Board Independence, CEO Pay, and Camouflaged Compensation [*]

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Abstract

We study how directors' reputational concerns influence executive compensation and the use of camouflaged forms of pay. We show that, in order to signal their independence to investors, boards lower managers' pay, but may also pay managers in hidden ways or structure compensation inefficiently. We also show that independent boards are more likely to make use of hidden compensation than manager-friendly boards. 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.

Keywords: executive compensation, board independence, hidden pay, signaling, director reputation.

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Boards of directors set CEO pay. Therefore, understanding how directors' incentives shape compensation contracts is essential for understanding executive pay. The prevailing view, shared by both optimal contracting and rent extraction explanations of CEO pay, is that reputational concerns largely determine directors' incentives. On the one hand, the optimal contracting view builds on the assumption that directors' reputational concerns align their incentives with those of shareholders (Fama and Jensen, 1983), resulting in compensation contracts that maximize shareholder wealth. On the other hand, rent extraction explanations of executive compensation view observed compensation practices as the result of directors' attempts to camouflage managerial rent extraction to protect their reputations from shareholder "outrage" (Bertrand and Mullainathan, 2000; Bebchuk and Fried, 2004). However, despite the key role that both views assign to directors' reputational concerns, there are to our knowledge no formal models of CEO pay that explicitly incorporate those concerns. Moreover, the very different conclusions about the effect of directors' reputational concerns reached by the optimal contracting and rent extraction views suggest that a formal model may help clarify the debate.

Incorporating directors' reputational concerns into a model of CEO pay may also shed light on the use of camouflaged forms of pay (such as difficult to observe perks, poorly disclosed pension plans, backdated options, strategically timed option grants, or manipulated performance measures), which are difficult to rationalize by optimal contracting models.[1] The very fact that some boards appear to be hiding part of CEO pay from shareholders' view suggests that they are concerned about the information that executive compensation arrangements convey to shareholders.

To analyze how directors' reputational incentives influence both disclosed and undisclosed CEO pay, we present a signaling model of executive compensation. The model has two key ingredients. The first one is that shareholders do not observe directors' independence from management. To be sure, shareholders observe formal measures of director independence (such as, for example, whether a director is a former employee of the firm). However, shareholders may be unaware of undisclosed

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[1]Recent reviews of the literature on CEO compensation emphasize this point: "[T]he widespread use of "stealth" compensation is difficult to explain if compensation were simply the efficient outcome of an optimal contract" (Frydman and Jenter, 2010, p. 91). "[T]here are a number of puzzles as yet unexplained by optimal contracting theories. Why was backdating of stock options so prevalent? Why is a significant proportion of compensation in hidden forms such as perks?" (Edmans and Gabaix, 2009, p. 494).

ties between directors and the firm or the CEO, or of other attributes, such as personality traits, that influence directors' ability and willingness to confront the CEO.[2] Since shareholders do not observe directors' true independence, they seek to infer it from directors' actions. Building on the idea that executive compensation is the "acid test" of corporate governance, in our model shareholders interpret pay decisions as potential signals of directors' independence.[3] In turn, directors determine CEO pay taking into account how it will affect shareholders' perception of their independence. The second key ingredient of the model is that, on top of the pay that is disclosed to shareholders, the board has the ability to pay the manager in hidden ways. Hiding compensation, however, is costly either because of the resources devoted to camouflaging pay or because the value for the manager of the hidden forms of compensation is lower than their cost to the firm. For example, a manager is likely to prefer 100,000 dollars in cash over a perk that costs $100,000 to the firm.

We show that independent boards will signal their independence to investors by lowering CEO pay. Lower CEO pay is a credible signal of director independence because reducing CEO pay has a greater private cost for manager-friendly boards. Therefore, the benefit to shareholders of directors' reputational concerns is that they generally lead to lower managerial pay. However, reputational concerns also have a dark side: If independent boards are forced to lower executive pay below their preferred level to signal their independence, they may allow the manager to "claw back" rents in costly undisclosed ways. Therefore, reputational concerns may induce boards to use inefficient hidden pay. Moreover, they may also lead independent boards to set inefficiently structured compensation contracts, since such contracts increase the cost of imitation for manager-friendly boards.[4] Although the use of hidden pay or inefficient compensation structures is often attributed to a lack of indepen-

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[2]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). Consistent with these limitations, satisfying the NYSE independence tests is considered by the NYSE a necessary, but not sufficient condition for independence. See Lochner (2009) for a discussion of hypothetical directors who would meet the NYSE independence test, but would be otherwise considered not to be independent.

[3]Warren Buffett, Chairman and CEO of Berkshire Hathaway, coined the metaphor of executive compensation as the acid test of corporate governance (see e.g., Buffett, 2002).

[4]These results are in line with Jensen and Murphy's (1990) conjecture that "political forces" together with disclosure requirements create distortions in the structure of compensation schemes.

dence, we show that independent boards are more likely than manager-friendly boards to engage in these practices. Thus, the model explains hidden pay or the use of inefficient compensation structures not as a vehicle used by manager-friendly boards to deceive shareholders, but, rather, as a result of independent boards' efforts to signal their independence to investors.

We use our framework to analyze the potential impact of recent regulatory changes and corporate governance trends towards greater transparency and board accountability. We show that disclosure requirements that seek to make executive compensation more transparent, or greater scrutiny of compensation packages by external monitors, will generally have the intended effect of discouraging the use of hidden pay.[5] However, greater transparency may have the effect of increasing disclosed pay. The reason is that greater transparency makes it harder to compensate managers in undisclosed ways and, thus, makes it more costly for manager-friendly boards to reduce disclosed pay to imitate the pay 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 often optimal for shareholders. Our model, thus, shows that although stricter disclosure requirements may have beneficial effects, there is such a thing as excessive mandated disclosure, a point made in a related context by Hermalin and Weisbach (2012).

We also study the impact of corporate governance trends that may have increased the value of a reputation of independence, such as the increase in institutional ownership, the adoption of voting rules that increase the influence of investors over the election of directors (such as replacing plurality rules by majority rules in board elections), the increased importance of proxy advisory firms, or the passage of "say-on-pay" legislation. We show that stronger reputational concerns will generally lead to lower executive compensation, but may have the unintended effect of increasing the use of hidden pay. In fact, when reputational pressure is strong enough, the distortions that it induces may reduce

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[5]In 2006, the SEC introduced a major revision of the disclosure of executive compensation. In response to the 2007-2009 financial crisis, in December of 2009 the SEC adopted 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.

shareholder wealth despite lowering CEO pay.

The predictions of the model shed new light on empirical results relating corporate governance and pay-performance sensitivity. For example, Hartzell and Starks (2003) find that pay-performance sensitivity is greater in firms where shareholders are likely to monitor management more closely, such as firms with a large shareholder or high institutional ownership concentration. Our theory suggests that the higher pay-performance sensitivity in these firms may not be optimal and thus, may not be considered as a standard of good practice. Instead, the pay practices of these firms may be an inefficient outcome of their board's efforts to signal their independence to shareholders.

Our model may also help explain the widespread increase in the use of stock options during the 1990s. On the one hand, if investors were not aware of the true cost of stock options, as proposed by Bebchuk and Fried (2004), our model would explain the excessive use of stock options as a form of hidden compensation. However, whereas 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. On the other hand, our model provides an alternative explanation for the increase in stock option compensation that does not rely on stock options being a camouflaged form of pay. Several authors have argued that stock options were inefficiently overused during the 1990s.[6] According to the model, the purportedly excessive use of options could have been an inefficient side effect of independent boards' increased efforts to signal their independence to investors.

Although most of the theoretical literature on executive compensation abstracts from the role of boards, there are exceptions. In an influential article, Hermalin and Weisbach (1998) propose a model in which the board decides whether to retain the CEO, and the board and the CEO bargain over the CEO's pay and the composition of the board. However, in Hermalin and Weisbach's model, there is no

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[6]See, e.g., Hall and Murphy (2003), Bebchuk and Fried (2004), and Dittmann and Maug (2007)—although see also Dittmann and Yu (2011) for the opposite view.

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 are determined both 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. 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. 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 relationship between director independence and equity compensation is ambiguous. None of these articles consider the impact of directors' reputation on their choice of CEO compensation.

Several other articles have provided models of the board as monitor or adviser of the manager (see Adams et al. (2010) for a review). However, none of these models investigate 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. In Song and Thakor's (2006) model, boards take into account the impact that their decision whether to accept a project proposed by the CEO will have on their reputation as experts.

The theoretical literature on executive compensation has, for the most part, ignored hidden compensation. An exception is the model proposed by Kuhnen and Zwiebel (2008), in which the CEO effectively sets his own compensation, both disclosed and hidden. However, Kuhnen and Zwiebel (2008) assume no role for the board, so their model cannot shed light on the role played by the board in determining executive pay.

1 The Model

We consider a model with a firm and two players: the firm's board of directors and the labor market for directors. The firm is run by a manager, whom we do not model explicitly as a player. The

board of directors sets the manager's disclosed compensation contract and may pay the manager an additional amount of hidden pay. The labor market for directors, which we treat as a single player, observes the disclosed compensation contract, but not the hidden pay, and allocates board seats to the firm's directors.[7]

Compensation contracts, the manager's actions, and payoffs. The board of directors has the task of designing a compensation contract for the firm's manager. The compensation contract determines the manager's incentives and, thus, the firm's expected revenues. It also determines the way in which revenues are shared between shareholders and the manager. Therefore, the board's choice of contract determines the firm's expected profits and the manager's expected utility. For the sake of both generality and simplicity, we do not model explicitly the compensation contract offered to the manager or the agency problem that the contract is meant to address. Instead, we assume that the board directly chooses and publicly announces the manager's certainty equivalent, w (which, abusing the term, we refer to as the manager's disclosed pay), and shareholders' expected profits, π, from a set F of feasible disclosed payoff pairs (w, π). Doing so allows us to simplify the analysis since we do not have to treat the manager as a strategic player and explicitly solve the underlying agency problem. At the same time, our results extend to any underlying agency problem that leads to the same set of feasible disclosed payoff pairs. To simplify both the exposition and the derivations, we make two assumptions about the underlying agency problem. To state formally these assumptions, we first note that, without loss of generality, a contract γ can be represented as $\gamma = \alpha + f$, where $\alpha \in \mathbb{R}$ is the manager's fixed pay and f some function of revenues.

Assumption 1 (No wealth effects.) *If disclosed contract $\gamma = \alpha + f$ leads to payoff pair (w, π), then disclosed contract $\gamma' = (\alpha + k) + f$, with $k \in \mathbb{R}$, generates payoffs $(w + k, \pi - k)$.*

Assumption 2 *The set of feasible disclosed payoff pairs has the form: $F \equiv \{(w, \pi) \in \mathbb{R}^2 : w + \pi \leq s^*\}$.*

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[7]See Ottaviani and Sørensen (2006) for a similar reduced form modeling of the labor market for forecasters as a single player.

In what follows, we let $s = w + \pi$ denote the total surplus (for the manager and shareholders) generated by payoff pair (w, π). Assumption 1 implies that an increase of \$1 in the fixed part of the manager's compensation increases the manager's equilibrium certainty equivalent by \$1 and reduces expected profits by the same amount, leaving total surplus unchanged. Assumption 1 will hold in a standard moral hazard model with an agent with CARA preferences. Assumption 2 simply states that any disclosed payoff pair that generates total surplus not greater than a maximum level s^* is feasible.[8] In Appendix B we provide a simple example that illustrates how the set F in Assumption 2 can be derived from a standard managerial moral hazard model. However, it is important to remark that although Assumptions 1 and 2 greatly simplify both the exposition and the proofs, they are not essential for our results.

Hidden pay. Apart from offering a disclosed contract to the manager—with corresponding disclosed payoffs (w, π)—the board also offers hidden pay $y \geq 0$, which is not observed by the labor market for directors. However, the labor market for directors is aware that directors can pay in hidden ways and it may be able to infer equilibrium hidden pay from boards' strategies.

Hidden pay is inefficient: y dollars of hidden pay reduce expected profits by $z(y) > y$ dollars. We assume that $z(0) = 0$, $z' > 1$, and $z'' > 0$. The inefficiency of hidden pay may emerge because of the costs of hiding monetary payments or because the value for the manager of hidden compensation vehicles is lower than their cost to the firm.[9] Alternatively, one can interpret z as also incorporating directors' psychological cost of hiding pay or the expected cost of potential legal penalties for directors or the firm. Although we acknowledge that certain forms of hidden pay may also provide incentives to the manager, we abstract from this consideration and assume that hidden pay takes the form of a lump sum payment. This assumption, together with Assumption 1, implies that payoffs net of hidden pay are simply $\bar{w} = w + y$ and $\bar{\pi} = \pi - z(y)$. Hereafter, we refer to $\bar{w}$ and $\bar{\pi}$ as total pay and net

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[8]Assumption 2 follows from Assumption 1 if there are no restrictions on the fixed part of pay, there is free disposal (so that any arbitrarily low s is feasible), and there exists a maximum feasible level of surplus s^*.

[9]To 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.

profits, respectively.

To be accepted by the manager, a disclosed payoff pair (w, π) and hidden pay y must provide the manager a certainty equivalent greater or equal to the manager's reservation utility level, which we express in certainty equivalent terms and denote by $\underline{w}$:

$$w + y \geq \underline{w}. \tag{1}$$

We assume that $s^* > \underline{w}$, so that it is not optimal to dissolve the firm.

Board preferences and independence. We consider the board as a single decision maker with preferences represented by the utility function:

$$u(\bar{w}, \bar{\pi}) + u_R, \tag{2}$$

where u_R is the board's expected utility from the board seats awarded by the labor market for directors.

We assume that u is increasing in both arguments. The board will prefer higher profits if directors' pay is tied to firm performance or if directors derive utility from, for example, fulfilling their fiduciary duty towards investors.[10] Importantly, while previous models of boards (Hermalin and Weisbach, 1998; Raheja, 2005) incorporate reputational concerns through a preference for higher profits, we model those reputational concerns explicitly through the impact of the board's decisions on u_R.

Directors may care about the manager's utility because it may influence the manager's willingness to favor the board. For example, higher pay may make the CEO more prone to support directors for reelection, to favor increases in board compensation, or to channel the firm's charitable donations to directors' preferred charities. Directors may also care about the manager's pay if they are averse to boardroom conflict (prefer a "quiet life") and higher pay makes the relation with the manager less adversarial. Finally, directors may feel the need to reciprocate if the CEO helped them get

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

elected to the board, they may identify with the CEO, who is likely to have similar sociodemographic characteristics, or they may be under the social influence of the CEO, whom directors may perceive as knowledgeable and authoritative.

For expositional simplicity, we follow previous theoretical models of boards, and assume that the board's preferences have an additive form:[11]

$$u(\bar{w}, \bar{\pi}) = \bar{\pi} + \theta v(\bar{w}), \tag{3}$$

where $\theta > 0, v' > 0$, and $v'' < 0$.

There are two types of boards, which differ in the weight they place on the manager's welfare relative to profits: manager-friendly (M) boards and independent (I) boards, with $\theta_I < \theta_M$. Throughout the article we use the letter T to refer to a generic board type. The probability that a board is independent is common knowledge and equal to $q \in (0, 1)$.

We make an additional technical assumption:

Assumption 3 $\frac{1}{v'(s^*)} > \theta_M > \frac{z'(0)}{v'(\underline{w})}$.

The first inequality ensures that the manager-friendly board does not want to transfer all the surplus to the manager. The second inequality guarantees that 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 utility level. 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.

The labor market for directors and the board's reputational concerns. A premise of the model is that the labor market for directors values director independence but cannot observe directors'

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[11]In the articles by Hermalin and Weisbach (1998) and Adams and Ferreira (2007), there is a conflict of interest between shareholders and the board because it is costly for boards to monitor the manager. Kumar and Sivaramakrishnan (2008) explicitly assume that the board may care about the manager's welfare, and Harris and Raviv (2008) allow for board members who have an interest in increasing the firm's scale beyond the profit-maximizing level. In all these models, firm profits and the other variables of interest for the board (monitoring costs, the utility of the manager, or the firm's scale) enter in an additive form.

true independence.[12] Instead of explicitly modeling the labor market for directors, we assume that directors' discounted utility u_R from future board appointments is an increasing function of the labor market's belief $\mu \in [0,1]$ that the board is independent. Therefore, $u_R(\mu)$ is the board's discounted expected utility if the labor market believes that the board is independent with probability μ and acts according to that belief. For ease of exposition, we assume a simple functional form for u_R:

$$u_R(\mu) = \eta\mu, \tag{4}$$

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 for directors of a reputation of independence. The discounted utility of a type-T board ($T \in \{I, M\}$) as a function of payoffs net of hidden pay $(\bar{w}, \bar{\pi})$ and reputation μ can then be written as:

$$U_T(\bar{w}, \bar{\pi}, \mu) \equiv u(\bar{w}, \bar{\pi}) + u_R(\mu) = \bar{\pi} + \theta_T v(\bar{w}) + \eta\mu. \tag{5}$$

We assume that directors prefer any feasible $(\bar{w}, \bar{\pi}, \mu)$ to leaving the firm, so we can disregard the board's participation constraint.

2 Hidden pay and the board's preferences over disclosed payoffs

Since hidden pay has no reputational or incentive consequences, for any disclosed contract, the board will offer the level of hidden pay that maximizes its utility given the disclosed contract. Linearity of the board's preferences implies that expected profits do not affect the board's choice of y, so we can let $y_T(w)$ represent the optimal level of hidden pay as a function of disclosed pay w for board type T.[13] The following lemma characterizes the board's choice of hidden pay as a function of both the

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[12]Although we assume that the market prefers independent boards over manager-friendly boards, such preference can, in fact, be generated from within the model: Since independent boards place a smaller weight on the manager's utility, their preferred compensation contracts (in the absence of reputational concerns) will lead to lower managerial pay and higher profits than those preferred by manager-friendly boards. We prove this assertion in Section 3.1.

[13]The fact that y_T does not depend on π simplifies the derivations but it is not essential to obtain our results.

manager's disclosed pay and the board's type (all proofs are in Appendix A):

Lemma 1

1. *For any level of disclosed pay w, the manager-friendly board pays (weakly) higher hidden pay.*

2. *Hidden pay is nonincreasing in w, and it is decreasing in w for levels of w such that the board pays hidden compensation.*

3. *For each $T \in \{I, M\}$, there exists a threshold level of disclosed pay w_T^y such that: (a) A type-T board pays hidden compensation if and only if $w < w_T^y$; and (b) $w_M^y > w_I^y$.*

4. *For any board type T: (a) the manager's total pay $(w + y_T(w))$ is nondecreasing in w, and (b) if $w' > w$ and $w' + y_T(w') > \underline{w}$, then $w' + y_T(w') > w + y_T(w)$.*

We note that part 1 of the lemma states that for a given level of disclosed pay, the manager-friendly board pays greater hidden pay. It does not state that the manager-friendly board will pay more hidden compensation in equilibrium, since in equilibrium each board type may pay a different level of disclosed compensation.

Part 4 of the lemma states that, even though y is nonincreasing in disclosed pay, w, total pay $(w + y_T(w))$ is nondecreasing in w. Moreover, for levels of w such that total pay is greater than the manager's reservation value, total pay is strictly increasing in disclosed pay w.

To simplify the description of the model's equilibrium, we do not consider y explicitly as a strategic variable. Instead, we restrict the board's offer of hidden pay to be the one that maximizes the board's utility given the disclosed contract offered to the manager, and we incorporate the choice of hidden pay into the board's utility, which we redefine as a function of disclosed payoffs (w, π) (rather than payoffs net of hidden pay). Therefore, we define $\overline{U}_T(w, \pi, \mu)$ as the derived utility of a type-T board if the disclosed payoff pair is (w, π), the labor market's belief that the board is independent is μ, and the board sets its preferred level of hidden pay given (w, π):

$$\overline{U}_T(w, \pi, \mu) \equiv U_T(w + y_T(w), \pi - z(y_T(w)), \mu). \tag{6}$$

Once we incorporate the hidden pay decision into the board's preferences, the model becomes a reduced form two-player signaling model: The board, with preferences over disclosed payoffs described by $\overline{U}$, picks a disclosed payoff pair (w, π). The labor market for directors observes the payoff pair selected by the board and updates its belief that the board is independent. In this reduced form signaling model, the labor market is assumed to play a best response to its beliefs about the board's independence. Therefore, we incorporate into the model the equilibrium condition that the labor market plays a best response through the term u_R in the board's preferences. The following lemma describes two key properties of the board's derived preferences $\overline{U}$:

Lemma 2 *Let* $w' > w$, *then for any levels of expected profits* π, π' *and beliefs* μ, μ':

1. *If* $w' + y_M(w') > \underline{w}$ *(the manager's participation constraint is not binding for* w'*), then:*

$$\overline{U}_M(w, \pi, \mu) \geq \overline{U}_M(w', \pi', \mu') \Rightarrow \overline{U}_I(w, \pi, \mu) > \overline{U}_I(w', \pi', \mu') \tag{7}$$

2. *If* $w' + y_M(w') = \underline{w}$ *(the manager's participation constraint is binding for* w'*), then:*

$$\overline{U}_M(w, \pi, \mu) - \overline{U}_M(w', \pi', \mu') = \overline{U}_I(w, \pi, \mu) - \overline{U}_I(w', \pi', \mu'). \tag{8}$$

The first part of the lemma shows that for levels of disclosed pay that are high enough so that the manager's participation constraint is not binding, the utility function $\overline{U}$ satisfies two single-crossing conditions. First, let $\pi' < \pi$ and $\mu' = \mu$, and suppose that disclosed pay w is such that the manager-friendly board would offer total pay greater than the manager's reservation value. Then, (7) implies that if a manager-friendly board is willing to reduce disclosed pay in exchange for an increase in profits, an independent board will also accept such an exchange. Second, if $\mu' < \mu$, and $\pi' = \pi$, then (7) implies that if a manager-friendly board is willing to accept a reduction in disclosed pay in exchange for an increase in reputation, then an independent board will also accept such an exchange.

To understand part 2 of the lemma, notice that the fact that total pay is nondecreasing in w (Part 4 in Lemma 1) implies that if the level of disclosed pay w' is so low that a manager-friendly board would pay just the amount of hidden compensation necessary to meet the manager's participation constraint (i.e., if $w' + y_M(w') = \underline{w}$), then: a) the independent board would pay the same level of hidden pay, and b) if $w < w'$, then both board types would pay the same level of hidden compensation for disclosed pay w as well (namely, the amount necessary to keep the manager at his reservation utility level). Therefore, for any two disclosed payoff pairs, (w', π') and (w, π), such that $w' + y_M(w') = \underline{w}$ and $w < w'$, both board types will offer the manager the same total pay. It follows that the net payoffs associated with disclosed payoffs (w', π') and (w, π) would differ only in the expected profit net of hidden pay. Since, keeping total pay constant, boards do not differ in their preferences for net profits, it follows, as stated in part 2 of Lemma 2, that both board types will have the same preferences over (w', π', μ') and (w, π, μ). All of our main results follow from the two properties of the board's preferences described in Lemma 2. The additional structure of the model helps clarify the analysis but is not essential for our results.

3 Board Independence, Reputation, and CEO Pay

3.1 Baseline case: No reputational concerns

We consider as a benchmark the behavior of a board with no reputational concerns (μ given). A type-T board with no reputational concerns would choose the payoff pair that, for a given μ, solves the problem:

$$\max_{(w,\pi)\in F} \quad \overline{U}_T(w, \pi, \mu)$$

$$s.t. \quad w + y_T(w) \geq \underline{w}. \tag{9}$$

Since hidden pay is costlier than disclosed pay, 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 hidden pay. Moreover, since the board's objective is increasing in both π and w, the board will choose an efficient compensation contract regardless of its type, i.e., a contract with associated payoffs (w, π) such that $w + \pi = s^*$. Finally, since the manager-friendly board places a larger weight on the manager's utility ($\theta_M > \theta_I$), it will pay the manager a higher disclosed compensation. We state these results formally in the following proposition:

Proposition 1 *Let (w_T^*, π_T^*) be the disclosed payoff pair chosen by a board of type T in the absence of reputational concerns. Then:*

1. *Both board types choose efficient disclosed payoff pairs, i.e., $w_T^* + \pi_T^* = s^*$ for $T \in \{I, M\}$.*

2. *$w_M^* > w_I^*$ and $\pi_M^* < \pi_I^*$.*

3. *Neither board type pays hidden compensation: $y_M(w_M^*) = y_I(w_I^*) = 0$.*

4. *Each board type T would chose (w_T^*, π_T^*) if hidden pay were not possible.*

Proposition 1 yields three messages: Neither board type will use inefficient hidden pay, both boards will choose efficient disclosed compensation contracts, and the manager-friendly board will pay the manager more. An additional implication of Proposition 1 is that, if there is a unique compensation structure that maximizes surplus, then both board types will choose the same compensation structure, and the manager-friendly board will simply pay a higher fixed pay.[14]

To analyze the board's pay decisions when those decisions may affect the board's reputation for independence, we hereafter analyze the (Perfect Bayesian) equilibria of the model. The equilibrium definition requires that the board play optimally given the market's beliefs and that these beliefs be consistent. To limit equilibrium multiplicity, we focus on equilibria that satisfy the Intuitive Criterion (Cho and Kreps, 1987), which restricts the labor market's beliefs off the equilibrium path. In Appendix A, we provide a formal definition of the equilibrium concept.

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[14]The example in Appendix B illustrates this possibility.

3.2 Efficient reputational concerns

To analyze the model's equilibria, we define the *separating pay* $\widetilde{w}$ as the level of disclosed pay (such that $\widetilde{w} < w_M^*$) that makes a manager-friendly board indifferent between (i) offering its preferred contract and being perceived as manager-friendly and (ii) offering an efficient disclosed contract with pay $\widetilde{w}$ and being perceived as independent:

$$\overline{U}_M(w_M^*, \pi_M^*, 0) = \overline{U}_M(\widetilde{w}, s^* - \widetilde{w}, 1). \tag{10}$$

We also define $\underline{w}_T$ as the threshold level of disclosed pay such that a board of type T sets total pay equal to the manager's reservation value $\underline{w}$ if and only if $w \leq \underline{w}_T$. We note that it follows from Lemma 1 that $\underline{w}_M < \underline{w}_I$. Further, the inequality $\theta_M v'(\underline{w}) > z'(0)$ in Assumption 3 implies that $\underline{w}_M < \underline{w}$.

Since a reputation for independence is valuable for directors, 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 board types.

At a separating equilibrium, the labor market for directors identifies the manager-friendly board as such. It follows that, at any separating equilibrium, the manager-friendly board will choose the disclosed payoff pair that it would have chosen in the absence of reputational concerns. Otherwise, deviating to its preferred payoff pair would be a profitable deviation for the manager-friendly board, since it would cause no reputational loss. Therefore, we obtain the following result:

Proposition 2 *At any separating equilibrium, the manager-friendly board selects the same efficient payoff pair that it would have selected in the absence of reputational concerns and pays no hidden compensation.*

It is worth clarifying that, even if it sets its preferred compensation contract, the manager-friendly board will suffer from being perceived as such at a separating equilibrium: 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 to serve on other boards.

If the independent board can avoid imitation while achieving its preferred payoff pair (w_I^*, π_I^*), it will do so. Therefore, if the separating level of pay $\widetilde{w}$ is large enough $(\widetilde{w} > w_I^*)$, reputational concerns will have no impact on CEO pay. However, if the independent board would trigger imitation by the manager-friendly board if it set its preferred payoff pair, the independent board will lower the manager's pay to signal its independence. The independent board will do this in the least costly way possible. Therefore, it will lower disclosed pay just enough to avoid imitation by the manager-friendly board (by setting $w_I = \widetilde{w}$) and will do so by lowering the fixed component of pay while keeping an efficient compensation structure. Further, if the reduction in fixed pay necessary to dissuade imitation by the manager-friendly board is small enough (i.e., if the separating level of pay $\widetilde{w}$ is greater than the threshold level of disclosed pay w_I^y above which the independent board pays no hidden compensation), the independent board will not compensate the manager in hidden ways for the reduction in disclosed pay. Letting (w_I, π_I) be the equilibrium disclosed payoff pair set by the independent board and s_I the resulting surplus level, the following proposition formally states these results:

Proposition 3 *If $\widetilde{w} \geq w_I^y$, there are no pooling equilibria, and at the unique separating equilibrium:*[15]

1. *If $\widetilde{w} \geq w_I^*$, then (w_I, π_I) will be efficient $(s_I = s^*)$ and equal to the one the independent board would have chosen in the absence of reputational concerns $(w_I = w_I^*, \pi_I = \pi_I^*)$. Moreover, the independent board will pay no hidden compensation $(y_I(w_I) = 0)$.*

2. *If $\widetilde{w} < w_I^*$, then (w_I, π_I) will be efficient $(s_I = s^*)$, $w_I = \widetilde{w} < w_I^*$, and $\pi_I > \pi_I^*$. Moreover, the independent board will pay no hidden compensation $(y_I(w_I) = 0)$.*

Therefore, it follows from Propositions 2 and 3 that if the reduction in pay needed to avoid imitation by manager-friendly boards is not too large $(\widetilde{w} \geq w_I^y)$, reputational concerns induce independent

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boards to efficiently transfer rents from the manager to shareholders and have no effect in equilibrium on the compensation decisions of manager-friendly boards.

The intuition behind Proposition 3 is simple. For large enough levels of disclosed pay, Lemma 2 implies that a reduction in the manager's disclosed pay is more costly for a manager-friendly board. If the independent board can separate from the manager-friendly board by either setting its preferred payoff pair or by lowering the manager's disclosed pay to a level that does not induce the board to pay hidden compensation, it will do so.

For parameter values such that the independent board would pay no hidden compensation at the separating level of pay ($\widetilde{w} \geq w_I^y$), Proposition 3 also shows that there are no pooling equilibria. In fact, we show in Appendix A that there are no pooling equilibria as long as $\widetilde{w}$ is strictly greater than the maximum disclosed pay, $\underline{w}_M$, such that the manager-friendly board would leave the manager at his reservation pay (where $\underline{w}_M < \underline{w} \leq w_I^y$). The reason is that for w to be set at a pooling equilibrium, w has to be greater than the the separating level of pay ($w > \widetilde{w}$). Now, if $\widetilde{w} > \underline{w}_M$, then Part 4 of Lemma 1 implies that $w + y_M(w) > \widetilde{w} + y_M(\widetilde{w}) > \underline{w}$. But then the single crossing condition (7) in Lemma 2 implies that deviating to a lower disclosed pay $w' < w$ would be more costly for the manager-friendly board. Therefore, independent boards could convince the labor market of their independence by lowering disclosed pay.

3.3   Reputational concerns, hidden pay, and inefficient compensation structures

If the disclosed pay necessary to dissuade the manager-friendly board from imitating the independent board is lower than the threshold level of pay below which the independent board would pay a positive level of hidden compensation ($\widetilde{w} < w_I^y$), the independent board will lower disclosed pay to $\widetilde{w}$ (by reducing the fixed pay) to signal its independence, but will compensate the manager for the reduced disclosed pay with hidden compensation:

Proposition 4 *If $\underline{w}_M < \widetilde{w} < w_I^y$, then there are no pooling equilibria, and separating equilibria are such that the independent board selects an efficient disclosed payoff pair ($s_I = s^*$) and a level of*

disclosed pay equal to $w_I = \widetilde{w}$, and pays hidden pay $y_I(w_I) > 0$.

Although the independent board offers an efficient disclosed compensation structure ($s_I = s^*$), it pays the manager inefficient hidden compensation. Therefore, 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.

Suppose now that the disclosed pay necessary for the independent board to signal its independence ($\widetilde{w}$) is so low that the manager-friendly board would leave the manager at his reservation utility level if it paid disclosed compensation $\widetilde{w}$ (i.e., $\widetilde{w} \leq \underline{w}_M < \underline{w}$). Then, on top of equilibria such as the ones described in Proposition 4, there are also separating equilibria at which the independent board may not only pay in hidden ways but also inefficiently distort the disclosed compensation contract (i.e., offer a disclosed payoff pair with $s_I < s^*$):

Proposition 5 *If $\widetilde{w} \leq \underline{w}_M$, then for each $w \in [\widetilde{w}, \underline{w}_M]$, there are separating equilibria with $w_I = w$ and $y_I(w_I) = \underline{w} - w_I > 0$. If $w_I > \widetilde{w}$, then the disclosed payoff pair is inefficient ($s_I < s^*$).*

In equilibria with inefficient disclosed pay, the independent board pays higher disclosed pay than in equilibria with efficient disclosed pay and achieves separation by reducing expected profits through an inefficient compensation structure. To understand this sort of equilibrium, suppose that to achieve separation with an efficient disclosed contract, the independent board has to set disclosed pair $(\widetilde{w}, \pi)$, with $\widetilde{w} < \underline{w}_M$ and $\pi = s^* - \widetilde{w}$. By definition of $\underline{w}_M$, such a disclosed payoff pair would lead to total pay $\underline{w}$ and net profits $s^* - \widetilde{w} - z(\underline{w} - \widetilde{w})$ for both board types. But then an inefficient disclosed payoff pair (w', π'), with $w' \in (\widetilde{w}, \underline{w}_M]$ and $\pi' = \pi - z(\underline{w} - \widetilde{w}) + z(\underline{w} - w')$, would lead to exactly the same net payoffs for both boards, so if there is a separating equilibrium at which the independent board sets $(\widetilde{w}, \pi)$, there is also a separating equilibrium at which the independent board sets (w', π').[16]

If $\widetilde{w} < \underline{w}_M$, there also exists a continuum of pooling equilibria:

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

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[16]The disclosed payoff pair is inefficient since $w' + \pi' = w' + \pi - z(\underline{w} - \widetilde{w}) + z(\underline{w} - w') < w' + \pi - z'(\underline{w} - w')(w' - \widetilde{w}) < w' + \pi - (w' - \widetilde{w}) = \pi + \widetilde{w} = s^*$, where the first inequality follows from convexity of z and the second one from $z' > 1$.

1. *For each $w \in (\widetilde{w}, \underline{w}_M]$, 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 equilibria, the manager-friendly board plays (w_I, π_I) (with $y_M(w_I) = y_I(w_I) = \underline{w} - w_I > 0$) with probability $\sigma \geq 0$, and (w_M^*, π_M^*) (with $y_M(w_M^*, \pi_M^*) = 0$) with probability $1 - \sigma$.*

The reason for this multiplicity of equilibria is that, as we show in Lemma 2, any two disclosed payoff pairs, (w, π) and (w', π'), with $w, w' \leq \underline{w}_M$ lead to the same total pay for the manager irrespectively of the board type, because, for such levels of disclosed pay, both board types offer the manager the amount of hidden pay that is needed to keep him at his reservation utility. Therefore, the two board types have exactly the same preferences over any two payoff pairs with $w, w' \leq \underline{w}_M$, and the single-crossing condition that ensures separation does not apply. It follows that if the labor market for directors expected both board types to choose (w, π) with $w < \underline{w}_M$, an independent board would not be able to convince the market of its independence by choosing a contract such that $w' < w$. Thus, an equilibrium at 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 Proposition 6, 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 at 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).

Figure 1 summarizes the main features of the model's equilibria for different values of the separating disclosed pay $\widetilde{w}$. Below the $\widetilde{w}$ axis we also indicate how the separating level of disclosed pay depends on the values of parameters η and κ. We introduce κ and derive the relation between parameter values, $\widetilde{w}$, and equilibrium disclosed pay in sections 4 and 5 below.
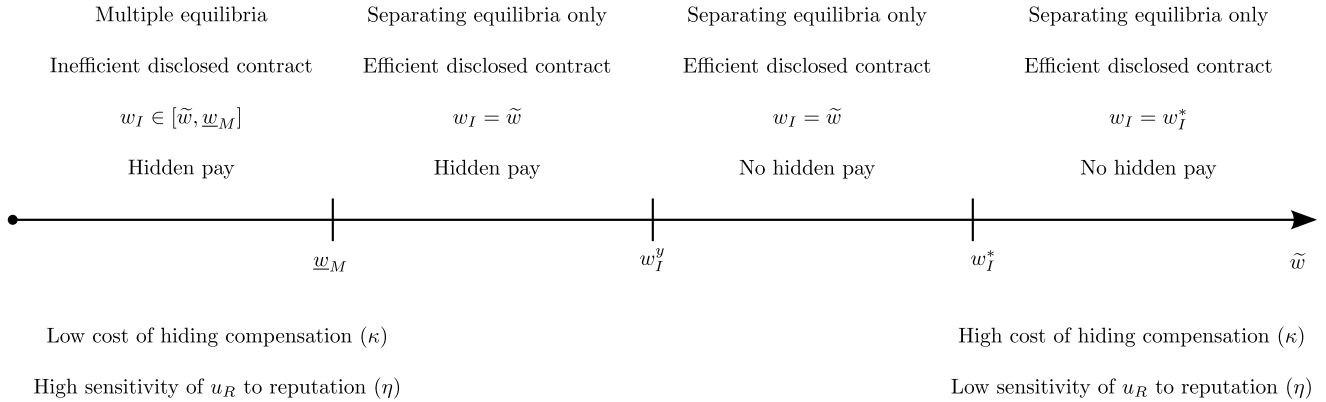
Figure 1: Equilibria and parameter values. The axis represents different values of the separating level of disclosed pay $\widetilde{w}$. Above the axis, the figure describes the different equilibria as functions of $\widetilde{w}$. Below the axis, the figure describes how $\widetilde{w}$ depends on parameter values η and κ. We define κ in Section 4. Propositions 7 and 9 describe the relation between $\widetilde{w}$ and parameter values κ and η, respectively.

3.4   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, sets the manager's compensation: If it is relatively easy to avoid imitation by manager-friendly boards, reputational concerns lead independent boards to lower the manager's pay, transferring wealth from the manager to shareholders with no efficiency loss. 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 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 backdating and other forms of poorly disclosed compensation. In fact, for most parameter values, the manager-friendly board pays no hidden compensation, and if it does (at pooling equilibria), it does not pay 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. Namely, camouflaged compensation could be the result of actions taken by captured directors or the manager himself to keep independent directors unaware of the CEO's true compensation.

Empirical implications. Since true independence is not observable, the model's predictions that directly relate true independence and compensation contracts are difficult to test. However, Cohen et al. (2012) provide suggestive evidence indicating that firms whose directors are more manager-friendly, yet still formally independent, pay their CEOs more. In particular, Cohen et al. (2012) show that CEO compensation increases in firms that appoint formally independent directors who may be expected to be more lenient towards the manager (former sell-side analysts who issued especially positive recommendations about the firm).

The model yields other potentially testable implications. First, since at any separating equilibrium the manager-friendly board sets a higher level of disclosed pay, all our results regarding separating equilibria imply that boards that pay higher disclosed pay are likely to suffer negative reputational effects. Both anecdotal and econometric evidence show that, at least in recent years, directors risk being singled out for their compensation decisions. Corporate governance watchdogs, such as *Institutional Shareholder Services* (ISS) or *GovernanceMetrics International*, or activist institutional investors, such as CalPERS, publish corporate governance ratings and watch lists, and boards' compensation decisions are a key factor in determining those ratings. Similarly, executive compensation practices significantly affect the voting recommendations of proxy advisory firms (ISS, 2011), and these recommendations have a substantial impact on voting outcomes (Alexander et al., 2009; Choi et al., 2009; Ertimur et al., 2011). Mutual funds' policies regarding proxy voting also identify compensation decisions as factors to determine their vote. In line with these practices, the empirical evidence suggests that excessive CEO pay affects voting outcomes in corporate elections (Morgan and Paulsen, 2006; Cai et al., 2009;

Fischer et al., 2009; Yermack, 2010; Ertimur et al. 2011). Additionally, Core et al. (2008) find that excess CEO pay leads to negative press coverage of firms' compensation practices, and Kuhnen and Niessen (2012) document that CEO pay is responsive to the negativity of the average media coverage of executive compensation.

Another implication of the model, which follows from Proposition 4, is that hidden compensation will be more likely in firms that pay relatively low disclosed compensation. This implication is potentially testable if reasonable proxies of camouflaged pay can be found. Such proxies could be ex post measures, like the use of option backdating or the frequency of scandals or litigation related to executive pay. To the extent that insider trading profits are not fully accounted for by investors, lax restrictions on insider trading by executives can also be understood as a form of hidden pay. Using different data sets and types of insider trading limitations, Roulstone (2003) and Henderson (2011) find that firms that restrict insider trading pay higher total compensation, which suggests a substitution between disclosed and undisclosed forms of pay. The use of compensation vehicles that are disclosed in such a way that investors may not grasp their true cost could also act as proxies for hidden pay. Stock options or pension fund contributions before regulation required firms to disclose them in a way that allows investors to better evaluate their costs could, arguably, be such proxies. In sections 4 and 5 we derive comparative statics results that provide further potentially testable implications.

It is important to emphasize that these empirical implications (and most of the implications discussed in sections 4 and 5) are all else equal, including the degree of formal independence of the board. 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.

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 the labor market underestimated the cost of option compensation for the firm (as argued by Hall and Murphy, 2003, who, however, propose that boards may have also underestimated that cost.)

Proposition 5 provides an alternative explanation for the excessive use of stock option compensation, which hinges on the arguments of, among others, Hall and Murphy (2003) and Dittmann and Maug (2007), which suggest that stock options may have been inefficiently overused during the 1990s: 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 in 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 boards and substituted inefficient stock option compensation for other forms of compensation.[17]

Welfare implications.   One has to be cautious when deriving welfare implications from our results because we derive the payoffs for the period under consideration in the model, but not for (unmodeled) future periods: Whereas the function u_R incorporates the future welfare effects that the choice of contract has for the board, we do not explicitly derive the effects on the manager's and shareholders' future wealth.

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[17]The tide turned in the 2000s: Kuhnen and Niessen (2012) report that stock option compensation was the form of compensation receiving the greatest (generally negative) attention by the press in the period 1997-2004

To shed some light on the welfare implications of the model, suppose that 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. Expected profits in the second period could also be higher with an independent board, if such a board is more likely to prevent potential value-destroying choices by the manager.

At a separating equilibrium, manager-friendly boards are identified as such and, thus, are likely to be replaced in the second period by a board with a positive probability of being independent. Therefore, at a separating equilibrium the probability that the board is independent in the second period is higher than the prior probability q.[18] 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 it is not possible to directly compare the welfare implications of equilibria with different degrees of pooling, because such comparison would require considering potential future effects on shareholder wealth. However, we can directly compare the welfare implications of different separating equilibria, since they all lead to the same amount of information revelation. 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.

Hidden pay and private benefits. Although we generally interpret hidden pay as a form of opaque monetary compensation, the model allows for an alternative interpretation in terms of non-

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[18]Let $q_2 > 0$ be the probability that a board hired in the second period is independent. If boards identified as manager-friendly were fired with probability one, the (ex ante) equilibrium probability that the board is independent in the second period would be $q + (1 - q)q_2 > q$.

monetary private benefits. Thus, y could be interpreted as the monetary value for the manager of some action taken by the firm and $z(y)$ as the cost to the firm of that action. For example, instead of compensating the manager for lower disclosed pay with, say, poorly disclosed pension benefits, the board could compensate the manager by allowing him to make some inefficient decision valued by the manager, such as hiring a relative or friend, directing the firm's charitable contributions to the charity favored by the manager (rather than the one favored by shareholders or with an optimal reputational impact for the firm), or even investing in negative NPV projects cherished by the manager.

Partly hidden pay. In the model, the labor market for directors observes only the disclosed contract when deciding the allocation of board seats. Of course, publicly available information other than the disclosed contract (such as information on realized revenues and profits) could, in principle, allow investors to learn about the amount of hidden pay. However, in practice, publicly available information will typically be only of limited use to infer the amount of hidden compensation paid to the CEO, since many factors other than the manager's pay determine profits, and investors observe only accounting measures of those factors (which the board could manipulate). For tractability, instead of incorporating explicitly into the model the possibility of partial learning about hidden pay by the labor market, we assume that the only piece of information used by the labor market when it attempts to infer the board's type is the disclosed contract.[19]We note that our assumption that hidden pay is truly hidden is compatible with the labor market correctly inferring the amount of hidden compensation paid by the board at separating equilibria.

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[19]Suppose that realized profits are given by $\Pi = r - t - c - z$, where r and t are the realized values of revenues and the manager's disclosed compensation, respectively, c are costs other than the manager's compensation, and z is the cost to the firm of hidden pay. 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, $\hat{c}$ (or Π) would be a valuable signal of hidden pay in those cases in which the labor market for directors a) observed a contract that is offered with positive probability by both board types and b) expected each board type to offer a different amount of hidden pay given that contract. However, if the distribution of c has a large variance, the information provided by this additional information would be limited. For tractability we do not model this possibility, because 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 survive in the presence of such noisy signals, since at these equilibria both boards set the same level of hidden pay.

4 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 reveal 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 one-parameter family of functions with 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 pay 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 disclosed pay that dissuades manager-friendly boards from imitating independent boards may increase and, thus, the equilibrium disclosed pay chosen by independent boards may increase as well. This increase, together with the greater cost of hiding compensation for independent boards, leads to a reduction in equilibrium hidden pay, so there is substitution between disclosed and undisclosed compensation. These results are stated in the following proposition and summarized in Figure 1:[20]

Proposition 7 *The separating level of disclosed pay $\widetilde{w}$ and the independent board's equilibrium disclosed pay are nondecreasing in κ. The equilibrium level of hidden compensation paid by the independent board is nonincreasing in κ.*

The substitution between disclosed and hidden pay implies that the observable effect of an increase in the cost of hidden compensation may be an increase in the (disclosed) pay offered by independent boards, and, thus, a reduction in the disclosed pay premium paid by manager-friendly boards.

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[20]For the region with multiple equilibria, we say that the equilibrium disclosed pay is increasing in κ if the minimum disclosed pay possible in equilibrium ($\widetilde{w}$) and the maximum disclosed pay (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.

It follows from Proposition 7 that stricter transparency requirements have both costs (higher disclosed pay) and benefits (lower hidden pay) for shareholders. To evaluate the net effect of more stringent disclosure requirements, consider the scenario described in Proposition 3. In that scenario the independent board sets a level of disclosed pay, $\widetilde{w}$, lower than its preferred level and pays no hidden compensation. An increase in the cost of hidden compensation, by making imitation more costly for the manager-friendly board, could allow the independent board to increase its disclosed pay and still achieve separation ($\widetilde{w}$ would increase). Since the independent board was not paying any hidden compensation, the increase in the cost of camouflage will not reduce hidden pay. Thus, the effect of an increase in the cost of hidden 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. Therefore, an increase in the cost of hidden compensation may make the manager better off and shareholders worse off. Intuitively, if disclosure requirements are lax, the independent board will be likely to make use of inefficient hidden pay, and making disclosure requirements more stringent will be likely to make shareholders better off. However, if disclosure requirements are already strict, greater transparency requirements may just have the undesired effect of increasing disclosed pay. In the following proposition we give a sufficient condition that ensures that there is such a thing as excessive transparency. Before doing so, we make a technical assumption about the family of functions z:

Assumption 4

1. $z_y(0; \kappa) \to \theta_M v'(\underline{w})$ when $\kappa \to K$, and $z_y(0; K) = \theta_M v'(\underline{w})$.

2. For $\kappa > 0$ low enough: $\overline{U}_M(\underline{w}, s^* - \underline{w}, 1) > \overline{U}_M(w_M^*, \pi_M^*, 0)$.

The first part of the assumption ensures that for any $w \geq \underline{w}$, $y_M(w) \to 0$ as $\kappa \to K$. At the same time, Assumption 3 ensures that $y_M(\underline{w}) > 0$ for any $\kappa \in [0, K)$. The second part of Assumption 4 states that when the cost of hiding pay is low enough, the manager-friendly board will 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 4 holds, that $w_I^* > \underline{w}$, and that:*

$$U_M(\underline{w}, s^* - \underline{w}, 1) < U_M(w_M^*, \pi_M^*, 0). \tag{11}$$

Then, there is a $\bar{\kappa} < K$ such that equilibrium profits are higher for $\bar{\kappa}$ than for any $\kappa \in (\bar{\kappa}, K]$.[21]

Inequality (11) means that if hidden pay were not possible the manager-friendly board would prefer setting its optimal contract and being recognized as manager-friendly over keeping the manager at his reservation utility level and passing as independent. The condition $w_I^* > \underline{w}$ implies that for small reductions in w below w_I^* the independent board would not compensate the manager with hidden pay. Together, this condition and inequality (11) ensure that the board's preferences place enough weight on the manager's utility. If these conditions hold, then Proposition 8 shows that making camouflage too costly (that is, making pay too transparent) is harmful for shareholders.

Hermalin and Weisbach (2012) also predict a positive impact of stricter disclosure requirements on CEO pay and argue that too much transparency may reduce firm value. In their model, improving disclosure may increase executive compensation because managers also capture some of the benefits of better monitoring or because they are adversely affected by greater disclosure, so that managerial pay has to rise as a compensating differential. Hermalin and Weisbach (2012) also discuss the possibility that better disclosure may lead managers to devote costly effort to distorting performance measures. The mechanism we highlight is different and operates through the extra cost that stricter disclosure requirements would impose on manager-friendly boards were they to imitate the compensation policies of independent boards. This extra cost reduces the pressure on independent boards to lower disclosed pay to signal their independence.

We note that even though we focus above on disclosure and auditing regulations as determinants of κ, the cost of hiding compensation may also increase if corporate governance watchdogs, analysts, or the media scrutinize more carefully firms' compensation practices, since such scrutiny could make

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[21]Notice the difference between the second part of Assumption 4, where the utility function is the derived $\overline{U}$, and expression (11), where the utility function is the primitive U.

it more expensive to effectively hide pay from the public view. However, these external monitors may also have an impact on equilibrium compensation by increasing the value of a reputation for independence. We analyze this potential impact in the following section.

5   Reputational Pressure and CEO Pay

The board's discounted future expected utility (u_R) is a function of the labor market's belief that the board is independent, μ, and the parameter η, which measures the sensitivity of the board's expected utility to the labor market's perception of its independence. In this section, we analyze how changes in η influence equilibrium outcomes, as well as the factors that determine η.

An increase in η, by making imitation of independent boards more attractive for manager-friendly boards, lowers independent boards' equilibrium disclosed pay, 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, which we also summarize in Figure 1:

Proposition 9

1. *The separating level of pay, $\widetilde{w}$, 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. *$y_I(\widetilde{w})$ is nondecreasing in η (and increasing in η if $y_I(\widetilde{w}) > 0$) 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 nondecreasing in η.*

For parameter values such that there are only separating equilibria, independent boards' equilibrium disclosed pay is $w_I = \min\{w_I^*, \widetilde{w}\}$. Therefore, part 1 implies that independent boards' disclosed

pay is nonincreasing in η and is decreasing in η as long as $\widetilde{w} < w_I^*$, that is, as long as the independent board has to reduce pay below its preferred level to signal its independence. When $\widetilde{w} < \underline{w}_M$, Propositions 5 and 6 show that there are multiple equilibria. In this case, part 1 ensures that the minimum disclosed pay possible in equilibrium ($\widetilde{w}$) 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, for parameter values for which there are only separating equilibria, the level of equilibrium hidden compensation paid by the independent board ($y_I(\widetilde{w})$) is nondecreasing in η. For parameter values such that there are multiple equilibria, the maximum level of hidden compensation possible in equilibrium ($y_I(\widetilde{w})$) is nondecreasing in η and the minimum level ($y_I(\underline{w}_M)$) is not affected by changes in η. Therefore, even in those cases in which 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 nondecreasing 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 $w_T^y = \widetilde{w}$ for $\eta = \eta_T^y$. Therefore, since hidden compensation is paid in equilibrium for $\widetilde{w} < w_I^y$, and $\frac{d\widetilde{w}}{d\eta} < 0$, 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 but also induce greater pay distortions that reduce profits for any level of disclosed pay. To ascertain the net impact on profits of a higher η 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 3.4. To formally state these results, let η_T be defined as the level of η such that $\widetilde{w} = \underline{w}_T$. Recalling that $\frac{d\widetilde{w}}{d\eta} < 0$, 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 equilibrium expected profits are increasing in η.*

2. *If $\eta > \eta_I$, then equilibrium expected 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 it 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 his reservation level $(\eta > \eta_I)$, further increases in η reduce disclosed pay but also increase hidden pay so that total managerial compensation is unchanged. However, profits fall because hidden pay is costly. Therefore, for $\eta < \eta_M$, the optimal level of η for shareholders lies in the interval $[\eta_I^y, \eta_I]$.

What factors are likely to determine the value of parameter η? First, η is likely to be greater if shareholders have a greater say in the appointment of directors. Second, greater scrutiny of executive pay by the media or governance watchdogs is likely to increase η if the labor market for directors reacts to media attention on executive pay or to the assessment of executive pay by corporate governance watchdogs, as suggested by the evidence provided by Core et al. (2008) and Kuhnen and Niessen (2012) (regarding press coverage of firms' compensation practices) and Alexander et al. (2009), Choi et al. (2009), and Ertimur et al. (2011) (regarding corporate watchdogs). Similarly, say-on-pay policies may also increase η both by focusing shareholder attention on executive pay and, in those cases in which compensation arrangements are voted down, by publicly signaling shareholder dissatisfaction with compensation practices. This public show of opposition to the board's pay decisions may hinder its reelection as well as focus the attention of the shareholders of other firms on the executive pay choices of the board whose pay proposal is voted down. Boards' compensation decisions will also

have a greater impact on directors' employment prospects if shareholders are more likely to attribute the board's actions to the board's formally independent directors. Thus, η may be higher if formally independent directors have a greater influence over board decisions, as in those boards with a large fraction of independent directors.[22] Poor firm performance may also focus shareholders' attention on the firm's compensation policies.[23] Finally, director age and past experience may also play a role, since the value of a reputation for independence may be, other things equal, lower for older directors, because they face a shorter career. Therefore, it follows from Propositions 9 and 10 that an increase in the power of shareholders in the election of directors, greater attention by the media or governance watchdogs on executive pay, greater formal board independence, the implementation of say-on-pay policies, the presence of younger outside directors, or poor firm performance may lead to lower disclosed pay and higher hidden pay. The net impact for shareholder wealth of these changes is likely to be positive when directors are very entrenched, but may become negative when directors' prospects depend strongly on their reputation for independence.

Proposition 10 may offer an explanation for the use of hidden pay and inefficient compensation structures in the 1990s and early 2000s at a time when many observers argue that the power of CEOs decreased (see, *e.g.*, Holmstrom, 2005) and directors became the subject of stricter monitoring. According to our model, these very changes in the labor market for directors may have led to greater pay distortions or more widespread use of hidden pay. Our model, however, does not yield the prediction that total compensation would have increased following these changes. Therefore, it does not explain the rapid increase in CEO compensation that took place in the 1990s. Complementary

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[22]Results by Coles 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 statistically significant in some specifications.

[23]Several articles provide suggestive evidence that shareholders may focus on compensation decisions when firms perform poorly. Ertimur et al. (2011) find that the probability of receiving a compensation-related shareholder proposal is decreasing in firm performance. Core et al. (2008) report that poor accounting performance is associated with a higher probability of press coverage of CEO compensation and, in some specifications, that poor operating performance is associated with greater negativity of press coverage. Core et al. find a less clear relation between stock returns and press coverage of CEO pay, with firms with high positive stock returns and very low negative returns being less likely to receive negative press coverage.

explanations, such as shifts in the demand for skills as 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.

6 Conclusion

Reputational concerns are, arguably, the single most powerful incentive for directors to act in the interest of shareholders. The alignment of the interests of shareholders and the board is especially important in the determination of executive compensation, because of the potentially strong incentives by directors to favor the CEO. 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 directors to lower executive pay. However, we show that reputational concerns may also lead boards to pay managers in hidden ways or structure compensation inefficiently. Moreover, a key insight of the model is that independent boards may be more likely than manager-friendly boards to pay in hidden ways. In our model, hidden pay emerges as an inefficient side effect of independent boards' efforts to signal their independence to investors, rather than as a strategy by manager-friendly boards to keep investors uninformed of the high levels of executive compensation at their firms.

Another key implication of our model is that there is substitutability between disclosed and camouflaged forms of pay. On the one hand, independent boards will generally have lower disclosed pay and higher hidden compensation than manager-friendly boards. On the other hand, independent boards substitute between disclosed and hidden pay as a response to changes that affect the costs of camouflaging pay or the value of a reputation for independence.

The theory developed in this paper yields several implications concerning the impact on executive compensation and shareholder value of corporate governance trends and regulatory reforms that tend to increase pay transparency and strengthen directors' reputational concerns. Thus, we show that corporate governance changes that increase the reputational pressure faced by directors are likely to

reduce disclosed pay, but may also lead to an increase in the use of hidden pay. Moreover, when reputational concerns are strong enough, a further increase in reputational pressure may reduce shareholder wealth. Therefore, 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.

We also show that corporate governance changes that make it more costly for boards to pay the CEO in hidden ways (such as stricter disclosure requirements, stronger incentives for accountants and auditors to fully disclose firms' compensation practices, or the emergence of corporate governance watchdogs) will generally discourage the use of hidden forms of pay. However, by making it more costly for manager-friendly boards to imitate the compensation policies of independent boards, such changes will also reduce the reputational pressure on independent boards to reduce transparent forms of pay and may, thus, lead to higher disclosed compensation. Moreover, if disclosure requirements are sufficiently stringent, making them stricter may reduce shareholder value. Therefore, the model has the implication that too much transparency may reduce shareholder value.

There are several issues that we do not address in this paper and that, in our view, warrant future research. First, we adopt a reduced form approach to modeling the labor market for directors. A more detailed model of the labor market for directors may generate valuable additional insights regarding the determinants of the value of a reputation for independence and its impact on boards' decisions. Second, we assume that hidden pay has no incentive effects. However, hidden pay could have incentive effects if, for example, it is used ex post to compensate the managers of underperforming firms for low realized levels of disclosed pay. We believe that the potential incentive effects of hidden pay deserve further study. Finally, in the model we take directors' compensation contracts as given. The interplay between reputational concerns and the compensation contracts that boards grant themselves is a fruitful area for future research.

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Appendix 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. Given disclosed payoffs (w, π), a board of type T will set the level of hidden pay y that solves problem (Y):

$$\max_{y} \quad (\pi - z(y)) + \theta_T v(w + y) + \eta\mu$$

$$\text{s.t} \quad y \geq 0 \tag{NN}$$

$$w + y \geq \underline{w}. \tag{PC}$$

Inspection of this maximization problem shows that π does not affect the board's choice of y. Further, the objective function is strictly concave, so for any (w, θ), (Y) has a unique solution, which can be expressed as a function $y(w, \theta)$ and satisfies the first order condition:

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

where $\lambda_T \geq 0$ and $\nu_T \geq 0$ are the Lagrange multipliers associated with the nonnegativity, (NN), and the manager's participation constraints, (PC), respectively.

Parts 1 and 2 of the lemma follow immediately from Theorems 4'-6 in Milgrom and Shannon (1994).[24] Let $V : Y \times W \times \Theta$ with $Y = \mathbb{R}_+, W = \mathbb{R}$, and $\Theta = \mathbb{R}_+$ be defined as $V(y, w, \theta) = (\pi - z(y)) + \theta_T v(w + y) + \eta\mu$. Let $S(w) = \{y \in Y : y \geq \underline{w} - w\}$ be the feasible set of problem (Y) as a function of w. It follows immediately from the definition of $S(w)$ that the set S is monotone nonincreasing in w (if $S(w)$ is an interval of the form $[\underline{y}(w), \infty)$, S is monotone nonincreasing if $w' > w$ implies that $\underline{y}(w') \leq \underline{y}(w)$.) Moreover, $\frac{\partial^2 V}{\partial y \partial \theta} > 0$ (i.e., V has increasing differences in (y, θ)) and $\frac{\partial^2 V}{\partial y \partial w} < 0$ (i.e, V has decreasing differences in (y, w)). Therefore, Theorem 5 in Milgrom and

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[24]Parts 1 and 2 can also be proven straightforwardly using standard implicit function techniques. We provide a proof that relies on monotone comparative statics methods for the sake of brevity and to highlight that the results follow from the sign of the cross-partial derivatives and do not hinge on the specific functional form assumed for U.

Shannon (1994) implies that $y(w, \theta)$ is nondecreasing in θ for any w, so that $y_M(w) \geq y_I(w)$, which proves part 1 of the lemma. Theorem 4' in Milgrom and Shannon (1994), in turn, implies that $y(w, \theta)$ is nonincreasing in w for any θ, so that $y_T(w)$ is nonincreasing in w, which proves the first statement in part 2 of the lemma.[25]

Suppose now that $y_M(w) > 0$. Then, either $y_M(w)$ is interior or $y_M(w) = \underline{w} - w$. In the former case, it follows from implicit differentiation of (FOC_y), $v'' < 0$ and $z'' > 0$ that:

$$y'_T = \frac{\theta_T v''}{z'' - \theta_T v''} < 0. \tag{12}$$

For w such that (PC) is binding: $y_T(w) = \underline{w} - w$. Therefore, $y'_T = -1 < 0$, which completes the proof of part 2 of the lemma.

We relegate the proof of parts 3 and 4 to the Online Addendum, since they follow straightforwardly from parts 1 and 2, $v'' < 0$, $z'' > 0$, and the first order condition (FOC_y) of Problem (Y).

Proof of Lemma 2. Define $\overline{U}(w, \pi, \mu; \theta)$ as the board's utility when the board's type is given by θ, disclosed payoffs are (w, π), the labor market's belief is μ, and the board sets its preferred level of hidden pay given (w, π), $y(w, \theta)$:

$$\overline{U}(w, \pi, \mu; \theta) \equiv U(w + y(w, \theta), \pi - z(y(w, \theta)), \mu; \theta). \tag{13}$$

To prove part 1, it suffices to show that for any π, π', μ, μ', if $w' > w$ and $w' + y_M(w') > \underline{w}$, then:

$$\left[\overline{U}(w', \pi', \mu'; \theta_I) - \overline{U}(w, \pi, \mu; \theta_I) \right] - \left[\overline{U}(w', \pi', \mu'; \theta_M) - \overline{U}(w, \pi, \mu; \theta_M) \right] < 0. \tag{14}$$

For fixed (w, π, μ) and (w', π', μ') with $w' > w$, define $G(\theta) \equiv \overline{U}(w', \pi', \mu'; \theta) - \overline{U}(w, \pi, \mu; \theta)$. Then, a sufficient condition for (14) is that $G'(\theta) \geq 0$ for any $\theta \in [\theta_I, \theta_M]$ and that there exists an interval $(\theta_a, \theta_b) \subset [\theta_I, \theta_M]$, such that $G'(\theta) > 0$ for any $\theta \in (\theta_a, \theta_b)$. Since $\overline{U}$ is the value function of problem

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[25]The theorems require Y to be a lattice, W and Θ to be partially ordered sets, and V to be supermodular in y. Since Y, W, and Θ are subsets of $\mathbb{R}$, they are lattices (and, hence, partially ordered). Moreover, since $Y \subset \mathbb{R}$, any function is supermodular in y (see Milgrom and Shannon, 1994, for details).

(Y), we can apply the Envelope Theorem and obtain:

$$\frac{\partial \overline{U}(w, \pi, \mu; \theta)}{\partial \theta} = v(w + y(w, \theta)). \tag{15}$$

Therefore:

$$G'(\theta) = v(w' + y(w', \theta)) - v(w + y(w, \theta)). \tag{16}$$

Thus, it follows from Lemma 1, $w' > w$, and $v' > 0$ that $G'(\theta) \geq 0$ for any θ. Further, we know from Lemma 1 that if $w' + y(w', \theta) > \underline{w}$ then $w' + y(w', \theta) > w + y(w, \theta)$. Therefore, if $w' + y(w', \theta_M) > \underline{w}$, then $G'(\theta) > 0$ in some interval $(\theta_a, \theta_b) \subset [\theta_I, \theta_M]$, which proves part 1 of the lemma.

If $w' + y(w', \theta_M) = \underline{w}$, then it follows from Lemma 1 that $w' + y(w', \theta_M) = w + y(w, \theta_M) = w' + y(w', \theta'_I) = w + y(w, \theta'_I) = \underline{w}$. Therefore:

$$\overline{U}(w', \pi', \mu'; \theta_I) - \overline{U}(w, \pi, \mu; \theta_I) = (\pi' - \pi) - \left[z(w' - \underline{w}) - z(w - \underline{w})\right] + \eta(\mu' - \mu) =$$

$$= \overline{U}(w', \pi', \mu'; \theta_M) - \overline{U}(w, \pi, \mu; \theta_M), \tag{17}$$

which proves part 2 of the lemma. ∎

Sketch of the proof of Proposition 1. The complete proof can be found in the Online Addendum. The basic idea is that the feasible set of the board's problem (in which the board can use hidden pay) is a subset of the feasible set of a modified problem in which hidden pay is not possible. This can be seen straightforwardly if one formulates both problems as finding the profit maximizing payoffs net of hidden pay $(\bar{w}, \bar{\pi})$ among the feasible ones. If hidden pay is not possible, for any feasible (w, π), $(\bar{w}, \bar{\pi}) = (w, \pi)$, so $(\bar{w}, \bar{\pi})$ is feasible if and only if $\bar{w} + \bar{\pi} \leq s^*$. If hidden pay is possible, the inefficiency of hidden pay implies that $w + \pi \geq \bar{w} + \bar{\pi}$, so $\bar{w} + \bar{\pi} > s^*$ would imply $w + \pi > s^*$. Therefore, a necessary condition for feasibility is that $\bar{w} + \bar{\pi} \leq s^*$. It follows that if $(\bar{w}, \bar{\pi})$ is feasible in the problem with hidden pay, then it is also feasible in the problem with no hidden pay. With hidden pay, feasibility

also requires that there exist some feasible disclosed payoff pair (w, π) such that $\bar{w} = w + y_T(w)$ and $\bar{\pi} = \pi - z(y_T(w))$. Thus, if $(\bar{w}^*, \bar{\pi}^*)$ is the solution to the (relaxed) problem with no hidden pay, then if $(\bar{w}^*, \bar{\pi}^*)$ is feasible if hidden pay is possible, it will also be the solution to the board's problem with hidden pay. Since $(\bar{w}^*, \bar{\pi}^*)$ is the board's optimal payoff pair, it follows that $y_T(\bar{w}^*) = 0$. Therefore, $(\bar{w}^*, \bar{\pi}^*)$ is feasible, and, hence, optimal, in the board's problem with hidden pay. It follows that the optimal contract with hidden pay is the same as with no hidden pay and that the board pays no hidden compensation. The efficiency of the contract follows from the fact that the board's preferences are increasing in π and w, so at the optimum $w^* + \pi^* = s^*$. The differences between the optimal contracts of the two board types follow straightforwardly from $\theta_M > \theta_I$.

Equilibrium Definition. We incorporate the equilibrium condition that the labor market act optimally given its belief μ into the function u_R, which can be interpreted as the board's expected utility if the market plays its best response given μ.[26] Thus, in our equilibrium definition we require only that the market's beliefs be consistent. We define an equilibrium as a Perfect Bayesian Equilibrium that satisfies the Intuitive Criterion. Although this equilibrium concept is standard (see, e.g., Fudenberg and Tirole (1991), page 452), we provide a definition applied to our model for the sake of clarity.

Let $\overline{U}_T^e$ 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:

$$\overline{U}_M(w, \pi, 1) < \overline{U}_M^e \text{ and } \overline{U}_I(w, \pi, 1) > \overline{U}_I^e \Rightarrow \mu(w, \pi) = 1 \tag{18}$$

$$\overline{U}_M(w, \pi, 1) > \overline{U}_M^e \text{ and } \overline{U}_I(w, \pi, 1) < \overline{U}_I^e \Rightarrow \mu(w, \pi) = 0 \tag{19}$$

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 labor market beliefs* $\mu(w, \pi)$ *is a*

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[26]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.

pure-strategy Perfect Bayesian equilibrium satisfying the Intuitive Criterion if:[27]

1. (w_T, π_T) *maximizes* $\overline{U}_T(w, \pi, \mu)$ *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 of Propositions 3-6.

Lemma 3 *Suppose that M plays* (w_M, π_M) *with positive probability at a candidate equilibrium strategy profile* s, *and let* $\mu(w_M, \pi_M)$ *be derived from* s *using Bayes rule. If* $\overline{U}_M(w_M, \pi_M, \mu(w_M, \pi_M)) \geq \overline{U}_M(w_M^*, \pi_M^*, 0)$, *then there are beliefs* $\mu^*(w, \pi)$ *that satisfy the Intuitive Criterion and such that, for those beliefs, there are no profitable deviations for M to payoff pairs not played by I.*

Proof of Lemma 3. Let (w_T, π_T) be a payoff pair played with positive probability by T according to s and let $\mu_T = \mu(w_T, \pi_T)$ be derived using Bayes rule from s. Now, let (w, π) be a payoff pair played with probability zero by both board types and such that $\overline{U}_M(w, \pi, 1) > \overline{U}_M(w_M, \pi_M, \mu_M)$. If $\overline{U}_I(w, \pi, 1) < \overline{U}_I(w_I, \pi_I, \mu_I)$, the Intuitive Criterion requires $\mu(w, \pi) = 0$. If $\overline{U}_I(w, \pi, 1) \geq \overline{U}_I(w_I, \pi_I, \mu_I)$, the Intuitive Criterion does not restrict $\mu(w, \pi)$. Thus, $\mu(w, \pi) = 0$ satisfies the Intuitive Criterion.

For any (w, π), $\overline{U}_M(w_M^*, \pi_M^*, 0) \geq \overline{U}_M(w, \pi, 0)$. Thus, if $\overline{U}_M(w_M, \pi_M, \mu_M) \geq \overline{U}_M(w_M^*, \pi_M^*, 0)$, then $\overline{U}_M(w_M, \pi_M, \mu_M) \geq \overline{U}_M(w, \pi, 0)$ for any (w, π). But for any (w, π) played with probability zero by both board types and such that (w, π) could potentially be a profitable deviation for M, $\mu(w, \pi) = 0$ satisfies the Intuitive Criterion, which completes the proof.[28] ∎

It follows from Lemma 3 that to show that M is playing a best response to at least some beliefs that satisfy the Intuitive Criterion it is enough to check that for any (w_M, π_M) played by M, $\overline{U}_M(w_M, \pi_M, \mu(w_M, \pi_M)) \geq \overline{U}_M(w_M^*, \pi_M^*, 0)$ and $\overline{U}_M(w_M, \pi_M, \mu(w_M, \pi_M)) \geq \overline{U}_M(w_I, \pi_I, \mu(w_I, \pi_I))$ for any (w_I, π_I) played by I, where $\mu(w_T, \pi_T)$ is derived from the boards' strategies using Bayes rule.

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[27] A mixed-strategy equilibrium is defined analogously.

[28] We note that requiring $\mu(w, \pi) = 0$ when the Intuitive Criterion does not pin down μ is not necessary to rule out profitable deviations. Less extreme beliefs would also work as long as $\overline{U}_I(w_I, \pi_I, 1) \geq \overline{U}_I(w, \pi, \mu)$. In the proofs below, we choose $\mu(w, \pi) = 0$ because it simplifies the derivations and because for some deviations, such beliefs would be in fact required by more stringent refinements such as D1 (Fudenberg and Tirole, 1991).

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

Lemma 4 *Let $\overline{U}_T^e$ denote the payoff of a type-T board at a candidate equilibrium e, and suppose that for some feasible (w, π), $\overline{U}_M(w, \pi, 1) \leq \overline{U}_M^e$ and $\overline{U}_I(w, \pi, 1) > \overline{U}_I^e$. Then, there exists a feasible payoff pair (w', π') such that $\overline{U}_M(w', \pi', 1) < \overline{U}_M^e$, $\overline{U}_I(w', \pi', 1) > \overline{U}_I^e$, and such that the Intuitive Criterion requires $\mu(w', \pi') = 1$. Thus, e is not an equilibrium, since there exists a profitable deviation for I.*

The following lemma proves the intuitive result that the board prefers an efficient disclosed payoff pair over any disclosed payoff pair with a salary further away from its preferred salary (the proof is in the Online Addendum):

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

Lemma 5 has the implication that if $(w, \pi) \neq (w_T^*, \pi_T^*)$ then it is always possible to locally increase the utility of a type T board (keeping μ constant), because if $\pi < s^* - w$, then an increase in π alone is feasible and it increases T's utility, and if $\pi = s^* - w$, then moving along the efficient frontier of F towards w_T^* also increases T's utility.

Lemma 5 and the Intuitive Criterion lead to the next lemma, which implies that M's incentive compatibility constraint is binding at any separating equilibrium in which $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ (the proof is in the Online Addendum):

Lemma 6 *Suppose that I plays (w_I, π_I) with $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ in equilibrium, and let $\mu_I = \mu(w_I, \pi_I)$ be derived by Bayes' rule from equilibrium strategies. Then, if $\overline{U}_M^e$ denotes M's equilibrium payoff, $\overline{U}_M(w_I, \pi_I, \mu_I) = \overline{U}_M^e$.*

Next, we provide two important lemmas. The first one characterizes I's equilibrium choices and shows, intuitively, that: 1) reputational concerns do not lead I to increase pay, 2) I does not lower pay below the level, $\widetilde{w}$, that is sufficient to efficiently separate from M (unless $\widetilde{w} > w_I^*$), and 3) as

long as there is room to lower total pay ($w_I > \underline{w}_M$), then I sets an efficient disclosed contract, since, otherwise, it would be possible for I to profitably deviate by increasing π and lowering w in a way that would not be profitable for M.

Lemma 7 *If I plays (w_I, π_I) in equilibrium, then: 1) $w_I \leq w_I^*$; 2) if $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$, then $w_I \geq \widetilde{w}$; and 3) if $w_I > \underline{w}_M$, then $\pi_I = s^* - w_I$ (i.e., the disclosed contract is efficient.)*

Proof of Lemma 7. Assume that I plays (w_I, π_I) in equilibrium and let $\mu_I = \mu(w_I, \pi_I) \leq 1$. First note that if $\overline{U}_M^e$ denotes M's equilibrium utility, then Lemma 6 implies that if $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$, then $\overline{U}_M^e = \overline{U}_M(w_I, \pi_I, \mu_I)$.

Suppose that $w_I > w_I^*$. It follows from the definition of w_I^* that $\overline{U}_I(w_I, \pi_I, \mu_I) < \overline{U}_I(w_I^*, \pi_I^*, 1)$. If $\overline{U}_M^e = \overline{U}_M(w_I, \pi_I, \mu_I) \geq \overline{U}_M(w_I^*, \pi_I^*, 1)$, then Lemma 4 shows that there is a profitable deviation for I. If $\overline{U}_M^e = \overline{U}_M(w_I, \pi_I, \mu_I) < \overline{U}_M(w_I^*, \pi_I^*, 1)$, then one can find a sufficiently unattractive payoff pair $(w', \pi') \in F$ such that $w' \leq w_I^*$ and $\overline{U}_M(w', \pi', 1) < \overline{U}_M(w_I, \pi_I, \mu_I)$. But then the Intermediate Value Theorem, continuity of $\overline{U}_M$, and connectedness of F ensure that one can find a payoff pair $(w'', \pi'') \in F$ with $w'' \leq w_I^* < w_I$ and $\overline{U}_M(w'', \pi'', 1) = \overline{U}_M(w_I, \pi_I, \mu_I) = \overline{U}_M^e$. Therefore, $w'' \leq w_I^* < w_I$, $w_I^* > \underline{w}_M$ and Lemma 2 imply that $\overline{U}_I(w'', \pi'', 1) > \overline{U}_I(w_I, \pi_I, \mu_I)$, so Lemma 4 shows that there is a profitable deviation for I. Thus, if I plays w_I in equilibrium, then it has to be the case that $w_I \leq w_I^*$.

Suppose that $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$, so $\overline{U}_M^e = \overline{U}_M(w_I, \pi_I, \mu_I)$. Lemma 5 implies that if $w_I < \widetilde{w}$, then $\overline{U}_M^e = \overline{U}_M(w_I, \pi_I, \mu_I) < \overline{U}_M(\widetilde{w}, s^* - \widetilde{w}, 1) = \overline{U}_M(w_M^*, \pi_M^*, 0)$, so M would have a profitable deviation. Thus, if $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$, then $w_I \geq \widetilde{w}$.

Suppose that $w_I > \underline{w}_M$. If $\pi_I < s^* - w_I$, then $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ (so that $\overline{U}_M^e = \overline{U}_M(w_I, \pi_I, \mu_I)$) and there exists a feasible (w, π) such that $w < w_I$, $\pi \geq \pi_I$, and $\overline{U}_M(w, \pi, 1) > \overline{U}_M(w_I, \pi_I, \mu_I) = \overline{U}_M^e$. But then (as above) one can find a sufficiently unattractive $(w'', \pi'') \in F$ with $w'' \leq w < w_I$ and $\overline{U}_M(w'', \pi'', 1) = \overline{U}_M(w_I, \pi_I, \mu_I) = \overline{U}_M^e$. Thus, it follows from Lemma 2 and $w_I > \underline{w}_M$ that $\overline{U}_I(w'', \pi'', 1) > \overline{U}_I(w_I, \pi_I, \mu_I)$, but Lemma 4 then implies that there is a profitable deviation for I, which proves part 3. of the lemma. ∎

The last lemma describes the range of parameter values for which there are no pooling equilibria and the levels of disclosed pay that can be played by both types at a pooling equilibrium:

Lemma 8 *If $\widetilde{w} > \underline{w}_M$, then there are no pooling equilibria. If both board types play (w, π) with positive probability in equilibrium, then $w + y_I(w) = w + y_M(w) = \underline{w}$, i.e., $w \le \underline{w}_M$.*

Proof of Lemma 8. Suppose that there is pooling at (w_p, π_p), so $\mu_p \equiv \mu(w_p, \pi_p) < 1$, and that $w_p > \underline{w}_M$. $\mu_p < 1$ implies that there are $(w, \pi) \in F$ close to (w_p, π_p) with $w < w_p$ and $\overline{U}_M(w, \pi, 1) > \overline{U}_M(w_p, \pi_p, \mu_p)$. But then (as in the proof of Lemma 7) one can find a payoff pair $(w'', \pi'') \in F$ with $w'' < w_p$ and $\overline{U}_M(w'', \pi'', 1) = \overline{U}_M(w_p, \pi_p, \mu_p)$. Thus, it follows from Lemma 2 and $w_p > \underline{w}_M$ that $\overline{U}_I(w'', \pi'', 1) > \overline{U}_I(w_p, \pi_p, \mu_p)$, but Lemma 4 then implies that there is a profitable deviation for I.

Lemma 7 implies that either $w_I = w_I^*$ or $w_I \ge \widetilde{w}$. By definition, $w_I^* \ge \underline{w} > \underline{w}_M$ so w_I^* cannot be a pooling salary. Therefore, if there is pooling at w_I, it has to be the case that $w_I \ge \widetilde{w}$. But, as we show in the previous paragraph, there can be pooling at w_I only if $w_I \le \underline{w}_M$. If $\widetilde{w} > \underline{w}_M$, the last two conditions cannot hold simultaneously. ∎

Proof of Proposition 3. First, note that if $\widetilde{w} > \underline{w}_M$, Lemma 8 shows that there are no pooling equilibria, so we restrict attention to separating equilibria. Thus, if (w_T, π_T) is the equilibrium payoff pair set by a type-T board, then Proposition 2 implies that $w_M = w_M^*$, $\pi_M = \pi_M^* = s^* - w_M^*$, and $\overline{U}(w_M, \pi_M, 0) = \overline{U}_M^*$. We describe the equilibria for different values of $\widetilde{w}$:

1. $\widetilde{w} \ge w_I^*$. If $w_I \ne w_I^*$, then part 1 of Lemma 7 implies that $w_I < w_I^*$. At the same time, part 2 of Lemma 7, $w_I \ne w_I^*$, and $\widetilde{w} \ge w_I^*$ imply that $w_I \ge \widetilde{w} \ge w_I^*$, a contradiction. Therefore, if there is an equilibrium, $w_I = w_I^*$. Part 3 of Lemma 7 and $w_I^* > \underline{w}_M$ then imply that $\pi_I = \pi_I^*$. But if $(w_I, \pi_I) = (w_I^*, \pi_I^*)$, then it follows from the definition of (w_I^*, π_I^*) that there are no profitable deviations for I. It also follows from $w_I^* \le \widetilde{w}$ and Lemma 4 that there are beliefs that satisfy the Intuitive Criterion such that there are no profitable deviations for M either.

2. $w_I^y \le \widetilde{w} < w_I^*$. In this case, I cannot play (w_I^*, π_I^*) at a separating equilibrium, since $w_I^* > \widetilde{w}$ and $\pi_I^* = s^* - w_I^*$ imply that M would imitate. Then, Lemma 7 implies that $w_I \ge \widetilde{w}$ and (since

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$\widetilde{w} \geq w_I^y > \underline{w}_M$) $\pi_I = s^* - w_I$. It follows that if $w_I > \widetilde{w}$, then M would imitate. Thus, if there is a separating equilibrium, $w_I = \widetilde{w}$ and $\pi_I = s^* - \widetilde{w}$. We check next that such separating equilibria exist.

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

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

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

Proof of Proposition 5. First note that (w_I^*, π_I^*) cannot be played by I at a separating equilibrium, since $w_I^* \in (\widetilde{w}, w_M^*)$ and $\pi_I^* = s^* - w_I^*$ imply that M would imitate. Thus, Lemma 7 implies that $w_I < w_I^*$ and $w_I \geq \widetilde{w}$. Now, if $w_I > \underline{w}_M$, then part 3 of Lemma 7 would imply that $\pi_I = s^* - w_I$, so $w_I > \underline{w}_M \geq \widetilde{w}$ and Lemma 5 would imply that M would imitate I. It follows that, in equilibrium, $w_I \in [\widetilde{w}, \underline{w}_M]$. Moreover, if we let $\pi_f(w)$ be defined implicitly by $\overline{U}_M(w, \pi_f(w), 1) = \overline{U}_M(w_M^*, \pi_M^*, 0)$, then $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ and Lemma 7 imply that $\pi_I = \pi_f(w_I)$.

Thus, let $w_I \in [\widetilde{w}, \underline{w}_M]$ and $\pi_I = \pi_f(w_I)$. 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 beliefs that satisfy the Intuitive Criterion such that there are no other profitable deviations for M. Therefore, it is enough to check that there are no profitable deviations for I.

Consider a feasible (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 it cannot be the case that the deviation is dominated for M but not for I. Thus, by definition of w_I^*, if $\overline{U}_I(w_I, \pi_I, 1) \geq \overline{U}_I(w_I^*, \pi_I^*, 0)$, then there are beliefs that satisfy the Intuitive

Criterion such that there are no profitable deviations for I with $w > \underline{w}_M$. Now, it follows (as in the proof of Proposition 3) from $\overline{U}_M(w_I, \pi_I, 1) = \overline{U}_M(w_M^*, \pi_M^*, 0) > \overline{U}_M(w_I^*, \pi_I^*, 0)$, $w_I < w_I^*$, and Lemma 2 that $\overline{U}_I(w_I, \pi_I, 1) > \overline{U}_I(w_I^*, \pi_I^*, 0)$. Thus, there are no profitable deviations for I with $w > \underline{w}_M$.

Consider now a deviation (w, π) with $w \leq \underline{w}_M$. Lemma 2 and the definition of π_f imply that:

$$\overline{U}_I(w, \pi, 1) - \overline{U}_I(w_I, \pi_I, 1) = \overline{U}_M(w, \pi, 1) - \overline{U}_M(w_I, \pi_I, 1) = \overline{U}_M(w, \pi, 1) - \overline{U}_M(w_M^*, \pi_M^*, 0), \quad (20)$$

so the Intuitive Criterion does not restrict $\mu(w, \pi)$. If we let $\mu(w, \pi) = 0$, (w, π) is not a profitable deviation for I, since $\overline{U}_I(w, \pi, 0) < \overline{U}_I(w_I^*, \pi_I^*, 0)$ and we showed above that $\overline{U}_I(w_I, \pi_I, 1) > \overline{U}_I(w_I^*, \pi_I^*, 0)$.

Since $w_I \leq \underline{w}_M < \underline{w}_I$, then $w_I + y_I(w_I) = \underline{w}$ at any separating equilibrium. Moreover, the definitions of $\widetilde{w}$ and π_f imply that if $w_I > \widetilde{w}$, then $\pi_I = \pi_f(w_I) < s^* - w_I$. $\blacksquare$

Proof of Proposition 6. Lemma 8 implies that if there is pooling at (w_p, π_p), then $w_p \leq \underline{w}_M$. If we let $\mu_p = \mu(w_p, \pi_p)$, then $w_p \leq \underline{w}_M$ implies that I cannot play with positive probability any (w', π') with $w' > \underline{w}_M$, since $\overline{U}_I(w', \pi', \mu') = \overline{U}_I(w_p, \pi_p, \mu_p)$, $w' > \underline{w}_M$, and Lemma 2, would imply $\overline{U}_M(w', \pi', \mu') > \overline{U}_M(w_p, \pi_p, \mu_p)$, so M would have a profitable deviation. Since $w_I^* > \underline{w}_M$, it follows that $w_I \neq w_I^*$, so Lemma 7 implies that if I plays (w_I, π_I) with positive probability at a pooling equilibrium, then $w_I \in [\widetilde{w}, \underline{w}_M]$. But this, in turn, implies that if M plays (w, π) with $w > \underline{w}_M$ with positive probability at a pooling equilibrium, then $\mu(w, \pi) = 0$. Thus, if M plays such (w, π) with positive probability, then $(w, \pi) = (w_M^*, \pi_M^*)$.

Let $\overline{\mu}(w, \pi)$ be defined by: $\overline{U}_M(w, \pi, \overline{\mu}(w, \pi)) = \overline{U}(w_M^*, \pi_M^*, 0)$. Thus, for M to play $(w, \pi) \neq (w_M^*, \pi_M^*)$, $\mu(w, \pi) \in [\overline{\mu}(w, \pi), 1]$. Further, if M plays (w_M^*, π_M^*) with positive probability, then $\mu(w, \pi) = \overline{\mu}(w, \pi)$ for any (w, π) also played by M. If we let $\overline{\mu}_M \equiv \overline{\mu}(\underline{w}_M, s^* - \underline{w}_M)$, then $\widetilde{w} \leq \underline{w}_M$ implies that $\overline{\mu}_M \leq 1$. Further, it follows from Lemma 5 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 board type T, $\overline{U}_T(\underline{w}_M, s^* - \underline{w}_M, \mu) > \overline{U}_T(w, \pi, \mu)$, so for any such (w, π), $\overline{\mu}(w, \pi) > \overline{\mu}_M$. Thus, if $\overline{\mu}_M > q$, then at any pooling equilibrium M must play (w_M^*, π_M^*) with positive probability. If $\overline{\mu}_M \leq q$, then there may exist 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 $\widetilde{w}$ that $\overline{\mu}(\widetilde{w}, \pi) \geq 1$ for any feasible π. Thus, (w_p, π_p) can be played with positive probability by both types only if $w_p \in (\widetilde{w}, \underline{w}_M]$ and $\pi_p \in (\pi_f(w_p), s^* - w_p]$ (for π_f as defined in the proof of Proposition 5). Take one such (w_p, π_p) and assume that I plays (w_p, π_p) with probability one and M plays (w_p, π_p) with probability $\sigma \in (0, 1]$ and (w_M^*, π_M^*) with probability $1 - \sigma$. If $\overline{\mu}(w_p, \pi_p) \leq q$, then the equilibrium must be fully pooling ($\sigma = 1$). If $\overline{\mu}(w_p, \pi_p) > q$, then M must play (w_M^*, π_M^*) with positive probability. We prove the existence of partly pooling equilibria for the latter case. The proof for the case $\overline{\mu}(w_p, \pi_p) \leq q$ is analogous, so we omit it.

Assume that $\overline{\mu}(w_p, \pi_p) > q$ and let $\sigma \in (0, 1)$ be such that, applying Bayes' rule, $\mu(w_p, \pi_p) = \overline{\mu}(w_p, \pi_p)$. By definition of $\overline{\mu}(w, \pi)$, M is indifferent between (w_M^*, π_M^*) and (w_p, π_p) if $\mu(w_p, \pi_p) = \overline{\mu}(w_p, \pi_p)$. 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 $(w, \pi) \neq (w_p, \pi_p)$. Further, for these beliefs there is no profitable deviation for I either. On the one hand, for any deviation with $w' > \underline{w}_M > w_p$, 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 and $w_p \leq \underline{w}_M$ imply 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. Finally, it follows from $w_p \leq \underline{w}_M$ that $y_I(w_p) = y_M(w_p) = \underline{w} - w_p$.

The previous paragraph fully characterizes pooling equilibria at which I chooses a single payoff pair with probability one. It can be shown analogously that there also exist pooling equilibria at which w_I randomizes between several payoff pairs with $w \in [\widetilde{w}, \underline{w}_M]$ and $\pi \in (\pi_f(w), s^* - w)$ and M randomizes between those payoff pairs and (w_M^*, π_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 $\widetilde{w}$, $\underline{w}_T$ and w_T^y (for $T = I, M$). Therefore, we relegate these proofs to the Online Addendum.

Appendix B Compensation Contracts, Managerial Actions and Payoff Pairs: A Simple Example

Suppose that revenues r are determined by the manager's action $e \in \mathbb{R}_+$ and a random shock ϵ: $r = e + \epsilon$, with $\epsilon \sim N(0, \sigma^2)$. Both e and ϵ are unobservable for the board. The board offers the manager a disclosed compensation contract that makes pay, t, linear in revenues. We let (α, β) represent the compensation contract such that $t = \alpha + \beta r$.

The manager is risk averse with exponential utility $u(t, e) = -e^{-\rho(t - g(e))}$, where t is the manager's pay and $g(e) = \frac{1}{2}e^2$ is the personal cost to the manager of taking action e. Therefore, the manager's certainty equivalent to contract (α, β) if the manager exerts effort e is simply $E(t(\alpha, \beta, r)|e) - \frac{\rho}{2}Var(t(\alpha, \beta, r)|e) - \frac{e^2}{2} = \alpha + \beta e - \frac{\rho \beta^2 \sigma^2}{2} - \frac{e^2}{2}$. It is immediate to show that the manager's choice of effort is $e(\alpha, \beta) = \beta$. Therefore:

$$w(\alpha, \beta) = \alpha + \frac{\beta^2}{2}(1 - \rho\sigma^2); \quad \pi(\alpha, \beta) = (1 - \beta)\beta - \alpha, \tag{21}$$

$$s(\beta) = \beta - \frac{\beta^2}{2}(1 + \rho\sigma^2). \tag{22}$$

It follows from (21)-(22) that total surplus depends only on the level of incentives β and that, if there are no restrictions on α, for any given β, any disclosed pair (w, π) such that $w + \pi = s(\beta)$ can be attained. Further, one can make $s(\beta)$ arbitrarily low by setting a high enough β.

In this example, s has a unique maximum at $\beta^* = \frac{1}{1+\rho\sigma^2}$, so $s^* = s(\beta^*) = \frac{1}{2(1+\rho\sigma^2)}$. Thus, the set of feasible payoffs is:

$$F = \left\{ (w, \pi) : w + \pi \leq \frac{1}{2(1 + \rho\sigma^2)} \right\}. \tag{23}$$

The fact that there is a unique level of beta that maximizes surplus implies that if two different disclosed payoff pairs are efficient, then both have the same level of incentives β^* and differ only in the base salary.

Appendix C   Online Addendum to "Board Independence, CEO Pay, and Camouflaged Compensation"

Proof of Lemma 1.   We prove Parts 1 and 2 in Appendix A of the article. We prove parts 3 and 4 below. Throughout the proof, Problem (Y), the first order condition (FOC_y), and the Lagrange multipliers λ_T and ν_T are as defined in Appendix A of the article.

Part 3. The first inequality in Assumption 3 ensures that for w' large enough:

$$\theta_T v'(w') - z'(0) < 0, \tag{24}$$

so $y_T(w') = 0$. On the other hand, for any $w'' < \underline{w}$, $y_T(w'') > 0$. Thus, it follows from continuity of y_T and the fact that y_T is nonincreasing that there exists a w_T^y such that $y_T(w_T^y) = 0$, $y_T(w) = 0$ for $w > w_T^y$, and $y_T(w) > 0$ for $w < w_T^y$, which proves part (a).

Part 1 implies that $w_M^y \geq w_I^y$. Now, $\theta_M v'(w_M^y) - z'(0) \leq 0$ implies that for some $w' \in (\underline{w}, w_M^y)$:

$$\theta_I v'(w) - z'(0) < 0, \text{ for any } w \in (w', w_M^y). \tag{25}$$

Now, $\nu_I = \nu_M = 0$ for $w > \underline{w}$ and Assumption 3 implies that $w_M^y > \underline{w}$. Thus, (25) ensures that for $w \in (w', w_M^y)$, $\lambda_I > 0$ and $y_I = 0$, so $w_I^y < w_M^y$, which proves part (b).

Part 4. Let $w' > w$ and assume that $w' + y_T(w') > \underline{w}$ and $w' + y_T(w') \leq w + y_T(w)$. Then, $y_T(w) > y_T(w') \geq 0$ and $w + y_T(w) > \underline{w}$, so $y_T(w)$ is an interior optimum and:

$$\theta_T v'(w + y_T(w)) - z'(y_T(w)) = 0. \tag{26}$$

But $z'' > 0$, $v'' < 0$ and the facts that $y_T(w) > y_T(w')$ and $w' + y_T(w') \leq w + y_T(w)$ then imply that

$$\theta_T v'(w' + y_T(w')) - z'(y_T(w')) > 0, \tag{27}$$

which is not possible, since $y_T(w')$ is optimal, which requires $\theta_T v'(w' + y_T(w')) - z'(y_T(w')) \leq 0$.

Thus, if $w' > w$ and $w' + y_T(w') > \underline{w}$, it is not possible that $w' + y_T(w') \leq w + y_T(w)$, which proves statement (a).

Now, suppose that $w' + y_T(w') = \underline{w}$. Then, an analogous argument shows that it is not possible that $w' + y_T(w') < w + y_T(w)$. Thus, it follows that if $w' + y_T(w') = \underline{w}$, then $w' + y_T(w') = w + y_T(w) = \underline{w}$, which proves statement (b).

Proof of Proposition 1.   We can write the type-T board's problem as:

$$\max_{\bar{w}, \bar{\pi}} \quad \bar{\pi} + \theta_T v(\bar{w})$$

$$s.t. \quad \bar{w} \geq \underline{w} \tag{28}$$

$$(\bar{w}, \bar{\pi}) \in F_T, \tag{29}$$

where $F_T \equiv \{(\bar{w}, \bar{\pi}) : \bar{w} = w + y_T(w), \bar{\pi} = \pi - z(y_T(w)), \text{ for some } (w, \pi) \text{ s.t. } w + \pi \leq s^*\}$.

Now, $w + \pi \leq s^*$ and $z' > 1$ imply that $\bar{\pi} + \bar{w} \leq s^*$. Thus, we can rewrite the board's problem as:

$$\max_{\bar{w}, \bar{\pi}} \quad \bar{\pi} + \theta_T v(\bar{w})$$

$$s.t. \quad \bar{w} \geq \underline{w} \tag{30}$$

$$\bar{\pi} + \bar{w} \leq s^* \tag{31}$$

$$(\bar{w}, \bar{\pi}) \in F_T. \tag{32}$$

Consider now the relaxed problem:

$$\max_{\bar{w}, \bar{\pi}} \quad \bar{\pi} + \theta_T v(\bar{w})$$

$$s.t. \quad \bar{w} \geq \underline{w} \tag{33}$$

$$\bar{\pi} + \bar{w} \leq s^*. \tag{34}$$

This relaxed problem corresponds to the board's problem if hidden pay is not possible, since, in this case, one can define $(\bar{w}, \bar{\pi}) = (w, \pi)$. To find the optimum of the board's problem, we first find the optimum of the relaxed problem $(\bar{w}_T^*, \bar{\pi}_T^*)$ and then show that $(\bar{w}_T^*, \bar{\pi}_T^*) \in F_T$, so that $(\bar{w}_T^*, \bar{\pi}_T^*)$ is an optimum of the board's problem.

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

$$\max_{\bar{w}} \quad (s^* - \bar{w}) + \theta_T v(\bar{w})$$

$$\text{s.t.} \quad \bar{w} \geq \underline{w}.$$

The concavity of v guarantees that the solution to this problem is given by the FOC:

$$-1 + \theta_T v'(\bar{w}_T^*) + \iota_T = 0. \tag{35}$$

where $\iota_T \geq 0$ is the multiplier associated with the manager's participation constraint. Assumption 3 guarantees that $\bar{w}_M^* > \underline{w}$ ($\iota_M = 0$). Therefore, $v'' < 0$ and $\theta_M > \theta_I$ imply that $\bar{w}_M^* > \bar{w}_I^*$, which, in turn, implies that $\bar{\pi}_M^* < \bar{\pi}_I^*$, since $\bar{w}^* + \bar{\pi}^* = s^*$.

Let disclosed payoff pair (w_T^*, π_T^*) be defined as $(w_T^*, \pi_T^*) = (\bar{w}_T^*, \bar{\pi}_T^*)$. Since $(\bar{w}_T^*, \bar{\pi}_T^*)$ satisfies (34), it follows that (w_T^*, π_T^*) is a feasible disclosed payoff pair. Now, (35), $\iota_T \geq 0$, and $z' > 1$, imply that:

$$-z'(0) + \theta_T v'(w_T^*) < 0. \tag{36}$$

But, then, the first order condition of Problem (Y), (FOC$_y$), implies that, in that problem, either $\lambda_T > 0$, so $y_T(w_T^*) = 0$, or $\nu_T > 0$, so $w_T^* + y_T(w_T^*) = \underline{w}$. But, in the latter case, $y_T(w_T^*) = 0$ as well, since $w_T^* \geq \underline{w}$. Thus, it follows from $(w_T^*, \pi_T^*) = (\bar{w}_T^*, \bar{\pi}_T^*)$, $y_T(w_T^*) = 0$, and feasibility of (w_T^*, π_T^*) that $(\bar{w}_T^*, \bar{\pi}_T^*) \in F_T$, so $(\bar{w}_T^*, \bar{\pi}_T^*)$ is the board's optimal payoff pair net of hidden pay. Disclosed payoff pair (w_T^*, π_T^*) generates net-of-hidden-pay payoff pair $(\bar{w}_T^*, \bar{\pi}_T^*)$, and one can immediately show that no

other feasible disclosed payoff pair leads to $(\bar{w}_T^*, \bar{\pi}_T^*)$. Thus, (w_T^*, π_T^*) is the unique optimal disclosed payoff pair of a type-T board. $\bar{w}_M^* > \bar{w}_I^*$ and $\bar{\pi}_M^* < \bar{\pi}_I^*$ imply that $w_M^* > w_I^*$ and $\pi_M^* < \pi_I^*$. ∎

Proof of Lemma 5. Consider problem (Y) with the additional restriction that $\pi = s^* - w$, and let $V_T(w) \equiv \overline{U}_T(w, s^* - w, \mu)$ be the value function of this problem (as a function of w). The Lagrangean of this problem is $\mathcal{L}_T = (s^* - w - z(y_T)) + \theta_T v(w + y_T) + \eta\mu + \hat{\lambda}_T y_T + \hat{\nu}_T(w + y_T - \underline{w})$, so applying the Envelope Theorem:

$$V_T' = \frac{\partial \mathcal{L}_T}{\partial w} = \theta_T v'(w + y_T(w)) - 1 + \hat{\nu}_T. \tag{37}$$

Let $w > w_T^*$. Then, it follows from Lemma 1 and $w_T^* \geq \underline{w}$ that $w + y_T(w) > w_T^* \geq \underline{w}$, so $\hat{\nu}_T = 0$. Further, the first order condition (35) implies that $\theta_T v'(w_T^*) - 1 \leq 0$. Thus, $v'' < 0$ implies that $\theta_T v'(w + y_T(w)) - 1 < 0$, so $V_T'(w) < 0$. Therefore, if $w > w' > w_T^*$, then for any $\mu' \geq \mu$ and $\pi \leq s^* - w$, $\overline{U}_T(w, \pi, \mu) \leq V_T(w) < V_T(w') \leq \overline{U}_T(w', s^* - w', \mu')$.

Let $w < w_T^*$. If $w_T^* > \underline{w}$, then Lemma 1 implies that $w + y_T(w) < w_T^*$. Further, the first order condition (35) implies that $\theta_T v'(w_T^*) - 1 = 0$. Thus, since $\hat{\nu}_T \geq 0$ and $v'' < 0$, it follows from (37) that $V_T'(w) > 0$. If $w_T^* = \underline{w}$ (which can happen only for I), then $w + y_T(w) = w_T^* = \underline{w}$ for any $w < w_T^*$. Thus, $z' > 1$ implies that $V_T'(w) > 0$. Therefore, if $w < w' \leq w_T^*$, then for any $\mu' \geq \mu$ and $\pi \leq s^* - w$, $\overline{U}_T(w, \pi, \mu) \leq V_T(w) < V_T(w') \leq \overline{U}_T(w', s^* - w', \mu')$. ∎

Proof of Lemma 6. If M sets (w_I, π_I) with positive probability (there is pooling at (w_I, π_I)), then it has to be the case that $\overline{U}_M(w_I, \pi_I, \mu_I) = \overline{U}_M^e$. Now suppose that, in equilibrium, only I sets (w_I, π_I) with positive probability (so $\mu_I = 1$) and $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$. If $\overline{U}_M(w_I, \pi_I, 1) > \overline{U}_M^e$, then (w_I, π_I) would be a profitable deviation for M. If $\overline{U}_M(w_I, \pi_I, 1) < \overline{U}_M^e$, then Lemma 5 and $(w_I, \pi_I) \neq (w_I^*, \pi_I^*)$ imply that there is a feasible (w', π') close enough to (w_I, π_I) such that $\overline{U}_I(w', \pi', 1) > \overline{U}_I(w_I, \pi_I, 1)$ and $\overline{U}_M(w', \pi', 1) < \overline{U}_M^e$. 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 $\overline{U}_M(w_I, \pi_I, 1) = \overline{U}_M^e$. ∎

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Proof of Proposition 7. Let $V_T(y, w, \kappa) \equiv U_T(w+y, \pi-z(y; \kappa), \mu)$ and $y_T(w; \kappa) = \arg\max_{y \in S} V(y, w, \kappa)$, where $S = \{y \in \mathbb{R}_+ : w + y \geq \underline{w}\}$. As in the proof of Lemma 1, it follows from $\frac{\partial^2 V_T}{\partial y \partial \kappa} = -z_{y\kappa} < 0$ and Theorem 5 in Milgrom and Shannon (1994) that $y_T(w; \kappa)$ is nonincreasing in κ.

Now, let $\widetilde{w}(\kappa)$ denote the value of $\widetilde{w}$ as a function of κ, defined implicitly as:

$$s^* - \widetilde{w}(\kappa) - z(y_M(\widetilde{w}(\kappa); \kappa); \kappa) + \theta_M v(\widetilde{w}(\kappa) + y_M(\widetilde{w}(\kappa); \kappa)) + \eta = s^* - w_M^* + \theta_M v(w_M^*). \quad (38)$$

Implicit differentiation of this expression yields:

$$\widetilde{w}'(\kappa) = \frac{z_\kappa(y_M(\widetilde{w}; \kappa); \kappa) - \frac{\partial y_M}{\partial \kappa}(\widetilde{w}; \kappa)[\theta_M v'(\widetilde{w} + y_M(\widetilde{w}; \kappa)) - z_y(y_M(\widetilde{w}; \kappa); \kappa)]}{\theta_M v'(\widetilde{w} + y_M(\widetilde{w}; \kappa)) - 1 + \frac{\partial y_M}{\partial w}(\widetilde{w}; \kappa)[\theta_M v'(\widetilde{w} + y_M(\widetilde{w}; \kappa)) - z_y(y_M(\widetilde{w}; \kappa); \kappa)]}. \quad (39)$$

First note that $\widetilde{w} < w_M^*$, $w_M^* > \underline{w}$ and Lemma 1 imply that $\widetilde{w} + y_M(\widetilde{w}; \kappa) < w_M^*$, so $\theta_M v'(\widetilde{w} + y_M(\widetilde{w}; \kappa)) - 1 > \theta_M v'(w_M^*) - 1 = 0$. Further, (FOC$_y$) implies that $\theta_M v'(\widetilde{w} + y_M(\widetilde{w}; \kappa)) - z_y(y_M(\widetilde{w}; \kappa); \kappa) \leq 0$. Finally, $\frac{\partial y_M}{\partial w} \leq 0$. Therefore, the denominator in (39) is strictly positive.

Now, if $\widetilde{w} > w_M^y$, then $y_M(\widetilde{w}; \kappa) = 0$, $\frac{\partial y_M}{\partial w}(\widetilde{w}; \kappa) = 0$, and $z_\kappa(0; \kappa) = 0$. Therefore, $\widetilde{w}'(\kappa) = 0$.

If $\widetilde{w} \in (\underline{w}_M, w_M^y)$, then $y_M(\widetilde{w}; \kappa)$ is interior, so $\theta_M v'(\widetilde{w} + y_M(\widetilde{w}; \kappa)) - z_y(y_M(\widetilde{w}; \kappa); \kappa) = 0$. Thus, since $z_\kappa(y; \kappa) > 0$ for $y > 0$, $\widetilde{w}'(\kappa) > 0$.

Finally, if $\widetilde{w} < \underline{w}_M$, then $y_M(\widetilde{w}; \kappa) = \underline{w} - \widetilde{w}$, so $\frac{\partial y_M}{\partial \kappa}(\widetilde{w}; \kappa) = 0$. Thus, since $z_\kappa(y; \kappa) > 0$ for $y > 0$, $\widetilde{w}'(\kappa) > 0$.

We consider first the case $\widetilde{w} \geq \underline{w}_M$. In this case, there are only separating equilibria with $w_I = \min\{\widetilde{w}, w_I^*\}$ and $w_M = w_M^*$. w_I^* and w_M^* do not depend on κ, and $\widetilde{w}' \geq 0$, so w_I is nondecreasing in κ. The equilibrium level of hidden pay is 0 if $w_I = w_I^*$ and equal to $y_I(\widetilde{w}; \kappa)$ if $w_I = \widetilde{w}$. From $\frac{\partial y_I}{\partial w}(\widetilde{w}; \kappa) \leq 0$, $\frac{\partial y_I}{\partial \kappa}(\widetilde{w}; \kappa) \leq 0$, and $\widetilde{w}'(\kappa) \geq 0$, it follows that:

$$\frac{dy_I}{d\kappa}(\widetilde{w}; \kappa) = \frac{\partial y_I}{\partial \kappa}(\widetilde{w}; \kappa) + \frac{\partial y_I}{\partial w}(\widetilde{w}; \kappa)\frac{d\widetilde{w}}{d\kappa} \leq 0. \quad (40)$$

Consider now the case $\widetilde{w} < \underline{w}_M$. In this case, there are multiple equilibria, so we provide compar-

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ative statics concerning the maximum and minimum levels of disclosed and hidden pay that I may set in equilibrium. If $\widetilde{w} < \underline{w}_M$, it follows from propositions 5 and 6 that the set of possible equilibrium levels of disclosed pay for I is $[\widetilde{w}, \underline{w}_M]$ and the set of possible equilibrium levels of hidden pay for I is $[y_I(\underline{w}_M), y_I(\widetilde{w})]$. We have already shown that $\widetilde{w}' \geq 0$ and $\frac{dy_I}{d\kappa}(\widetilde{w}; \kappa) \leq 0$. Thus, we need only determine how $\underline{w}_M$ and $y_I(\underline{w}_M)$ change with κ. Now, $\underline{w}_M(\kappa)$ is given by the FOC:

$$\theta_M v'(\underline{w}) - z_y(\underline{w} - \underline{w}_M(\kappa); \kappa) = 0. \tag{41}$$

Implicit differentiation of this expression yields:

$$\underline{w}'_M(\kappa) = \frac{z_{y\kappa}(\underline{w} - \underline{w}_M; \kappa)}{z_{yy}(\underline{w} - \underline{w}_M; \kappa)} > 0. \tag{42}$$

Therefore, since $y_I(\underline{w}_M) = \underline{w} - \underline{w}_M$ for any κ, $y_I(\underline{w}_M)$ is decreasing in κ. ∎

Proof of Proposition 8. As a preliminary step, we derive how w_T^y changes with κ. For any T, κ, $w_T^y(\kappa) \geq \underline{w}$. Now, if $\theta_T v'(\underline{w}) - z_y(0; \kappa') \leq 0$ for some κ' (which can happen only for $T = I$), then $w_T^y(\kappa') = \underline{w}$. But then it follows from $z_{y\kappa} > 0$ that $\theta_T v'(\underline{w}) - z_y(0; \kappa) \leq 0$ and $w_T^y(\kappa) = \underline{w}$ for any $\kappa > \kappa'$, so $\frac{dw_T^y}{d\kappa} = 0$. If $w_T^y(\kappa) > \underline{w}$, then $\theta_T v'(w_T^y(\kappa)) - z_y(0; \kappa) = 0$. Thus, $z_{y\kappa} > 0$ and $v'' < 0$ imply that $\frac{dw_T^y}{d\kappa} < 0$.

Therefore, since $\widetilde{w}'(\kappa') \geq 0$, if $\widetilde{w}(\kappa) > w_T^y(\kappa)$ for some κ, then $\widetilde{w}(\kappa') > w_T^y(\kappa')$ for any $\kappa' > \kappa$. Now, since $\lim_{\kappa \to K} y_M(\underline{w}) = 0$, it follows that:

$$\lim_{\kappa \to K} [\overline{U}_M(\underline{w}, s^* - \underline{w}, 1) - U_M(\underline{w}, s^* - \underline{w}, 1)] = 0. \tag{43}$$

Thus, if (11) holds, then (43) implies that for $\kappa < K$ large enough:

$$\overline{U}_M(\underline{w}, s^* - \underline{w}, 1) < U_M(w_M^*, \pi_M^*, 0) = \overline{U}_M(w_M^*, \pi_M^*, 0), \tag{44}$$

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so $\widetilde{w}(\kappa) > \underline{w}$. Now, for κ large enough, it follows from part 1 of Assumption 4 that $w_I^y(\kappa) = \underline{w}$. Thus, (11) implies that for $\kappa < K$ large enough $\widetilde{w}(\kappa) > w_I^y(\kappa)$. Further, part 2 of Assumption 4 implies that for $\kappa > 0$ low enough, $\widetilde{w} < \underline{w} \leq w_T^y$ for any T. Therefore if we define $\bar{\kappa} \equiv \inf\{\kappa : \widetilde{w}(\kappa) > w_I^y(\kappa)\}$, then $0 < \bar{\kappa} < K$. By continuity of w_I^y and $\widetilde{w}$, $w_I^y(\bar{\kappa}) = \widetilde{w}(\bar{\kappa})$. Thus, since $w_M^y > w_I^y$ for any $\kappa < K$, it follows that $w_M^y(\bar{\kappa}) > \widetilde{w}(\bar{\kappa})$ and there is a $\kappa_0 \in (\bar{\kappa}, K]$ such that $\kappa \in [\bar{\kappa}, \kappa_0) \Rightarrow \widetilde{w}(\kappa) < w_M^y(\kappa)$.

Assume that $w_I^* > \underline{w}$ Then, $w_I^y(\kappa) < w_I^*$ for any $\kappa > 0$, so $\widetilde{w}(\bar{\kappa}) = w_I^y(\bar{\kappa})$ implies that there is a $\kappa_1 \in (\bar{\kappa}, K]$, such that $\widetilde{w}(\kappa) < w_I^*$ for $\kappa \in [\bar{\kappa}, \kappa_1)$. Letting $\kappa_2 = \min\{\kappa_0, \kappa_1\}$, it, thus, follows that if $\kappa \in (\bar{\kappa}, \kappa_2)$, then $w_I^* > \widetilde{w}$ and $w_M^y > \widetilde{w} > w_I^y$.

If there is a unique separating equilibrium, let $\widehat{\pi}_I(\kappa) \equiv s^* - w_I(\kappa) - z\left(y_I(w_I(\kappa); \kappa); \kappa\right)$. Therefore:

$$\widehat{\pi}_I'(\kappa) = -w_I'(\kappa) - z_\kappa(y_I(w_I; \kappa); \kappa) - z_y(y_I(w_I; \kappa); \kappa)\left[\frac{\partial y_I}{\partial \kappa}(w_I; \kappa) + \frac{\partial y_I}{\partial w}(w_I; \kappa)w_I'(\kappa)\right]. \qquad (45)$$

Suppose now that $\kappa \geq \bar{\kappa}$. Since $w_I^y(\kappa) \geq \underline{w}$ for any κ, and $\underline{w}_M < \underline{w}$ for any $\kappa < K$, it follows from $\widetilde{w}(\kappa) \geq w_I^y(\kappa)$ that $\widetilde{w}(\kappa) > \underline{w}_M$, so there is a unique separating equilibrium with $w_I(\kappa) = \min\{\widetilde{w}(\kappa), w_I^*\}$. Now, if $\kappa > \bar{\kappa}$, then $y_I = 0$ and $\widehat{\pi}_I'(\kappa) = -w_I'(\kappa)$. If $\widetilde{w}(\kappa) > w_I^*$, then $w_I(\kappa) = w_I^*$ and $\widehat{\pi}_I' = 0$. If $\widetilde{w}(\kappa) < w_I^*$, then $w_I(\kappa) = \widetilde{w}(\kappa)$, so $\widetilde{w}' \geq 0$ implies that $\widehat{\pi}_I' \leq 0$. Therefore, $\kappa > \bar{\kappa} \Rightarrow \widehat{\pi}_I' \leq 0$. Further, if $\kappa \in (\bar{\kappa}, \kappa_2)$, then $w_I^* > \widetilde{w}$ and $w_M^y > \widetilde{w} > w_I^y$, so (39) implies that $\widetilde{w}' > 0$ and $\widehat{\pi}_I' < 0$. Therefore $\widehat{\pi}_I(\bar{\kappa}) > \widehat{\pi}_I(\kappa)$ for any $\kappa > \bar{\kappa}$. ∎

Proof of Proposition 9. The definition of $\underline{w}_M$ implies that $\underline{w}_M$ is unaffected by η. Abusing notation, let $\widetilde{w}(\eta)$ be defined implicitly by:

$$[s^* - \widetilde{w}(\eta) - z(y_M(\widetilde{w}(\eta)))] + \theta_M v(\widetilde{w}(\eta) + y_M(\widetilde{w}(\eta))) + \eta = (s^* - w_M^*) + \theta_M v(w_M^*). \qquad (46)$$

Implicit differentiation of the above expression yields:

$$\widetilde{w}'(\eta) = -\left(\frac{1}{\theta_M v'(\widetilde{w} + y_M(\widetilde{w})) - 1 + y_M'(\widetilde{w})\left[\theta_M v'(\widetilde{w} + y_M(\widetilde{w})) - z'(y_M(\widetilde{w}))\right]}\right) < 0, \qquad (47)$$

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

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

To prove part 3, let $\{(w_1, \pi_1), \ldots, (w_n, \pi_n)\}$, with $w_i \leq \underline{w}_M$, be the set of payoff pairs played with positive probability by I at a pooling equilibrium, and let $(\sigma_{T1}, \ldots, \sigma_{Tn})$ denote the probabilities with which T plays the corresponding payoff pairs. Let μ_i denote the equilibrium beliefs for (w_i, π_i). It follows from Bayes' rule that for a given σ_{Ii} and for $\mu_i \in \left[\frac{q\sigma_{Ii}}{q\sigma_{Ii}+(1-q)}, 1\right]$:

$$\sigma_{Mi} = \sigma_{Ii} \left(\frac{q}{1-q}\right) \left(\frac{1-\mu_i}{\mu_i}\right) \in [0,1]. \tag{48}$$

Let σ_M be the probability with which M pays hidden compensation at a given pooling equilibrium:

$$\sigma_M \equiv \sum_{i=1}^{n} \sigma_{Mi} = \left(\frac{q}{1-q}\right) \sum_{i=1}^{n} \sigma_{Ii} \left(\frac{1-\mu_i}{\mu_i}\right). \tag{49}$$

It follows from the proof of Proposition 6 that at any pooling equilibrium $\mu_i \geq \overline{\mu}(w_i, \pi_i) \geq \overline{\mu}(\underline{w}_M, s^* - \underline{w}_M) = \overline{\mu}_M$ and $\overline{\mu}(w_i, \pi_i) > \overline{\mu}_M$ for $(w_i, \pi_i) \neq (\underline{w}_M, s^* - \underline{w}_M)$. We also show in that proof that $\sum_i \sigma_{Ii} = 1$. Therefore:

$$\overline{\sigma} \equiv \left(\frac{q}{1-q}\right) \left(\frac{1-\overline{\mu}_M}{\overline{\mu}_M}\right) \geq \left(\frac{q}{1-q}\right) \sum_{i=1}^{n} \sigma_{Ii} \left(\frac{1-\mu_i}{\mu_i}\right). \tag{50}$$

Now, if $\mu_M \geq q$, then $\overline{\sigma}$ can be attained if $\sigma_I((\underline{w}_M, s^* - \underline{w}_M)) = 1$, $\sigma_M((w, \pi)) = 0$ for any $(w, \pi) \notin \{(\underline{w}_M, s^* - \underline{w}_M), (w_M^*, \pi_M^*)\}$ and $\sigma_M((\underline{w}_M, s^* - \underline{w}_M))$ is such that by Bayes' rule one obtains $\mu(\underline{w}_M, s^* - \underline{w}_M) = \overline{\mu}_M$. Thus, $\overline{\sigma}$ is the maximum value of σ_M possible at a pooling equilibrium. Then, from the definition of $\overline{\mu}_M$, it follows immediately that $\overline{\mu}_M$ is decreasing in η, so $\overline{\sigma}$ is increasing in η. For any $\mu_M < q$, the maximum σ_M is one (since a fully pooling equilibrium is possible), so the maximum probability with which M pays hidden pay is nondecreasing in η. ∎

Proof of proposition 10. For any η, it follows from Lemma 1, Proposition 1, and Assumption 3 that $w_M^* > w_M^y > w_I^y \geq \underline{w} \geq \underline{w}_I > \underline{w}_M$.

Let η_T^y be defined by $w_T^y = \widetilde{w}(\eta_T^y)$. Similarly, let η_T be defined by $\underline{w}_T = \widetilde{w}(\eta_T)$. It follows from Proposition 9 that $\eta_M^y < \eta_I^y \leq \eta_I < \eta_M$. Now, $\widetilde{w}(\eta) \to w_M^*$ as $\eta \to 0$. Therefore, for $\eta > 0$ low enough $\widetilde{w}(\eta) > w_M^y > w_I^y \geq \underline{w} \geq \underline{w}_I > \underline{w}_M$. 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 $\widehat{\pi}_I(\eta) \equiv s^* - \widetilde{w}(\eta) - z(y_I(\widetilde{w}(\eta)))$. Then:

$$\frac{d\widehat{\pi}_I}{d\eta} = -\frac{d\widetilde{w}}{d\eta}\left(1 + z_y(y_I)\frac{dy_I}{dw}\right). \tag{51}$$

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

$$\frac{d\widehat{\pi}_I}{d\eta} > 0 \iff 1 + z_y(y_I(\widetilde{w}(\eta)))\frac{dy_I}{dw}(\widetilde{w}(\eta)) > 0 \tag{52}$$

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

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

$$1 + z_y(y_I(\widetilde{w}(\eta)))\frac{dy_I}{dw}(\widetilde{w}(\eta)) = 1 - z_y(y_I(\widetilde{w}(\eta))) < 0, \tag{53}$$

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