline{\eta}_M$ lies in the interval $[\eta_I^y, \underline{\eta}_I]$.

To interpret Proposition 10, note that η will be greater if shareholders have a greater say in the appointment of board directors, since shareholders are interested in keeping independent boards and replacing manager-friendly ones. If we consider board composition, η may also be higher in boards with a higher fraction of formally independent directors. This will be the case if shareholders are more inclined to attribute the board's actions to the board's formally independent directors in those cases in which formally independent directors are expected to have a greater influence over board decisions. In such cases, the board's decisions will be more informative about outside directors' independence and, thus, may have a greater impact on the outside directors' employment prospects. Boards with more powerful insiders could thus be less likely to pay in hidden ways.

Proposition 10 may offer an explanation for the use of hidden pay and inefficient compensation structures in the 1990s and the 2000s at a time when many observers argue that the power of CEOs decreased (see, e.g., Holmstrom, 2005) and investors and other market participants became more active in their monitoring of board directors. According to our model, these very changes in the labor market for board directors may have led to greater pay distortions or more widespread use of hidden pay. Our model, however, does not yield the prediction that disclosed salaries would have increased following these changes. Therefore, it does not explain the increase in disclosed managers'

compensation. Complementary explanations based on shifts in the demand for skills, such as the ones proposed by Gabaix and Landier (2008) and Murphy and Zabojnik (2004), would be necessary to generate both increases in observed compensation and an increase in the use of hidden pay or inefficient compensation structures.

7 Conclusion

In this paper, we propose a model to investigate the impact of boards' reputational concerns on the level and structure of executive compensation. Our model yields the expected result that reputational concerns induce boards to lower managers' pay. However, we show that reputational concerns may also lead boards to pay managers in hidden ways or structure compensation inefficiently. Our model thus provides an explanation for the use of hidden pay, which is difficult to rationalize as part of an optimal contract. Interestingly, we show that independent boards may be more likely than manager-friendly boards to pay in hidden ways. The explanation of this apparently counter-intuitive result is that to signal their independence to investors, independent boards will reduce disclosed managerial pay below their desired level or below the manager's reservation value. If hidden compensation is possible, independent boards compensate the manager in hidden ways at least partially for the compensation cut necessary to signal their independence.

We analyze the consequences of an increase in the reputational pressure faced by board directors and find that greater pressure may lead to an increase in the use of hidden pay to the extreme that, when reputational concerns are strong enough, it may reduce shareholder wealth. Thus, although greater media or investor attention to compensation decisions or greater influence by shareholders over the director nomination process could lead to an efficient transfer of wealth from managers to shareholders in some circumstances, such changes may also lead to an increase in the use of inefficient hidden pay or to inefficient distortions in compensation contracts and may even hurt shareholders.

The model also has the implication that some pay opacity may be good for shareholders. The reason is that reducing the cost of hiding pay makes it easier for manager-friendly boards to imitate

the publicly announced compensation contracts of independent boards. This, in turn, puts additional pressure on independent boards to reduce managerial pay. Therefore, overly strict disclosure or auditing requirements may have the undesired effect of easing the pressure on independent boards, and may thus lead to higher managerial pay.

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A Proofs

In all proofs we refer to the manager-friendly and the independent board as M and I , respectively.

Sketch of the proof of Lemma 1. For any (w, π) , the board sets the y that solves:

$$(Y) \begin{cases} \max_y & \tau(\pi - z(y)) + \theta_T v(w + y) + \eta\mu \\ \text{s.t} & y \geq 0 \\ & w + y \geq \underline{w}. \end{cases}$$

The first order condition of this problem is:

$$\theta_T v'(w + y) - \tau z'(y) + \lambda_T + \nu_T = 0, \quad (\text{FOC}_y)$$

where λ and ν are the Lagrange multipliers associated with the nonnegativity and the manager's participation constraints, respectively. Lemma 1 follows from straightforward manipulation of this first order condition, so we relegate the proof to the Online Addendum.

Sketch of the proof of Proposition 1. The proof of this proposition is straightforward. The basic idea is that the board's problem when hidden pay is possible is identical to the board's problem when hidden pay is not possible, except that the former problem has an additional constraint: the only pairs of payoffs net of hidden pay $(\bar{w}, \bar{\pi})$ that are feasible are those that can be attained by some feasible disclosed payoff pair (w, π) such that $\bar{w} = w + y(w)$ and $\bar{\pi} = \pi - z(y(w))$. However, the fact that hidden pay is costly implies that the solution to the relaxed problem (without the extra constraint implied by the existence of hidden pay) is also the solution to the board's problem. In words, since the board is attaining its most preferred payoff pair at that solution, it does not further compensate the manager with costly hidden pay. The complete proof is in the Online Addendum.

Proof of Lemma 2. To prove part 1 of the lemma it suffices to show that for any π, π', μ, μ' , if

$w' > w$:

$$[\bar{U}(w', \pi', \mu'; \theta_I) - \bar{U}(w, \pi, \mu; \theta_I)] - [\bar{U}(w', \pi', \mu'; \theta_M) - \bar{U}(w, \pi, \mu; \theta_M)] < 0 \quad (16)$$

Define: $G(\theta) \equiv \bar{U}(w', \pi', \mu'; \theta) - \bar{U}(w, \pi, \mu; \theta)$. Then, a sufficient condition for (16) is that $\frac{\partial G}{\partial \theta} \geq 0$ for any $\theta \in [\theta_I, \theta_M]$ and that there exists an interval (θ_a, θ_b) with $\theta_I \leq \theta_a < \theta_b \leq \theta_M$, such that $\frac{\partial G}{\partial \theta} > 0$ for any $\theta \in (\theta_a, \theta_b)$. Applying the Envelope Theorem (\bar{U} is the value function of problem Y) we obtain:

$$\frac{\partial \bar{U}(w, \pi, \mu; \theta)}{\partial \theta} = v(w + y(w, \theta)) \quad (17)$$

Therefore:

$$\frac{\partial G}{\partial \theta} = v(w' + y(w', \theta)) - v(w + y(w, \theta)) \quad (18)$$

Thus, it follows from Lemma 1 that for any θ , $\frac{\partial G}{\partial \theta} \geq 0$. Further, if for some interval contained in (θ_I, θ_M) , $w' + y(w', \theta) > w + y(w, \theta)$, then $\frac{\partial G}{\partial \theta} > 0$ in that interval and the result is proven. Now, we know from Lemma 1 that if $w' + y(w', \theta) > \underline{w}$, then $w' + y(w', \theta) > w + y(w, \theta)$ and that if $\theta > \theta'$, then $w' + y(w', \theta) \geq w' + y(w', \theta')$. Therefore, a necessary and sufficient condition for $\frac{\partial G}{\partial \theta} > 0$ in some interval $(\theta_a, \theta_b) \subset [\theta_I, \theta_M]$ is $w' + y(w', \theta_M) > \underline{w}$.

If $\bar{w} + y_M(\bar{\pi}, \bar{w}) = \underline{w}$, then it follows from Lemma 1 that $\bar{w} + y_I(\bar{\pi}, \bar{w}) = \underline{w}$, therefore $\frac{\partial G}{\partial \theta} = 0$ for any $\theta \in [\theta_I, \theta_M]$ and

$$[\bar{U}(w', \pi', \mu'; \theta_I) - \bar{U}(w, \pi, \mu; \theta_I)] - [\bar{U}(w', \pi', \mu'; \theta_M) - \bar{U}(w, \pi, \mu; \theta_M)] = 0, \quad (19)$$

which proves the second part of the lemma. ■

Equilibrium Definition.

We consider a two-player game between the board and the market for directors. A pure strategy

for a board of type T is a disclosed payoff pair (w_T, π_T) such that $w_T + \pi_T \leq s^*$.²⁴ Since we are using the indirect utility function \bar{U} , we do not include y as a component of the board's strategy. We do not model the market explicitly as a strategic player. Instead, we assume that the market's belief μ that the board is independent leads to a utility for the board $u_R = \eta\mu$.²⁵

An equilibrium is defined as a Perfect Bayesian Equilibrium that satisfies the Intuitive Criterion. Although this equilibrium concept is standard (see Cho and Kreps, 1987; or Fudenberg and Tirole (1991), page 452), we nonetheless provide a definition applied to our model for the sake of clarity.

Let \bar{U}_T^* denote the equilibrium payoff of a type- T board. Then, the labor market's beliefs satisfy the Intuitive Criterion if for any disclosed payoff pair (w, π) played with zero probability in equilibrium:

$$\bar{U}_M(w, \pi, 1) < \bar{U}_M^* \text{ and } \bar{U}_I(w, \pi, 1) > \bar{U}_I^* \Rightarrow \mu(w, \pi) = 1 \quad (20)$$

$$\bar{U}_M(w, \pi, 1) > \bar{U}_M^* \text{ and } \bar{U}_I(w, \pi, 1) < \bar{U}_I^* \Rightarrow \mu(w, \pi) = 0 \quad (21)$$

Thus, if a payoff pair (w, π) is dominated by the equilibrium payoff pair for board type T but not for type T' , if the market observes (w, π) , then it believes that the board setting (w, π) is of type T' .

Definition 1 *A profile of board strategies $((w_I, \pi_I), (w_M, \pi_M))$ and investor beliefs $\mu(w, \pi)$ is a pure-strategy Perfect Bayesian equilibrium satisfying the Intuitive Criterion if:*²⁶

1. (w_T, π_T) maximizes $\bar{U}_T(w, \pi, \mu)$ given $\mu(w, \pi)$ for $T = I, M$.
2. $\mu(w_M, \pi_M)$ and $\mu(w_I, \pi_I)$ are derived from the equilibrium strategies using Bayes' rule.
3. For any $(w, \pi) \notin \{(w_I, \pi_I), (w_M, \pi_M)\}$, $\mu(w, \pi)$ satisfies the Intuitive Criterion.

We provide next a series of lemmas that we use repeatedly in the proofs. The first one follows

²⁴We could alternatively define the board's strategy set as the set of contracts $(\alpha_T, \beta_T) \in \mathbb{R}^2$. Since it greatly simplifies the derivations, we define the board's strategy set in terms of disclosed payoffs rather than the disclosed contract.

²⁵One can interpret u_R as the board's utility if the market plays its best response given μ . This interpretation makes our definition of equilibrium below coincide fully with the Perfect Bayesian Equilibrium in that all players are playing best response. However, it is not necessary to assume that the market will play a best response in equilibrium, only that the board knows the market's response to belief μ .

²⁶A mixed-strategy equilibrium is defined analogously.

from the definition of the Intuitive Criterion:

Lemma 3 *Suppose that M plays (w_M, π_M) and $\bar{U}_M(w_M, \pi_M, \mu_M) \geq \bar{U}_M(w_M^*, \pi_M^*, 0)$ (where $\mu_M = \mu_M(w_M, \pi_M)$). Then for any (w, π) that is not played by I , there exist beliefs that satisfy the Intuitive Criterion such that, for those beliefs, (w, π) is not a profitable deviation for M .*

Proof of Lemma 3. Let $\bar{U}_M^* \equiv \bar{U}_M(w_M^*, \pi_M^*, 0)$ and note that for (w_M, π_M) to be an equilibrium strategy for M it must be the case that $\bar{U}_M(w_M, \pi_M, \mu_M) \geq \bar{U}_M^*$, since, otherwise, it would be optimal for M to deviate to (w_M^*, π_M^*) . Let (w_I, π_I) be a payoff pair played with positive probability by I and let $\mu_I = \mu(w_I, \pi_I)$. Suppose that (w, π) is played with probability zero by both board types, so $\mu(w, \pi)$ is restricted only by the Intuitive Criterion. Suppose $\bar{U}_M(w, \pi, 1) > \bar{U}_M(w_M, \pi_M, \mu_M)$. If $\bar{U}_I(w, \pi, 1) < \bar{U}_I(w_I, \pi_I, \mu_I)$ the Intuitive Criterion requires $\mu(w, \pi) = 0$. If $\bar{U}_I(w, \pi, 1) \geq \bar{U}_I(w_I, \pi_I, \mu_I)$, the Intuitive Criterion does not restrict $\mu(w, \pi)$. Thus, $\mu(w, \pi) = 0$ satisfies the criterion. If $\mu(w, \pi) = 0$, then, (w, π) can be a profitable deviation for M only if $\bar{U}_M(w, \pi, 0) > \bar{U}_M(w_M, \pi_M, \mu_M)$, which is impossible since $\bar{U}_M(w_M, \pi_M, \mu_M) \geq \bar{U}_M^*$. Therefore, (w, π) is not a profitable deviations for M .²⁷ ■

The second Lemma follows immediately from the definition of the Intuitive Criterion and the fact that \bar{U} is continuous and strictly increasing in its arguments:

Lemma 4 *Let \bar{U}_T denote the equilibrium payoff of a type- T board, and suppose that for some (w, π) , $\bar{U}_M(w, \pi, 1) = \bar{U}_M$ and $\bar{U}_I(w, \pi, 1) > \bar{U}_I$. Then, there exists a payoff pair (w', π') close to (w, π) such that $\bar{U}_M(w', \pi', 1) < \bar{U}_M$, $\bar{U}_I(w', \pi', 1) > \bar{U}_I$, and such that the Intuitive Criterion requires $\mu(w', \pi') = 1$. Therefore, there exists a profitable deviation for I .*

The proofs of the following two lemmas are in the Online Addendum:

Lemma 5 *If $w < w' < w_T^*$ and $\mu' \geq \mu$, then $\bar{U}_T(w', s^* - w', \mu') > \bar{U}_T(w, \pi, \mu)$ for any $\pi \leq s^* - w$.*

Lemma 6 *If $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ at a separating equilibrium, then $\bar{U}_M(w_I, \pi_I, 1) = \bar{U}_M(w_M^*, \pi_M^*, 0)$.*

²⁷We note that requiring $\mu(w, \pi) = 0$ is not necessary to rule out profitable deviations. Less extreme beliefs would also work as long as $\bar{U}_I(w_I, \pi_I, 1) \geq \bar{U}_I(w, \pi, \mu)$. We choose $\mu(w, \pi) = 0$ because it simplifies the proof and because for some deviations, such beliefs would be in fact required by more stringent refinements such as D1 (Fudenberg and Tirole, 1991).

Finally, we provide an important lemma that guarantees that there are no pooling equilibria for a wide range of parameter values:

Lemma 7 *If an equilibrium involves pooling at (w, π) , then $w + y_I(w) = w + y_M(w) = \underline{w}$, i.e., $w \leq \underline{w}_M < \underline{w}_I$.*

Proof of Lemma 7. Suppose that there is pooling at the disclosed payoff pair (w, π) and that $w + y_M(w) > \underline{w}$. Consider (w', π') played with zero probability by both board types with $w' < w$, $\pi' > \pi$, such that $\bar{U}_M(w', \pi', 1) = \bar{U}_M(w, \pi, \mu)$, where $\mu = \mu(w, \pi)$. Then, Lemma 2 implies that $\bar{U}_I(w', \pi', 1) > \bar{U}_I(w, \pi, \mu)$, and, thus, Lemma 4 implies that there is a profitable deviation for I . ■

Proof of Proposition 3. Since it simplifies the exposition, we solve the equilibria in terms of payoff pairs. Then we retrieve the equilibrium contracts from the equilibrium payoff pairs. We note that Proposition 2 shows that at any separating equilibrium, $w_M = w_M^*$, $\pi_M = \pi_M^* = s^* - w_M^*$, and $\bar{U}(w_M, \pi_M, 0) = \bar{U}_M^*$.

1. $\tilde{w} \geq w_I^*$. In this case, there cannot be separating equilibria with $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$, since $w_I^* \leq \tilde{w}$, Lemma 5, and the Intuitive Criterion would imply that $\mu(w_I^*, \pi_I^*) = 1$, so that (w_I^*, π_I^*) would be a profitable deviation for I . For any feasible $(w, \pi) \neq (w_I^*, \pi_I^*)$, $\bar{U}_I(w_I^*, \pi_I^*, 1) > \bar{U}_I(w, \pi, 1)$. Thus, if $(w_I, \pi_I) = (w_I^*, \pi_I^*)$ at a separating equilibrium, then (w, π) is not a profitable deviation for I . Since $w_I^* \leq \tilde{w}$, it follows from Lemma 5 that $\bar{U}_M(w_I^*, \pi_I^*, 1) < \bar{U}_M(\tilde{w}, s^* - \tilde{w}, 1) = \bar{U}_M^*$. Further, Lemma 3 implies that there are beliefs such that there are no profitable deviations for M off the equilibrium path. Thus, at the unique separating equilibrium $(w_I, \pi_I) = (w_I^*, \pi_I^*)$.

2. $w_I^y \leq \tilde{w} < w_I^*$. If $w_I^y \leq \tilde{w} < w_I^*$, it follows from Lemma 5 that $\bar{U}_I(\tilde{w}, s^* - \tilde{w}, \mu) > \bar{U}_I(w, \pi, \mu)$ for any (w, π) such that $w < \tilde{w}$ and $\pi \leq s^* - w$. Therefore, in a separating equilibrium $w_I \geq \tilde{w}$, since if $w_I < \tilde{w}$, then the definition of \tilde{w} and Lemma 4 would imply that there is a profitable deviation for I . Now suppose that I plays (w_I, π_I) with $w_I \geq \tilde{w}$ and $\pi_I < s^* - w$ at a separating equilibrium. Then $\pi_I < s^* - w_I$ and $w_I \geq \tilde{w} > \underline{w}_M$ imply that we can find a $w' \in (\underline{w}_M, w_I)$ and $\pi' > \pi_I$ such

that $\bar{U}_I(w', \pi', 1) = \bar{U}_I(w_I, \pi_I, 1)$. But then Lemma 2, $w' > \underline{w}_M$, and the assumption that (w_I, π_I) is I 's equilibrium strategy at a separating equilibrium imply that $\bar{U}_M(w', \pi', 1) < \bar{U}_M(w_I, \pi_I, 1) \leq U_M^*$. Therefore, Lemma 4 implies that there is a profitable deviation for I . It follows that if there is a separating equilibrium, I sets $w_I \geq \tilde{w}$ and $\pi_I = s^* - w_I$. But then, by definition of \tilde{w} , it has to be the case that $w_I = \tilde{w}$ or, else, M would imitate. Therefore, if there is a separating equilibrium, then $(w_I, \pi_I) = (\tilde{w}, s^* - \tilde{w})$. Since $(\tilde{w}, s^* - \tilde{w})$ is an efficient payoff pair, the contract offered by I is $(\alpha_I^* - h, \beta^*)$, where $h \equiv w_I^* - \tilde{w}$. We check next that such separating equilibria exist.

Let $w_I = \tilde{w}$ and $\pi_I = s^* - \tilde{w}$. First, Lemma 5 and $\tilde{w} < w_I^*$ imply that no feasible (w, π) with $w < \tilde{w}$ can be a profitable deviation for I . Consider now deviations (w, π) with $w > \tilde{w}$. Since $\pi_I = s^* - \tilde{w}$, for any such deviation $\pi < \pi_I$. But then Lemma 2 implies $\bar{U}_I(w, \pi, 1) > \bar{U}_I(w_I, \pi_I, 1) \Rightarrow \bar{U}_M(w, \pi, 1) > \bar{U}_M(w_I, \pi_I, 1) = \bar{U}_M^*$, since $w > \tilde{w} \geq w_I^y > \underline{w}_M$. Therefore, the Intuitive Criterion does not restrict $\mu(w, \pi)$ for (w, π) that are potentially profitable deviations for I , so we can let $\mu(w, \pi) = 0$ for those (w, π) . Hence, if $\bar{U}_I(w_I, \pi_I, 1) \geq \bar{U}_I(w_I^*, \pi_I^*, 0)$, then there are no profitable deviations for I . Now, it follows from optimality of (w_M^*, π_M^*) that $\bar{U}_M(w_I, \pi_I, 1) = \bar{U}_M(w_M^*, \pi_M^*, 0) > \bar{U}_M(w_I^*, \pi_I^*, 0)$. Thus, Lemma 2 implies that $\bar{U}_I(w_I, \pi_I, 1) > \bar{U}_I(w_I^*, \pi_I^*, 0)$, so there are no profitable deviations for I .

Finally, $w_I = \tilde{w}$ and Lemma 3 imply that there are beliefs satisfying the Intuitive Criterion such that there are no profitable deviations for M .

3. No pooling equilibria. From Lemma 7, if an equilibrium involves pooling at (w, π) , then $w \leq \underline{w}_M$. But $\tilde{w} \geq w_I^y$ and $w_I^y \geq \underline{w} > \underline{w}_M$ imply that $\tilde{w} > \underline{w}_M$. Now, for any $w < \tilde{w}$ and $\pi \leq s^* - w$, Lemma 5 implies that $\bar{U}_M(w_M^*, \pi_M^*, 0) = \bar{U}_M(\tilde{w}, s^* - \tilde{w}, 1) > \bar{U}_M(w, \pi, \mu)$. Therefore, if M played $w \leq \underline{w}_M$ with positive probability in equilibrium, then (w_M^*, π_M^*) would be a profitable deviation. Thus, there cannot be pooling in equilibrium if $\tilde{w} \geq w_I^y$. ■

Proof of Proposition 4. The proof is identical to the proof of the case in which $w_I^y \leq \tilde{w} < w_I^*$ and is omitted. The only difference is that $\tilde{w} < w_I^y$ implies that $y_I(\tilde{w}) > 0$. ■

Proof of Proposition 5. Let $\pi_f(w_I)$ be defined as $\bar{U}_M(w_I, \pi_f(w_I), 1) = \bar{U}_M(w_M^*, \pi_M^*, 0)$. Thus,

Lemma 6 implies that if I plays $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ at a separating equilibrium, then $\pi_I = \pi_f(w_I)$. Note that $\pi_f(\tilde{w}) = s^* - \tilde{w}$, and $w_I > \tilde{w} \Rightarrow \pi_f(w_I) < s^* - w_I$.

Suppose that I plays $(w_I, \pi_f(w_I))$ at a separating equilibrium. Then, if $w_I > \underline{w}_M > \tilde{w}$ it follows from lemmas 2 and 4, as in the proof of Proposition 3, that there are profitable deviations for I .

Thus, let $w_I \leq \underline{w}_M$. The definition of π_f implies that (w_I, π_I) is not a profitable deviation for M and Lemma 3 implies that there are no other profitable deviations for M . Therefore, it is enough to check that there are no profitable deviations for I . Take (w, π) with $w > \underline{w}_M$. Since $w > \underline{w}_M \geq w_I$, Lemma 2 implies that we can let $\mu(w, \pi) = 0$, since either the deviation is dominated by the equilibrium play for both types, or is dominated for neither, or is dominated for I but not for M . Therefore, there will be no profitable deviations for I with $w > \underline{w}_M$ if $\bar{U}_I(w_I, \pi_f(w_I), 1) \geq \bar{U}_I(w_I^*, \pi_I^*, 0)$. Now, $\bar{U}_M(w_I, \pi_f(w_I), 1) = \bar{U}_M(w_M^*, \pi_M^*, 0) > \bar{U}_M(w_I^*, \pi_I^*, 0)$, so Lemma 2 implies that $\bar{U}_I(w_I, \pi_f(w_I), 1) > \bar{U}_I(w_I^*, \pi_I^*, 0)$. Thus, there are no profitable deviations for I with $w > \underline{w}_M$. Consider now a deviation (w, π) with $w \leq \underline{w}_M$, so $w + y_I(w) = w_I + y_I(w_I) = w_M + y_M(w_I) = \underline{w}$. It follows from Lemma 2 and the definition of π_f that:

$$\bar{U}_I(w, \pi, 1) - \bar{U}_I(w_I, \pi_f(w_I), 1) = \bar{U}_M(w, \pi, 1) - \bar{U}_M(w_M^*, \pi_M^*, 0), \quad (22)$$

but then the Intuitive Criterion does not restrict $\mu(w, \pi)$. If we let $\mu(w, \pi) = 0$, then (w, π) is not a profitable deviation, since $\bar{U}_M(w, \pi, 0) < \bar{U}_I(w_I^*, \pi_I^*, 0) < \bar{U}_M(w_M^*, \pi_M^*, 0)$. \blacksquare

Proof of Proposition 6. Lemma 7 implies that if there is pooling at a payoff pair (w, π) , then $w \leq \underline{w}_M$. Therefore, if M plays (w, π) with $w > \underline{w}_M$ with positive probability, then $\mu(w, \pi) = 0$. It follows that if M plays a payoff pair (w, π) with $w > \underline{w}_M$ with positive probability, then $(w, \pi) = (w_M^*, \pi_M^*)$. Lemma 5 and $\tilde{w} \leq \underline{w}_M$ imply that I plays with positive probability only payoff pairs with $w \leq \underline{w}_M$.

Let $\bar{\mu}(w, \pi)$ be defined by: $\bar{U}_M(w, \pi, \bar{\mu}(w, \pi)) = \bar{U}(w_M^*, \pi_M^*, 0) = \bar{U}_M^*$. It follows that for M to play $(w, \pi) \neq (w_M^*, \pi_M^*)$ with positive probability: $\mu(w, \pi) \in [\bar{\mu}(w, \pi), 1]$. Moreover, if M plays (w_M^*, π_M^*) with positive probability, it has to be the case that $\mu(w, \pi) = \bar{\mu}(w, \pi)$ for any (w, π) also played with

positive probability by M . Let

$$P \equiv \{\mu \in [0, 1) : \exists(w, \pi), \text{ with } w \leq \underline{w}_M, \text{ such that } \mu = \bar{\mu}(w, \pi)\}. \quad (23)$$

Since for any (w, π) with $w \leq \underline{w}_M$, $w + y_I(w) = w + y_M(w) = \underline{w}$, it follows that, for any type T and $w' \leq \underline{w}$, $\bar{U}_T(w, \pi, \mu) > \bar{U}_T(w', \pi, \mu)$ if and only if $w > w'$ (so that $z(y_T(w)) < z(y_T(w'))$). Since $\bar{U}_T(w, \pi, \mu) > \bar{U}_T(w, \pi', \mu)$ if and only if $\pi' > \pi$, it follows that for any μ , any feasible payoff pair $(w, \pi) \neq (\underline{w}_M, s^* - \underline{w}_M)$ with $w \leq \underline{w}_M$, and any and board type T , $\bar{U}_T(\underline{w}_M, s^* - \underline{w}_M, \mu) > \bar{U}_T(w, \pi, \mu)$. Therefore, if we let $\bar{\mu}_M \equiv \bar{\mu}(\underline{w}_M, s^* - \underline{w}_M)$, it follows from $\tilde{w} < \underline{w}_M$ that $\bar{\mu}_M < 1$. Moreover, $P = [\bar{\mu}_M, 1)$. Thus, if $\bar{\mu}_M > q$, then at any pooling equilibrium M plays (w_M^*, π_M^*) with positive probability. If $\bar{\mu}_M \leq q$, then there are pooling equilibria at which both board types play with positive probability only payoff pairs with $w \leq \underline{w}_M$.

Now, it follows from the definition of π_f and Lemma 5 that for any $w \in (\tilde{w}, \underline{w}_M]$, $\bar{\mu}(w, \pi_f(w)) < 1$ and for any feasible (w, π) with $w \leq \tilde{w}$, $\bar{\mu}(w, \pi) \geq 1$. Therefore, (w, π) can be played with positive probability by both types only if $w \in (\tilde{w}, \underline{w}_M]$ and $\pi \in (\pi_f(w), s^* - w]$.

Let (w, π) be a payoff pair with $w \in (\tilde{w}, \underline{w}_M]$ and $\pi \in (\pi_f(w), s^* - w]$, and assume that I plays (w, π) with probability one and M plays (w, π) with probability $\sigma \in (0, 1]$ and (w_M^*, π_M^*) with probability $1 - \sigma$. If $\bar{\mu}(w, \pi) \leq q$, then $\sigma = 1$, so the equilibrium is fully pooling. If $\bar{\mu}(w, \pi) > q$, then M plays (w_M^*, π_M^*) with positive probability. We prove the existence of partly pooling equilibria for the latter case. The proof of the existence of pooling equilibria when $\bar{\mu}(w, \pi) \leq q$ is analogous, so we omit it.

Assume that $\bar{\mu}(w, \pi) > q$, so $\sigma \in (0, 1)$. By definition of $\bar{\mu}(w, \pi)$, M is indifferent between (w_M^*, π_M^*) and (w, π) if $\mu(w, \pi) = \bar{\mu}(w, \pi)$. Let σ be such that, applying Bayes' rule, $\mu(w, \pi) = \bar{\mu}(w, \pi)$. Then, it follows from Lemma 3 that there are beliefs that satisfy the Intuitive Criterion and for which there are no profitable deviations for M for any $(w, \pi) \neq (w_I, \pi_I)$. Further, for these beliefs there is no profitable deviation for I either. On the one hand, for any deviation with $w' > \underline{w}_M$, Lemma 2 implies that if there is no profitable deviation for M , there is no profitable deviation for I either. On the other hand, for any deviation with $w' \leq \underline{w}_M$, Lemma 2 shows that the deviation is profitable for I

if and only if it is profitable for M . Since there are no profitable deviations for M , this implies that there are no profitable deviations for I either.

The previous paragraph fully characterizes pooling equilibria at which I chooses a single payoff pair with positive probability. It can be shown analogously that there also exist pooling equilibria at which w_I randomizes between several payoff pairs with $w \leq \underline{w}_M$ and $\pi \in (\pi_f(w), s^* - w)$ and M randomizes between those payoff pairs and (w_M^*, π_M^*) .

Only (w, π) with $w \leq \underline{w}_M$ can be played with positive probability by both types. It thus follows from the definition of \underline{w}_M that for any such payoff pair $y_I(w) = y_M(w) = \underline{w} - w$, which proves part 2.

Part 3. follows from the fact that $\min(P) = \bar{\mu}(\underline{w}_M, s^* - \underline{w}_M)$. ■

Proofs of propositions 7-10. The proofs of propositions 7-10 consist mostly of straightforward, yet somewhat tedious, implicit differentiation of the equations that define \tilde{w} , \underline{w}_T and w_Y^y (for $T = I, M$) and of the first order conditions of problem (Y) and the board's problem, as well of the application of the envelope theorem. Therefore, we relegate these proofs to the Online Addendum.

B Online Addendum to “Board Reputation, CEO Pay, and Camouflaged Compensation”

This Addendum contains the proofs that are omitted in the main text of the article.

Proof of Lemma 1. For any (w, π) , the board sets the y that solves:

$$(Y) \begin{cases} \max_y & \tau(\pi - z(y)) + \theta_T v(w + y) + \eta\mu \\ \text{s.t} & y \geq 0 \\ & w + y \geq \underline{w}. \end{cases}$$

The first order condition of this problem is:

$$\theta_T v'(w + y) - \tau z'(y) + \lambda_T + \nu_T = 0, \quad (\text{FOC}_y)$$

where λ and ν are the Lagrange multipliers associated with the nonnegativity and the manager’s participation constraints, respectively.

1. We consider first values of (w, π) such that the manager’s participation constraint is binding for M . Thus, $w \leq \underline{w}$, $y_M(w) = \underline{w} - w$, and $\nu_M > 0$. Assumption 2 guarantees that the manager’s participation constraint cannot be binding for $w = \underline{w}$, since that would require:

$$\theta_M v'(\underline{w}) - \tau z'(0) < 0. \quad (24)$$

Therefore, if $w + y_M(w) = \underline{w}$, then $w < \underline{w}$, so $y_M > 0$ and $\lambda_M = 0$. Now, $w < \underline{w}$ implies that $y_I > 0$ and $\lambda_I = 0$. Thus, the first order condition for I is:

$$\theta_I v'(w + y_I) - \tau z'(y_I) + \nu_I = 0 \quad (25)$$

It follows from $v'' < 0$, $z'' > 0$, and $\theta_I < \theta_M$ that $\nu_I > 0$ (since if $y_I > y_M$ and $w + y_I > \underline{w}$,

$\theta_I v'(w + y_I) - \tau z'(y_I) < \theta_M v'(\underline{w}) - \tau z'(0) < 0$). Therefore, $y_I = \underline{w} - w = y_M$.

Consider now (w, π) such that $w + y_M > \underline{w}$ (so $\nu_M = 0$) and $y_M > 0$ (so $\lambda_M = 0$). In this case, M 's optimum is interior and it follows from the first order condition that:

$$\theta_M v'(w + y_M) - \tau z'(y_M) = 0 \quad (26)$$

If I 's optimum is interior as well:

$$\theta_I v'(w + y_I) - \tau z'(y_I) = 0 \quad (27)$$

Therefore, it follows from $v'' < 0$, $z'' > 0$, and $\theta_I < \theta_M$ that $y_I < y_M$. If any of the constraints is binding for I at y_I is not interior, then either $y_I = 0 < y_M$ or $w + y_I = \underline{w}$ whereas $w + y_M > \underline{w}$, so that $y_I < y_M$ as well. It follows that if $w + y_M > \underline{w}$ and $y_M > 0$, then $y_M > y_I$.

Finally, consider (w, π) such that $w + y_M > \underline{w}$ (so $\nu_M = 0$), $y_M = 0$, and $\lambda_M > 0$, so that

$$\theta_M v'(w) - \tau z'(0) < 0. \quad (28)$$

Note that $w + y_M > \underline{w}$ and $y_M = 0$ imply that $w > \underline{w}$, so that the manager's participation constraint cannot be binding for any choice of y . Therefore, either $y_I = y_M = 0$ or $y_I > 0$ is an interior optimum satisfying:

$$\theta_I v'(w + y_I) - \tau z'(y_I) = 0, \quad (29)$$

but this is not possible since $v'' < 0$, $z'' > 0$, $\theta_I < \theta_M$ and $\theta_M v'(w) - \tau z'(0) < 0$. Therefore, whenever $y_M = 0$, $y_I = 0$ as well, which completes the proof of part 1 of the Lemma.

2. Part 2. of the Lemma follows immediately from $v'' < 0$ and $z'' > 0$. Whenever neither constraint is binding, implicit differentiation of the first order condition yields (we omit the subscript

denoting the board's type when not necessary):

$$\frac{dy}{dw} = \frac{\theta v''}{\tau z'' - \theta v''} < 0. \quad (30)$$

For w such that the participation constraint is binding: $y(w) = \underline{w} - w$. Therefore, $\frac{dy}{dw} = -1 < 0$. Finally, if the nonnegativity constraint is binding $y(w) = 0$ and $\frac{dy}{dw} = 0$.²⁸

3. To prove part 3, let $w > w'$ and assume that $w + y(w) \leq w' + y(w')$ and $w' + y(w') > \underline{w}$. $w > w'$ and $w + y(w) < w' + y(w')$ imply that $y(w') > y(w) \geq 0$, which, together with $w' + y(w') > \underline{w}$ imply that $y(w')$ is an interior optimum. Therefore:

$$\theta v'(w' + y(w')) - \tau z'(y(w')) = 0 \quad (31)$$

But convexity of z , concavity of v and the facts that $y(w') > y(w)$ and $w + y(w) \leq w' + y(w')$ then imply that

$$\theta v'(w + y(w)) - \tau z'(y(w)) > 0, \quad (32)$$

which is not possible, since $y(w)$ is optimal, which requires $\theta v'(w + y(w)) - \tau z'(y(w)) \leq 0$. Thus, if $w > w'$, it is not possible that $w + y(w) < w' + y(w')$, since that would imply that $w' + y(w') > \underline{w}$, leading to a contradiction. Moreover, if $w + y(w) > \underline{w}$, then it cannot be the case either that $w + y(w) = w' + y(w')$. Therefore, if $w + y(w) > \underline{w}$ then $w + y(w) > w' + y(w')$. Finally, if $w + y(w) = \underline{w}$, then $w + y(w) = w' + y(w') = \underline{w}$.

4. Part 2. of the lemma implies that if $y_T(w) = 0$ for some w , then $y_T(w') = 0$ for any $w' > w$. Similarly, if $y_T(w) > 0$ for some w , then $y_T(w') > 0$ for any $w' < w$. For $w < \underline{w}$, $y_T(w) > 0$, so there exist values of w such that $y_T(w) > 0$. On the other hand, Assumption ?? ensures that

²⁸Assumption 2 implies that the two constraints can be binding simultaneously only for the independent board. If it were the case that for some w the two constraints are binding for the independent board, then the right and left derivatives would be different at w .

for $w' \geq \underline{w}$ large enough:

$$\theta_T v'(w') - \tau z'(0) < 0. \quad (33)$$

For such w' , the first order condition of the problem ensures that $y_T(w') = 0$. Therefore, it follows from monotonicity of $y_T(\cdot)$ and the fact that there exist w' such that $y_T(w') = 0$ and w such that $y_T(w) > 0$ that there is a w_T^y such that $y_T(w) = 0$ for $w > w_T^y$ and $y_T(w) > 0$ for $w < w_T^y$. It only rests to check that $y_T(w_T^y) = 0$. To see this, note that for $w \geq \underline{w}$, $y_T(w) = 0$ only if:

$$\theta_T v'(w) - \tau z'(0) \leq 0. \quad (34)$$

Therefore, for any $\epsilon > 0$:

$$\theta_T v'(w_T^y + \epsilon) - \tau z'(0) \leq 0 \quad (35)$$

Thus, $y_T(w_T^y) = 0$, since if we take the limit of the above expression when $\epsilon \rightarrow 0$, we obtain:

$$\theta_T v'(w_T^y) - \tau z'(0) \leq 0. \quad (36)$$

To prove part 4.(b) note that part 1. of the lemma implies $w_M^y \geq w_T^y$. Now, Assumption ?? implies that

$$\theta_M v'(\underline{w}) - \tau z'(0) > 0, \quad (37)$$

and, thus, that $w_M^y > \underline{w}$ and:

$$\theta_M v'(w_M^y) - \tau z'(0) = 0. \quad (38)$$

It follows that

$$\theta_I v'(w) - \tau z'(0) < 0 \quad (39)$$

for any $w \geq w_M^y$ and for $w \in (\underline{w}, w_M^y)$ close enough to w_M^y . Thus, $w_I^y < w_M^y$. ■

Proof of Proposition 1. Let F denote the set of feasible net-of-hidden-pay payoff pairs (we omit the subscript denoting the board's type when not necessary):

$$F \equiv \{(\bar{w}, \bar{\pi}) : \exists(\pi, w) \text{ s.t. } \bar{w} = w + y(w), \bar{\pi} = \pi - z(y(w)), w + \pi \leq s^*\}. \quad (40)$$

Then, we can write the board's problem as:

$$\begin{aligned} \max_{\bar{w}, \bar{\pi}} \quad & \tau \bar{\pi} + \theta v(\bar{w}) \\ \text{s.t.} \quad & \bar{w} \geq \underline{w} \end{aligned} \quad (41)$$

$$(\bar{w}, \bar{\pi}) \in F, \quad (42)$$

Noting that the last constraint implies that $\bar{\pi} + \bar{w} \leq s^*$, we can rewrite the board's problem as:

$$\begin{aligned} \max_{\bar{w}, \bar{\pi}} \quad & \tau \bar{\pi} + \theta v(\bar{w}) \\ \text{s.t.} \quad & \bar{w} \geq \underline{w} \end{aligned} \quad (43)$$

$$\bar{\pi} + \bar{w} \leq s^* \quad (44)$$

$$(\bar{w}, \bar{\pi}) \in F, \quad (45)$$

Consider now the relaxed problem:

$$\begin{aligned} \max_{w, \pi} \quad & \tau\pi + \theta v(w) \\ \text{s.t.} \quad & w \geq \underline{w} \end{aligned} \tag{46}$$

$$\pi + w \leq s^*. \tag{47}$$

This relaxed problem corresponds to the board's problem when hidden pay is not possible. To find the optimum of the board's problem we first find the optimum of the relaxed problem (w^*, π^*) and then show that $(w^*, \pi^*) \in F$, so that $(\bar{w}^*, \bar{\pi}^*) = (w^*, \pi^*)$ is an optimum of the board's problem.

Since the board's objective is strictly increasing in π and w , at the optimum payoff pair (w^*, π^*) of the relaxed problem: $w^* + \pi^* = s^*$. Thus, the relaxed problem of a type-T board becomes:

$$\begin{aligned} \max_w \quad & \tau(s^* - w) + \theta_T v(w) \\ \text{s.t.} \quad & w \geq \underline{w}. \end{aligned}$$

The concavity of v guarantees that the solution to this problem is given by the first order condition:

$$-\tau + \theta_T v'(w_T^*) + \iota_T = 0. \tag{48}$$

where $\iota_T \geq 0$ is the Lagrange multiplier associated with the manager's participation constraint. Assumption 2 guarantees that the solution of this problem is interior for the manager-friendly board ($\iota_M = 0$). Therefore, the concavity of v and $\theta_M > \theta_I$ imply that $w_M^* > w_I^*$.

We now check that $(w^*, \pi^*) \in F$. To do so it is sufficient to check that $y(w^*) = 0$. The first order condition (48) implies that $-\tau + \theta v'(w^*) \leq 0$. Then, it follows from $z'(0) > 1$ that

$$-\tau z'(0) + \theta v'(w^*) < 0. \tag{49}$$

But, then, the first order condition (FOC_y) implies that either $y(w^*) = 0$ or $w^* + y(w^*) = \underline{w}$. In the latter case, it follows from $w^* \geq \underline{w}$ that $y(w^*) = 0$ as well. Therefore, $y(w^*) = 0$ for either board type and, thus, $(w^*, \pi^*) \in F$, so the board's optimum coincides with the optimum of the relaxed problem. Therefore, the board chooses the same disclosed contract it would have chosen if hidden pay were not possible. Further, it follows from $w^* + \pi^* = s^*$ for either board type that $\beta_M^* = \beta_I^* = \beta^*$. Therefore, $w_M^* > w_I^* \Rightarrow \alpha_M^* > \alpha_I^*$. Finally, $w_M^* > w_I^*$ and $w^* + \pi^* = s^*$ imply that $\pi_M^* < \pi_I^*$. ■

Proof of Lemma 5. Let $V_T(w) \equiv \bar{U}_T(w, s^* - w, \mu) = U_T(w + y_T(w), s^* - w - z(y_T(w)), \mu)$. If $w_T^* = \underline{w}$ (which can only happen for I), then $w + y_T(w) = w_T^* = \underline{w}$ for any $w < w_T^*$. It then follows immediately from $z' > 1$ that $V_T(w)$ is increasing in w for $w < w_T^*$. If $w_T^* > \underline{w}$, consider the Lagrangean of the problem (Y) restricted to $\pi = s^* - w$: $\mathcal{L}_T = U(w + y, s^* - w - z(y), \mu) + \lambda y + \nu(w - \underline{w})$. Applying the Envelope Theorem, we obtain:

$$\frac{dV_T}{dw} = \frac{d\mathcal{L}_T}{dw} = \theta_T v'(w + y_T(w)) - \tau + \nu > 0 \quad (50)$$

Since $w_T^* > \underline{w}$, by Lemma 1 and Proposition 1, $w + y_T(w) < w_T^*$ and $\theta_T v'(w_T^*) - \tau = 0$. Since $\nu \geq 0$ and $v'' < 0$, it follows that $\frac{dV_T}{dw} > 0$. Therefore, $\bar{U}_T(w', s^* - w', \mu) > \bar{U}_T(w, s^* - w, \mu)$. Since \bar{U} is increasing in both π and μ , we obtain that for any $\mu \leq \mu'$ and $\pi \leq s^* - w$, $\bar{U}_T(w', s^* - w', \mu') > \bar{U}_T(w, \pi, \mu)$. ■

Proof of Lemma 6. Let $\tilde{w} < w_I^*$ and suppose that I sets $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ at a separating equilibrium. If $\bar{U}_M(w_I, \pi_I, 1) > \bar{U}_M(w_M^*, \pi_M^*, 0)$, M would imitate. If $\bar{U}_M(w_I, \pi_I, 1) < \bar{U}_M(w_M^*, \pi_M^*, 0)$, then there is a (w', π') close enough to (w_I, π_I) such that $\bar{U}_I(w', \pi', 1) > \bar{U}_I(w_I, \pi_I, 1)$ and $\bar{U}_M(w', \pi', 1) < \bar{U}_M(w_M^*, \pi_M^*, 0)$. Therefore, the Intuitive Criterion would require $\mu(w', \pi') = 1$, and (w', π') would be a profitable deviation for I . Thus, it has to be the case that $\bar{U}_M(w_I, \pi_I, 1) = \bar{U}_M(w_M^*, \pi_M^*, 0)$. ■

Proof of Proposition 7. First note that w_M^* does not depend on κ . Therefore, κ will influence only the salary paid by I at separating equilibria and, when they exist, the pooling salaries played at pooling equilibria. We consider first parameter values such that $\tilde{w} \geq \underline{w}_M$, so that only separating

equilibria exist. At these equilibria, $w_I = \tilde{w}$.

Let $y_T(w; \kappa)$ denote the optimal y for a board of type T as a function of w and κ . From the first order condition of the hidden pay problem (FOC _{y}), we know that if $w < w_T^y$ and $w > \underline{w}_T$:

$$\theta_T v'(w + y_T(w; \kappa)) - \tau z_y(y_T(w; \kappa); \kappa) = 0. \quad (51)$$

In this case, it follows from $v'' < 0$, $z_{yy} > 0$, and $z_{y\kappa} > 0$ that:

$$\frac{\partial y_T}{\partial \kappa} = \frac{-\tau z_{y\kappa}}{\tau z_{yy} - \theta_T v''} < 0. \quad (52)$$

If either $w > w_T^y$ (so $y_T(w; \kappa) = 0$) or $w < \underline{w}_T$ (so $y_T(w; \kappa) = \underline{w} - w$), then $\frac{\partial y_T}{\partial \kappa} = 0$ and

$$\theta_T v'(w + y_T(w; \kappa)) - \tau z_y(y_T(w; \kappa); \kappa) < 0, \quad (53)$$

Now, from the definition of \tilde{w} :

$$\tau(s^* - \tilde{w} - z(y_M(\tilde{w}; \kappa); \kappa)) + \theta_M v(\tilde{w} + y_M(\tilde{w}; \kappa)) + \eta = \tau(s^* - w_M^*) + \theta_M v(w_M^*). \quad (54)$$

Implicit differentiation of the above expression yields:

$$\frac{d\tilde{w}}{d\kappa} = \frac{\tau z_\kappa(y_M(\tilde{w}; \kappa); \kappa) - \frac{\partial y_M}{\partial \kappa}(\tilde{w}; \kappa) [\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau z_y(y_M(\tilde{w}; \kappa); \kappa)]}{\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau + \frac{\partial y_M}{\partial w}(\tilde{w}; \kappa) [\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau z_y(y_M(\tilde{w}; \kappa); \kappa)]}. \quad (55)$$

Now, if $\tilde{w} > w_M^y$, then $\frac{\partial y_M}{\partial w}(\tilde{w}; \kappa) = \frac{\partial y_M}{\partial \kappa}(\tilde{w}; \kappa) = 0$, so

$$\tilde{w} > w_M^y \Rightarrow \frac{d\tilde{w}}{d\kappa} = \frac{\tau z_\kappa(0; \kappa)}{\theta_M v'(\tilde{w}) - \tau} = 0, \quad (56)$$

since $z(0; \kappa) = 0$ for all κ .

If $\tilde{w} \in (\underline{w}_M, w_M^y)$, then $\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau z_y(y_M(\tilde{w}; \kappa); \kappa) = 0$. Therefore,

$$\tilde{w} \in (\underline{w}_M, w_M^y) \Rightarrow \frac{d\tilde{w}}{d\kappa} = \frac{\tau z_\kappa(y_M(\tilde{w}; \kappa); \kappa)}{\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau} = \frac{z_\kappa(y_M(\tilde{w}; \kappa); \kappa)}{z_y(y_M(\tilde{w}; \kappa); \kappa) - 1} > 0 \quad (57)$$

Finally, if $\tilde{w} < \underline{w}_M$, then $\frac{\partial y_M}{\partial w}(\tilde{w}; \kappa) = -1$ and $\frac{\partial y_M}{\partial \kappa}(\tilde{w}; \kappa) = 0$. Thus,

$$\begin{aligned} \tilde{w} < \underline{w}_M \Rightarrow \frac{d\tilde{w}}{d\kappa} &= \frac{\tau z_\kappa(y_M(\tilde{w}; \kappa); \kappa)}{\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau - [\theta_M v'(\tilde{w} + y_M(\tilde{w}; \kappa)) - \tau z_y(y_M(\tilde{w}; \kappa); \kappa)]} = \\ &= \frac{z_\kappa(y_M(\tilde{w}; \kappa); \kappa)}{z_y(y_M(\tilde{w}; \kappa); \kappa) - 1} > 0 \end{aligned} \quad (58)$$

The equilibrium level of hidden pay at a separating equilibrium is $y_I(\tilde{w}; \kappa)$. From $\frac{\partial y_I}{\partial w}(\tilde{w}; \kappa) \leq 0$, $\frac{\partial y_I}{\partial \kappa}(\tilde{w}; \kappa) \leq 0$, and $\frac{d\tilde{w}}{d\kappa} \geq 0$, it follows that:

$$\frac{dy_I}{d\kappa}(\tilde{w}; \kappa) = \frac{\partial y_I}{\partial \kappa}(\tilde{w}; \kappa) + \frac{\partial y_I}{\partial w}(\tilde{w}; \kappa) \frac{d\tilde{w}}{d\kappa} \leq 0. \quad (59)$$

Consider now parameter values such that $\tilde{w} < \underline{w}_M$. For these parameter values there is a large multiplicity of equilibria, so precise comparative statics are not possible. However, we can provide comparative statics concerning the maximum and minimum salaries and levels of hidden pay that are possible in equilibrium. If $\tilde{w} < \underline{w}_M$ it follows from propositions 5 and 6 that the maximum equilibrium salary played by I is \underline{w}_M and the minimum equilibrium salary played by I is \tilde{w} . Therefore, the maximum level of hidden pay paid by I in equilibrium is $y_I(\tilde{w})$ and the minimum level $y_I(\underline{w}_M)$. We have already shown that \tilde{w} is nondecreasing in κ and $y_I(\tilde{w})$ nonincreasing in κ . Therefore, it rests to determine how \underline{w}_M and $y_I(\underline{w}_M)$ change with κ . The salary \underline{w}_M is given by the first order condition:

$$\theta_M v'(\underline{w}) - \tau z_y(\underline{w} - \underline{w}_M; \kappa) = 0. \quad (60)$$

Implicit differentiation of this expression yields:

$$\frac{d\underline{w}_M}{d\kappa} = \frac{z_{y\kappa}(\underline{w} - \underline{w}_M; \kappa)}{z_{yy}(\underline{w} - \underline{w}_M; \kappa)} > 0. \quad (61)$$

Therefore, if $\kappa' > \kappa$, then $\underline{w}_M(\kappa') > \underline{w}_M(\kappa)$ and, since $y_I(\underline{w}_M) = \underline{w} - \underline{w}_M$ for any κ , then $y_I(\underline{w}_M(\kappa'); \kappa') < y_I(\underline{w}_M(\kappa); \kappa)$. ■

Proof of Proposition 8. Suppose $\tilde{w} > \underline{w}_M$, so there is a unique separating equilibrium with $w_I = \tilde{w}$, and let $\hat{\pi}_I(\kappa) \equiv s^* - \tilde{w}(\kappa) - z(y_I(\tilde{w}(\kappa); \kappa); \kappa)$. Then:

$$\frac{d\hat{\pi}_I}{d\kappa} = -\frac{d\tilde{w}}{d\kappa} - z_\kappa(y_I(\tilde{w}; \kappa); \kappa) - z_y(y_I(\tilde{w}; \kappa); \kappa) \left[\frac{\partial y_I}{\partial \kappa}(\tilde{w}; \kappa) + \frac{\partial y_I}{\partial w}(\tilde{w}; \kappa) \frac{d\tilde{w}}{d\kappa} \right]. \quad (62)$$

Let $\tilde{w}(\kappa)$ and $w_I^y(\kappa)$ stand for the separating salary, and the minimum salary for which $y_I = 0$, respectively, as functions of κ . Suppose that for some κ , $\tilde{w}(\kappa) > w_I^y(\kappa)$. Then $y_I(\tilde{w}; \kappa) = 0$, $\frac{\partial y_I}{\partial w}(\tilde{w}; \kappa) = 0$, and $\frac{\partial y_I}{\partial \kappa}(\tilde{w}; \kappa) = 0$. Therefore, if $\tilde{w}(\kappa) > w_I^y(\kappa)$, then $\frac{d\hat{\pi}_I}{d\kappa} \leq 0$, since $\frac{d\tilde{w}}{d\kappa} \geq 0$ and $z_\kappa \geq 0$. Moreover, if $\tilde{w}(\kappa) < w_I^y(\kappa)$ as well, then $\frac{d\hat{\pi}_I}{d\kappa} < 0$.

Now, $w_T^y \geq \underline{w}$. If $w_T^y = \underline{w}$ (which can only happen for $T = I$), then:

$$\theta_T v'(\underline{w}) - \tau z_y(0; \kappa) \leq 0. \quad (63)$$

If $w_T^y > \underline{w}$, w_T^y is given by the first order condition:

$$\theta_T v'(w_T^y) - \tau z_y(0; \kappa) = 0. \quad (64)$$

Thus, since $z_{y\kappa} > 0$ and $v'' < 0$, if $w_T^y = \underline{w}$, $\frac{dw_T^y}{d\kappa} = 0$ and if $w_T^y > \underline{w}$, $\frac{dw_T^y}{d\kappa} < 0$. Therefore, if $\tilde{w}(\kappa) > w_T^y(\kappa)$ for some κ , then $\tilde{w}(\kappa') > w_T^y(\kappa')$ and $\frac{d\hat{\pi}_I}{d\kappa} \leq 0$ for any $\kappa' > \kappa$.

Let $K_I \equiv \{\kappa : \tilde{w}(\kappa) > w_T^y(\kappa)\}$. By definition of \bar{U} , for any (w, π, μ) : $\bar{U}(w, \pi, \mu) - U(w, \pi, \mu) \geq 0$.

In particular, for any κ :

$$\bar{U}(\underline{w}, s^* - \underline{w}, 1) - U(\underline{w}, s^* - \underline{w}, 1) = \theta_M[v(\underline{w} + y_M(\underline{w})) - v(\underline{w})] - \tau z(y_M(\underline{w})) \geq 0. \quad (65)$$

Now, since $\lim_{\kappa \rightarrow K} y_M(\underline{w}) = 0$, it follows that:

$$\lim_{\kappa \rightarrow K} [\bar{U}(\underline{w}, s^* - \underline{w}, 1) - U(\underline{w}, s^* - \underline{w}, 1)] = 0 \quad (66)$$

Assume that (15) holds. Then (66) implies that for κ large enough:

$$\bar{U}_M(\underline{w}, s^* - \underline{w}, 1) < U_M(w_M^*, \pi_M^*, 0) = \bar{U}_M(w_M^*, \pi_M^*, 0). \quad (67)$$

Thus, if (15) holds, for large enough κ , $\tilde{w}(\kappa) > \underline{w}$. Now, for κ large enough, it follows from part 1 of Assumption 3 that $w_I^y(\kappa) = \underline{w}$. Therefore, if (15) holds, then $\tilde{w}(\kappa) > w_I^y(\kappa)$ for κ large enough, so $K_I = (\bar{\kappa}, K)$. It also follows from part 2 of Assumption 3 that for low enough κ , $\tilde{w} < \underline{w} \leq w_T^y$ for any T , so that $\bar{\kappa} > 0$.

Now, let $K_{IM} \equiv \{\kappa : w_M^y(\kappa) > \tilde{w}(\kappa) > w_I^y(\kappa)\}$, so $K_{IM} \subset K_I$. It follows from continuity that $w_I^y(\bar{\kappa}) = \tilde{w}(\bar{\kappa})$. Therefore, since $w_M^y > w_I^y$ for any κ , it follows that for some $\kappa_M > \bar{\kappa}$, $(\bar{\kappa}, \kappa_M) \subset K_{IM}$. Therefore, for $\kappa \in (\bar{\kappa}, \kappa_M)$, $\frac{d\tilde{w}}{d\kappa} < 0$ and for (κ_M, K) , $\frac{d\tilde{w}}{d\kappa} \leq 0$. Thus, if we let κ^* denote the κ that is optimal for shareholders, it follows that $\kappa^* \leq \bar{\kappa}$. ■

Proof of Proposition 9. From the definition of \tilde{w} :

$$\tau[s^* - \tilde{w} - z(y_M(\tilde{w}))] + \theta_M v(\tilde{w} + y_M(\tilde{w})) + \eta = \tau(s^* - w_M^*) + \theta_M v(w_M^*) \quad (68)$$

Implicit differentiation of the above expression yields:

$$\frac{d\tilde{w}}{d\eta} = - \left(\frac{1}{\theta_M v'(\tilde{w} + y_M(\tilde{w})) - \tau + y'_M(\tilde{w}) [\theta_M v'(\tilde{w} + y_M(\tilde{w})) - \tau z'(y_M(\tilde{w}))]} \right) < 0, \quad (69)$$

since we show in the proof of Proposition 7 that the denominator is positive for any \tilde{w} .

That \underline{w}_M is unaffected by η follows directly from the definition of \underline{w}_M .

For given w , $y_T(w)$ is unaffected by η . Therefore, since $\frac{d\tilde{w}}{d\eta} < 0$ and $y_T(w)$ is nonincreasing in w and decreasing if $y_T(w) > 0$, it follows that $y_I(\tilde{w})$ is nondecreasing in η and is increasing if $y_I(\tilde{w}) > 0$. It also follows from Lemma 1 that $w + y_I(w)$ is nonincreasing in η (and decreasing if $\tilde{w} + y_I(\tilde{w}) > \underline{w}$).

To prove Part 4. of the proposition, suppose that at a pooling equilibrium the set of payoff pairs played with positive probability by I is a subset of $\{(w_1, \pi_1), \dots, (\bar{w}, \bar{\pi})\}$, where $w_i \leq \underline{w}_M$, and let $(\sigma_{T1}, \dots, \sigma_{Tn})$, with $\sigma_{Ti} \in [0, 1]$, denote the probabilities with which board type T plays the corresponding payoff pairs. From the proof of Proposition 6, it follows that a pooling equilibrium, $\sum_i \sigma_{Ii} = 1$ and $\sum_i \sigma_{Mi} \leq 1$. For each (w_i, π_i) , let μ_i denote the equilibrium beliefs for (w_i, π_i) :

$$\mu_i \equiv \frac{q\sigma_{Ii}}{q\sigma_{Ii} + (1-q)\sigma_{Mi}}. \quad (70)$$

Therefore,

$$\sigma_{Mi} = \sigma_{Ii} \left(\frac{q}{1-q} \right) \left(\frac{1-\mu_i}{\mu_i} \right). \quad (71)$$

If we let σ_M denote the probability with which the manager-friendly board pays hidden compensation (i.e., plays some salary lower than \underline{w}_M) at a given pooling equilibrium, then:

$$\sigma_M = \sum_{i=1}^n \sigma_{Mi} = \left(\frac{q}{1-q} \right) \sum_{i=1}^n \sigma_{Ii} \left(\frac{1-\mu_i}{\mu_i} \right). \quad (72)$$

For a given $\{(w_1, \pi_1), \dots, (\bar{w}, \bar{\pi})\}$, it follows from $\sum_{i=1}^n \sigma_{Ii} = 1$ that σ_M is maximized when $\sigma_{Ii} = 1$ for the payoff pair such that $\left(\frac{1-\mu_i}{\mu_i} \right)$ is maximum, i.e., for the payoff pair with the minimum μ_i .

It follows from the proof of Proposition 6 that $\bar{\mu}_M = \bar{\mu}(\underline{w}_M, s^* - \underline{w}_M)$ is the lowest possible value of $\mu(w, \pi)$ for any (w, π) played with positive probability by both board types at any pooling equilibrium. Therefore, σ_M is maximized when $\sigma_I((\underline{w}_M, s^* - \underline{w}_M)) = 1$, $\sigma_M((w, \pi)) = 0$ for any

$(w, \pi) \notin \{(\underline{w}_M, s^* - \underline{w}_M), (w_M^*, s^* - w_M^*)\}$ and $\sigma_M((\underline{w}_M, s^* - \underline{w}_M))$ is such that by Bayes' rule one obtains $\mu(\underline{w}_M, s^* - \underline{w}_M) = \bar{\mu}_M$. Thus, if we let $\bar{\sigma}$ denote the maximum probability with which M pays hidden compensation in equilibrium, then:

$$\bar{\sigma} = \left(\frac{q}{1-q} \right) \left(\frac{1 - \bar{\mu}_M}{\bar{\mu}_M} \right). \quad (73)$$

Finally, from the definition of $\bar{\mu}(\underline{w}_M, s^* - \underline{w}_M)$, it follows immediately that $\bar{\mu}(\underline{w}_M, s^* - \underline{w}_M)$ is decreasing in η . Therefore, $\bar{\sigma}$ is increasing in η . ■

Proof of proposition 10. For any η , it follows from Lemma 1, Proposition 1, and Assumption 2 that $w_M^* > w_M^y > w_I^y \geq \underline{w} \geq \underline{w}_I > \underline{w}_M$.

Let $\tilde{w}(\eta)$ denote the function that relates \tilde{w} and η , and let η_T^y be defined by $w_T^y = \tilde{w}(\eta_T^y)$. Similarly, let η_I be defined by $\underline{w}_I = \tilde{w}(\eta_I)$. It follows from Proposition 9 that $\eta_M^y < \eta_I^y \leq \eta_I < \eta_M$. Now, $\tilde{w}(\eta) \rightarrow w_M^*$ as $\eta \rightarrow 0$. Therefore, for $\eta > 0$ low enough $\tilde{w}(\eta) > w_M^y > w_I^y \geq \underline{w} \geq \underline{w}_I > \underline{w}_M$. Thus, $\eta_M^y > 0$, so all the regions described in the statement of the proposition are nonempty. Hereafter, we assume that $\eta < \eta_M$.

Let $\hat{\pi}_I(\eta) \equiv s^* - \tilde{w}(\eta) - z(y_I(\tilde{w}(\eta)))$. Then:

$$\frac{d\hat{\pi}_I}{d\eta} = -\frac{d\tilde{w}}{d\eta} \left(1 + z_y(y_I) \frac{dy_I}{dw} \right). \quad (74)$$

Since $\frac{d\tilde{w}}{d\eta} < 0$, it follows that

$$\frac{d\hat{\pi}_I}{d\eta} > 0 \iff 1 + z_y(y_I(\tilde{w}(\eta))) \frac{dy_I}{dw}(\tilde{w}(\eta)) > 0 \quad (75)$$

Assume that $\eta < \eta_I^y$, so that $\tilde{w}(\eta) > w_I^y$. It follows that $\frac{dy_I}{dw}(\tilde{w}(\eta)) = 0$ and, therefore, $\frac{d\hat{\pi}_I}{d\eta} > 0$. Therefore, for $\eta < \eta_I^y$ profits are increasing in η .

Assume now that $\eta > \eta_I$, so that $\tilde{w}(\eta) < \underline{w}_I$. It follows that $\frac{dy_I}{dw}(\tilde{w}(\eta)) = -1$. Therefore:

$$1 + z_y(y_I(\tilde{w}(\eta))) \frac{dy_I}{dw}(\tilde{w}(\eta)) = 1 - z_y(y_I(\tilde{w}(\eta))) < 0, \quad (76)$$

since $z_y > 1$. Therefore, for $\eta > \eta_I$ profits are decreasing in η . ■