

# Attracting Attention: Cheap Managerial Talk and Costly Market Monitoring\*

**Andres Almazan**  
University of Texas

**Sanjay Banerji**  
University of Durham

**Adolfo de Motta**  
McGill University

10 June 2005

## **Abstract**

This paper provides a theory of informal communication (cheap talk) between firms and the capital market. The theory emphasizes the central role that agency conflicts play in firms' disclosure policies. Since managers' information is a consequence of their actions, incentive compensation and information disclosure become two intrinsically linked aspects of corporate governance. In the model, the information disclosed by managers attracts market attention and guides investors in their investigation efforts. Optimal incentive compensation, however, discourages managers from attracting market attention unless the firm is severely undervalued. The analysis relates the credibility of managerial announcements to the use of stock based compensation, the presence of informed trading, and the level of liquidity in the market. The study can also explain why apparently innocuous corporate events (e.g., a stock dividend or a name change) can affect a firm's stock price, and suggests that an adequate use of incentive compensation can foster the communication of managerial information to the market.

---

\*We would like to thank Aydogan Altı, Steven Gallaher, Jay Hartzell, Paul Newman, Ramesh Rao, Ronnie Shah, seminar participants at Concordia University, University of Leeds, McGill University, the University of Texas, University of Warwick and the Accounting and Finance Conference at UT-Austin, and especially Sheridan Titman. The remaining errors are our sole responsibility. Address correspondence to Andres Almazan, Department of Finance, McCombs School of Business, University of Texas at Austin, TX, 78712-1179. E-mail address: [andres.almazan@mcombs.utexas.edu](mailto:andres.almazan@mcombs.utexas.edu). De Motta is grateful for financial support from SSHRC.



# 1 Introduction

One of the central issues in finance is how information about a firm is incorporated into its stock price. Among other things, stock prices guide the allocation of capital to firms, are used in incentive compensation to address agency conflicts, and influence the perception of the firm by its stakeholders and hence, the firm's ability to conduct business.

By disseminating their privately held information, firms can contribute to making prices more efficient.<sup>1</sup> Companies, nevertheless, can find it difficult to convey *soft* information, i.e., information that cannot be substantiated with hard evidence. One way for firms to convey such soft information is through the use of costly signals (e.g., Ross 1977). Alternatively, this paper proposes a theory of informal communication (cheap talk) between firms and the capital market where firms suffer no signaling costs but must induce managerial disclosure of soft information to the market.<sup>2</sup>

In contrast to previous literature, our theory emphasizes the central role that agency conflicts (i.e., self-interested managers) play in firms' disclosure policies. Indeed, to the extent that managers' information is partially a consequence of their actions, incentive compensation and information disclosure become two intrinsically linked aspects of corporate governance.<sup>3</sup> Specifically, we model a firm subject to moral hazard where managers subsequently obtain soft information about the company's prospects. Incentive compensation, which addresses managerial moral hazard, must induce managers to disclose information that then can be used to evaluate their performance.

An important aspect of the analysis is the fact that speculators can produce information

---

<sup>1</sup>Recent regulations (e.g., regulation FD and Sarbanes-Oaxley Act) emphasize the importance of providing accurate and timely information to investors.

<sup>2</sup>The literature has reported a number of corporate actions that produce valuation effects without disclosing any certifiable information or incurring any obvious signaling costs. Examples of such actions include stock splits and stock dividends (e.g., Grinblatt, Masulis and Titman 1984), name changes (e.g., Cooper, Dimitrov and Rau 2001) and, more generally, non-binding announcements by firms (e.g., Ikenberry, Lakonishok and Vermaelen 1995).

<sup>3</sup>This is consistent with the view expressed in the Stern Stewart Executive Round Table 2001, p. 37: "...the managers of most companies would rather not disclose things if they don't have to. They don't want you to see what they are doing..."

that is complementary to the information disclosed by managers. On one hand, since it is costly to investigate firms, managerial announcements attract attention to the firm and provide guidance to speculators in their investigation efforts. On the other hand, since due to speculation the firm's stock price becomes more informative, it can be used to assess the credibility of managerial announcements. Indeed, as we show, in the absence of this (indirect) verification mechanism provided by speculation, the need to induce managerial truth-telling would preclude any of the disclosed information from being used to evaluate the managers' performance.<sup>4</sup>

By considering agency conflicts, the analysis yields a number of insights related to firms' information disclosure. Specifically, the model (i) identifies a trade-off faced by firms in their disclosure policy: more disclosure increases price efficiency (and hence ameliorates agency conflicts) but attracts costly speculation to the firm's stock;<sup>5</sup> (ii) shows that when market research is costly, a policy of *discretionary* and *selective* information disclosure can create shareholder value; (iii) rationalizes the valuation effects of apparently innocuous actions (e.g., stock dividends, stock splits, name changes, and more generally non-binding announcements by firms) as a form of cheap talk communication between firms and investors; (iv) predicts positive valuation effects after managerial cheap talk;<sup>6,7</sup> and finally (v) suggests a novel role for managerial compensation, namely to facilitate the transmission of information from firms to the capital market. Empirically, this implies that the presence of agency conflicts that require the use of high-powered incentive compensation should be accompanied by more

---

<sup>4</sup>An alternative mechanism would involve having an auditor certify the information conveyed by the manager. Recent corporate scandals, however, suggest that auditing is far from being a perfect certification mechanism. Previous literature, for example, has examined the problems that arise when auditors and managers can collude (Tirole 1986 and Kofman and Lawarree 1993). In that sense, this paper complements the literature that focuses on the role that auditors have in certifying firms' information.

<sup>5</sup>Speculation is costly for the firm because uninformed shareholders who trade against speculators require a liquidity premium to hold the firm shares.

<sup>6</sup>This occurs because, although market research is equally effective in scrutinizing overvalued and undervalued firms, optimal incentives only encourage managers of substantially undervalued firms to attract the market's attention.

<sup>7</sup>Stock prices, on average, react positively to stock dividend and stock split announcements (Grinblatt, Masulis and Titman 1984), to the announcement of corporate name changes to Internet related dotcom names (Cooper, Dimitrov and Rau 2001), to corporate presentations to securities analysts (Francis, Hanna and Philbrick 1998), and to non-binding announcements of share repurchase programs (Ikenberry, Lakonishok and Vermaelen 1995).

intense disclosure of information by managers.<sup>8</sup>

Our paper belongs to the literature on discretionary disclosure. The cornerstone of this literature is the unraveling theorem, that is the notion that withheld information can be “unraveled” by the behavior of rational agents.<sup>9</sup> Subsequent research shows that information can be nevertheless withheld when: (i) disclosing information is costly, (Jovanovic 1982, and Verrecchia 1983); (ii) there is uncertainty about the type of manager or whether or not the manager is informed, (Dye 1985); or (iii) the information is soft and the manager can only talk cheap, (Crawford and Sobel 1982).<sup>10</sup> Within this literature, our paper is one of costless signaling and cheap talk. Specifically, it is related to Bhattacharya (1980) which shows that managers can be induced to disclose their soft private information if there is an exogenous verifiable signal correlated with that information.<sup>11</sup> In contrast to the rest of the literature, we stress the agency conflicts that arise between managers and shareholders in large corporations, and examine the trade-off that these conflicts create in disclosure decisions.<sup>12</sup>

Our study also emphasizes the interaction between managerial disclosure and the production of information about firms in the market. This aspect of the analysis is related to a number of studies that have examined how managerial moral hazard can be alleviated by using information generated by public trading in the stock market (Diamond and Verrecchia 1982, Holmstrom and Tirole 1993, and Faure-Grimaud and Gromb 2004). In those papers, however, managers do not have an active role in attracting attention and disclosing information to the market, which is precisely the focus of our paper.

---

<sup>8</sup>Nagar, Nanda and Wysocki (2003) and Miller and Piotroski (2000) provide evidence that firms’ information disclosures are positively related to the proportion of CEO stock based compensation.

<sup>9</sup>See Grossman and Hart (1980), Grossman (1981), Milgrom (1981), or chapter 5 in Bolton and Dewatripont (2005) for analyses of this “unraveling” principle and its implications.

<sup>10</sup>In a cheap talk game the message affects the payoff only if agents respond to the messages, Farrell and Rabin (1996). See also Austen-Smith and Banks (2000) and Harris and Raviv (2004) for a recent application to corporate finance.

<sup>11</sup>Other papers on costless signalling in financial markets include Brennan and Kraus (1987), Franke (1987) and Bhattacharya and Dittmar (2003).

<sup>12</sup>In a related literature, Stocken (2000) and Fisher and Heinkel (2003) consider reputation-based mechanisms to elicit managerial truth-telling.

The paper is organized as follows. In Section 2 we describe the model. In Section 3 we present the main analysis, and derive the model's main implications. Section 4 considers several extensions and robustness issues and Section 5 concludes.

## 2 The Model

### 2.1 Agents, technology and managerial news

We consider an all-equity firm that operates in a risk-neutral economy where the market rate of return is normalized to zero. The firm consists of a project that yields a terminal cash flow  $z$  that equals  $R > 0$  with probability  $q$  or 0 with probability  $(1 - q)$ .<sup>13</sup> The firm is run by a manager who has no wealth, is protected by limited liability, and has a zero reservation level of utility. The firm's stock trades in a market with three (classes of) participants: liquidity traders, a speculator, and a market maker.

There are four dates,  $t = 0, 1, 2, 3$ . At  $t = 0$ , the firm sells a proportion  $\delta \in [0, 1]$  of the shares in the open market and offers a compensation contract to the manager who then makes an effort choice. At  $t = 1$ , the manager receives private information about the firm and makes a public announcement about the content of such information. At  $t = 2$ , given the announcement, the speculator decides whether or not to investigate and trade the firm's stock. Finally, at  $t = 3$ , the firm's cash-flow is realized and the managerial compensation contract is enforced.

Managerial effort  $e \in \{0, 1\}$  affects  $q$ , the probability that the project yields  $R$ . In particular, high effort increases  $q$  from  $q_0$  to  $q_1$  at the expense of a managerial private benefit  $B$ . We assume that

$$(q_1 - q_0)R > \frac{q_1}{q_1 - q_0}B, \tag{1}$$

which guarantees, not only that high effort is efficient, i.e.,  $(q_1 - q_0)R > B$ , but also that, after considering managerial rents, it is beneficial for shareholders to induce managers to

---

<sup>13</sup>This is for simplicity. Assuming that  $z \in \{R + h, h\}$ , with  $h > 0$  would not change the results.

exert high effort.<sup>14</sup>

After the effort is chosen, the firm reaches one of three states  $\omega \in \{b, n, g\}$  that differ on their (updated) probability of the project success  $s_\omega$  where  $s_g > s_n > s_b$ . These states, which we refer to as bad,  $b$ , neutral,  $n$ , and good,  $g$ , occur with the following probabilities:

$$\omega = \begin{cases} b & \text{with prob. } \beta - \Delta e \\ n & \text{with prob. } 1 - \beta - \gamma \\ g & \text{with prob. } \gamma + \Delta e \end{cases} . \quad (2)$$

In words, we are assuming that high effort ( $e = 1$ ) increases by  $\Delta > 0$  the likelihood of  $g$  vis-à-vis  $b$ , (i.e.,  $q_1 - q_0 = \Delta(s_g - s_b)$ ) but does not affect the likelihood of  $n$ .<sup>15</sup> The assumption that the likelihood of state  $n$  is not affected by the level of effort is done for simplicity. The key assumption is that the likelihood ratio that the manager has exerted effort is greater in  $g$  than in  $n$ , which in turn, is greater than in  $b$ , i.e., the distribution satisfies the monotone likelihood ratio property. The manager privately observes the firm's state  $\omega$  and makes a public announcement,  $f \in \{\hat{b}, \hat{n}, \hat{g}\}$ . We refer to these managerial announcements as “flags” and to the action of the announcement as “raising a flag.”

## 2.2 Investigation by the speculator and trading in the market

We use a setting similar to Kyle (1985), also considered in Holmstrom and Tirole (1993) and, more recently, in Faure-Grimaud and Gromb (2004). In particular, there are three market participants: (i) liquidity traders who are equally likely to collectively buy or sell  $D(\delta)$  shares where  $D(0) = 0$  and  $D'(\delta) > 0$ , (i.e., the volume of trade increases with the shares initially sold in the open market);<sup>16</sup> (ii) a speculator who decides on his demand after, possibly, acquiring some private information about the firm; and (iii) a competitive market

---

<sup>14</sup>In this setting, the manager can be induced to exert high effort with a compensation scheme that pays  $\bar{w} = \frac{B}{q_1 - q_0}$  in case of success and zero otherwise, i.e.,  $q_1 \bar{w} \geq q_0 \bar{w} + B$ . Shareholders benefit from managerial effort if  $q_1(R - \frac{B}{q_1 - q_0}) > q_0 R$  which is implied by (1). See Hoshi, Kashyap and Scharfstein (1991) or Holmstrom and Tirole (1997) for papers with a similar setup.

<sup>15</sup>This implies that the realization of state  $n$  does not contain any information about the level of managerial effort. In other words, the realization of state  $n$  is as likely to come from a situation in which the manager has exerted effort as from a situation in which he has not.

<sup>16</sup>For notational simplicity we normalize the total number of shares to one so that  $D(\delta)$  is both the number and the proportion of the shares traded by the noise traders.

maker who sets the break-even price  $p$  for the shares after observing all publicly available information, i.e., the stock order flow, the flag, and the manager's compensation contract.

Investigating the firm provides the speculator with a private signal  $\sigma \in \{\sigma_L, \sigma_H\}$  of the project's probability of success, with  $\sigma_L < \sigma_H$ . Specifically, in state  $\omega$ ,  $\sigma_H$  is observed with a frequency of  $x_\omega$  and  $\sigma_L$  with a frequency of  $(1 - x_\omega)$ . Notice that consistency requires that for each state  $\omega$

$$x_\omega \sigma_H + (1 - x_\omega) \sigma_L = s_\omega. \quad (3)$$

We assume that the cost of investigating a firm depends on the firm's state. Specifically  $k > 0$  is the research cost in states  $b$  and  $g$ , and  $\alpha k$ , with  $\alpha > 1$ , is the research cost in state  $n$ . Furthermore, we assume the following bounds for  $k$ :

$$\underline{k} < k < \bar{k} \quad (4)$$

where  $\underline{k} \equiv \frac{(\sigma_H - \sigma_L) RD(1)}{4[(\gamma + \beta) + \alpha(1 - \gamma - \beta)]}$  and  $\bar{k} \equiv \frac{(\sigma_H - \sigma_L) RD(1)}{[\min\{x_b(1 - x_b), x_g(1 - x_g)\}]^{-1}}$ . Assumption 4 will imply that investigation costs are high enough in state  $n$  and low enough in states  $b$  and  $g$  so the speculator does not find it profitable to investigate unless state  $n$  is sorted out.<sup>17</sup> This assumption is a simple form of capturing the basic intuition that market scrutiny is relatively more valuable in "news" states, i.e.,  $b$  and  $g$ , than in situations of "business as usual," i.e.,  $n$ . The assumption that investigation costs differ across states, however, is done for simplicity. In the appendix, we show that similar results can be obtained from alternative formulations in which either the precision of the speculator's information or the probability that the speculators find information about the firm, rather than the investigation costs, differ across states.

### 2.3 Information and contracting

The setting consists of moral hazard on  $e$  followed by asymmetric information on  $\omega$ . To address these informational problems, we allow contracting in observable variables: (i) the

---

<sup>17</sup>In the appendix, we discuss how the bounds are related to the profits from speculation.



managerial announcement  $f$  at  $t = 1$ , (ii) the stock price  $p$  at  $t = 2$ , and (iii) the realized cash-flow  $z$  at  $t = 3$ . Contracts, however, cannot be contingent on: (i) managerial effort  $e$  at  $t = 0$ , (ii) managerial information  $\omega$  at  $t = 1$ , and (iii) the speculator's assessment  $\sigma$  at  $t = 2$ . The analysis will examine how the asymmetry of information on  $\omega$  and the incentive problems on  $e$  interact with the incentives of a third party (the speculator) to generate information, i.e., to investigate and trade.

Shareholders offer the manager a compensation contract contingent on  $f$ ,  $p$  and  $z$  in order to maximize firm value net of compensation and speculation costs. A central issue in the contracting problem is whether the subsequent updates on the project's probability of success can be incorporated, at least partially, into the compensation contract. In the setting above, the probability of success is updated from the managerial choice at  $t = 0$ ,  $q \in \{q_0, q_1\}$ , to the managerial information at  $t = 1$ ,  $s \in \{s_b, s_g, s_n\}$ , to the speculator's assessment due to his investigations at  $t = 2$ ,  $\sigma \in \{\sigma_L, \sigma_H\}$ .

Figure 1 summarizes the timing of events in the model.



Figure 1: Timing of events.

### 3 Analysis of the model

In this section, we solve the previous model under two simplifications which allows us to investigate most of the issues of interest with a considerable reduction in complexity. First, we restrict managerial announcements (flags) to merely convey the presence of news without differentiating on the content of the news. Formally, in each state  $\omega$ , we restrict flags to be a binary variable  $f \in \{-1, +1\}$ , rather than the triple  $f \in \{\hat{b}, \hat{n}, \hat{g}\}$ . This formulation captures the idea that managers “attract” the market attention to their firms in some states,  $f = +1$ ,

but not in others,  $f = -1$ . Second, we focus on managerial compensation contracts that (i) are contingent on prices  $p$  and cash flows  $z$  but not on flags  $f$ , and that (ii) pay zero when the firm's cash flow is low, i.e.,  $z = 0$ .<sup>18</sup> In Section 4, we show the robustness of the results when these simplifications are no longer considered.

Solving the model implies finding the compensation contract that maximizes ex-ante shareholder value, i.e., the firm's expected cash flow net of compensation and speculation costs. To do so, we examine the effects of compensation contracts not only on the manager's effort and disclosure incentives but also on the speculator's incentives to investigate and trade.<sup>19</sup> Specifically, we solve the model in four steps:

1. We distinguish the four cases that can arise in terms of managerial disclosure of information. We refer to each case as a *flagging convention*, and denote them as  $F_J = \{f_J^b, f_J^n, f_J^g\}$ ,  $J = 1, 2, 3, 4$ , where  $f_J^\omega$  represents the flag raised under convention  $F_J$  in state  $\omega$ .
2. For each  $F_J$ , we derive the distribution of stock prices at  $t = 2$ ,  $P_J$ , taking into account the speculator's incentives to investigate and trade.
3. Having derived  $P_J$ , we solve for the contract  $W_J^*$  that minimizes managerial compensation costs,  $C_J^*$ , and calculate its associated speculation costs,  $S_J^*$ .
4. Finally, we find the optimal convention, i.e., the convention that minimizes the sum of compensation and speculation costs,  $C_J^* + S_J^*$ .

---

<sup>18</sup>These restrictions in compensation retain the realistic flavor of stock-based compensation with positive pay for performance sensitivity.

<sup>19</sup>Since compensation affects managerial disclosures (and hence stock prices), there is a feedback effect from compensation to stock prices. For this reason, solving for the optimal compensation contract requires the simultaneous consideration of stock price formation and the managerial incentives to disclose information.

### 3.1 Flagging conventions

Flagging is a costless managerial action that conveys information only when it is accepted and understood by the market.<sup>20</sup> In this setting a flagging convention conveys the same information as its reciprocal. For instance, a convention like  $\{+1, -1, +1\}$ , where a flag is raised only in states  $b$  and  $g$ , is equivalent to a convention where the flag is raised only in  $n$ ,  $\{-1, +1, -1\}$ . Therefore, four (essentially different) flagging conventions can emerge: (1) “no-flag,”  $F_1 = \{-1, -1, -1\}$ , i.e., the manager never raises the flag; (2) “g-flag,”  $F_2 = \{-1, -1, +1\}$ , i.e., the manager only flags state  $g$ ; (3) “b-flag,”  $F_3 = \{+1, -1, -1\}$ , i.e., the manager only flags state  $b$ ; and (4) “b & g flag,”  $F_4 = \{+1, -1, +1\}$ , i.e., the manager flags both  $b$  and  $g$ .

### 3.2 The distribution of stock prices at $t = 2$ , $P_J$

Under each convention  $F_J$ , the distribution of stock prices at  $t = 2$ ,  $P_J$ , depends on the speculator’s incentives to investigate and trade. Assumption 4 implies that investigation costs are high enough in state  $n$  and low enough in states  $b$  and  $g$  so the speculator does not find it profitable to investigate unless state  $n$  is sorted out. As it turns out, unless managers (truthfully) disclose their private information, speculators would be unable to exclude state  $n$  and thus, would not investigate the firm.

Taking into account the speculator’s incentives, the market maker sets the stock price equal to the firm’s expected cash flow conditional on the available information (i.e., the flag, the order flow, and the incentive compensation scheme offered to the manager). For simplicity, we assume that the market maker can observe the trade orders but not the identity of the trader passing each order.<sup>21</sup>

Let  $\Omega_J^f$  be the order flow for the firm’s stock under convention  $F_J$  and flag  $f$ . If the flag is

---

<sup>20</sup>In section 4, we discuss the possibility of “babbling” equilibria in which the market ignores the manager’s announcements.

<sup>21</sup>This assumption (also made in Faure-Grimaud and Gromb 2004) simplifies the derivations by ruling out speculators’ trading in mixed strategies. Relaxing this assumption complicates the analysis without qualitatively changing the results.

not raised,  $f = -1$ , by virtue of Assumption 4, the speculator does not investigate (or trade). In this case, the order flow only contains the liquidity traders' demand,  $\Omega_J^{-1} \in \{-D, +D\}$ , and therefore, the stock price after "no-flag",  $p_J^N$ , is independent of order flow. Alternatively, if the flag is raised,  $f = +1$ , the speculator investigates and the order flow has two distinct components: (i) the liquidity traders' demand (either  $-D$  or  $+D$  with equal probability), and (ii) the speculator's demand, (either  $-D$  when the investigation yields  $\sigma_L$  or  $+D$  when it instead yields  $\sigma_H$ ).<sup>22</sup> Thus  $\Omega_J^{+1} \in \{(+D, +D), (-D, -D), (-D, +D)\}$  and three prices can hold:  $p_J^H$  for a high order flow  $(+D, +D)$ ,  $p_J^M$  for a medium order flow  $(-D, +D)$ , and  $p_J^L$  for a low order flow  $(-D, -D)$ .

In summary, under each convention  $F_J$  there are in total four possible prices, i.e.,  $P_J = \{p_J^L, p_J^M, p_J^H, p_J^N\}$  defined by the following equation:<sup>23</sup>

$$p_J^i = E_J(z - w(z, p_J^i) \mid f, \Omega_J^f, W_J), \quad (5)$$

for  $i = N, L, M, H$ , where  $w(z, p_J^i)$  is the manager's wage under convention  $F_J$  (contingent on price  $p_J^i$  and cash flow  $z$ ) and  $W_J$  is the manager's compensation contract (i.e., the set of possible wages under convention  $F_J$ ).<sup>24</sup>

### 3.3 Optimal compensation contracts

Having obtained the distribution of the stock price,  $P_J$ , we now solve for the optimal compensation contract, i.e., the contract that minimizes compensation costs under each convention  $F_J$ . Once such contract is obtained, we will compute the speculation costs associated to it.<sup>25</sup>

---

<sup>22</sup>By demanding  $+D$  or  $-D$  the speculator may disguise his information, since the market maker cannot disentangle from a flow of  $(-D, +D)$  whether the speculator order was  $+D$  or  $-D$ .

<sup>23</sup>Under  $F_1$  raising the flag is a managerial out-of-equilibrium action and trading on the stock a speculator's out-of-equilibrium action. In this case, to complete the description of the equilibrium, we simply assume that the speculator does not change his prior beliefs after a flag and hence, does not perform any investigation of the firm. Therefore, under convention  $F_1$ , there is a unique price  $p_1^N$ .

<sup>24</sup>For example, under  $F_2$ ,  $\Omega_2^{+1} = (+D, +D)$  corresponds to the case in which both the liquidity traders and the speculator buy shares (i.e., state  $g$  is realized, the flag is raised, and the speculator investigates and receives signal  $\sigma_H$ ). Therefore,  $\Omega_2^{+1} = (+D, +D)$  leads to a stock price  $p_2^H = \sigma_H \cdot (R - w(R, p_2^H))$ . In the appendix, we provide a complete description of the price distribution,  $P_J$ , under each convention.

<sup>25</sup>As in Holsmtrom and Tirole (1993), in the model we can separate the analysis of compensation and speculation costs. In our case, as explained below, this procedure works because shareholders, through the choice of the stock's liquidity  $\delta$  disentangle speculation and compensation costs.

Under  $F_J$ , a compensation contract  $W_J = \{w_J^N, w_J^L, w_J^M, w_J^H\}$  consists of four non-negative payments to the manager contingent on the price at  $t = 2$ ,  $p_J^i$ , and on the realization of a high cash flow,  $z = R$ , i.e.,  $w_J^i \equiv w(R, p_J^i)$ . Formally, the optimal compensation corresponds to the solution of the following linear program:

$$\min_{W_J \in \mathbb{R}_+^4} \sum_i^{N,L,M,H} \Pr(R, p_J^i | e = 1) w_J^i \quad (6)$$

s.t.

$$\sum_i^{N,L,M,H} \Pr(R, p_J^i | e = 1) w_J^i \geq B + \sum_i^{N,L,M,H} \Pr(R, p_J^i | e = 0) w_J^i \quad (7)$$

$$f_J^b \cdot \sum_k^{L,M,H} \Pr(R, p_J^k | b) w_J^k \geq f_J^b \cdot \Pr(R, p_J^N | b) w_J^N \quad (8)$$

$$f_J^n \cdot \sum_k^{L,M,H} \Pr(R, p_J^k | n) w_J^k \geq f_J^n \cdot \Pr(R, p_J^N | n) w_J^N \quad (9)$$

$$f_J^g \cdot \sum_k^{L,M,H} \Pr(R, p_J^k | g) w_J^k \geq f_J^g \cdot \Pr(R, p_J^N | g) w_J^N. \quad (10)$$

The objective function (6) is the expected compensation cost under convention  $F_J$ . Constraint (7), the moral hazard constraint, induces the manager to exert effort,<sup>26</sup> and the asymmetric information constraints, (8), (9), and (10), ensure that the manager's announcements at  $t = 1$  are truthful.<sup>27</sup> For instance, constraint (8) refers to the flagging behavior in state  $b$ : If shareholders wish to induce the manager to flag state  $b$ ,  $f_J^b = +1$ , then, his expected compensation when flagging state  $b$  (i.e.,  $\sum_i^{L,M,H} \Pr(p_J^i | b) \Pr(R | p_J^i, b) w_J^i$ ) must be higher than when not flagging it (i.e.,  $\Pr(p_J^N | b) \Pr(R | p_J^N, b) w_J^N$ ). Alternatively, if shareholders do not wish to induce flagging in state  $b$  then the opposite must hold ( $f_J^b = -1$ , and inequality (8) is reversed).<sup>28</sup> Next, we derive the optimal compensation contract under each specific convention  $F_J$ .

---

<sup>26</sup>The manager's participation constraint has been ignored since it is trivially satisfied. In particular, the manager's reservation utility is zero but he can always obtain a positive expected utility (in private benefits) of at least  $B$  by exerting no effort.

<sup>27</sup>Since the state  $\omega$  is a sufficient statistic for effort  $e$ , it is unnecessary to condition on the level of effort in the asymmetric information constraints.

<sup>28</sup>Notice that constraints (8)-(10) can accommodate the possibility of mixed strategies in flagging if they hold with equality. Mixed strategies in flagging, however, would not increase shareholder value.

### 3.3.1 Ignoring flags: $F_1$

Under  $F_1$  there is no flagging or speculation and hence, the stock price at  $t = 2$  contains no information about the state  $\omega$  reached at  $t = 1$ . As a result, managerial compensation is independent of the stock price (i.e.,  $W_1 = \{w_1^N, w_1^L, w_1^M, w_1^H\} = \{w_1, w_1, w_1, w_1\}$ ) and the shareholders' problem is reduced to:

$$\begin{aligned} & \min_{w_1 \geq 0} q_1 w_1 & (11) \\ \text{s.t.} \quad & q_1 w_1 \geq B + q_0 w_1. \end{aligned}$$

We state the solution to this problem in the following proposition:

**Proposition 1** *The optimal compensation under  $F_1$ ,  $W_1^*$ , consists of a wage contingent on the high-cash flow,  $w_1^* = \frac{B}{q_1 - q_0}$ . The compensation costs associated to  $W_1^*$  are:*

$$C_1^* = \frac{q_1}{\Delta(s_g - s_b)} B.$$

The (expected) compensation costs,  $C_1^*$ , correspond to the value of the objective function (11) under the optimal compensation contract,  $W_1^*$ .<sup>29</sup> Finally, notice that, since there is no flagging (and hence no speculation) the firm incurs no speculation costs. This implies that shareholder value is simply the project's expected cash flow minus the expected compensation costs,  $V_1^* = q_1 R - C_1^*$ .

### 3.3.2 Flagging good news: $F_2$

Under  $F_2$ , a compensation contract  $W_2$  consists of four distinct wages,  $\{w_2^N, w_2^L, w_2^M, w_2^H\}$ , each associated to a different stock price:  $p_2^N$  after  $f = -1$ , and  $p_2^L$ ,  $p_2^M$  and  $p_2^H$  after  $f = +1$ . Therefore, shareholders solve the following optimization problem:

$$\min_{W_2 \in \mathbb{R}_+^4} (\gamma + \Delta) \frac{[x_g \sigma_H w_2^H + (1 - x_g) \sigma_L w_2^L + s_g w_2^M]}{2} + [(1 - \gamma - \beta) s_n + (\beta - \Delta) s_b] w_2^N \quad (12)$$

s.t.

---

<sup>29</sup>To facilitate comparisons, it is useful to rewrite  $C_1^*$  as  $\frac{q_1}{\Delta(s_g - s_b)} B$ .

$$x_g \sigma_H w_2^H + (1 - x_g) \sigma_L w_2^L + s_g w_2^M \geq \frac{2B}{\Delta} + 2s_b w_2^N \quad (13)$$

$$x_b \sigma_H w_2^H + (1 - x_b) \sigma_L w_2^L + s_b w_2^M \leq 2s_b w_2^N \quad (14)$$

$$x_n \sigma_H w_2^H + (1 - x_n) \sigma_L w_2^L + s_n w_2^M \leq 2s_n w_2^N \quad (15)$$

$$x_g \sigma_H w_2^H + (1 - x_g) \sigma_L w_2^L + s_g w_2^M \geq 2s_g w_2^N, \quad (16)$$

where (13) induces high managerial effort, and (14), (15) and (16) ensure that the manager only raises the flag in state  $g$ . Proposition 2, proved in the appendix, states the solution to the above problem:

**Proposition 2** *The optimal compensation contract under  $F_2$  is:*

$$W_2^* = (w_2^{L*}, w_2^{M*}, w_2^{H*}, w_2^{N*}) = \left( 0, 0, \frac{2s_n B}{\Delta(x_g s_n - x_n s_b) \sigma_H}, \frac{x_n B}{\Delta(x_g s_n - x_n s_b)} \right).$$

*The compensation costs associated to  $W_2^*$  are*

$$C_2^* = \frac{[(\gamma + \Delta)x_g + (1 - \gamma - \beta)x_n]s_n + (\beta - \Delta)x_n s_b}{\Delta(x_g s_n - x_n s_b)} B.$$

As Proposition 2 shows, the optimal compensation scheme  $W_2^*$  consists of a positive wage when the flag is not raised,  $w_2^{N*} > 0$ , a bonus when a raised flag is followed by a high stock price,  $w_2^{H*} > w_2^{N*}$ , and a zero wage when a raised flag is not followed by a high stock price,  $w_2^{L*} = w_2^{M*} = 0$ . This compensation scheme is necessary to simultaneously induce high managerial effort, and the desired managerial disclosure (i.e., under  $F_2$ , flagging in the good state  $g$ ). As we show below, by using the information disclosed by the manager that is incorporated in the stock price, shareholders can save on managerial compensation, i.e.,  $C_2^* < C_1^*$ .

The speculation costs,  $S_2^*$ , correspond to the speculator's expected profits from trading. These profits must at least compensate the speculator for the investigation costs,  $k$ , which, under  $F_2$ , are incurred with probability  $(\gamma + \Delta)$  (i.e., in state  $g$ ). Therefore, from an ex-ante perspective, speculation costs under  $F_2$  are at least  $(\gamma + \Delta)k$ , that is,  $S_2^* \geq (\gamma + \Delta)k$ . As we discuss in section 3.4, however, by influencing the volume of noise trading  $D(\delta)$  through

the stock's liquidity  $\delta$ , a firm can set the speculation costs at the minimum bound, i.e.,  $S_2^* = (\gamma + \Delta)k$ . Consequently, the firm's value under  $F_2$  is  $V_2^* = q_1R - C_2^* - (\gamma + \Delta)k$ .

### 3.3.3 Other conventions: Flagging bad news ( $F_3$ ) and flagging news ( $F_4$ )

For brevity, we simply state the optimal contracts for  $F_3$  and  $F_4$  and refer the reader to the appendix for a formal derivation. Proposition 3 describes the optimal compensation contracts under these conventions.<sup>30</sup>

**Proposition 3** *The following contracts minimize compensation costs under  $F_3$  and  $F_4$ :*

$$W_3^* = (w_3^{L*}, w_3^{M*}, w_3^{H*}, w_3^{N*}) = \left( \frac{2s_b B}{\Delta(s_g - s_b)(1 - x_b)\sigma_L}, 0, 0, \frac{B}{\Delta(s_g - s_b)} \right)$$

and

$$W_4^* = (w_4^{L*}, w_4^{M*}, w_4^{H*}, w_4^{N*}) = \left( 0, \frac{2B}{\Delta(s_g - s_b)}, 0, \frac{B}{\Delta(s_g - s_b)} \right).$$

*In both conventions, compensation costs are:*

$$C_3^* = C_4^* = \frac{q_1}{\Delta(s_g - s_b)} B.$$

Proposition 3 shows that  $F_3$  and  $F_4$  have the same compensation costs as  $F_1$ , i.e.,  $C_3^* = C_4^* = C_1^*$ . Although under  $F_3$  and  $F_4$  the stock price at  $t = 2$  does contain information about the state reached at  $t = 1$ , shareholders cannot take advantage of this information to reduce compensation costs. The reason is that inducing managerial disclosure of information under  $F_3$  and  $F_4$  interferes with the provision of incentives to exert effort: Rewarding the manager for flagging state  $b$  increases the opportunity cost of exerting managerial effort. Therefore, since  $F_3$  and  $F_4$  have the same compensation costs as  $F_1$  but higher speculation costs, conventions  $F_3$  and  $F_4$  are strictly dominated by  $F_1$ .<sup>31</sup>

---

<sup>30</sup>In fact, while the optimal contracts under  $F_1$  and  $F_2$  are unique, it is possible to find multiple optimal contracts that induce a managerial disclosure behavior consistent with  $F_3$  or  $F_4$ . We report in the appendix the full class of contracts that induce this behavior.

<sup>31</sup>While under  $F_1$  speculation costs are zero, under  $F_3$  and  $F_4$  speculation costs are at least  $(\beta - \Delta)k$  and  $(\gamma + \beta)k$  respectively, i.e., under  $F_3$  (under  $F_4$ ) the speculator investigates in  $b$  (in both  $g$  and  $b$ ) which occurs with probability  $(\beta - \Delta)$  ( $(\gamma + \beta)$ ).



### 3.4 The optimal convention

The optimal convention is the one that maximizes shareholder value or equivalently that minimizes the sum of compensation and speculation costs,  $C_j^* + S_j^*$ . Since conventions  $F_3$  and  $F_4$  are dominated by  $F_1$ , finding the optimal convention boils down to a comparison between  $F_1$  and  $F_2$ , that is a trade-off between the larger speculation costs associated to  $F_2$ ,  $S_2^* = (\gamma + \Delta)k > 0 = S_1^*$ , and, as the next proposition states, its smaller compensation costs:

**Proposition 4** *Compensation costs under  $F_2$  are smaller than those under  $F_1$ , i.e.,  $C_2^* < C_1^*$ .*

According to Proposition 4, inducing managers to attract attention to their firms when they have good news (i.e., in state  $g$ ) allows the firm to save on compensation costs. By flagging the presence of state,  $g$ , and attracting speculation, the information is incorporated into the stock price and can be used to compensate the manager. Since the joint presence of high output and high stock price is a stronger indication of high effort than just the presence of high output, the firm is able to induce high managerial effort at a lower cost. This result holds even though the presence of good news does not have any additional effect on the firm's activities, and, even though, by design, the speculator is equally effective in scrutinizing overvalued and undervalued firms, i.e., the speculator can profit from buying undervalued stock as well as from selling overvalued stock. It is important, however, to notice that speculation is essential for the previous result despite that once  $g$  is flagged the speculator's research does not provide any additional information about effort, i.e., the state  $\omega$  is a sufficient statistic of managerial effort with respect to  $z$ . As we show in Proposition 9, in the absence speculation, the need to induce managerial truth-telling would prevent any of the disclosed information from being used to evaluate the managers' performance.

Notice that in our analysis, in contrast to Holmstrom and Tirole (1993), the role of the information generated by the speculator is not to provide additional information about effort but to induce managerial truth-telling. Moreover, in our case, the speculator finds it unprofitable to investigate firms unless the manager guides such investigation (attracts their

attention). What we find is that shareholders can encourage such guidance from managers, who *will voluntarily disclose information*, even though, managers end up receiving lower rents in the process.

We now discuss the factors that make  $F_1$  or  $F_2$  more likely to hold as the optimal convention:

**Proposition 5**  $F_2$  is more likely to be the optimal convention vis-à-vis  $F_1$  when: (i) the speculator's investigation costs,  $k$ , are small; (ii) the moral hazard problem is severe (large private benefits,  $B$ , or a low likelihood ratio,  $q_1/q_0$ ); (iii) the firm's state is very informative about the effort (a high likelihood ratio,  $\Delta/\gamma$ ); (iv) the speculator's information and trading allows inducing managerial truth-telling at a low cost (a high ratio  $x_g/x_n$ ).

The effect of the investigation cost  $k$  is straightforward. Under convention  $F_2$  the speculator must be induced to investigate in state  $g$  (after flagging); if the investigation cost  $k$  is large, inducing the speculator to do so becomes very expensive for the firm.<sup>32</sup> The severity of the moral hazard also plays an important role in the choice of convention. If the private benefit  $B$  is large or if the likelihood ratio of success with and without effort,  $q_1/q_0$ , is low, i.e., if the final output is not very informative about effort,<sup>33</sup> the additional information disclosed under  $F_2$  becomes especially useful in alleviating moral hazard. Whether the manager should be induced to disclose information also depends on how informative is the firm's state about effort. In particular, if, for a given ratio  $q_1/q_0$ , reaching state  $g$  is a very strong indication that the manager has exerted high effort ( $\Delta/\gamma$  is high) then making the compensation contract contingent on  $g$  being reached provides the manager with very strong incentives to indeed exert high effort. Finally, since the managerial private information is soft and cannot be directly verified, the compensation contract needs to rely on the specu-

---

<sup>32</sup>If  $k$  is large, the firm must increase the liquidity of its equity (i.e., sell more equity) in order to allow enough speculator's profits to recover  $k$ . Since equity must be sold at a discount to compensate liquidity traders for the future losses that they will incur if they have to trade against the speculator, the speculation costs are borne *ex-ante* by the firm.

<sup>33</sup>For a given value of effort  $(q_1 - q_0)R$ , final output is less informative about effort the larger the increase in output  $R$  (and hence, the smaller the increase in probability  $(q_1 - q_0)$ ). Note that under  $F_1$ , the manager's rent is  $C_1 - B = \frac{q_0}{q_1 - q_0}B$  which is decreasing in  $(q_1 - q_0)$ .

lator's trading activities and the subsequent stock price. Specifically, under  $F_2$  the manager must be induced to flag  $g$  but not  $n$ , and this can be more easily accomplished when the probability of a high price in state  $g$  relative to state  $n$ , i.e.,  $x_g/x_n$ , is large.<sup>34</sup>

### 3.5 Discussion and empirical implications

The previous analysis yields several implications. First, firms face a trade-off when they disclose information to the market: Prices become more informative but speculators find it easier to investigate the firm. In other words, managerial disclosure of information, even though hampered by agency conflicts, plays a role in attracting attention and directing market research. This is consistent with available empirical evidence, reviewed in Healy and Palepu (2001), which shows that voluntary disclosure of information increases analysts coverage and the speed with which information gets into prices.<sup>35</sup>

Second, the model predicts cross-sectional differences on the frequency of the information disclosure. In particular, the model suggests that stock based compensation should be associated with more voluntary disclosure of information. Consistent with this implication, Nagar, Nanda and Wysocki (2003) find that firms' disclosures are positively related to the proportion of CEO compensation affected by stock price and by the value of the shares held by the CEO. In addition, Miller and Piotroski (2000) find that managers of firms in turnaround situations are more likely to provide earnings forecasts if they have higher stock option compensation at risk.

Finally, the model also predicts that firms may want to regulate the disclosure of information to attract speculation in certain cases but discouraging it in others. In particular, undervalued firms are more likely to try to grab the attention of the market. Abundant evi-

---

<sup>34</sup>In fact, it must prevent the manager from raising the flag in  $n$  and  $b$ . However, the binding constraint is only the one that prevents the manager from raising the flag in state  $n$ .

<sup>35</sup>Francis, Hanna and Philbrick (1998) document that making conference calls increases firms' analysts coverage and Healy, Hutton and Palepu (1999) show that firms that expand information disclosure experience contemporaneous increases in stock prices unrelated to current earnings and have an increase in analysts coverage. In addition, Bushee, Matsumoto and Miller (2003) document that the provision of unlimited real-time access to corporate conference calls is associated with a greater increase in small trades and a higher price volatility during the call period.

dence has documented a positive market reaction to attention grabbing events. For example, a number of studies show that stock prices, on average, react positively to stock dividend and stock split announcements (Grinblatt, Masulis and Titman 1984), to the announcement of corporate name changes (Cooper, Dimitrov and Rau 2001), to corporate presentations to securities analysts (Francis, Hanna and Philbrick 1998), to non-binding announcements of share repurchase programs (Ikenberry, Lakonishok and Vermaelen 1995).<sup>36</sup>

## 4 Robustness and extensions

So far in the analysis, we have restricted the message space to be binary,  $f \in \{-1, +1\}$ . We have also not allowed the compensation contract to be contingent on the flag or to reward the manager after a low cash flow. In this section, we examine the robustness of the results in the absence of these simplifying assumptions. We then consider a number of extensions in an effort to develop a better understanding of the main economic forces driving the results.

### 4.1 Richer compensation contracts

In Section 3, we focused on compensation contracts that could not be contingent on flags,  $f$ , and that pay zero after a low cash flow, i.e.,  $w(0, p_J^i) = 0$ . The following proposition considers the case in which these assumptions are relaxed.

**Proposition 6** *Allowing for contracts that can pay a positive wage after a low cash-flow and/or that can be contingent on flags does not reduce compensation costs under any convention. Therefore, under each convention  $F_J$ , the derived compensation scheme,  $W_J^*$ , remains optimal.*

The proposition states that we have not lost generality by focusing on contracts that pay a zero wage after a low cash flow. Intuitively this holds, because since managerial effort is positively correlated with a high cash flow, paying a positive wage after a low cash flow,

---

<sup>36</sup>Stephens and Weisbach (2000) document that a significant number of firms announcing share repurchases do not repurchase at all.

$w(0, p_j^i) > 0$ , would reduce the manager’s incentives to exert effort. Furthermore, although  $w(0, p_j^i) > 0$  could conceivably facilitate inducing the manager to disclosure information (particularly when  $\omega = b$ ), shareholders refrain from fostering information disclosure at state  $b$ . As we discussed in the previous section, rewarding the manager for reaching state  $b$  would increase the opportunity cost of exerting effort and hence, the overall compensation costs.

Proposition 6 also states that focusing on contracts that cannot be directly contingent on flags,  $f$ , is without loss of generality. Because the distribution of stock prices depends on whether or not a flag has been raised contracts based solely on stock prices can incorporate any information contained in the flag and hence, flags become redundant as contracting devices in our model. Verifiability problems aside,<sup>37</sup> contracting simultaneously on flags and prices, however, could be useful to reduce compensation costs in settings in which stock prices do not fully reveal the content of the flag. Nevertheless, even in settings like those, the central message remains valid: managerial cheap talk (i.e., flagging) is a valuable device to reduce compensation costs.

## 4.2 Differentiated flags

Next, we extend the analysis in Section 3 by enriching the message space to allow full information disclosure. Specifically, we consider flags of the form  $f \in \{\hat{b}, \hat{g}, \hat{n}\}$  rather than binary flags  $f \in \{-1, +1\}$ .<sup>38</sup> This amounts to consider an additional convention  $F_5$  in which the managerial announcements distinguishes among the three states ( $f = \hat{b}$  if  $\omega = b$ ;  $f = \hat{n}$  if  $\omega = n$ ; and  $f = \hat{g}$  if  $\omega = g$ ) and investigation and speculation takes place both in  $b$  and  $g$ .<sup>39</sup>

---

<sup>37</sup>Verifiability concerns could make it difficult to use flags as contracting devices. For instance, unless confirmed by market prices, a court may not be able to verify whether a manager is or is not attracting attention to the firm.

<sup>38</sup>For simplicity, we exclude the possibility of mixed strategies in announcements. More precisely, we assume that if an announcement includes multiple states, the relative prior likelihood of the states is maintained. For instance, the announcement “either state  $b$  or  $g$  hold” implies  $b$  with likelihood  $\frac{\beta - \Delta e}{\beta + \gamma}$  and  $g$  with likelihood  $\frac{\gamma + \Delta e}{\beta + \gamma}$ .

<sup>39</sup>This is without loss of generality because inducing speculation in  $\omega = g$  ( $\omega = b$ ) but not in  $\omega = b$  ( $\omega = g$ ) is equivalent in terms of managerial and speculation costs to convention  $F_2$  ( $F_3$ ). See also Section 4.3.1 for the analysis of the optimal contract in the absence of speculators.

Under convention  $F_5$ , flagging good news,  $f = \hat{g}$ , or bad news,  $f = \hat{b}$ , leads to speculation and hence, to one of six possible stock prices,  $(p_5^{gL}, p_5^{gM}, p_5^{gH})$  and  $(p_5^{bL}, p_5^{bM}, p_5^{bH})$  respectively. Alternatively, flagging “no news,”  $f = \hat{n}$ , does not induce speculation and leads to a unique stock price,  $p_5^{nN}$ . Consequently, a compensation scheme has seven wages, contingent on  $z = R$ , each associated to one of the possible stock prices at  $t = 2$ :<sup>40</sup>

$$W_5 \equiv \left( (w_5^{bL}, w_5^{bM}, w_5^{bH}), w_5^{nN}, (w_5^{gL}, w_5^{gM}, w_5^{gH}) \right). \quad (17)$$

To find the optimal managerial compensation, shareholders solve:

$$\begin{aligned} \min_{W_5 \in \mathbb{R}_+^7} (\gamma + \Delta) \frac{[x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM}]}{2} + (1 - \gamma - \beta) s_n w_5^{nN} + \\ + (\beta - \Delta) \frac{[x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM}]}{2} \end{aligned} \quad (18)$$

s.t.

$$x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM} \geq \frac{2B}{\Delta} + x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM} \quad (19)$$

$$x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM} \geq x_b \sigma_H w_5^{gH} + (1 - x_b) \sigma_L w_5^{gL} + s_b w_5^{gM} \quad (20)$$

$$x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM} \geq x_g \sigma_H w_5^{bH} + (1 - x_g) \sigma_L w_5^{bL} + s_g w_5^{bM} \quad (21)$$

$$x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM} \geq 2s_b w_5^{nN} \quad (22)$$

$$x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM} \geq 2s_g w_5^{nN} \quad (23)$$

$$x_n \sigma_H w_5^{bH} + (1 - x_n) \sigma_L w_5^{bL} + s_n w_5^{bM} \leq 2s_n w_5^{nN} \quad (24)$$

$$x_n \sigma_H w_5^{gH} + (1 - x_n) \sigma_L w_5^{gL} + s_n w_5^{gM} \leq 2s_n w_5^{nN} \quad (25)$$

The objective function (18) represents the expected compensation cost under  $F_5$ . Constraint (19), the moral hazard constraint, guarantees high managerial effort. Constraints (21) and (23), the truth-telling constraints for state  $g$ , ensure that,  $f = \hat{g}$  if  $\omega = g$ . Similarly, constraints (20) and (22) and constraints (24) and (25) are respectively the truth-telling constraints for state  $b$  and  $n$ , which ensure that  $f = \hat{b}$  if  $\omega = b$ , and  $f = \hat{n}$  if  $\omega = n$ , respectively.

Proposition 7 describes the solution to this optimization problem.

---

<sup>40</sup>We again restrict compensation contracts that pay zero after a low cash-flows,  $z = 0$ . As shown in the appendix, this is without loss of generality.

**Proposition 7** Under  $F_5$ , the following contract  $W_5^*$  minimizes compensation costs:

$$W_5^* = \left( \left( \frac{B}{\Delta(\frac{x_g}{x_n} s_n - s_b)}, \frac{B}{\Delta(\frac{x_g}{x_n} s_n - s_b)}, \frac{B}{\Delta(\frac{x_g}{x_n} s_n - s_b)} \right), \frac{B}{\Delta(\frac{x_g}{x_n} s_n - s_b)}, \left( \frac{2s_n B}{\Delta(x_g s_n - x_n s_b) \sigma_H}, 0, 0 \right) \right).$$

The compensation costs,  $C_5^*$ , associated to  $W_5^*$  are:

$$C_5^* = C_2^* = \frac{[(\gamma + \Delta)x_g + (1 - \gamma - \beta)x_n]s_n + (\beta - \Delta)x_n s_b}{\Delta(x_g s_n - x_n s_b)} B.$$

The optimal compensation scheme consists of (i) a positive wage,  $w_5^{bL} = w_5^{bM} = w_5^{bH} = w_5^{nN^*} > 0$ , when  $f \in \{\hat{b}, \hat{n}\}$ ; (ii) a bonus when  $f = \hat{g}$  leads to a high stock price,  $w_5^{gH^*} > w_5^{nN^*}$ ; and (iii) a zero wage when  $f = \hat{g}$  leads to a medium or a low price,  $w_5^{gL^*} = w_5^{gL^*} = 0$ . Notice that the compensation costs associated to the optimal contract under convention  $F_5$  are the same as those under convention  $F_2$ . In fact, the compensation after  $f = \hat{g}$  and  $f = \hat{n}$  under  $F_5$ , is equal to the compensation after  $f = +1$  and  $f = -1$  under  $F_2$  (i.e.,  $w_5^{gH^*} = w_2^{H^*}$  and  $w_5^{nN^*} = w_2^{N^*}$ ).<sup>41</sup> In other words even though, under convention  $F_5$ , unlike under  $F_2$ , the manager discloses which state  $n$  or  $b$  has been reached, the truthtelling constraints do not allow to incorporate this information into the compensation contract (and hence,  $C_5^* = C_2^*$ ). The following proposition compares convention  $F_5$  to  $F_2$  in terms of shareholder value:

**Proposition 8** Convention  $F_5$  is dominated by convention  $F_2$ , i.e.,  $C_2^* + S_2^* < C_5^* + S_5^*$ .

Since  $C_2^* = C_5^*$ , the comparison between  $F_2$  and  $F_5$  boils down to the relative importance of speculation costs,  $S_2^*$  versus  $S_5^*$ . While under both conventions investigation and speculation take place in  $g$ , under  $F_5$ , speculation also takes place in  $b$ , and, as a result,  $S_5^* > S_2^*$ . In summary, even in the presence of a richer message space, it remains optimal for the firm either to only attract attention in the presence of good news (convention  $F_2$ ) or avoid attention altogether (convention  $F_1$ ).<sup>42</sup>

<sup>41</sup>Even though under  $F_5$ , there are several contracts that minimize compensation costs ( $W_5^*$  is not unique), the wages paid after flags  $f = \hat{g}$  and  $\hat{n}$  are the same in all the optimal contracts. The wages paid after flag  $f = \hat{b}$ , however, can be structured in several ways although all the possible combinations have the same expected cost for the firm. See the appendix for details.

<sup>42</sup>Under convention  $F_5$ , allowing for contracts that can promise a positive wage after a low cash-flow ( $z = 0$ ) and/or that can be contingent on flags does not reduce compensation costs, in fact, the derived compensation scheme,  $W_5^*$ , remains optimal. The proof of this result (which is similar the proof of Proposition 6) is omitted to save space.

### 4.3 Further analysis

In this section, we consider several departures from the assumptions of the model in order to develop a better understanding of the main economic forces driving the results. Specifically, we examine the importance that speculation, stock liquidity, and contract observability have on the results.

#### 4.3.1 On the role of speculation

Speculation plays a central role in our analysis. For example, under convention  $F_2$ , we obtain that investigation and speculation occurs in state  $g$  when the manager raises the flag.<sup>43</sup> A natural question is whether similar results could be reached in a situation in which contracts can still be based on managerial announcements (flags), prices and cash flows, but in which market speculation is absent. The following proposition addresses this issue:

**Proposition 9** *In the absence of speculation,  $F_1$  is optimal even if (i) the message space allows the manager to fully disclose his information,  $f \in \{\hat{g}, \hat{n}, \hat{b}\}$ ; and (ii) compensation contracts can be made contingent on flags, and can pay a positive wage after a low cash flow.*

The above proposition highlights the central role that the speculator plays in alleviating moral hazard. In the absence of speculation, having the manager announce his information, and allowing his compensation to be contingent on the announcement, does not reduce compensation costs with respect to  $F_1$ , the case in which the manager does not disclose any information. In other words, in the absence of (indirect) verification by the speculator, the need to induce managerial truth-telling precludes the incorporation of any of the disclosed information into the compensation contract which, therefore, makes the disclosure of information futile in the first place.<sup>44</sup>

---

<sup>43</sup>In other words, the firm chooses a level of liquidity  $\delta$  that compensates the speculator for the investigation costs and hence induces speculation after the flag has been raised.

<sup>44</sup>Bhattacharya (1980) considers a similar setting but without moral hazard (i.e., the manager makes an announcement, there is an exogenous signal correlated with the announcement, e.g., the final output, and the manager's compensation can be made contingent on both the announcement and the signal). As Proposition 9 shows, however, in the absence of investigation and speculation, inducing managerial announcements and making managers' compensation contingent on such announcements does not alleviate moral hazard.



### 4.3.2 On the role of endogenous stock liquidity

In previous sections, we solved the model by exploiting the separation between compensation and speculation costs that occurs because the firm can influence the speculator's profits through the stock's liquidity  $\delta$ .<sup>45</sup> In particular, under each convention, first we solved for the contract that minimizes compensation costs, and then, chose  $\delta$  such that the speculator just recovers his investigation costs  $k$ . As the next proposition shows, solving the model under exogenous stock liquidity (out of shareholders' control) would have produced the following results:

**Proposition 10** *If  $F_1$  is the optimal convention when  $\delta$  is endogenous, then it remains optimal for any level of liquidity. In contrast, if  $F_2$  is the optimal convention when  $\delta$  is endogenous, then there exist  $\delta_l$  and  $\delta_h$  such that: (i) if  $\delta \in [\delta_l, \delta_h]$ ,  $F_2$  and  $W_2^*$  remain optimal; and (ii) if  $\delta \notin (\delta_l, \delta_h)$ ,  $F_1$  and  $W_1^*$  become optimal instead.*

The previous proposition states that  $F_1$  and  $F_2$  remain as the only two potentially optimal conventions for any given level of stock liquidity. Notice however, that while stock liquidity  $\delta$  does not affect the value of firm under  $F_1$ , deviating from the “optimal” level of liquidity reduces the value of firm under  $F_2$ . On one hand, if the level of liquidity is too low ( $\delta < \delta_l$ ) the speculator's profits from trading do not compensate him for the investigation costs, and, as showed by Proposition 9, in the absence of speculation convention  $F_1$  becomes optimal. On the other hand, if the level of liquidity is too high ( $\delta > \delta_h$ ) the speculator's profits from trading become excessively large and hence the savings in compensation costs associated to  $F_2$  versus  $F_1$ , i.e.,  $C_2^* - C_1^*$ , would not compensate the shareholders for the speculation costs,  $S_2^*(\delta)$ .<sup>46</sup>

---

<sup>45</sup>As mentioned before,  $\delta$  affects  $D(\delta)$ , which in turn, influences the speculator's trading profits.

<sup>46</sup>However, in a setting in which competition among speculators reduces the profits from speculation, excess liquidity would be less likely to be an issue. This suggests that a convention like  $F_2$  sustained by managerial flagging should be more preeminently observed in situations of high stock liquidity.

### 4.3.3 On the observability of compensation

We have assumed that compensation contracts  $W_J$  are publicly observable and hence, that affect the formation of prices in the market, i.e., equation (5).<sup>47</sup> Consistent with this, in the analysis, firms were able to choose the convention that was in their best interest. In contrast, if managerial contracts were unobservable, firms would find it difficult to direct the market to follow a specific convention. This could result in a self-fulfilling equilibrium, that is a situation in which the market's beliefs would play a determinant role on compensation. For instance, even if  $F_2$  were the optimal convention, the following situation would be a “babbling” equilibrium: The market believes that flags convey no information (hence prices remain uninformative after flagging) and firms renounce to make compensation contingent on prices (hence confirming that flags are uninformative in equilibrium).<sup>48</sup>

The previous discussion suggests an additional effect of regulations on managerial compensation disclosure. In addition to the commonly mentioned effect that disclosing managerial compensation reduces managers' ability to extract rents from the firm (e.g., Bebchuk and Fried 2003), the arguments above suggest a reinforcing effect on corporate governance: it can enhance the importance of market scrutiny and increase the production of information about the firm in the market.

## 5 Concluding Remarks

We have developed a theory of informal communication between firms and capital markets in the presence of agency conflicts. The theory is based on three premises: (1) the presence of a managerial agency problem that shareholders must address; (2) the existence of managerial information that cannot be substantiated with hard evidence; and (3) the ability

---

<sup>47</sup>This is line with current regulations. On October 1992 the SEC expanded required compensation disclosures in annual proxy statements. Recent regulatory changes have reinforced the trend toward disclosure in compensation. Since August 2004, the SEC requires compensation disclosure to occur within days of entering the firm in the employment contracts.

<sup>48</sup>In contrast, when contracts are observable, babbling equilibria are not sequentially optimal. Roughly speaking, if  $W_2^*$  is in place the market would interpret flagging as more likely to come from  $g$  and the uninformative equilibrium unravels.

of market speculators to produce additional information about the firm at a cost. In this setting, firms face a trade-off when they disclose information to the market: Prices become more informative but speculators find it easier to investigate the firm. In other words, managerial disclosure of information, even though hampered by agency conflicts, plays a role in attracting attention and directing market research. This trade-off suggests a theory of discretionary disclosure: Firms may want to regulate the disclosure of information to attract speculation in certain cases but discourage it in others. The study also explores the interactions between agency conflicts, managerial compensation and information disclosure. In particular, the analysis shows that the presence of strong agency conflicts that require the use of high-power incentive compensation should be accompanied by a more intense disclosure of information by managers.

The study has implications on the debate about the effects of regulation on capital markets. For instance, recent regulatory changes in the US have stressed the importance of providing equal information to investors (i.e., regulation FD) and of making managers more responsible for their communications with the market (i.e., Sarbanes-Oxley Act). This analysis suggests that these regulations may have the unintended effect of encouraging some forms of informal communications between managers and capital markets. Rather than directly disclosing the information to professional analysts and be exposed to future legal actions, managers can now be compelled to rely on more subtle mechanisms which attract the attention of sophisticated investors. In this sense, these new regulations may produce, contrary to their intended objective, higher rather than lower information asymmetries among different market participants.

## REFERENCES

- Admati, A. and P. Pfleiderer (2000) "Forcing Firms to Talk: Financial Disclosure Regulation and Externalities," *Review of Financial Studies*, 13, pp. 479-519.
- Almazan, A. and J. Suarez (2003) "Managerial Compensation and the Market Reaction to Bank Loans," *Review of Financial Studies* 16, pp. 237-261
- Almazan, A., J. Suarez and S. Titman (2004) "Stakeholders, Transparency and Capital Structure" Working Paper, University of Texas.
- Austen-Smith, D. and J. Banks (2000) "Cheap Talk and Burned Money", *Journal of Economic Theory*, 91, pp. 1-16.
- Bebchuk, L., and J. Fried (2003) "Executive Compensation as an Agency Problem", *Journal of Economic Perspectives*, 17, pp. 71-92.
- Bhattacharya, S. (1980) "Nondissipative Signalling Structures and Dividend Policy," *The Quarterly Journal of Economics*, 95-1, pp. 1-24.
- Bhattacharya, U. and A. Dittmar (2003) "Costless Versus Costly Signaling: Theory and Evidence," Working Paper, Indiana University.
- Bolton P. and M. Dewatripont, *Contract Theory*, Cambridge, MA: MIT Press, 2005.
- Brennan, M. and P. Hughes (1991) "Stock Prices and the Supply of Information," *Journal of Finance*, 46, pp. 1665-1691.
- Brennan, M. and A. Kraus, (1987) "Efficient Financing Under Asymmetric Information", *Journal of Finance*, 42, pp. 1225-1243.
- Bushee, B., D. Matsumoto and G. Miller (2003), "Open versus Closed Conference Calls: the Determinants and Effects of Broadening Access to Disclosure," *Journal of Accounting and Economics*, 34, pp. 149-180
- Cooper, M., O. Dimitrov and R. Rau (2001) "A Rose.Com By Any Other Name", *Journal of Finance*, 56, 2371-2388.
- Crawford, V. and J. Sobel (1982) "Strategic Information Transmission," *Econometrica*, 50, pp. 1431-1451.
- Clark, J., A. Khorana, A. Patel. R. Rau (2004) "The Good the Bad and the Ugly? Differences in Analysts Behavior at Investment Banks, Brokerages and Independent Research Firms," Working Paper.
- Diamond, D., (1985) "Optimal Release of Information by Firms," *Journal of Finance*, 60, pp. 1071-1094.
- Diamond, D. and R. Verrecchia (1982) "Optimal Managerial Contracts and Equilibrium Security Prices," *Journal of Finance*, 37, pp. 275-287.
- Dye, R. (1985) "Disclosure of Nonproprietary Information," *Journal of Accounting Research*, 23, pp. 123-145.
- Farrell, J. and M. Rabin (1996) "Cheap Talk," *Journal of Economic Perspectives*, 10-3, pp. 103-118.
- Faure-Grimaud, A. and D. Gromb (2004), "Public Trading and Private Incentives," *Review of Financial Studies*.

- Fisher, A. and R. Heinkel (2003) "Reputation and Managerial Truth-Telling as Self-Insurance," Working Paper, University of British Columbia.
- Fishman, M. and K. Hagerty (1997) "Disclosure in Markets with Sophisticated and Unsophisticated Customers," Working Paper.
- Francis, J., J. Hanna and D. Philbrick (1998) "Management Communications with Securities Analysts," *Journal of Accounting and Economics*, 24, pp. 363-394.
- Franke, G. (1987) "Costless Signalling in Financial Markets," *Journal of Finance*, 42, pp. 809-822.
- Graham, J., C. Harvey and S. Rajgopal (2004) "The Economic Implications of Corporate Financial Reporting," NBER Working Paper 10550.
- Grinblatt, M., R. Masulis and S. Titman (1984) "The Valuation Effects of Stock Splits and Stock Dividends," *Journal of Financial Economics*, 13, pp. 461-490.
- Grossman, S. (1981) "The Role of Warranties and Private Disclosure about Product Quality," *Journal of Law and Economics*, 24, pp. 461-483.
- Grossman, S. and O. Hart (1980) "Disclosure Laws and Takeover Bids," *Journal of Finance*, 35, pp. 323-334.
- Grossman, S. and J. Stiglitz (1980) "On the Impossibility of Informationally Efficient Markets," *American Economic Review*, 70, pp. 393-408.
- Harris, M. and A. Raviv (2004), "Allocation of Decision-Making Authority," Working Paper, University of Chicago.
- Healy, P., A. Hutton, and K. Palepu (1999) "Stock Performance and Intermediation Changes Surrounding Sustained Increases in Disclosure," *Contemporary Accounting Research*, 16, pp. 485-520.
- Healy, P. and K. Palepu (2001) "Information asymmetry, corporate disclosure, and the capital markets: A review of the empirical disclosure literature," *Journal of Accounting and Economics*, 31, pp. 405-440.
- Holmstrom, B. and J. Tirole (1993) "Market liquidity and performance monitoring," *Journal of Political Economy*, 101, pp. 678-709.
- Ikenberry, D., J. Lakonishok and T. Vermaelen (1995) "Market Underreaction to Open-Market Stock Repurchases," *Journal of Financial Economics*, 39, pp. 181-208.
- Jovanovic, B. (1982) "Truthful Disclosure of Information," *Bell Journal of Economics*, 16, pp. 328-40.
- Kofman, F., and J. Lawarree (1993) "Collusion in Hierarchical Agency," *Econometrica*, 61, pp. 629-56.
- Kyle, A. (1985) "Continuous Auctions and Insider Trading," *Econometrica*, 53, pp. 1315-35.
- Lamoureux, C. and P. Poon (1987) "The Market Reaction to Stock Splits," *Journal of Finance*, 42, pp. 1347-70.
- Leuz, C., and R. Verrecchia (2000) "The Economic Consequences of Increased Disclosure," *Journal of Accounting Research*, 38, pp. 91-124.
- Miller, G. and J. Piotroski (2000) "The Role of Disclosure for High Book-to-Market Firms," Working Paper, Harvard University.

- Nanda, D., V. Nagar and P. Wysocki (2003) "Discretionary Disclosure and Stock-Based Incentives," *Journal of Accounting and Economics*, 34, pp. 283-309.
- Rau, R., A. Patel, I. Osobov, A. Khorana and M. Cooper (2004) "Managerial actions in response to a market downturn: Valuation effects of name changes in the dot.com decline," *Journal of Corporate Finance*, forthcoming.
- Ross, S. (1977) "The Determination of Financial Structure: The Incentive-Signaling Approach," *Bell Journal of Economics*, 8, pp. 23-40.
- Tirole, J. (1986) "Hierarchies and Bureaucracies: On the Role of Collusion in Organizations," *Journal of Law Economics and Organizations*, 2, pp. 181-214.
- Stocken, P. (2000) "Credibility of Voluntary Disclosure," *Rand Journal of Economics*, 31, pp. 359-374.
- Stephens, C., and M. Weisbach (1998) "Actual Share Repurchase in Open-Market re-Purchase Programs," *Journal of Finance*, 53, pp. 313-333.
- Stern, S. (2001) "Stern Stewart Roundtable on Capital Structure and Stock Repurchases," *Journal of Applied Corporate Finance*, 14, pp. 8-41.
- Verrecchia, R. (1983) "Discretionary Disclosure," *Journal of Accounting and Economics*, 5, pp. 179-194.
- Verrecchia, R. (2001) "Essays on Disclosure," *Journal of Accounting and Economics*, 32, pp 97-180.

## Appendix

### PRICES AND PROBABILITIES UNDER THE DIFFERENT CONVENTIONS

$$\begin{aligned}
 \mathcal{P}_2 & \begin{cases} p_2^N = \frac{s_n(1-\gamma-\beta)+s_b(\beta-\Delta e)}{1-\gamma-\Delta e} (R - w_2^N) & \text{w.p. } 1 - \gamma - \Delta e \\ p_2^H = \sigma_H (R - w_2^H) & \text{w.p. } \frac{(\gamma+\Delta e)x_g}{2} \\ p_2^L = \sigma_L R (R - w_2^L) & \text{w.p. } \frac{(\gamma+\Delta e)(1-x_g)}{2} \\ p_2^M = s_g (R - w_2^M) & \text{w.p. } \frac{(\gamma+\Delta e)^2}{2} \end{cases} \\
 \mathcal{P}_3 & \begin{cases} p_3^N = \frac{s_n(1-\gamma-\beta)+s_g(\gamma+\Delta e)}{1-\beta+\Delta e} (R - w_3^N) & \text{w.p. } 1 - \beta + \Delta e \\ p_3^H = \sigma_H (R - w_3^H) & \text{w.p. } \frac{(\beta-\Delta e)x_b}{2} \\ p_3^L = \sigma_L (R - w_3^L) & \text{w.p. } \frac{(\beta-\Delta e)(1-x_b)}{2} \\ p_3^M = s_b (R - w_3^M) & \text{w.p. } \frac{(\beta-\Delta e)^2}{2} \end{cases} \\
 \mathcal{P}_4 & \begin{cases} p_4^N = s_n (R - w_4^N) & \text{w.p. } 1 - \gamma - \beta \\ p_4^H = \sigma_H (R - w_4^H) & \text{w.p. } \frac{(\gamma+\Delta e)x_g+(\beta-\Delta e)x_b}{2} \\ p_4^L = \sigma_L (R - w_4^L) & \text{w.p. } \frac{(\gamma+\Delta e)(1-x_g)+(\beta-\Delta e)(1-x_b)}{2} \\ p_4^M = \frac{(\gamma+\Delta e)\sigma_H+(\beta-\Delta e)\sigma_L}{\gamma+\beta} (R - w_4^M) & \text{w.p. } \frac{\gamma+\beta}{2} \end{cases} \\
 \mathcal{P}_5 & \begin{cases} p_5^N = s_n (R - w_5^N) & \text{w.p. } 1 - \gamma - \beta \\ p_5^gH = \sigma_H (R - w_5^gH) & \text{w.p. } \frac{(\gamma+\Delta e)x_g}{2} \\ p_5^gL = \sigma_L (R - w_5^gL) & \text{w.p. } \frac{(\gamma+\Delta e)(1-x_g)}{2} \\ p_5^gM = s_g (R - w_5^gM) & \text{w.p. } \frac{(\gamma+\Delta e)^2}{2} \\ p_5^bH = \sigma_H (R - w_5^bH) & \text{w.p. } \frac{(\beta-\Delta e)x_b}{2} \\ p_5^bL = \sigma_L (R - w_5^bL) & \text{w.p. } \frac{(\beta-\Delta e)(1-x_b)}{2} \\ p_5^bM = s_b (R - w_5^bM) & \text{w.p. } \frac{(\beta-\Delta e)^2}{2} \end{cases}
 \end{aligned}$$

### SPECULATOR'S PROFITS FROM TRADING AND LIMITS OF $k$ AND $\alpha$

#### Profits from trading unconditionally (i.e., under $F_1$ ) for a given $\delta$

Probability that the speculator gets a good ( $\sigma_H$ ) and a bad signal ( $\sigma_L$ ):

$$\Pr(\sigma_H) = (\gamma + \Delta)x_g + (\beta - \Delta)x_b + (1 - \beta - \gamma)x_n \equiv P_H \quad (\text{A.1})$$

$$\Pr(\sigma_L) = (\gamma + \Delta)(1 - x_g) + (\beta - \Delta)(1 - x_b) + (1 - \beta - \gamma)(1 - x_n) = 1 - P_H \quad (\text{A.2})$$

Firm's value conditioning on speculator's signal:  $V(\sigma_H) = \sigma_H (R - w_1^*)$  and  $V(\sigma_L) = \sigma_L (R - w_1^*)$ .

Prices if speculators trade under low, high and medium order flow (i.e.,  $p_1^L$ ,  $p_1^H$ ,  $p_1^M$  respectively):

$$p_1^L = p(-L, -L) = \sigma_L (R - w_1^*); \quad p_1^H = p(+L, +L) = \sigma_H (R - w_1^*) \quad (\text{A.3})$$

$$p_1^M = P_H \sigma_H (R - w_1^*) + (1 - P_H) \sigma_L (R - w_1^*) \quad (\text{A.4})$$

where:  $w_1^* = \frac{B}{\Delta(x_g - x_b)}$  and  $P_H$  is defined in (A.1).

Speculator's expected profits from trading:

$$\begin{aligned}
 \pi_S^{1*} &= \frac{D(\delta)}{2} ([V(\sigma_H) - p_1^M] P_H + [p_1^M - V(\sigma_L)] (1 - P_H)) = \\
 &= D(\delta) (1 - P_H) P_H (\sigma_H - \sigma_L) \left( R - \frac{B}{\Delta(x_g - x_b)} \right)
 \end{aligned} \quad (\text{A.5})$$

The speculator will not investigate if the profits from trading (i.e.,  $\pi_S^{1*}$ ) do not compensate him for the expected investigation costs  $\bar{k} \equiv k(\gamma + \beta) + k_n(1 - \gamma - \beta) = k[(\gamma + \beta) + \alpha(1 - \gamma - \beta)]$ :

$$\pi_S^{1*} < \frac{1}{4} RD(1)(\sigma_H - \sigma_L) < \bar{k} \quad (\text{A.6})$$

### Profits from trading in $g$ (e.g., under $F_2$ ) for a given level liquidity $\delta$

Firm's value conditioning on speculator's signal (i.e.,  $\sigma$ ), state  $g$ , and a medium order flow:

$$V(\sigma_H, g, (-L, +L)) = \sigma_H (R - w_2^{M*}); \text{ and } V(\sigma_L, g, (-L, +L)) = \sigma_L (R - w_2^{M*}) \quad (\text{A.7})$$

where:  $w_2^{M*} = 0$ . The speculator's expected profits from trading is:

$$\begin{aligned} \pi_S^{2*} &= \frac{D(\delta)}{2} ([\sigma_H R - p_2^M] x_g + [p_2^M - \sigma_L R] (1 - x_g)) = \\ &= \frac{D(\delta)R}{2} ([\sigma_H - s_g] x_g + [s_g - \sigma_L] (1 - x_g)) = (\sigma_H - \sigma_L) x_g (1 - x_g) D(\delta)R \end{aligned}$$

The speculator will investigate if the profits from trading (i.e.,  $\pi_S^{2*}$ ) compensate him for the investigation costs (i.e.,  $K$ ). Notice that under the parametric conditions in equation (4) the speculator will indeed investigate after state  $g$  has been flagged if the level of liquidity  $\delta$  is set high enough:

$$\pi_S^{2*} < \frac{(\sigma_H - \sigma_L)D(1)R}{[\min\{x_b(1 - x_b), x_g(1 - x_g)\}]^{-1}} < k \quad (\text{A.8})$$

### Profits from trading in $b$ (e.g., under $F_3$ ) for a given $\delta$

Following similar steps as before, the speculator's expected profits from trading:

$$\pi_S^{3*} = \frac{D(\delta)}{2} ([\sigma_H R - p_3^M] x_b + [p_3^M - \sigma_L R] (1 - x_b)) = (\sigma_H - \sigma_L) x_b (1 - x_b) D(\delta)R. \quad (\text{A.9})$$

The speculator will investigate if the profits from trading (i.e.,  $\pi_S^{3*}$ ) compensate him for the investigation costs (i.e.,  $K$ ). Notice that under the parametric conditions in equation (4) the speculator will indeed investigate after state  $b$  has been flagged if the level of liquidity  $\delta$  is set high enough:

$$\pi_S^{3*} < \pi_c \frac{(\sigma_H - \sigma_L)D(1)R}{[\min\{x_b(1 - x_b), x_g(1 - x_g)\}]^{-1}} < k. \quad (\text{A.10})$$

#### DERIVATION OF OPTIMAL CONTRACTS

### Contract for $F_2$ (Proof of Proposition 2)

$$\min_{w_2 \in \mathbb{R}_+^4} (\gamma + \Delta) \left[ \frac{x_g \sigma_H}{2} w_2^H + \frac{(1 - x_g) \sigma_L}{2} w_2^L + \frac{s_g}{2} w_2^M \right] + [(1 - \gamma - \beta) s_n + (\beta - \Delta) s_b] w_2^N \quad (\text{A.11})$$

$$\text{s.t.} \quad \frac{x_g \sigma_H}{2} w_2^H + \frac{(1 - x_g) \sigma_L}{2} w_2^L + \frac{s_g}{2} w_2^M \geq s_b w_2^N + \frac{B}{\Delta} \quad (\text{A.12})$$

$$\frac{x_b \sigma_H}{2} w_2^H + \frac{(1 - x_b) \sigma_L}{2} w_2^L + \frac{s_b}{2} w_2^M \leq s_b w_2^N \quad (\text{A.13})$$

$$\frac{x_g \sigma_H}{2} w_2^H + \frac{(1 - x_g) \sigma_L}{2} w_2^L + \frac{s_g}{2} w_2^M \geq s_g w_2^N \quad (\text{A.14})$$

$$\frac{x_n \sigma_H}{2} w_2^H + \frac{(1 - x_n) \sigma_L}{2} w_2^L + \frac{s_n}{2} w_2^M \leq s_n w_2^N \quad (\text{A.15})$$

The problem can be simplified by noting that any contract for which  $w_2^L$  (or  $w_2^M$ ) is positive can be replaced by an alternative contract that reduces  $w_2^L$  (or  $w_2^M$ ) by  $\varepsilon > 0$  and increases  $w_2^H$  by  $\varepsilon \frac{(1 - x_g) \sigma_L}{x_g \sigma_H}$  (or  $\varepsilon \frac{s_g}{x_g \sigma_H} > 0$ ). The new contract does not affect the value of the objective function or of constraints (A.12) and (A.14), and strictly helps on constraints (A.13) and (A.15). Hence, imposing  $w_2^L = w_2^M = 0$ , (A.12)-(A.15) boils down to:

$$\frac{\sigma_H}{2} w_2^H \geq \frac{s_b}{x_g} w_2^N + \frac{B}{x_g \Delta} \quad (\text{A.16})$$

$$\frac{\sigma_H}{2} w_2^H \leq \frac{s_b}{x_b} w_2^N \quad (\text{A.17})$$

$$\frac{\sigma_H}{2} w_2^H \geq \frac{s_g}{x_g} w_2^N \quad (\text{A.18})$$

$$\frac{\sigma_H}{2} w_2^H \leq \frac{s_n}{x_n} w_2^N \quad (\text{A.19})$$



Since  $\frac{s_g}{x_g} < \frac{s_n}{x_n} < \frac{s_b}{x_b}$ , (A.19) implies (A.17) so (A.17) can be ignored. Furthermore, (A.19) must be binding (otherwise reducing  $w_2^N$  would relax (A.16) and (A.18) and decrease the objective function). If (A.19) is binding implies that (A.18) is not ( $\frac{s_n}{x_n} < \frac{s_b}{x_b}$ ). Finally (A.16) must be binding (otherwise reducing  $w_2^H$  would relax (A.19) and decrease the objective function). In summary, (A.16) and (A.19) must bind. Solving the linear system formed by them gives the optimal contract, which substituted into the objective function yields  $C_2^*$ .

**Contract for  $F_3$  (Proof of Proposition 3 first-part)**

$$\min_{w_3 \in \mathbb{R}_+^4} (\beta - \Delta) \left[ \frac{x_b \sigma_H}{2} w_3^H + \frac{(1-x_b) \sigma_L}{2} w_3^L + \frac{s_b}{2} w_3^M \right] + [(1-\gamma-\beta)s_n + (\gamma+\Delta)s_g] w_3^N \quad (\text{A.20})$$

s.t.

$$\frac{x_b \sigma_H}{2} w_3^H + \frac{(1-x_b) \sigma_L}{2} w_3^L + \frac{s_b}{2} w_3^M \leq s_g w_3^N - \frac{B}{\Delta} \quad (\text{A.21})$$

$$\frac{x_b \sigma_H}{2} w_3^H + \frac{(1-x_b) \sigma_L}{2} w_3^L + \frac{s_b}{2} w_3^M \geq s_b w_3^N \quad (\text{A.22})$$

$$\frac{x_g \sigma_H}{2} w_3^H + \frac{(1-x_g) \sigma_L}{2} w_3^L + \frac{s_g}{2} w_3^M \leq s_g w_3^N \quad (\text{A.23})$$

$$\frac{x_n \sigma_H}{2} w_3^H + \frac{(1-x_n) \sigma_L}{2} w_3^L + \frac{s_n}{2} w_3^M \leq s_n w_3^N \quad (\text{A.24})$$

The problem can be simplified by noting that for any contract with strictly positive  $w_3^H$  (or  $w_3^M$ ) we can reduce  $w_3^H$  (or  $w_3^M$ ) by  $\varepsilon > 0$  and increase  $w_2^L$  by  $\varepsilon \frac{x_b}{(1-x_b)} \frac{\sigma_H}{\sigma_L}$  (or  $\varepsilon \frac{s_b}{(1-x_b)\sigma_L} > 0$ ). Such change does not affect the value of the objective function or of constraints (A.21), and (A.22) and strictly relaxes constraints (A.23) and (A.24) (notice that  $\frac{x_g \sigma_H}{2} > \frac{(1-x_g) \sigma_L}{2} \frac{x_b}{(1-x_b)} \frac{\sigma_H}{\sigma_L}$  and  $\frac{s_g}{2} > \frac{(1-x_g) \sigma_L}{2} \frac{s_b}{(1-x_b) \sigma_L}$  for (A.23) and  $\frac{x_n \sigma_H}{2} > \frac{(1-x_n) \sigma_L}{2} \frac{x_b}{(1-x_b)} \frac{\sigma_H}{\sigma_L}$  and  $\frac{s_n}{2} > \frac{(1-x_n) \sigma_L}{2} \frac{s_b}{(1-x_b) \sigma_L}$  for (A.24)). Hence, we can impose w.l.o.g. that  $w_3^H = w_3^M = 0$ , (A.21)-(A.24) boils down to:

$$\frac{\sigma_L}{2} w_3^L \leq \frac{s_g}{1-x_b} w_3^N - \frac{B}{(1-x_b)\Delta} \quad (\text{A.25})$$

$$\frac{\sigma_L}{2} w_3^L \geq \frac{s_b}{1-x_b} w_3^N \quad (\text{A.26})$$

$$\frac{\sigma_L}{2} w_3^L \leq \frac{s_g}{1-x_g} w_3^N \quad (\text{A.27})$$

$$\frac{\sigma_L}{2} w_3^L \leq \frac{s_n}{1-x_n} w_3^N \quad (\text{A.28})$$

Since  $\frac{s_g}{1-x_g} > \frac{s_n}{1-x_n} > \frac{s_b}{1-x_b}$ , (A.28) implies (A.27) so (A.27) can be ignored. Furthermore, (A.26) must be binding (otherwise reducing  $w_3^L$  relaxes (A.25) and (A.28) and decreases the objective function). If (A.26) is binding implies (A.28) is not ( $\frac{s_n}{1-x_n} > \frac{s_b}{1-x_b}$ ). Finally (A.25) must be binding (otherwise reducing  $w_3^N$  relaxes (A.26) and decreases the objective function). In sum, solving the linear system formed by (A.25) and (A.26) gives the optimal contract, which substituted into the objective function yields  $C_3^*$  (which equals  $C_1^*$ ).

**Contract for  $F_4$  (Proof of Proposition 3 second-part)**

$$\begin{aligned} \min_{w_4 \in \mathbb{R}_+^4} (1-\gamma-\beta)s_n w_4^N + \frac{(\gamma+\Delta) [x_g \sigma_H w_4^H + s_g w_4^M + (1-x_g) \sigma_L w_4^L]}{2} + \\ + \frac{(\beta-\Delta) [x_b \sigma_H w_4^H + s_b w_4^M + (1-x_b) \sigma_L w_4^L]}{2} \end{aligned} \quad (\text{A.29})$$

s.t.

$$\frac{(x_g - x_b)\sigma_H}{2}w_4^H - \frac{(x_g - x_b)\sigma_L}{2}w_4^L + \frac{(s_g - s_b)}{2}w_4^M \geq \frac{B}{\Delta} \quad (\text{A.30})$$

$$\frac{x_b\sigma_H}{2}w_4^H + \frac{(1 - x_b)\sigma_L}{2}w_4^L + \frac{s_b}{2}w_4^M \geq s_b w_4^N \quad (\text{A.31})$$

$$\frac{x_g\sigma_H}{2}w_4^H + \frac{(1 - x_g)\sigma_L}{2}w_4^L + \frac{s_g}{2}w_4^M \geq s_g w_4^N \quad (\text{A.32})$$

$$\frac{x_n\sigma_H}{2}w_4^H + \frac{(1 - x_n)\sigma_L}{2}w_4^L + \frac{s_n}{2}w_4^M \leq s_n w_4^N \quad (\text{A.33})$$

Define  $\alpha(v) \equiv \frac{x_v\sigma_H}{s_v} \in [0, 1]$  for  $v \in \{b, g, n\}$ , and rewrite the constraints as:

$$\frac{(x_g - x_b)\sigma_H}{2}w_4^H - \frac{(x_g - x_b)\sigma_L}{2}w_4^L + \frac{s_g - s_b}{2}w_4^M \geq \frac{B}{\Delta} \quad (\text{A.34})$$

$$\alpha(b)w_4^H + (1 - \alpha(b))w_4^L + w_4^M \geq 2w_4^N \quad (\text{A.35})$$

$$\alpha(g)w_4^H + (1 - \alpha(g))w_4^L + w_4^M \geq 2w_4^N \quad (\text{A.36})$$

$$\alpha(n)w_4^H + (1 - \alpha(n))w_4^L + w_4^M \leq 2w_4^N \quad (\text{A.37})$$

and since  $\alpha(b) < \alpha(n) < \alpha(g)$  then  $w_4^H = w_4^L \equiv w_4^{HL}$  and constraints (A.35)-(A.37) are binding. Furthermore, (A.34) must be binding (otherwise reducing  $w_4^{HL}$  or  $w_4^M$  by  $2\varepsilon$  and  $w_4^N$  by  $\varepsilon$  would leave constraints (A.35)-(A.37) unaffected and decrease the objective function). In summary, the optimization problem boils down to solving the linear system of the binding constraints:

$$w_4^{HL} + w_4^M = \frac{2B}{\Delta(s_g - s_b)} \quad (\text{A.38})$$

$$w_4^N = \frac{B}{\Delta(s_g - s_b)} \quad (\text{A.39})$$

Furthermore the objective function (since  $w_4^H = w_4^L \equiv w_4^{HL}$ ) boils down to:

$$\min_{W^4 \in \mathbb{R}_+^4} \frac{(\gamma + \Delta)s_g(w_4^{HL} + w_4^M) + (\beta - \Delta)s_b(w_4^{HL} + w_4^M)}{2} + (1 - \gamma - \beta)s_n w_4^N.$$

Therefore the system is determined up to  $(w_4^{HL} + w_4^M)$ ; imposing w.l.o.g.  $w_4^{HL} = 0$  the optimal contract is obtained. Substituting it into the objective constraint yields  $C_4^*$  which equals  $C_1^*$ .

COMPARATIVE STATICS

**Proof of Proposition 4 (Comparison between  $C_1^*$  and  $C_2^*$ )**

$$C_1^* = \frac{q_1}{(q_1 - q_0)} B = B + \frac{q_0}{(q_1 - q_0)} B \quad (\text{A.40})$$

$$C_2^* = \frac{(\gamma + \Delta) \frac{x_g}{x_n} s_n + (1 - \gamma - \beta) s_n + (\beta - \Delta) s_b}{\Delta \left( \frac{x_g}{x_n} s_n - s_b \right)} B = B + \frac{\left( \gamma \left( \frac{x_g}{x_n} s_n - s_g \right) + q_0 \right) B}{\Delta \left( \frac{x_g}{x_n} s_n - s_g \right) + (q_1 - q_0)} \quad (\text{A.41})$$

$$\begin{aligned} C_1^* - C_2^* &= \frac{q_0 \Delta - \gamma (q_1 - q_0)}{\left[ \Delta \left( \frac{x_g}{x_n} s_n - s_g \right) + (q_1 - q_0) \right] (q_1 - q_0)} \left( \frac{x_g}{x_n} s_n - s_g \right) B \\ &= \frac{(1 - \gamma - \beta) s_n + (\beta + \gamma) s_b}{\left[ \Delta \left( \frac{x_g}{x_n} s_n - s_g \right) + (q_1 - q_0) \right] (q_1 - q_0)} \Delta \left( \frac{x_g}{x_n} s_n - s_g \right) B > 0 \end{aligned} \quad (\text{A.42})$$

**Proof of Proposition 5 (Comparison between  $F_1^*$  and  $F_2^*$ )**

Using equation (A.42):

$$C_1^* - C_2^* = \frac{q_0 \Delta - \gamma (q_1 - q_0)}{\left[ \Delta \left( \frac{x_g}{x_n} s_n - s_g \right) + (q_1 - q_0) \right] (q_1 - q_0)} \left( \frac{x_g}{x_n} s_n - s_g \right) B$$

$$\left[ \frac{\partial (C_1^* - C_2^*)}{\partial B} \right]_{Ceteris\ Paribus} > 0 ; \left[ \frac{\partial (C_1^* - C_2^*)}{\partial (q_1 - q_0)} \right]_{Cet\ Par} < 0 \quad (\text{A.43})$$

$$\left[ \frac{\partial (C_1^* - C_2^*)}{\partial q_0} \right]_{Cet.\ Par.} > 0 ; \left[ \frac{\partial (C_1^* - C_2^*)}{\partial \Delta} \right]_{Cet.\ Par.} > 0 \quad (\text{A.44})$$

$$\left[ \frac{\partial (C_1^* - C_2^*)}{\partial \gamma} \right]_{Cet.\ Par.} < 0 ; \left[ \frac{\partial (C_1^* - C_2^*)}{\partial \left( \frac{x_g}{x_n} s_n - s_g \right)} \right]_{Cet.\ Par.} > 0 \quad (\text{A.45})$$

where ceteris paribus means keeping constant (all but one) of the following six variables  $\gamma$ ,  $\Delta$ ,  $q_0$ ,  $\left( \frac{x_g}{x_n} s_n - s_g \right)$ ,  $(q_1 - q_0)$ , and  $B$ .

ROBUSTNESS AND EXTENSIONS

**Proof of Proposition 6 (Limited Liability)**

a) Under convention  $F_1$ , a positive wage after  $z = 0$ ,  $w^0 > 0$ , strictly increases compensation costs because it increases the value of the objective function and makes the incentive constraint harder to satisfy. (See footnote 14 for details.) In fact we can express  $C_1(w^0) = w^0 + \frac{B}{q_1 - q_0}$ , an expression that it is minimized when  $w^0 = 0$ . In what follows, we use the notation  $w_J^{0,i} \equiv w(0, p_J^i)$  and  $w_J^{R,i} \equiv w(R, p_J^i)$

b) Convention  $F_2$ . Without imposing limited liability up-front, the problem is:

$$\begin{aligned} \min_{W_2 \in \mathbb{R}_+^8} (\gamma + \Delta) &\left[ \frac{x_g \sigma_H}{2} w_2^{R,H} + \frac{x_g (1 - \sigma_H)}{2} w_2^{0,H} + \frac{(1 - x_g) \sigma_L}{2} w_2^{R,L} \right] + \\ &+ \frac{(1 - x_g) (1 - \sigma_L)}{2} w_2^{0,L} + \frac{s_g}{2} w_2^{R,M} + \frac{(1 - s_g)}{2} w_2^{0,M} \\ &+ [(1 - \gamma - \beta) s_n + (\beta - \Delta) s_b] w_2^{R,N} + \\ &+ [(1 - \gamma - \beta) (1 - s_n) + (\beta - \Delta) (1 - s_b)] w_2^{0,N} \end{aligned} \quad (\text{A.46})$$

s.t.

$$\left[ \begin{array}{l} \frac{x_g \sigma_H}{2} w_2^{R,H} + \frac{x_g(1-\sigma_H)}{2} w_2^{0,H} + \frac{(1-x_g)\sigma_L}{2} w_2^{R,L} + \\ \frac{(1-x_g)(1-\sigma_L)}{2} w_2^{0,L} + \frac{s_g}{2} w_2^{R,M} + \frac{(1-s_g)}{2} w_2^{0,M} \end{array} \right] \geq s_b w_2^{R,N} + (1-s_b) w_2^{0,N} + \frac{B}{\Delta} \quad (\text{A.47})$$

$$\left[ \begin{array}{l} \frac{x_g \sigma_H}{2} w_2^{R,H} + \frac{x_g(1-\sigma_H)}{2} w_2^{0,H} + \frac{(1-x_g)\sigma_L}{2} w_2^{R,L} + \\ \frac{(1-x_g)(1-\sigma_L)}{2} w_2^{0,L} + \frac{s_g}{2} w_2^{R,M} + \frac{(1-s_g)}{2} w_2^{0,M} \end{array} \right] \geq s_g w_2^{R,N} + (1-s_g) w_2^{0,N} \quad (\text{A.48})$$

$$\left[ \begin{array}{l} \frac{x_n \sigma_H}{2} w_2^{R,H} + \frac{x_n(1-\sigma_H)}{2} w_2^{0,H} + \frac{(1-x_n)\sigma_L}{2} w_2^{R,L} + \\ \frac{(1-x_n)(1-\sigma_L)}{2} w_2^{0,L} + \frac{s_n}{2} w_2^{R,M} + \frac{(1-s_n)}{2} w_2^{0,M} \end{array} \right] \leq s_n w_2^{R,N} + (1-s_n) w_2^{0,N} \quad (\text{A.49})$$

$$\left[ \begin{array}{l} \frac{x_b \sigma_H}{2} w_2^{R,H} + \frac{x_b(1-\sigma_H)}{2} w_2^{0,H} + \frac{(1-x_b)\sigma_L}{2} w_2^{R,L} + \\ \frac{(1-x_b)(1-\sigma_L)}{2} w_2^{0,L} + \frac{s_b}{2} w_2^{R,M} + \frac{(1-s_b)}{2} w_2^{0,M} \end{array} \right] \leq s_b w_2^{R,N} + (1-s_b) w_2^{0,N} \quad (\text{A.50})$$

To prove that contracts that limit payments to positive cash flows are without loss of generality, we can proceed as follows: **(1)** Any contract for which  $w_2^{0,H}$  (or  $w_2^{0,L}$ ) is greater than zero can be replaced with an “alternative” contract that reduces  $w_2^{0,H}$  (or  $w_2^{0,L}$ ) by  $\varepsilon > 0$  and increases  $w_2^{R,H}$  (or  $w_2^{R,L}$ ) by  $\frac{1-\sigma_H}{\sigma_H} \varepsilon$  (or  $\frac{1-\sigma_L}{\sigma_L} \varepsilon$ ). These alternative contracts do not change the value of the objective function or any of the constraints, and therefore, in the above optimization problem we can impose  $w_2^{0,H} = w_2^{0,L} = 0$ . **(2)** Any contract for which  $w_2^{0,M}$  is greater than zero can be replaced with an “alternative” contract that reduces  $w_2^{0,M}$  by  $\varepsilon > 0$  and increases  $w_2^{R,M}$  by  $\frac{1-s_g}{s_g} \varepsilon$ . This alternative contract does not change the value of the objective function or constraints (A.47) and (A.48), and relaxes (A.49) and (A.50), and therefore, in the above optimization problem we can impose  $w_2^{0,M} = 0$ . **(3)** Any contract for which  $w_2^{R,L}$  (or  $w_2^{R,M}$ ) is positive can be replaced by an alternative contract that reduces  $w_2^{R,L}$  (or  $w_2^{R,M}$ ) by  $\varepsilon > 0$  and increases  $w_2^{R,H}$  by  $\varepsilon \frac{(1-x_g)\sigma_L}{x_g \sigma_H}$  (or  $\varepsilon \frac{s_g}{x_g \sigma_H} > 0$ ). This alternative contract does not change the value of the objective function or constraints (A.47) and (A.48), and relaxes constraints (A.49) and (A.50), and therefore, in the above optimization problem we can impose  $w_2^{R,L} = w_2^{R,M} = 0$ . **(4)** Imposing  $w_2^{0,H} = w_2^{0,L} = w_2^{0,M} = w_2^{R,L} = w_2^{R,M} = 0$ , and solving the problem by ignoring by now constraints (A.48) and (A.50), it is immediate to check that, in this relaxed problem, any contract that pays  $w_2^{0,N} > 0$  can be replaced by an alternative contract that reduces  $w_2^{0,N}$  by  $\varepsilon > 0$  and increases  $w_2^{R,N}$  by  $\frac{1-s_n}{s_n} \varepsilon$ . The new contract does not affect the value of the objective function, relaxes (A.47), and does not affect constraint (A.49). **(5)** Notice that after imposing  $w_2^{0,N} = 0$ , this relaxed problem has the same solution as the one solved for convention  $F_2$  under Proposition 2,  $W_2^*$  (i.e., see Proof of Proposition 2 in this Appendix). As  $W_2^*$  verifies constraints (A.48) and (A.50) the solution is optimal.

c) Convention  $F_3$ . Without imposing limited liability up-front, the optimization problem in  $F_3$  is:

$$\begin{aligned} \min_{W_3 \in \mathbb{R}_+^s} (\beta - \Delta) & \left[ \begin{array}{l} \frac{x_b \sigma_H}{2} w_3^{R,H} + \frac{x_b(1-\sigma_H)}{2} w_3^{0,H} + \frac{(1-x_b)\sigma_L}{2} w_3^{R,L} \\ + \frac{(1-x_b)(1-\sigma_L)}{2} w_3^{0,L} + \frac{s_b}{2} w_3^{R,M} + \frac{(1-s_b)}{2} w_3^{0,M} \end{array} \right] + \\ & + [(1-\gamma-\beta)s_n + (\gamma+\Delta)s_g] w_2^{R,N} + \\ & + [(1-\gamma-\beta)(1-s_n) + (\gamma+\Delta)(1-s_g)] w_2^{0,N} \end{aligned} \quad (\text{A.51})$$

$$\text{s.t.} \quad \left[ \begin{array}{l} \frac{x_b \sigma_H}{2} w_3^{R,H} + \frac{x_b(1-\sigma_H)}{2} w_3^{0,H} + \frac{(1-x_b)\sigma_L}{2} w_3^{R,L} + \\ \frac{(1-x_b)(1-\sigma_L)}{2} w_3^{0,L} + \frac{s_b}{2} w_3^{R,M} + \frac{(1-s_b)}{2} w_3^{0,M} \end{array} \right] + \frac{B}{\Delta} \leq s_g w_3^{R,N} + (1-s_g) w_3^{0,N} \quad (\text{A.52})$$

$$\left[ \begin{array}{l} \frac{x_g \sigma_H}{2} w_3^{R,H} + \frac{x_g(1-\sigma_H)}{2} w_3^{0,H} + \frac{(1-x_g)\sigma_L}{2} w_3^{R,L} + \\ \frac{(1-x_g)(1-\sigma_L)}{2} w_3^{0,L} + \frac{s_g}{2} w_3^{R,M} + \frac{(1-s_g)}{2} w_3^{0,M} \end{array} \right] \leq s_g w_3^{R,N} + (1-s_g) w_3^{0,N} \quad (\text{A.53})$$

$$\left[ \begin{array}{l} \frac{x_n \sigma_H}{2} w_3^{R,H} + \frac{x_n(1-\sigma_H)}{2} w_3^{0,H} + \frac{(1-x_n)\sigma_L}{2} w_3^{R,L} + \\ \frac{(1-x_n)(1-\sigma_L)}{2} w_3^{0,L} + \frac{s_n}{2} w_3^{R,M} + \frac{(1-s_n)}{2} w_3^{0,M} \end{array} \right] \leq s_n w_3^{R,N} + (1-s_n) w_3^{0,N} \quad (\text{A.54})$$

$$\left[ \begin{array}{l} \frac{x_b \sigma_H}{2} w_3^{R,H} + \frac{x_b(1-\sigma_H)}{2} w_3^{0,H} + \frac{(1-x_b)\sigma_L}{2} w_3^{R,L} + \\ \frac{(1-x_b)(1-\sigma_L)}{2} w_3^{0,L} + \frac{s_b}{2} w_3^{R,M} + \frac{(1-s_b)}{2} w_3^{0,M} \end{array} \right] \geq s_b w_3^{R,N} + (1-s_b) w_3^{0,N} \quad (\text{A.55})$$

The proof for convention  $F_3$  is parallel to the one above for  $F_2$ . **(1)** Show that without loss of generality  $w_3^{0,H} = w_3^{0,L} = 0$ : decreasing  $w_3^{0,H}$  (or  $w_3^{0,L}$ ) by  $\varepsilon > 0$  and increasing  $w_3^{R,H}$  (or  $w_3^{R,L}$ ) by  $\frac{1-\sigma_H}{\sigma_H}\varepsilon$  (or  $\frac{1-\sigma_L}{\sigma_L}\varepsilon$ ) does not change the value of the objective function or any of the constraints. **(2)** Show that without loss of generality  $w_3^{R,H} = w_3^{R,M} = 0$ : decreasing  $w_3^{R,H}$  (or  $w_3^{R,M}$ ) by  $\varepsilon > 0$  and increasing  $w_2^{R,L}$  by  $\varepsilon \frac{x_b}{(1-x_b)} \frac{\sigma_H}{\sigma_L}$  (or  $\varepsilon \frac{s_b}{(1-x_b)\sigma_L}$ ) does not change the value of the objective function or constraints (A.52) and (A.55), and relaxes constraints (A.53) and (A.54). **(3)** Ignoring by now constraints the asymmetric information constraints for states  $g$  and  $n$  (i.e., constraints (A.53), (A.54)), show that in this relaxed problem  $w_3^{0,M} = 0$ : decreasing  $w_3^{0,M}$  by  $\varepsilon$  and increasing  $w_3^{R,L}$  by  $\frac{(1-s_b)}{(1-x_b)\sigma_L}\varepsilon$  does not effect the value of the objective function or constraints (A.52) and (A.55). **(4)** Notice that after imposing  $w_3^{0,H} = w_3^{0,L} = w_3^{0,M} = w_3^{R,H} = w_3^{R,M} = 0$ , this relaxed problem has the same solution as the one solved for convention  $F_3$  under Proposition 3,  $W_3^*$  (i.e., see Proof of Proposition 3 first part in this Appendix). **(5)** As  $W_3^*$  verifies the asymmetric information constraints for states  $g$  and  $n$  do not bind (i.e., constraints (A.53), (A.54)).

**d)** Convention  $F_4$ .

$$\begin{aligned} \min_{W_4 \in \mathbb{R}_+^8} (\gamma + \Delta) & \left[ \frac{x_g \sigma_H w_4^{R,H} + x_g (1-\sigma_H) w_4^{0,H} + \frac{(1-x_g)\sigma_L w_4^{R,L} +}{2} \right. \\ & \left. \frac{(1-x_g)(1-\sigma_L) w_4^{0,L} + s_g w_4^{R,M} + \frac{(1-s_g) w_4^{0,M}}{2}}{2} \right] \\ & + (\beta - \Delta) \left[ \frac{x_b \sigma_H w_4^{R,H} + x_b (1-\sigma_H) w_4^{0,H} + \frac{(1-x_b)\sigma_L w_4^{R,L} +}{2} \right. \\ & \left. \frac{(1-x_b)(1-\sigma_L) w_4^{0,L} + \frac{s_b w_4^{R,M} + \frac{(1-s_b) w_4^{0,M}}{2}}{2}}{2} \right] \\ & + (1 - \gamma - \beta) \left( s_n w_4^{R,N} + (1 - s_n) w_4^{0,N} \right) \end{aligned} \quad (\text{A.56})$$

$$\text{s.t.} \quad \left[ \begin{array}{l} \frac{x_g \sigma_H w_4^{R,H} + x_g (1-\sigma_H) w_4^{0,H} + \frac{(1-x_g)\sigma_L w_4^{R,L} +}{2} \\ \frac{(1-x_g)(1-\sigma_L) w_4^{0,L} + s_g w_4^{R,M} + \frac{(1-s_g) w_4^{0,M}}{2}}{2} - \\ - \left[ \frac{x_b \sigma_H w_4^{R,H} + x_b (1-\sigma_H) w_4^{0,H} + \frac{(1-x_b)\sigma_L w_4^{R,L} +}{2} \right. \\ \left. \frac{(1-x_b)(1-\sigma_L) w_4^{0,L} + \frac{s_b w_4^{R,M} + \frac{(1-s_b) w_4^{0,M}}{2}}{2}}{2} \right] \end{array} \right] \geq \frac{B}{\Delta} \quad (\text{A.57})$$

$$\left[ \frac{x_g \sigma_H w_4^{R,H} + x_g (1-\sigma_H) w_4^{0,H} + \frac{(1-x_g)\sigma_L w_4^{R,L} +}{2} \right. \\ \left. \frac{(1-x_g)(1-\sigma_L) w_4^{0,L} + s_g w_4^{R,M} + \frac{(1-s_g) w_4^{0,M}}{2}}{2} \right] \geq s_g w_4^{R,N} + (1 - s_g) w_4^{0,N} \quad (\text{A.58})$$

$$\left[ \frac{x_n \sigma_H w_4^{R,H} + x_n (1-\sigma_H) w_4^{0,H} + \frac{(1-x_n)\sigma_L w_4^{R,L} +}{2} \right. \\ \left. \frac{(1-x_n)(1-\sigma_L) w_4^{0,L} + s_n w_4^{R,M} + \frac{(1-s_n) w_4^{0,M}}{2}}{2} \right] \leq s_n w_4^{R,N} + (1 - s_n) w_4^{0,N} \quad (\text{A.59})$$

$$\left[ \frac{x_b \sigma_H w_4^{R,H} + x_b (1-\sigma_H) w_4^{0,H} + \frac{(1-x_b)\sigma_L w_4^{R,L} +}{2} \right. \\ \left. \frac{(1-x_b)(1-\sigma_L) w_4^{0,L} + \frac{s_b w_4^{R,M} + \frac{(1-s_b) w_4^{0,M}}{2}}{2}}{2} \right] \geq s_b w_4^{R,N} + (1 - s_b) w_4^{0,N} \quad (\text{A.60})$$

Notice that: **(1)** w.l.o.g.  $w_4^{0,H} = w_4^{0,L} = 0$  by conveniently increasing  $w_4^{R,H}$  and  $w_4^{R,L}$  respectively. **(2)** No contract can be optimal and have  $w_4^{0,M} > 0$  and  $w_4^{0,N} > 0$  simultaneously, because, in that case, a simultaneous reduction of both variables would reduce compensation costs. Hence, we compare the possibly optimal contract among those for which (i)  $w_4^{0,N} > 0$  and  $w_4^{0,M} = 0$  and (ii)  $w_4^{0,M} > 0$  and  $w_4^{0,N} = 0$ .

**Fact 1**  $W_4^*$  in Proposition 3 is optimal among contracts for which  $w_4^{0,N} \geq 0$  and  $w_4^{0,M} = 0$ .

For any possible optimal contract with  $w_4^{0,N} > 0$ : (1) Constraint (A.57) must be binding; (2) Constraint (A.59) must be binding, otherwise reduce  $s_n w_4^{R,N} + (1 - s_n) w_4^{0,N}$ ; (3) W.l.o.g. we can restrict our attention to contracts in which (A.58) is binding; otherwise reduce  $w_4^{0,N}$  and increase  $w_4^{R,N}$  keeping  $(s_n w_4^{R,N} + (1 - s_n) w_4^{0,N})$  constant. (4) Use (A.57) and (A.58) to rewrite (A.60):

$$s_g (w_4^{R,N} - w_4^{0,N}) \geq s_b (w_4^{R,N} - w_4^{0,N}) + \frac{B}{\Delta} \quad (\text{A.61})$$

which implies that  $w_4^{R,N} > w_4^{0,N} \geq 0$ . (5) Constraint (A.60) must bind. If (A.60) slacks then we can reduce  $w_4^{R,N}$  and increase  $w_4^{0,N}$  keeping  $(s_n w_4^{R,N} + (1 - s_n) w_4^{0,N})$  constant until either (A.60) binds or  $w_4^{R,N} = 0$ . But if  $w_4^{R,N} = 0$  then  $w_4^{0,N} = 0$  (i.e.,  $w_4^{R,N} > w_4^{0,N} \geq 0$ ) which would violate constraint (A.59) (i.e., constraint (e) forces  $w_4^{R,H}$  or  $w_4^{R,L}$  or  $w_4^{R,M}$  to be positive). (6) Therefore from (A.61)  $w_4^{R,N} = w_4^{0,N} + \frac{B}{\Delta(s_g - s_b)}$ , and substituting (A.58) and (A.60) in the objective function:  $V_4^{**} = w_4^{0,N} + \sum s_\omega \frac{B}{\Delta(s_g - s_b)}$  where  $V_4^{**}$  is the value of the objective function for the candidate contract. Both of these expressions are minimized when  $w_4^{0,N} = 0$  and  $V_4^* = \sum s_\omega \frac{B}{\Delta(s_g - s_b)}$ , which are the expressions obtained in the case in which  $w_4^{0,N} = 0$  was imposed to start with.

**Fact 2**  $W_4^*$  in Proposition 3 is optimal among contracts for which  $w_4^{0,N} = 0$  and  $w_4^{0,M} \geq 0$ .

For any possible optimal contract with  $w_4^{0,M} > 0$ : (1) (A.57) must be binding; (2) Constraint (A.59) must be binding, otherwise reduce  $s_n w_4^{R,N} + (1 - s_n) w_4^{0,N}$ . (3) Constraint (A.60) must be binding, otherwise reduce  $w_4^{0,M}$  and increase  $w_4^{R,M}$  keeping  $s_g w_4^{R,M} + (1 - s_g) w_4^{0,M}$  constant. Do this until either (A.60) binds or  $w_4^{0,M} = 0$ . (4) If (A.58) is binding, then subtracting (A.60) from (A.58) we obtain  $w_4^{R,N} = \frac{B}{\Delta(s_g - s_b)}$  and  $V_4^{**} = \sum s_v \frac{B}{\Delta(s_g - s_b)}$  where  $V_4^{**}$  is the value of the objective function for the candidate contract, which in this case coincides with  $V_4^* = \sum s_v \frac{B}{\Delta(s_g - s_b)}$ , which are the expressions obtained in the case in which  $w_4^{0,N} = 0$  was imposed to start with. (5) If (A.58) is not binding then: **(i)**  $(w_4^{0,M}, w_4^{R,M}, w_4^{R,N})$  cannot be all positive; Assume otherwise, then reducing  $w_4^{R,M}$  and  $w_4^{0,M}$  by  $\varepsilon$ , and  $w_4^{R,N}$  by  $\frac{\varepsilon}{s_n}$  does not change (A.57) or (A.59), relaxes (A.60), and reduces the objective function. But notice that  $w_4^{R,N}$  must be positive to verify (A.59) so if  $w_4^{0,M} > 0$  then it follows that  $w_4^{R,M} = 0$ ; **(ii)** Given that (A.60) is binding  $w_4^{R,H} > w_4^{R,L}$  otherwise (A.58) cannot be satisfied. **(iii)**  $(w_4^{R,H}, w_4^{R,L}, w_4^{0,M}, w_4^{R,N})$  cannot be all positive; Assume otherwise, then reducing  $w_4^{R,M}$ ,  $w_4^{R,L}$  and  $w_4^{0,M}$  by  $\varepsilon$ , and  $w_4^{R,N}$  by  $\frac{\varepsilon}{s_n}$  does not change (A.57) or (A.59), relaxes (A.60), and reduces the objective function. Given that  $w_4^{R,H} > w_4^{R,L}$  and that, as argued above  $w_4^{R,N} > 0$ , then  $w_4^{0,M} > 0$  implies that  $w_4^{R,L} = 0$ ; **(iii)** Solving the 3 by equation system (i.e., equations (A.57) (A.59) (A.60) and unknowns  $(w_4^{R,H}, w_4^{0,M}, w_4^{R,N})$  yields:  $w_4^{R,N} = \frac{B}{\Delta(x_g - x_b)(\sigma_H - \sigma_L)}$  which is the same as the wage paid to the manager in state  $n$  under convention  $F_4^*$  when with limited liability (i.e.,  $w_4^{R,N} = w_4^{N*}$ ). Furthermore, under  $F_4^*$  with limited liability all incentive compatibility constraints are binding and hence, the expected compensation cost is smaller than under the case in which  $w_4^{0,M} > 0$  and (A.58) is not binding. So this cannot be optimal.

**Contract for  $F_5$  (Proof of Proposition 7)**

$$\min_{w_5 \in \mathbb{R}_+^7} (\gamma + \Delta) \frac{[x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM}]}{2} +$$

$$+ (\beta - \Delta) \frac{[x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM}]}{2} + (1 - \gamma - \beta) s_n w_5^{nN}$$

$$\text{s.t.} \quad \frac{1}{2} [x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM}] \geq s_g w_5^{nN} \quad (\text{A.62})$$

$$\frac{1}{2} [x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM}] \geq s_b w_5^{nN} \quad (\text{A.63})$$

$$\frac{1}{2} [x_n \sigma_H w_5^{gH} + (1 - x_n) \sigma_L w_5^{gL} + s_n w_5^{gM}] \leq s_n w_5^{nN} \quad (\text{A.64})$$

$$\frac{1}{2} [x_n \sigma_H w_5^{bH} + (1 - x_n) \sigma_L w_5^{bL} + s_n w_5^{bM}] \leq s_n w_5^{nN} \quad (\text{A.65})$$

$$x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM} \geq \frac{2B}{\Delta} + x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM} \quad (\text{A.66})$$

$$x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM} \geq x_g \sigma_H w_5^{bH} + (1 - x_g) \sigma_L w_5^{bL} + s_g w_5^{bM} \quad (\text{A.67})$$

$$x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM} \geq x_b \sigma_H w_5^{gH} + (1 - x_b) \sigma_L w_5^{gL} + s_b w_5^{gM} \quad (\text{A.68})$$

Assume that (A.62)-(A.65)-(A.67)-(A.68) are not binding. In other words, assume that the only possibly binding constraints are (A.66) (the moral hazard constraint), (A.63) (the IR constraint that prevents the bad-news, state  $b$ , from imitating the no-news, state  $n$ ) and (A.64) (the IR constraint that prevents the no-news, state  $n$ , from imitating the good-news, state  $g$ ). Then:

$$\begin{aligned} \min_{w_5 \in \mathbb{R}_+^7} (\gamma + \Delta) \frac{[x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM}]}{2} + \\ + (\beta - \Delta) \frac{[x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM}]}{2} + (1 - \gamma - \beta) s_n w_5^{nN} \end{aligned} \quad (\text{A.69})$$

$$\text{s.t.} \quad \frac{1}{2} [x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM}] \geq s_n w_5^{nN} \quad (\text{A.70})$$

$$\frac{1}{2} [x_n \sigma_H w_5^{gH} + (1 - x_n) \sigma_L w_5^{gL} + s_n w_5^{gM}] \leq s_n w_5^{nN} \quad (\text{A.71})$$

$$\frac{2B}{\Delta} + x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM} \leq x_g \sigma_H w_5^{gH} + (1 - x_g) \sigma_L w_5^{gL} + s_g w_5^{gM} \quad (\text{A.72})$$

In the above problem: (1)  $(w_5^{bL}, w_5^{bM}, w_5^{bH})$  is only determined up to  $[x_b \sigma_H w_5^{bH} + (1 - x_b) \sigma_L w_5^{bL} + s_b w_5^{bM}]$ . Therefore we can assume w.l.o.g. that  $w_5^{bL} = w_5^{bM} = w_5^{bH} = w_5^b$ ; (2)  $w_5^{gL}$  (and  $w_5^{gM}$ ) can be set equal to zero. Otherwise reduce  $w_5^{gL}$  ( $w_5^{gM}$ ) it by  $\varepsilon$  and increase  $w_5^{gH}$  by  $\frac{(1-x_g)\sigma_L}{x_g\sigma_H}\varepsilon$  ( $\frac{s_g}{x_g\sigma_H}\varepsilon$ ) which does not alter the objective function, (A.70) or (A.72) and relaxes (A.71):

$$(\text{A.71}): \left( \frac{x_n(1-x_g)}{x_g} - (1-x_n) \right) \sigma_L \varepsilon < 0$$

$$(\text{A.71}): \left( \frac{x_n s_g}{x_g} - s_n \right) \varepsilon = \left( \frac{x_n - x_g}{x_g} \right) \sigma_L \varepsilon < 0$$

Therefore the relaxed problem boils down to:

$$\min_{w_5 \in \mathbb{R}_+^4} (\gamma + \Delta) \frac{x_g \sigma_H w_5^{gH}}{2} + (1 - \gamma - \beta) s_n w_5^{nN} + (\beta - \Delta) s_b w_5^b \quad (\text{A.73})$$

$$\text{s.t.} \quad x_g \sigma_H w_5^{gH} \geq \frac{2B}{\Delta} + 2s_b w_5^b \quad (\text{A.74})$$

$$s_b w_5^b \geq s_b w_5^{nN} \quad (\text{A.75})$$

$$\frac{1}{2} x_n \sigma_H w_5^{gH} \leq s_n w_5^{nN} \quad (\text{A.76})$$

Notice that: (A.74) must be binding, otherwise we could reduce  $w_5^{gH}$ ; (A.76) must be binding, otherwise reduce  $w_5^{nN}$ ; (A.75) must be binding, otherwise reduce  $w_5^b$ . Solving the linear system we get  $w_5^{nN*} = w_5^{b*} = \frac{B}{\Delta(\frac{x_g}{x_n} s_n - s_b)}$  and  $w_5^{gH*} = \frac{2B s_n}{\Delta(\frac{x_g}{x_n} s_n - s_b) x_n \sigma_H}$ , which substituted in the objective constraint gives:  $C_5^* = \frac{(\gamma + \Delta) \frac{x_g s_n}{x_n} + (1 - \gamma - \beta) s_n + (\beta - \Delta) s_b}{\Delta(\frac{x_g}{x_n} s_n - s_b)} B = C_2^*$ . Finally, we must check that indeed satisfies restrictions (A.62)-(A.65)-(A.67)-(A.68):

$$(\text{A.62}): w_5^{gH} \geq \frac{2s_g}{x_g \sigma_H} w_5^{nN} \stackrel{\text{Using (A.76)}}{=} \frac{s_g x_n}{x_g s_n} w_5^{gH} < w_5^{gH}$$

$$(\text{A.65}): w_5^b \leq \frac{2s_n}{2s_n} w_5^{nN} \stackrel{\text{Using (A.75)}}{=} w_5^b$$

$$(\text{A.67}): w_5^{gH} \geq \frac{2s_g}{x_g \sigma_H} w_5^b \stackrel{\text{Using (A.75) and (A.76)}}{=} \frac{s_g x_n}{x_g s_n} w_5^{gH} < w_5^{gH}$$

$$(\text{A.68}): w_5^b \geq \frac{x_b \sigma_H}{2s_b} w_5^{gH} \stackrel{\text{Using (A.75) and (A.76)}}{=} \frac{s_n x_b}{x_n s_b} w_5^b < w_5^b$$

**Proof of Proposition 9 (Absence of Speculation)**

Let  $w_z^i$  be the wage paid to a manager who announces state  $i$  when output is  $z$ . Shareholders solve:

$$\min_{w \in \mathbb{R}_+} \sum_i^{g,b,n} \Pr(R, i | e = 1) w_R^i + \sum_i^{g,b,n} w_0^i \Pr(0, i | e = 1) w_0^i \quad (\text{A.77})$$

s.t.

$$\sum_i^{g,b,n} \Pr(R, i | e = 1) w_R^i + \sum_i^{g,b,n} w_0^i \Pr(0, i | e = 1) w_0^i \geq \quad (\text{A.78})$$

$$B + \sum_i^{g,b,n} w_R^i \Pr(R, i | e = 0) w_R^i + \sum_i^{g,b,n} w_0^i \Pr(0, i | e = 0) w_0^i$$

$$\Pr(R | b) w_R^b + \Pr(0 | b) w_0^b \geq \Pr(R | b) w_R^g + \Pr(0 | b) w_0^g \quad (\text{A.79})$$

$$\Pr(R | b) w_R^b + \Pr(0 | b) w_0^b \geq \Pr(R | b) w_R^n + \Pr(0 | b) w_0^n \quad (\text{A.80})$$

$$\Pr(R | g) w_R^g + \Pr(0 | g) w_0^g \geq \Pr(R | g) w_R^b + \Pr(0 | g) w_0^b \quad (\text{A.81})$$

$$\Pr(R | g) w_R^g + \Pr(0 | g) w_0^g \geq \Pr(R | g) w_R^n + \Pr(0 | g) w_0^n \quad (\text{A.82})$$

$$\Pr(R | n) w_R^n + \Pr(0 | n) w_0^n \geq \Pr(R | n) w_R^g + \Pr(0 | n) w_0^g \quad (\text{A.83})$$

$$\Pr(R | n) w_R^n + \Pr(0 | n) w_0^n \geq \Pr(R | n) w_R^b + \Pr(0 | n) w_0^b \quad (\text{A.84})$$

which can be rewritten as:

$$\min_{w \in \mathbb{R}_+} (\gamma + \Delta) [s_g w_R^g + (1 - s_g) w_0^g] + (\beta - \Delta) [s_b w_R^b + (1 - s_b) w_0^b]$$

$$+ (1 - \beta - \gamma) [s_n w_R^n + (1 - s_n) w_0^n]$$

s.t.

$$\Delta [s_g w_R^g + (1 - s_g) w_0^g - s_b w_R^b - (1 - s_b) w_0^b] \geq B \quad (\text{A.85})$$

$$s_b w_R^b + (1 - s_b) w_0^b \geq s_b w_R^g + (1 - s_b) w_0^g \quad (\text{A.86})$$

$$s_b w_R^b + (1 - s_b) w_0^b \geq s_b w_R^n + (1 - s_b) w_0^n \quad (\text{A.87})$$

$$s_g w_R^g + (1 - s_g) w_0^g \geq s_g w_R^n + (1 - s_g) w_0^n \quad (\text{A.88})$$

$$s_g w_R^g + (1 - s_g) w_0^g \geq s_g w_R^b + (1 - s_g) w_0^b \quad (\text{A.89})$$

$$s_n w_R^n + (1 - s_n) w_0^n \geq s_n w_R^g + (1 - s_n) w_0^g \quad (\text{A.90})$$

$$s_n w_R^n + (1 - s_n) w_0^n \geq s_n w_R^b + (1 - s_n) w_0^b \quad (\text{A.91})$$

Assume that (A.85), (A.87), and (A.90) are the only constraints that could (possibly) bind:

$$\min_{w \in \mathbb{R}_+} (\gamma + \Delta) [s_g w_R^g + (1 - s_g) w_0^g] + (\beta - \Delta) [s_b w_R^b + (1 - s_b) w_0^b]$$

$$+ (1 - \beta - \gamma) [s_n w_R^n + (1 - s_n) w_0^n]$$

s.t.

$$s_g w_R^g + (1 - s_g) w_0^g \geq \frac{B}{\Delta} + s_b w_R^b + (1 - s_b) w_0^b \quad (\text{A.92})$$

$$s_b w_R^b + (1 - s_b) w_0^b \geq s_b w_R^n + (1 - s_b) w_0^n \quad (\text{A.93})$$

$$s_n w_R^n + (1 - s_n) w_0^n \geq s_n w_R^g + (1 - s_n) w_0^g \quad (\text{A.94})$$

Notice the following: (1)  $w_0^g = 0$  otherwise reduce  $w_0^g$  by  $\varepsilon$  and increase  $w_R^g$  by  $\frac{1-s_g}{s_g} \varepsilon$  which leaves  $s_g w_R^g + (1 - s_g) w_0^g$  constant and reduces  $s_n w_R^n + (1 - s_n) w_0^n$ ; (2) (A.92) must be binding otherwise reduce  $w_R^g$ ; (3)  $w_0^n = 0$  otherwise reduce  $w_0^n$  by  $\varepsilon$  and increase  $w_R^n$  by  $\frac{1-s_n}{s_n} \varepsilon$  which leaves  $s_n w_R^n + (1 - s_n) w_0^n$  constant and reduces  $s_b w_R^b + (1 - s_b) w_0^b$ ; (4) (A.94) must be binding otherwise reduce  $w_R^n$  and hence,  $w_R^n = w_R^g$ ; (5) (A.93) must be binding otherwise reduce  $(s_b w_R^b + (1 - s_b) w_0^b)$ ; (6) The pair  $(w_R^b, w_0^b)$  is defined up to  $(s_b w_R^b + (1 - s_b) w_0^b)$  so *w.l.o.g.* we can assume that  $w_0^b = 0$  and hence, from (A.93),  $w_R^b = w_R^n$ . Hence,



using constraint (A.92) and the above results, we obtain  $w_R^g = w_R^n = w_R^b = \frac{B}{\Delta(s_g - s_b)} = \frac{B}{q_1 - q_0}$ . Finally, it is straightforward to verify that all the constraints in the original problem are indeed satisfied (the contract is not contingent on the announcement). In summary:  $w_R^g = w_R^n = w_R^b = \frac{B}{\Delta(s_g - s_b)} = \frac{B}{q_1 - q_0}$ ;  $w_0^g = w_0^n = w_0^b = 0$  and  $C_1^{\text{No Spec}} = C_1^{**} = \frac{q_1 B}{\Delta(q_1 - q_0)}$ .

### Proof of Proposition 10 (Endogenous Liquidity)

When  $\delta$  is endogenous, the firm can set a level of liquidity  $\delta^{**}$  such that the profits from speculation in state  $g$  just compensate the speculator for the investigation cost  $k$ . When  $\delta$  is exogenous: (i) If  $\delta < \delta^{**}$  the speculator does not have incentive to investigate in the good state  $g$ , and as seen in Proposition (9) convention  $F_1$  is an optimal convention; alternatively (ii) If  $\delta > \delta^{**}$  the speculator does have incentive to investigate in the good state  $g$  but now speculation is more costly for the firm since the profits from speculation more than compensate the speculator for the investigation cost  $k$  and therefore,  $F_2$  becomes less attractive for the firm vis-à-vis  $F_1$ .

### ALTERNATIVE FORMULATIONS

In the main text we have assumed that research costs differ across states (i.e.,  $k > 0$  in states  $b$  and  $g$ , and  $\alpha k$ , with  $\alpha > 1$ ). We discuss here two alternative formulations in which the precision of the speculator's information *or* the probability of finding information, rather than the investigation costs, differs across states. We show that in both formulations similar results hold.

Consider first the case in which research costs *do not* differ across states ( $\alpha = 1$ ) but that in state  $n$  the speculator investigation produces a low precision signal. Specifically,  $\sigma \in \{\sigma_H, \sigma_L\}$ , with probability  $x_n$  and  $(1 - x_n)$  respectively, which is unbiased (i.e.,  $x_n \sigma_H + (1 - x_n) \sigma_L = s_n$ ) but noisy i.e., contains no information about the probability of success (i.e.,  $P(R|n, \sigma_H) = P(R|n, \sigma_L) = s_n$ ). We assume that (i) the probability of a high signal conditional on high output in  $b$  is lower than in  $n$  (i.e.,  $\frac{\sigma_H x_b}{s_b} < \frac{s_n x_n}{s_n}$ ), which ensures the incentives of firms in  $n$  are stronger than in  $b$  to mimic firms in  $g$ ; and (ii) research costs  $k$  and/or the probability of state  $n$  are large enough to ensure that speculators do not investigate unless  $n$  is excluded. Under these assumptions the following results follow:

**Proposition A.1.** *Conventions  $F_3, F_4,$  and  $F_5$  are dominated by either convention  $F_1$  or  $F_2$ .*

The intuition of the proof is similar to the one in the main text: (i)  $F_3, F_4$  do not save in compensation costs with respect to  $F_1$  but have larger speculation costs and (ii)  $F_5$  does not save in compensation costs with respect to  $F_2$  but have larger speculation costs. Regarding compensation contracts, under convention  $F_1$ , since there is no speculation, the optimal compensation contract,  $W_1^*$ , and its associated compensation costs,  $C_1^*$ , are the same as in proposition 1. Under convention  $F_2$ , however, the firm solves a slightly different problem:

$$\min_{W_2 \in \mathbb{R}_+^4} (\gamma + \Delta) \left[ \frac{x_g \sigma_H}{2} w_2^H + \frac{(1 - x_g) \sigma_L}{2} w_2^L + \frac{s_g}{2} w_2^M \right] + [(1 - \gamma - \beta) s_n + (\beta - \Delta) s_b] w_2^N \quad (\text{A.95})$$

$$\text{s.t.} \quad \frac{x_g \sigma_H}{2} w_2^H + \frac{(1 - x_g) \sigma_L}{2} w_2^L + \frac{s_g}{2} w_2^M \geq s_b w_2^N + \frac{B}{\Delta} \quad (\text{A.96})$$

$$\frac{x_b \sigma_H}{2} w_2^H + \frac{(1 - x_b) \sigma_L}{2} w_2^L + \frac{s_b}{2} w_2^M \leq s_b w_2^N \quad (\text{A.97})$$

$$\frac{x_g \sigma_H}{2} w_2^H + \frac{(1 - x_g) \sigma_L}{2} w_2^L + \frac{s_g}{2} w_2^M \geq s_g w_2^N \quad (\text{A.98})$$

$$\left( \frac{x_n}{2} w_2^H + \frac{(1 - x_n)}{2} w_2^L + \frac{1}{2} w_2^M \right) s_n \leq s_n w_2^N \quad (\text{A.99})$$

Notice that now the truth-telling constraint under state  $n$  (i.e., A.99) is different because in state  $n$  the true probability of success is  $s_n$  regardless of the signal observed by the speculator. The following proposition characterizes the optimal compensation contract under  $F_2$ :

**Proposition A.2.** *The optimal compensation contract under  $F_2$  is:*

$$W_2^{**} = (w_2^{L**}, w_2^{M**}, w_2^{H**}, w_2^{N**}) = \left( 0, 0, \frac{2B}{\Delta(x_g\sigma_H - x_n s_b)}, \frac{x_n B}{\Delta(x_g\sigma_H - x_n s_b)} \right)$$

and its associated (expected) compensation costs are:

$$C_2^{**} = \frac{(\gamma + \Delta)x_g\sigma_H + (1 - \gamma - \beta)x_n s_n + (\beta - \Delta)x_n s_b}{\Delta(x_g\sigma_H - x_n s_b)} B.$$

The proof of this proposition is similar to the proof of the corresponding proposition 2: *First*, the problem can be simplified by noting that  $w_2^L = w_2^M = 0$ ; *second* among the constraints only (A.96) (A.99) are binding; third, solving the linear system formed by (A.96) (A.99) we obtain the optimal contract  $W_2^{**}$ , and substituting in the objective function we obtain the compensation costs associated to that contract  $C_2^{**}$ .

**Proposition A.3.** *The compensation costs under  $F_2$  are smaller than those under  $F_1$  (i.e.,  $C_2^{**} < C_1^*$ ).*

The above proposition again points out that firms face the same trade-off as in the main text when choosing between convention  $F_1$  and  $F_2$ . On the one hand, convention  $F_2$  allows to save in compensation costs but, on the other hand, it involves speculation costs.<sup>49</sup>

Finally we consider a formulation in which the probability of finding information, rather than the investigation costs, differs across states. Specifically, we assume that in states  $b$  and  $g$  the speculator always finds a signal  $\sigma \in \{\sigma_L, \sigma_H\}$  after investigation while in state  $n$ , the probability that the speculator finds a signal is  $\phi_n$ . Alternatively, with probability  $(1 - \phi_n)$ , the speculator get no signal which in this setting confirms the realization of state  $n$ . We assume that (i)  $\frac{s_n}{\phi_n x_n} < \frac{s_b}{x_b}$ , i.e., that the speculator's investigation is "relatively" more likely to produce a good signal (i.e.,  $\sigma_H$ ) in  $n$  than in  $b$ ; and (ii)  $q_0 < s_n < q_1$  so  $n$  is "relative good news" without effort and "relatively bad news" with effort, which guarantees that under convention  $F_1$  the speculator has incentives to sell if it receives no signal (i.e., and hence that  $\omega = n$ ).

For brevity, we simply describe the main results under this setting: (1) Conventions  $F_3$ ,  $F_4$ , and  $F_5$  are dominated by either convention  $F_1$  or  $F_2$ . (2) While  $W_1^*$  remains unaltered,  $W_2^*$  changes to  $W_2^{***} = \left( 0, 0, \frac{2s_n B}{\Delta(x_g s_n - \phi_n x_n s_b)\sigma_H}, \frac{\phi_n x_n B}{\Delta(x_g s_n - \phi_n x_n s_b)} \right)$  (which exhibit expected compensation costs  $C_2^{***}$  decreasing in  $\phi_n$ ). (3) Compensation costs under  $F_2$  are smaller than those under  $F_1$  (i.e.,  $C_2^{**} < C_1^*$ ); as before convention  $F_2$  allows to save in compensation costs but entails speculation costs. Please contact the authors for a complete derivation of these results.

---

<sup>49</sup>We also explored the case in which  $\frac{\sigma_H x_b}{s_b} > \frac{s_n x_n}{s_n}$ . In that case, the firm would save on managerial compensation in  $F_5$  with respect to  $F_2$  and there would be a trade-off between lower compensation costs in  $F_5$  and lower speculation costs in  $F_2$ .