

# Voluntary Disclosure and the Internal Information Environment of the Firm\*

Joaquin Peris<sup>†</sup>

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## Abstract

This study explores how a firm's internal information environment affects a manager's decision to voluntarily disclose information to investors. It presents a model where the probability that a manager has information depends on whether the information is favorable or unfavorable. In the model, an internal information environment is defined as conservative (aggressive) if it is more (less) likely to inform the manager about negative outcomes. The study shows that conservative internal information environments decrease voluntary disclosure. Additionally, in conservative (aggressive) internal information environments, an increase in information asymmetry between a manager and investors leads to less (more) voluntary disclosure. This finding illuminates how the firm's internal and external information environments interact to determine the extent of voluntary disclosure and is thus of empirical relevance.

**Keywords:** Voluntary Disclosure, Financial Reporting, Internal Information Environment, Management Accounting, Conservatism

**JEL Codes:** C72, D21, D53, D82, D83, M41

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<sup>†</sup>Purdue University: [jperispe@purdue.edu](mailto:jperispe@purdue.edu)

# 1 Introduction

*In many companies, bad news travels very slowly, while good news travels fast. We tried hard to combat that. . . . I used the term—making bad news travel fast—all the time.*

— Bill Gates, Gates Notes (2021)

A manager’s voluntary disclosures are jointly shaped by that person’s ability and incentive to disclose: is the manager endowed with value-relevant information to disclose and would disclosing this information increase the stock price? The analytical literature has given scant attention to the firm’s internal information environment, simply assuming the probability that the manager is informed is independent of the nature of information (e.g., [Dye, 1985](#); [Jung and Kwon, 1988](#), hereafter DJK). However, in practice, the flow of information to upper management often varies, depending on whether the information is favorable or unfavorable. This study investigates how the nature of a firm’s internal information environment, particularly the likelihood that it informs the manager about positive versus negative information, influences the manager’s choice to voluntarily disclose this information to investors.

I develop a model of voluntary disclosure where the probability of the manager having information depends on whether the information is favorable or unfavorable. I refer to an internal information environment as more conservative (aggressive) if it is more (less) likely to provide information about negative outcomes to the manager. It is neutral if the likelihood of providing information is the same for any outcome, as in DJK. It is important to clarify that the terms “conservative” and “aggressive” as used here refer to the generation and transmission of internal information, rather than the company’s external financial reporting.<sup>1</sup>

This setting captures numerous real-world scenarios in which negative information might flow more rapidly than positive information (or the reverse) within an organization. For

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<sup>1</sup>While much of the literature on accounting conservatism focuses on external financial reporting, the concept of conservatism existed prior to the emergence of capital markets (see [Glover and Xue, 2023](#)).

example, some managers foster an environment that prioritizes the sharing of negative information so that they can take corrective actions promptly (see [Bill Gates, 2021](#); [Times of India, 2023](#)). Similarly, when referring to key performance indicators (KPIs), experts suggest praising and rewarding employees who identify and report red flag indicators. Timely communication of bad news provides management with crucial information needed to effectively manage risks; see [Forbes \(2023\)](#). In addition, some industries, such as banking, naturally pay more attention to downside outcomes, establishing systems of internal control to spotlight adversity. If a borrower postpones a payment, the bank’s internal controls will trigger an alert. But prompt payments by the borrower go unreported. As a result, the design of the internal controls ensures that bad news circulates faster than good.<sup>2,3</sup> On the other hand, certain factors could result in the preferential transmission of positive information. For instance, middle managers might want to conceal or limit the flow of bad news to senior management (see [Read, 1962](#); [Harvard Business Review, 1999](#); [Milliken, Morrison, and Hewlin, 2003](#); [Tan, Smith, Keil, and Montealegre, 2003](#); [Stubben and Welch, 2020](#)).<sup>4</sup>

The main message that emerges is that the internal information environment crucially affects the manager’s incentives to voluntarily disclose. First, I show that a more conservative environment reduces voluntary disclosure. The intuition is as follows: as in DJK, when the manager has negative information below a certain threshold (the disclosure threshold), that manager is incentivized to withhold this information and pretend to be uninformed, rather than disclosing it and causing investors to lower the firm’s valuation. Understanding the manager’s strategic behavior, when investors observe no disclosure, they infer that either

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<sup>2</sup>This also happens in nonfinancial firms. For example, in the retail industry: “If we have missed major customer orders or if the store orders are showing a declining trend, these should be surfaced to the management at the earliest so that requisite corrective actions can be taken well in time.” See [Reflexive \(2020\)](#).

<sup>3</sup>The tendency of certain industries to focus more on negative outcomes may also be related to their payoff structures. For instance, the banking industry, whose business is centered on debt holding, may have a capped upper payoff, which leads to a greater focus on downward outcomes. In this paper, however, considerations of payoff structures linked to different internal information environments are set aside, and the focus is solely on the information aspects.

<sup>4</sup>“At Kmart, for example, managers were reportedly reluctant to tell leadership team about problems in the business . . . while upstart competitor Sam Walton was known for prodding his subordinates to deliver bad news quickly.”

the manager is genuinely uninformed or the manager has negative information below the threshold and is choosing to withhold it. Consequently, stock price in the absence of disclosure is a weighted average of the firm's value, assuming the manager is uninformed, and the firm's value, assuming the manager is withholding negative information. When the internal information environment is conservative, the manager is more likely to be uninformed about positive developments. Therefore, if the manager is uninformed, the firm's value is likely to be high. As a result, investors increase their valuation of the firm when they observe no disclosure. This makes withholding information more attractive to the informed manager. Thus, in equilibrium, voluntary disclosure diminishes, in terms of both a higher threshold and a lower probability of disclosure.<sup>5</sup>

This result implies that a better informed manager may not necessarily disclose more. The reason is the following: among internal information environments equally likely to inform the manager, a neutral one is the least informative. This is because the neutral environment does not resolve any uncertainty for the manager when it does not provide information. In contrast, conservative and aggressive environments do resolve some uncertainty, even if the manager does not receive information, since the probability of receiving no information depends on whether the firm's value is positive or negative. Consequently, the manager's uncertainty is highest for a neutral environment and decreases as the environment becomes more conservative or aggressive. Therefore, when the internal information environment is neutral, shifting toward a more aggressive environment leads to a manager who is better informed (less managerial uncertainty) and discloses more in equilibrium. However, any change toward a more conservative internal information environment leads to a better informed manager who discloses less in equilibrium. This observation contrasts with DJK,

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<sup>5</sup>This result provides a rationale for how a conservative internal information environment can give rise to conservative external reporting. In this setting, as the internal information environment becomes more conservative, additional positive signals that would have otherwise been disclosed are instead pooled with negative signals and not disclosed. This is roughly consistent with the way conservatism is modeled in most accounting theory papers (see [Kwon, Newman, and Suh, 2001](#); [Gigler and Hemmer, 2001](#)). A similar discussion can be found in [Nan, Tang, and Zhang \(2024\)](#). Of course, nondisclosure differs from pooling positive signals with negative signals in a binary model, but the result that negative signals (nondisclosure) are less informative also arises in the present model.

where a better informed manager always discloses more in equilibrium.

Finally, I explore how the nature of the internal information environment, whether conservative or aggressive, interacts with the external information environment to determine the extent of voluntary disclosure. Here, the external information environment is characterized by investors' prior uncertainty about firm value, which reflects the level of information asymmetry between the manager and investors. I show that, in conservative internal information environments, an increase in investors' prior uncertainty about firm value reduces voluntary disclosure, suggesting that higher information asymmetry diminishes voluntary disclosure. Conversely, in aggressive internal information environments, more dispersed investor beliefs about firm value increase voluntary disclosure, implying that higher information asymmetry leads to more voluntary disclosure.

How does information asymmetry affect the firm's willingness to disclose? The canonical model, DJK, yields a no-result: the probability of disclosure is unaffected by a change in investors' prior uncertainty about firm value.<sup>6</sup> However, if the probability of the manager's learning depends on the nature of the information, this will change. An increase in investors' prior uncertainty about firm value creates conflicting effects. On one hand, when investors observe no disclosure, the probability of extreme negative firm value realizations below some fixed disclosure threshold increases, due to more dispersed beliefs about the firm's value. This *left-tail effect* causes investors to lower their valuation of the firm when they see no disclosure, increasing the manager's incentive to disclose voluntarily. On the other hand, the manager is more likely to be uninformed about exceptionally positive outcomes. This *right-tail effect* leads investors to increase their valuation of the firm in the absence of disclosure, reducing the manager's incentive to disclose voluntarily. Whether investors' uncertainty leads to more or less voluntary disclosure depends on which of these effects dominates. In an aggressive internal information environment, the probability that the manager is uninformed

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<sup>6</sup>The paper by [Penno \(1997\)](#) demonstrates that changes in the dispersion of investors' beliefs about firm value have no impact on the probability of disclosure when investors' beliefs follow a normal distribution. Furthermore, [Acharya, DeMarzo, and Kremer \(2011\)](#) extend this finding, showing that it holds more broadly beyond the normal distribution setting.

about exceptionally positive news is low, ensuring that the *left-tail effect* always dominates, leading to increased voluntary disclosure. Conversely, in a conservative environment, the probability of the manager being uninformed about exceptionally good news is high, and thus the *right-tail effect* prevails, resulting in decreased voluntary disclosure.

This finding is relevant for policymakers, as it illuminates why information asymmetry can lead to increased voluntary disclosure in some scenarios and decreased disclosure in others. Regulators often justify disclosure requirements as a way to reduce information asymmetry between firms and investors. While a common critique is that such policies may *crowd out* voluntary disclosure (e.g., [Verrecchia, 1990](#)), empirical research has documented mixed evidence. Studies by [Balakrishnan, Billings, Kelly, and Ljungqvist \(2014\)](#), [Guay, Samuels, and Taylor \(2016\)](#), [Barth, Landsman, and Taylor \(2017\)](#), [Glaeser \(2018\)](#), and [Noh, So, and Weber \(2019\)](#) suggest that higher information asymmetry leads to increased voluntary disclosure. In contrast, other studies, including [Francis, Nanda, and Olsson \(2008\)](#), [Ball, Jayaraman, and Shivakumar \(2012\)](#), [Bischof and Daske \(2013\)](#), [Li and Yang \(2016\)](#), [Kleymenova and Zhang \(2019\)](#), and [Kim and Ljungqvist \(2023\)](#), indicate that lower information asymmetry results in more voluntary disclosure. The present paper helps reconcile these findings by offering new cross-sectional predictions that highlight the role of the firm’s internal information environment in shaping how information asymmetry impacts voluntary disclosure.

Different factors can affect the firm’s internal information environment. For example, litigation risk creates an asymmetry between positive and negative information ([Marinovic and Varas, 2016](#)), as negative events are far more likely to result in lawsuits. As a result, industries with high litigation risk may invest more in internal systems that help detect negative information, aiming to preempt lawsuits. Another key factor is regulation; for instance, the Sarbanes-Oxley Act (SOX) was introduced to strengthen internal controls and detect internal fraud. Additionally, in safety-critical industries, regulatory oversight pushes firms to enhance their internal systems to prevent failures. For example, Boeing, following

a U.S. Department of Transportation order, developed a comprehensive strategy to improve production systems and encourage employees to report safety and quality issues (BBC, 2024).

The present paper predicts that regulations encouraging firms to detect negative events (conservative environments) may reduce managers’ incentives to voluntarily disclose information. Furthermore, in lightly regulated or low-risk industries, such as emerging sectors or entertainment, where firms face less pressure to detect negative events (aggressive environments), expanding mandatory disclosure is more likely to *crowd out* voluntary disclosure. In contrast, in industries facing strong regulatory or litigation pressures, such as pharmaceuticals, automobiles, or financial services, mandatory disclosure requirements can actually *crowd in* additional voluntary disclosure.

## 1.1 Literature Review

This paper belongs to the body of research on voluntary disclosure of verifiable information pioneered by Grossman and Hart (1980), Grossman (1981) and Milgrom (1981), which established that, under certain conditions, full disclosure or “unraveling” is the only equilibrium. Subsequent works by Dye (1985) and Jung and Kwon (1988) show that the unraveling result may not hold when investors are uncertain about the manager’s information endowment, that is, whether the manager has information.<sup>7</sup> Building on this approach, the present paper examines voluntary disclosure under uncertainty about the manager’s information endowment but departs from Dye (1985) and Jung and Kwon (1988) by allowing the probability of the manager being informed to depend on whether the information is favorable or unfavorable.

Studies by Shin (1994) and Lichtig and Weksler (2023) also consider settings where the

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<sup>7</sup>Other factors that suppress voluntary disclosure include disclosure costs (Jovanovic, 1982; Verrecchia, 1983), particularly costs related to the proprietary nature of the information (Darrough and Stoughton, 1990; Wagenhofer, 1990; Dye, 1986), managerial uncertainty about investors’ response (Nagar, 1999; Suijs, 2007), uncertainty about audience preferences (Bond and Zeng, 2022), the presence of unsophisticated investors in the market (Fishman and Hagerty, 2003), market uncertainty regarding managerial goals (Einhorn, 2007), the interaction between operating and disclosure decisions of firms (Einhorn and Ziv, 2007), and the aggregation of information across multiple segments (Arya, Frimor, and Mittendorf, 2010). For surveys of the literature on corporate voluntary disclosure, see Verrecchia (2001), Dye (2001), Beyer, Cohen, Lys, and Walther (2010) and Stocken (2013).

manager’s information endowment depends on the nature of the information.<sup>8</sup> They show that, when the manager has a higher pointwise likelihood of being informed for each firm value realization—meaning the manager is better informed in a Blackwell sense—this leads to more disclosure. The present paper differs by examining information endowments where, although the manager is equally likely on average to have information, the likelihood of being informed about positive versus negative information varies. As a result, one manager’s information endowment cannot be strictly classified as more informative than another’s.

The works by [DeMarzo, Kremer, and Skrzypacz \(2019\)](#) and [Bertomeu, Cheynel, and Cianciaruso \(2021\)](#) relate to the present work, as they examine a setting where the structure of the internal information environment influences disclosure. However, while these studies focus on the optimal design of the internal information environment, the present paper treats the environment as exogenous and investigates how its characteristics and interaction with the external information environment affect voluntary disclosure decisions. [DeMarzo et al. \(2019\)](#) introduce an information design framework where a manager privately designs an internal information environment that leads to a disclosure decision. Their primary finding is that the optimal internal information environment has a pass-fail structure, indicating that information is provided to the manager only when it exceeds a certain threshold. [Bertomeu et al. \(2021\)](#) focus on the optimal precision of the signal. By incorporating a nondisclosure cost, as in [Dye \(2017\)](#), they demonstrate that the optimal internal information environment provides less precise information to the manager about moderate negative events.

The present paper also contributes to the analytical literature exploring the relationship between investors’ information environments and firms’ voluntary disclosures. The common intuition is that improving investors’ information crowds out voluntary disclosure by firms (e.g., [Verrecchia, 1990](#); [Bertomeu, Vaysman, and Xue, 2021](#); [Heinle, Samuels, and Taylor, 2023](#)). Several studies challenge this notion by showing that, under certain conditions, improvements in the investors’ information environment may actually crowd in voluntary disclo-

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<sup>8</sup>See also [Hart, Kremer, and Perry \(2017\)](#).

sure. For instance, [Einhorn \(2005\)](#) shows that specific correlation structures between public information and voluntary disclosure can make them complements. [Friedman, Hughes, and Michaeli \(2020, 2022\)](#) show that this complementarity may arise when firm payoffs are discrete and depend on investors' expectations exceeding a threshold. [Frenkel, Guttman, and Kremer \(2020\)](#) demonstrate that analyst coverage can crowd in firm disclosures when analysts and firms share correlated information endowments. [Banerjee, Marinovic, and Smith \(2024\)](#) find that, when investors are privately informed and disclosure costs are high, investors' information and voluntary disclosure may complement each other. The present paper introduces a new economic channel—centered on the firm's internal information environment, specifically the likelihood of being informed about positive versus negative events—that explains how improvements in the investors' information environment can either crowd in or out voluntary disclosure.

Conservatism in information systems is typically formalized either through a measurement-based approach or by constraining the message space (e.g., [Gigler and Hemmer, 2001](#); [Guay and Verrecchia, 2006](#); [Gigler, Kanodia, Sapra, and Venugopalan, 2009](#); [Goex and Wagenhofer, 2009](#); [Caskey and Hughes, 2012](#); [Ewert, Wagenhofer, et al., 2012](#); [Nan and Wen, 2014](#)). The present paper offers an alternative approach to modeling conservatism (inside the firm) by introducing asymmetry in the probability of having information, based on whether the information is positive or negative. In doing so, it shows how internal conservatism affects the firm's voluntary disclosures to investors.

The rest of the paper is organized as follows. Section [2](#) presents an example. Section [3](#) develops the model and characterizes the properties of the internal information environment. Section [4](#) derives the equilibrium and comparative statics. Section [5](#) explores implications under the normal distribution. Section [6](#) provides empirical applications. Section [7](#) concludes.

## 2 Example

Consider a single-period communication game in which, at its commencement, the firm's manager and the risk-neutral investors hold identical beliefs about the end-of-period value of the firm:  $\tilde{v} \sim U[-\frac{1}{2}, \frac{1}{2}]$ . In the course of the period, the manager is informed about the realized value of the firm,  $v$ , with probability  $q(v)$ . The function  $q(v)$  represents the internal information environment of the firm and is common knowledge. The manager cannot credibly assert that he has no information and, when uninformed,  $ui$ , can only send no message, denoted as  $m = \emptyset$ . Conversely, if informed,  $inf$ , the manager can truthfully disclose his information,  $m = v$ , or send no message,  $m = \emptyset$ . Investors are risk neutral and price the firm rationally as  $\mathbb{E}[\tilde{v} \mid m]$ . The manager chooses a disclosure strategy that maximizes the firm's price.

If the manager discloses his information, the price of the firm becomes the disclosed  $v$ . On the other hand, the firm's price following nondisclosure is a weighted average of the expected firm value when the manager has no information and the expected value when the manager is informed but decides to withhold:

$$\mathbb{E}[\tilde{v} \mid \emptyset] = \mathbb{P}(ui \mid \emptyset) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, ui] + \mathbb{P}(inf \mid \emptyset) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, inf].$$

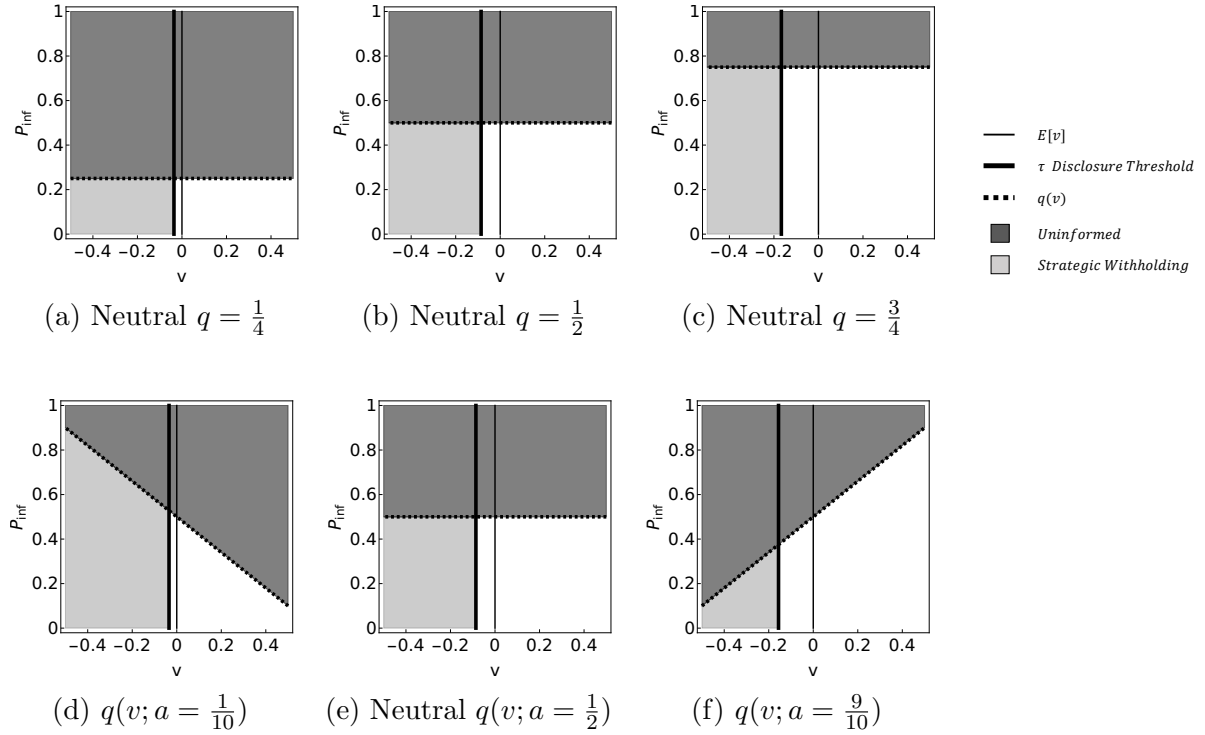
When the manager is informed, he will withhold if his signal falls below a certain threshold,  $\tau \in [-\frac{1}{2}, 0]$ . Hence, in a rational expectations equilibrium:

$$\mathbb{E}[\tilde{v} \mid \emptyset] = \tau.$$

If  $q(v)$  is neutral, i.e.,  $q(v) = q$  is the same across  $v$ , then  $\mathbb{E}[\tilde{v} \mid \emptyset, ui] = \mathbb{E}[\tilde{v}] = 0$ . The probability that the manager is informed, conditional on no disclosure, is  $\mathbb{P}(inf \mid \emptyset) = \frac{q(1+2\tau)}{2-q+2q\tau}$ , and the expected value, conditional on being informed, is  $\mathbb{E}[\tilde{v} \mid \emptyset, inf] = \frac{2\tau-1}{4}$ . Hence, in equilibrium:  $\tau = \frac{2\sqrt{1-q}+q-2}{2q}$ . As established by DJK, the equilibrium threshold

decreases in  $q$ . That is, as the manager's probability of being informed increases, more voluntary disclosure occurs in equilibrium, with full unraveling as the limit case where  $q \rightarrow 1$ , (Milgrom, 1981).

Figure 1: Illustration of example of Section 2.



**Note:** Prior beliefs about firm value follow a uniform  $U[-\frac{1}{2}, \frac{1}{2}]$ . The internal information environment provides information to the manager with probability  $q(v) = q$  in Figures 1(a), 1(b), and 1(c), and with probability  $q(v; a) = (2a - 1)v + \frac{1}{2}$  in Figures 1(d), 1(e), and 1(f). The parameter  $a \in [0, 1]$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones:  $a > \frac{1}{2}$  indicates an aggressive environment,  $a < \frac{1}{2}$  a conservative one, and  $a = \frac{1}{2}$  a neutral environment.

Now I explore the scenario in which the manager's probability of being informed,  $q(v)$ , varies, depending on firm value,  $v$ . Specifically,

$$q(v; a) = (2a - 1)v + \frac{1}{2} \quad \text{where } a \in [0, 1].$$

A property of  $q(v; a)$  is that the ex ante probability of the manager being informed is  $\frac{1}{2}$ ,

independent of  $a$ . Note that  $a$  represents how the manager is more likely to be informed of positive realizations versus negative ones. In particular, if  $a < \frac{1}{2}$ , the internal information environment is conservative; i.e., the manager is more likely informed about negative outcomes. Conversely, if  $a > \frac{1}{2}$ , the internal information environment is aggressive; i.e., the manager is more likely informed about positive outcomes. When  $a = \frac{1}{2}$ , it corresponds to the scenario in which  $q(v; a) = \frac{1}{2}$  is neutral.

Does altering the relative probability of the manager having information about negative or positive outcomes affect the voluntary disclosure decision? When  $q(v; a)$  depends on  $v$ , the expected firm value, conditional on the manager being uninformed, differs from the prior mean  $\mathbb{E}[\tilde{v}] = 0$ ; specifically,  $\mathbb{E}[\tilde{v} \mid \emptyset, ui] = \frac{\int_{-1/2}^{1/2} (1-q(v))v dv}{\int_{-1/2}^{1/2} (1-q(v))dv} = \frac{1}{6}(1-2a)$ . This implies that, as the manager's informational advantage skews toward negative outcomes (i.e., lower  $a$ ), the expected firm value, conditional on the manager being uninformed, increases. More importantly, one can readily verify that, in equilibrium, the disclosure threshold,  $\tau$ , decreases monotonically in  $a$ :

$$\frac{d\tau}{da} < 0.$$

This suggests that the manager's incentive to voluntarily disclose decreases as his informational advantage skews toward negative outcomes. The intuition is that the manager becomes less likely to have information about positive outcomes. As a result, when the manager is uninformed, firm value is more likely to be high; i.e.,  $\mathbb{E}[\tilde{v} \mid \emptyset, ui]$  increases. Investors internalize this and adjust their valuation in the absence of disclosure upward, i.e., higher  $\mathbb{E}[\tilde{v} \mid \emptyset]$ , which reduces the manager's incentive to disclose. This example highlights the importance of the *shape* of  $q(v)$  in determining the equilibrium threshold. In the following sections, I generalize this intuition and provide implications.

### 3 Model

I now present a formal model that generalizes the example. Building on DJK, it is a one-period communication game between a manager and investors. I refer to the underlying state as firm value. Firm value  $\tilde{v} \in \mathfrak{R}$  is uncertain. At the onset of the game, both the manager and investors have the same prior belief about firm value  $\tilde{v}$ , with  $\mathbb{E}[\tilde{v}] = 0$  and  $Var(\tilde{v}) = \sigma^2$ . The distribution function symbolizing these starting beliefs is denoted by  $F$  and admits a p.d.f.  $f$ , which is strictly positive throughout its domain and symmetric at  $v = 0$ , such that  $f(v) = f(-v)$ .<sup>9</sup>

The firm has an internal information environment that privately and accurately informs the manager about firm value  $v$  with probability  $q(v) : \mathfrak{R} \rightarrow [0, 1]$ . I assume the internal information environment  $q(v)$  is monotonic with respect to firm value  $v$  and is an odd function; that is,  $q(v) = 2q(0) - q(-v)$ .<sup>10</sup> The monotonicity can be interpreted as the firm’s information production having a predisposition toward conveying more about positive outcomes compared to negative outcomes, or vice versa.<sup>11</sup>, see [GoCardless \(2021\)](#). Both  $f$  and  $q$  are common knowledge.

The manager can be either informed or uninformed, denoted by  $s \in \{inf, ui\}$ . If the manager is uninformed ( $s = ui$ ), the manager cannot convincingly tell investors he lacks information and thus can only opt to send no message,  $m = \emptyset$ . Conversely, when the manager is informed ( $s = inf$ ), he can either truthfully reveal the information,  $m = v$ , or

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<sup>9</sup>Assuming the expected value of the firm being centered at zero is without loss of generality. The symmetry assumption is made for technical convenience. Additionally, to simplify the proof of [Proposition 3](#), it is assumed that  $\lim_{v \rightarrow \infty} v^2 f(v) = 0$ , a condition satisfied by many common distributions, including the normal distribution.

<sup>10</sup>The symmetry assumption is made for technical reasons. An odd function satisfies  $f(-x) = -f(x)$  throughout its domain. Graphically, odd functions exhibit symmetry around the origin. For the function  $q(v)$ , I adjust it to exhibit self-symmetry around the point  $(0, q(0))$  rather than the origin, ensuring  $q(v) > 0$  across its entire domain.

<sup>11</sup>There could be scenarios in which the monotonicity assumption is too strong. For example, when firms use variance analysis, extreme information may flow more quickly within the organization compared to moderate information. In [Appendix B](#), I provide an example where the monotonicity assumption is relaxed. Nonetheless, the conservative definition proposed here may still be relevant in those contexts, as extreme negative events may still be treated differently than extreme positive ones: “If you’ve encountered a favorable variance in your budget, there’s a limited amount that you need to do ... With unfavorable variance, it’s a different story. There are many different steps you can take to rectify an unfavorable variance”

choose to withhold it by sending no message,  $m = \emptyset$ . Investors determine the firm's price based on the manager's disclosure or its absence. If investors observe a disclosure, the firm's price equals the disclosed value  $v$ . However, absent a disclosure, investors value the firm according to their updated belief about its value, given the disclosure's absence, that is,  $\mathbb{E}[\tilde{v} \mid \emptyset]$ . The manager aims to maximize the price of the firm, using a disclosure strategy  $D : \{inf, ui\} \times \mathfrak{R} \rightarrow \{dis, \emptyset\}$ .

### 3.1 Properties of the Internal Information Environment $q(v)$

In the canonical model, the probability that the manager is informed,  $q(v) = q$ , is constant across all firm values. As a result, the ex ante probability that the internal information environment provides information is given by  $Q = \int_{-\infty}^{\infty} f(v)q \, dv = q$ . However, when the internal information environment  $q(v)$  varies with  $v$ , the ex ante probability of information,  $Q$ , depends on both the likelihood of the internal information environment providing information for a specific  $v$  and the probability of  $v$  occurring. In that case, the ex ante probability of providing information by  $q(v)$  is:

$$Q = \int_{-\infty}^{\infty} f(v)q(v) \, dv = \int_0^{\infty} f(v) (2q(0) - q(v)) \, dv + \int_0^{\infty} f(v)q(v) \, dv = q(0).$$

Due to the symmetry properties of  $q(v)$  and  $f(v)$ , the ex ante likelihood of information by a specific  $q(v)$  is simply  $q(v = 0)$ . Any increase in information at  $v$  is offset by a corresponding decrease in information at  $-v$ . Note that, in the canonical model,  $Q$  uniquely characterizes an internal information environment  $q$ . Yet, in the present setting, it is possible to have two different internal information environments,  $q_1(v)$  and  $q_2(v)$ , with the same probability of providing information ex ante as long as  $q_1(0) = q_2(0)$ . This implies a family of internal information environments exist that differ in how frequently they offer information, conditional on specific realizations of  $v$ , yet all of them are equivalently informative in terms of the probability of providing information. Another insight is that the ex ante likelihood

of information provided by the environment  $q(v)$  is independent of specific attributes of the prior beliefs distribution  $f$ , such as its variance  $\sigma^2$ .

I now offer two definitions aimed at comparing various internal information environments based on their informational structures. The first evaluates internal information environments based on the overall information they provide. The second assesses them by how often they provide information on high versus low firm value realizations.

**Definition 1** *Given any two internal information environments,  $q_1(v)$  and  $q_2(v)$ ,  $q_1(v)$  is strictly more informative than  $q_2(v)$  if and only if:*

$$q_1(v) > q_2(v) \quad \forall v.$$

**Definition 2** *(Conservatism)*

- i. An internal information environment is labeled conservative (aggressive), if  $q(v)$  is monotonically decreasing (increasing). It is labeled neutral if  $q(v) = q$  is constant across  $v$ .*
- ii. Given any two internal information environments,  $q_1(v)$  and  $q_2(v)$ , with the same likelihood of providing information ex ante,  $Q_1 = Q_2$ , then  $q_1(v)$  is more conservative (aggressive) than  $q_2(v)$  if and only if:*

$$q_1(v) > q_2(v) \quad \forall v : v < 0 (v > 0).$$

In the canonical model in which  $q(v) = q$  is neutral, the posterior manager's distribution of the firm's value remains identical to its prior distribution when the manager is uninformed ( $s = ui$ ). In other words, not learning the state has no updating value to the manager. However, when  $q(v)$  varies with  $v$ , the manager's posterior distribution of the firm's value, conditional on the absence of any signal, is distinct from the prior distribution and has the

following form:

$$\tilde{v} \mid ui, q(v) \sim \frac{(1 - q(v)) f(v)}{1 - Q}.$$

**Lemma 1** *Consider two internal information environments,  $q_1(v)$  and  $q_2(v)$ . If  $q_1(v)$  is more conservative than  $q_2(v)$ , the expected firm value, conditional on no information ( $s = ui$ ), is higher under  $q_1(v)$  compared to  $q_2(v)$ :*

$$\mathbb{E}[\tilde{v} \mid ui, q_1(v)] > \mathbb{E}[\tilde{v} \mid ui, q_2(v)].$$

As the internal information environment becomes more conservative, the probability of the manager being informed of positive realizations decreases. Thus, conditional on being uninformed, the expected value of the firm increases with a more conservative internal information environment.

**Lemma 2** *For a given family of internal information environments with the same  $Q$ , the firm variance, conditional on no information,  $Var(\tilde{v} \mid ui, q(v))$ , is highest when  $q(v) = q$  for all  $v$ . In addition, given any two internal information environments, where  $q_1(v)$  is more conservative (less aggressive) than  $q_2(v)$ :*

- i. *If the internal information environments are aggressive,  $\frac{dq_1(v)}{dv} > 0$  and  $\frac{dq_2(v)}{dv} > 0$ , then  $Var(\tilde{v} \mid ui, q_1(v)) > Var(\tilde{v} \mid ui, q_2(v))$ .*
- ii. *If the internal information environments are conservative,  $\frac{dq_1(v)}{dv} < 0$  and  $\frac{dq_2(v)}{dv} < 0$ , then  $Var(\tilde{v} \mid ui, q_1(v)) < Var(\tilde{v} \mid ui, q_2(v))$ .*

For any two internal information environments with the same  $Q$ , the difference in the manager's uncertainty between these environments is determined by what happens when the manager has no information. This is represented by the manager's posterior variance, conditional on receiving no information:

$$Var(\tilde{v} \mid ui, q(v)) = \sigma^2 - \left( \frac{2}{1 - Q} \int_0^\infty v f(v) (q(0) - q(v)) dv \right)^2.$$

*Lemma 2* shows that the constant internal information environment  $q(v) = q$  for all  $v$  results in the largest  $Var(\tilde{v} \mid ui, q(v))$ , meaning the highest managerial uncertainty. Additionally, among any two conservative (aggressive) internal information environments, the one that is more conservative (aggressive) will have a smaller  $Var(\tilde{v} \mid ui, q(v))$ . Intuitively, this means that internal information environments that are more conservative (or aggressive) are inherently more informative to the manager compared to neutral internal information environments.

## 4 Analysis

Following the arguments presented by DJK, the equilibrium disclosure strategy is upper-tailed with a unique threshold, denoted as  $\tau$ , such that the informed manager discloses if and only if  $v > \tau$ . After observing no disclosure,  $m = \emptyset$ , investors value the firm as a weighted average of its expected value when the manager is uninformed and when the manager is informed but chooses to withhold information. Specifically, this can be represented as

$$\begin{aligned} \mathbb{E}[\tilde{v} \mid \emptyset] &= \mathbb{P}(ui \mid \emptyset) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, ui] + \mathbb{P}(inf \mid \emptyset) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, inf] \\ &= \frac{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv}{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv + \int_{-\infty}^{\tau} q(v) f(v) dv} \cdot \frac{\int_{-\infty}^{\infty} v (1 - q(v)) f(v) dv}{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv} \\ &\quad + \frac{\int_{-\infty}^{\tau} q(v) f(v) dv}{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv + \int_{-\infty}^{\tau} q(v) f(v) dv} \cdot \frac{\int_{-\infty}^{\tau} v q(v) f(v) dv}{\int_{-\infty}^{\tau} q(v) f(v) dv}. \end{aligned}$$

If  $q$  is neutral (DJK), the expected firm value, given the manager is uninformed ( $s = ui$ ), equals the prior expected firm value,  $\mathbb{E}[\tilde{v} \mid \emptyset, ui] = \mathbb{E}[\tilde{v}]$ . Here, however, this equality no longer holds, as the distribution of firm value, conditional on the manager receiving no information, generally differs from the prior distribution because the event ( $s = ui$ ) is itself an informative, if noisy, signal of  $v$ . In a rational expectations equilibrium, the investors conjecture regarding the threshold value  $\tau$  must be consistent with the optimal disclosure

policy of the manager:

$$\mathbb{E}[\tilde{v} \mid \emptyset] = \tau.$$

**Proposition 1** *For any  $q(v)$ , the manager's equilibrium disclosure strategy,  $D : \{inf, ui\} \times \mathbb{R} \rightarrow \{dis, \emptyset\}$  is upper-tailed with a unique threshold  $\tau \in \mathbb{R}$ , such that for any  $s \in \{inf, ui\}$  and  $v \in \mathbb{R}$ ;*

$$D(s, v) = \begin{cases} dis & \text{if } s = inf \text{ and } v > \tau \\ \emptyset & \text{otherwise} \end{cases}.$$

*The threshold  $\tau$  is characterized by the following equation:*

$$\tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv = 0.$$

This result generalizes DJK. The equilibrium properties, of uniqueness and upper-tailed disclosure, in the canonical model can be extended when  $q(v)$  depends on  $v$ . However, the introduction of this dependency adds another degree of freedom in the information structure: the relative probability of being informed about different outcomes. Therefore, a natural question is how this second dimension affects the equilibrium. The following results illuminate this.

**Lemma 3** *Consider two internal information environments,  $q_1(v)$  and  $q_2(v)$ . If  $q_1(v)$  is strictly more informative than  $q_2(v)$ , the disclosure threshold  $\tau$  is lower and the probability of disclosure higher under  $q_1(v)$  as compared to  $q_2(v)$ .*

*Lemma 3* can be found in [Shin \(1994\)](#) and [Lichtig and Weksler \(2023\)](#) and demonstrates that an internal information environment that is more likely to inform, conditional on any firm value realization, leads to higher voluntary disclosure. The probability of coming across an uninformed manager diminishes. Hence, when investors see no disclosure, they are more inclined to believe they are dealing with an informed manager holding negative information rather than an uninformed one, leading them to adjust the price downward in the absence

of disclosure. This shift reduces the informed manager's incentives to withhold information. In the limit, this dynamic would lead to complete unraveling as  $q(v) \rightarrow 1$  for all  $v$  (Milgrom, 1981). The following result uses *Definition 2* to compare internal information environments in which one is not point-wise more informative across all possible firm value realizations.

**Proposition 2** *Consider two internal information environments,  $q_1(v)$  and  $q_2(v)$ , with identical  $Q$ . If  $q_1(v)$  is more conservative (aggressive) than  $q_2(v)$ , then:*

- i. The disclosure threshold  $\tau$  is higher (lower) under  $q_1(v)$*
- ii. The probability of disclosure,  $\mathbb{P}_{dis} = \int_{\tau}^{\infty} q(v)f(v)dv$ , is lower (higher) under  $q_1(v)$ .*

*Proposition 2* compares internal information environments with identical ex ante probabilities of information but with differential information arrival for bad and good news, respectively. When an internal information environment mainly relays positive outcomes, the chances of the manager being uninformed about positive outcomes shrink. Consequently, the expected firm value, conditional on the manager being uninformed, also decreases (*Lemma 1*). Investors, understanding this dynamic, deduce from a lack of disclosure that either an informed manager is withholding negative developments or an uninformed manager is unaware of those developments. This lowers the stock price in the absence of disclosure. Therefore, the informed manager is more inclined to disclose.<sup>12</sup>

**Corollary 1** *Consider two internal information environments,  $q_1(v)$  and  $q_2(v)$ , with identical  $Q$ , where  $q_1(v)$  is more conservative (less aggressive) than  $q_2(v)$ :*

- i. If the internal information environments are aggressive,  $\frac{dq_1(v)}{dv} > 0$  and  $\frac{dq_2(v)}{dv} > 0$ , the manager's uncertainty is lower and the probability of disclosure is higher under  $q_2(v)$ .*

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<sup>12</sup>Some economic forces here may resemble those in Acharya et al. (2011) but with fundamental differences. Acharya et al. (2011) study dynamic disclosure under uncertainty about the manager's information and correlated external news. There, negative external signals shift firm value beliefs downward for both uninformed and strategic managers. In contrast, the present paper assumes that the manager's information endowment depends on whether information is positive or negative, which causes the distributions of firm value for uninformed and informed managers to shift in opposite directions, leading to a different equilibrium characterization. See also Guttman, Kremer, and Skrzypacz (2014).

- ii. If the internal information environments are conservative,  $\frac{dq_1(v)}{dv} < 0$  and  $\frac{dq_2(v)}{dv} < 0$ , the manager's uncertainty and the probability of disclosure are higher under  $q_2(v)$ .

*Corollary 1* follows directly from *Lemma 2* and *Proposition 2*, highlighting that a better informed manager does not necessarily disclose more. Specifically, when the internal information environment is aggressive, shifting toward a more aggressive environment leads to a manager who is better informed (less managerial uncertainty, conditional on receiving no information) and discloses more in equilibrium. However, when the internal information environment is conservative, any change toward a more conservative internal information environment leads to a better informed manager who discloses less in equilibrium. This finding contrasts with those of DJK, where a better informed manager always discloses more in equilibrium.

The previous results explore voluntary disclosure changes in response to shifts in the internal information environment. The next proposition studies how a change in the external information environment characterized by investors' uncertainty regarding firm value affects voluntary disclosure incentives. This uncertainty can proxy for the information asymmetry between the manager and investors: the greater the prior uncertainty, the more pronounced the information asymmetry between them.

**Proposition 3** Consider two prior beliefs about the firm value  $\tilde{v}$ , represented as  $f_1(v)$  and  $f_2(v)$ , and assume that  $f_1(v) \succ_{SOSD} f_2(v)$ :

- i. If the internal information environment  $q(v)$  is aggressive or neutral, i.e.,  $\frac{dq(v)}{dv} \geq 0$ , the disclosure threshold  $\tau$  is higher under the prior beliefs  $f_1(v)$  compared to  $f_2(v)$ .
- ii. There exists a conservative internal information environment,  $\bar{q}(v)$ , i.e.,  $\frac{d\bar{q}(v)}{dv} < 0$ , such that for any  $q(v)$  more conservative than  $\bar{q}(v)$ , the disclosure threshold  $\tau$  is lower under the prior beliefs  $f_1(v)$  compared to  $f_2(v)$ .

The nature of the internal information environment, whether conservative or aggressive, interacts with the external information environment to determine the extent of voluntary

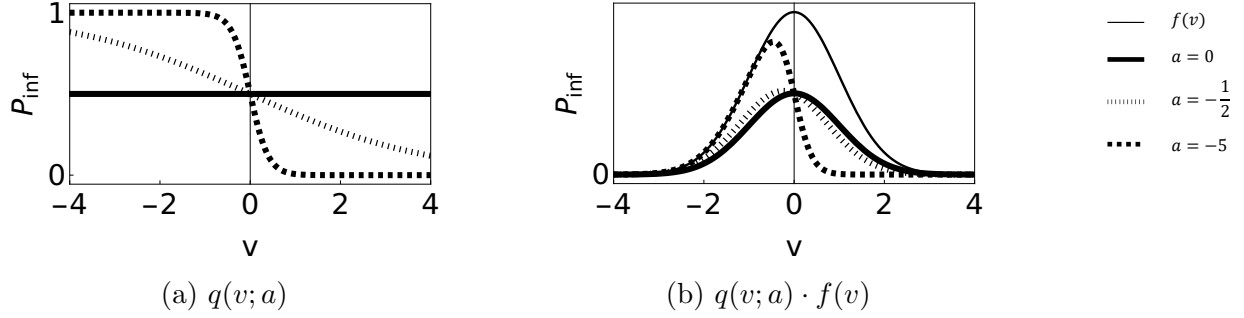
disclosure. In particular, in conservative internal information environments, an increase in investors' prior uncertainty about firm value increases the disclosure threshold, suggesting that higher information asymmetry diminishes voluntary disclosure. Conversely, in aggressive internal information environments, more dispersed investor beliefs about firm value decrease the disclosure threshold, implying that higher information asymmetry leads to more voluntary disclosure. The intuition is as follows: an increase in the dispersion of investors' prior beliefs regarding firm value creates conflicting effects. On the one hand, for a given disclosure threshold, more dispersion implies that the probability of a manager with extremely negative information below the disclosure threshold increases. This *left-tail effect* causes investors to revise their value estimates for the firm downward after no disclosure. Consequently, the manager's disclosure incentives increase. On the other hand, as beliefs become more dispersed, the probability that the manager is uninformed about exceptionally positive information grows. This *right-tail effect* increases investors' valuation of the firm after no disclosure, inducing the manager to withhold information.

As a result, when the internal information environment is aggressive, that is, a low probability exists of a manager being uninformed about positive outcomes, the *left-tail effect* dominates, reducing the disclosure threshold. This also happens when the internal information environment is neutral, as demonstrated by Jung and Kwon (1988). However, when the internal information environment is sufficiently conservative, the likelihood of a manager being unaware of positive outcomes increases. This results in the *right-tail effect* prevailing over the *left-tail effect*, increasing the disclosure threshold.

## 5 The Normal Distribution Case

To generate predictions about the probability of disclosure, which is a construct that lends itself more easily to empirical tests, in the following analysis, I turn to a more tractable version of the model. I propose two functional forms for  $f(v)$  and  $q(v)$  that possess desirable

Figure 2: Graphical illustration of  $q(v; a, b) = \frac{b}{1+e^{-av}}$ .



**Note:** Prior beliefs are normally distributed,  $f(v) \sim \mathcal{N}(0, 1)$ . The internal information environment is characterized by  $q(v; a, b) = \frac{b}{1+e^{-av}}$ . The parameter  $a$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones. If  $a > 0$ , the internal information environment is aggressive. If  $a < 0$ , the internal information environment is conservative. If  $a = 0$ , it aligns with the canonical framework in which  $q$  remains neutral. In this graphic,  $b = 1$ .

attributes and add tractability. The prior beliefs regarding the value of the firm are normally distributed  $\tilde{v} \sim \mathcal{N}(0, \sigma^2)$ . For the internal information environment, I employ the logistic family of sigmoid functions:

$$q(v; a, b) = \frac{b}{1 + e^{-av}} \quad \text{with} \quad b \in (0, 1) \quad \text{and} \quad a \in \mathbb{R}.$$

**Property 1** *Given prior beliefs  $f(v) \sim \mathcal{N}(0, \sigma^2)$  and an internal information environment  $q(v; a, b) = \frac{b}{1+e^{-av}}$ , the ex ante probability of the manager being informed is:*

$$Q = \int_{-\infty}^{\infty} f(v)q(v; a, b) dv = \frac{b}{2}.$$

For the logistic sigmoid function, the ex ante probability of providing information by  $q(v; a, b)$  solely depends on the  $b$  parameter, whereas the *shape* parameter  $a$  indicates the relative propensity of an internal information environment  $q(v; a, b)$  to provide information about positive outcomes versus negative ones. If  $a > 0$ , the internal information environment displays a monotonically increasing trend, implying a higher likelihood of providing positive outcomes. Conversely, with  $a < 0$ , the internal information environment is monotonically

decreasing with a higher chance of informing about negative outcomes. If  $a = 0$ , it recoups the canonical framework in which  $q$  is neutral.

**Property 2** *Given two internal information environments  $q(v; a_1, b_1)$  and  $q(v; a_2, b_2)$ :*

- i. If  $a_1 = a_2$  and  $b_1 > b_2$ , then  $q(v; a_1, b_1)$  is strictly more informative.*
- ii. If  $a_1 < a_2$  and  $b_1 = b_2$ , then  $q(v; a_1, b_1)$  is more conservative.*

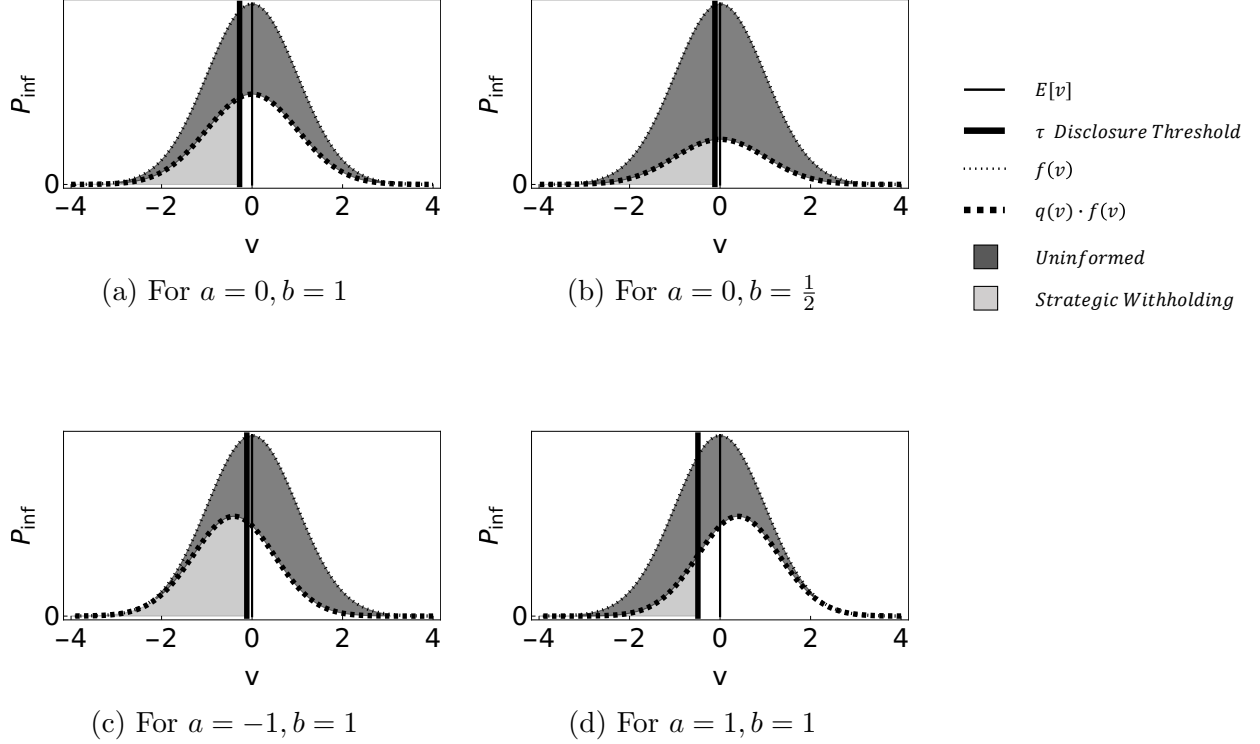
*Property 2* formally establishes that, within  $q(v; a, b)$ , the parameters  $a$  and  $b$  define the two aspects of the information structure previously discussed: the relative likelihood of information, conditional on firm value  $v$ , and the ex ante probability of information  $Q$ .

**Property 3** *Given prior beliefs  $f(v) \sim \mathcal{N}(0, \sigma^2)$  and an internal information environment  $q(v; a, b) = \frac{b}{1+e^{-av}}$ , for any fixed  $b$ , the manager's uncertainty,  $\text{Var}(\tilde{v} \mid ui, q(v))$ , is maximized when  $a = 0$ . If  $a < 0$ , then  $\frac{d\text{Var}(\tilde{v} \mid ui, q(v))}{da} > 0$ , whereas if  $a > 0$ , then  $\frac{d\text{Var}(\tilde{v} \mid ui, q(v))}{da} < 0$ .*

*Property 3* directly follows from *Lemma 2*. For the family of internal information environments with the same  $b$ , the difference in the manager's uncertainty between these environments is determined by the manager's posterior variance, conditional on receiving no information  $\text{Var}(\tilde{v} \mid ui, q(v))$ . The constant internal information environment  $a = 0$  results in the largest  $\text{Var}(\tilde{v} \mid ui, q(v))$ , meaning the highest managerial uncertainty. Additionally, among any two conservative (aggressive) internal information environments, the one that is more conservative (aggressive) will have a smaller  $\text{Var}(\tilde{v} \mid ui, q(v))$ . Intuitively, this means that internal information environments that are more conservative (or aggressive) are inherently more informative to the manager compared to neutral internal information environments  $a = 0$ .

**Property 4** *Given prior beliefs  $f(v) \sim \mathcal{N}(0, \sigma^2)$  and an internal information environment  $q(v; a, b) = \frac{b}{1+e^{-av}}$ , then  $\frac{d\tau}{da} < 0$  and  $\frac{d\tau}{db} < 0$ , whereas  $\frac{d\mathbb{P}_{dis}}{da} > 0$  and  $\frac{d\mathbb{P}_{dis}}{db} > 0$ .*

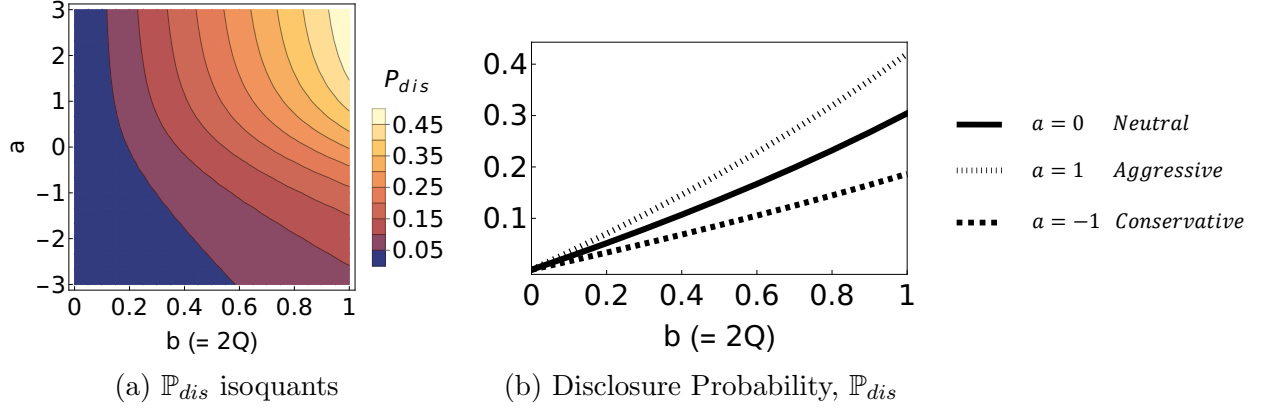
Figure 3: Illustration of *Property 4*.



**Note:** Prior beliefs are normally distributed,  $f(v) \sim \mathcal{N}(0, 1)$ . The internal information environment is characterized by  $q(v; a, b) = \frac{b}{1 + e^{-av}}$ . The parameter  $a$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones:  $a > 0$  indicates an aggressive environment,  $a < 0$  a conservative one and  $a = 0$  a neutral environment. The parameter  $b$  represents the ex ante probability of information,  $Q$ , recall  $Q = \frac{b}{2}$ .

*Property 4* directly follows from *Lemma 3* and *Proposition 2*. By decreasing  $b$ , the internal information environment becomes strictly less informative, reducing voluntary disclosure. Conversely, by augmenting  $a$ , we are shifting the internal information environment to be less conservative, increasing voluntary disclosure. This result has implications for structural estimation studies that aim to estimate the probability of a manager being informed based on their disclosure behavior, as explored by Bertomeu, Ma, and Marinovic (2020). For such an estimate to be valid, a key assumption is that no alternative mechanisms exist that are observationally equivalent to the one linking the manager's disclosure with that manager's ex ante probability of being informed,  $b$ . However, as shown in *Property 4*, disclosure behavior

Figure 4: Illustration of *Property 4*.

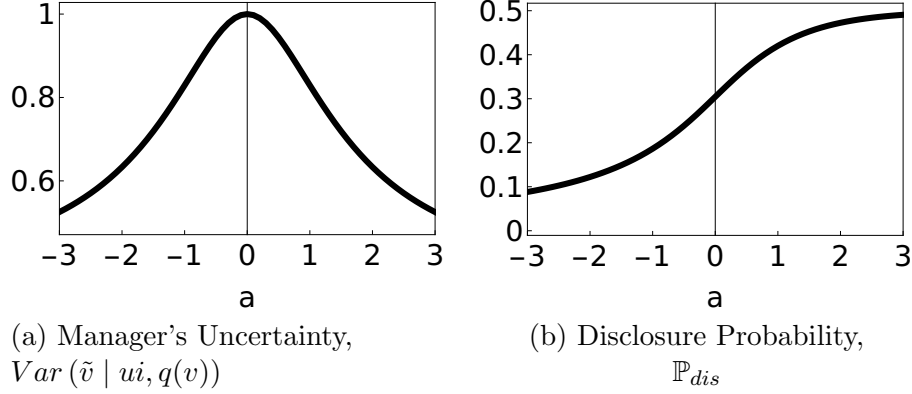


**Note:** Prior beliefs are normally distributed,  $f(v) \sim \mathcal{N}(0, 1)$ . The internal information environment is characterized by  $q(v; a, b) = \frac{b}{1 + e^{-av}}$ . The parameter  $a$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones:  $a > 0$  indicates an aggressive environment,  $a < 0$  a conservative one and  $a = 0$  a neutral environment. The parameter  $b$  represents the ex ante probability of information,  $Q$ , recall  $Q = \frac{b}{2}$ .

may depend not only on the ex ante probability of the manager being informed,  $b$ , but also on the relative likelihood of the manager being informed about positive versus negative information,  $a$ . Consequently, observed changes in disclosure could be driven by variations in  $a$  rather than changes in  $b$ . This is illustrated in Figure 4(a), which shows disclosure isoquants for different combinations of  $a$  and  $b$ . These isoquants show that a given probability of disclosure does not correspond to a unique internal information environment  $q(v)$  but could arise from a range of environments. Therefore, when estimating the unobservable  $b$  based on the firm's observable disclosures, it is crucial to account for this aspect. Another observation is that the impact of  $b$  on the manager's disclosure becomes more pronounced as the internal information environment becomes more aggressive (i.e., as  $a$  increases), as illustrated in Figure 4(b).

Figure 5 illustrates *Corollary 1* for the normal distribution case, highlighting that a better informed manager does not necessarily disclose more in equilibrium. Specifically, when the internal information environment is aggressive  $a > 0$ , increasing  $a$  results in a manager with lower uncertainty who discloses more in equilibrium. Conversely, when the internal information environment is conservative  $a < 0$ , decreasing  $a$  leads to a better informed

Figure 5: Illustration of *Corollary 1*.



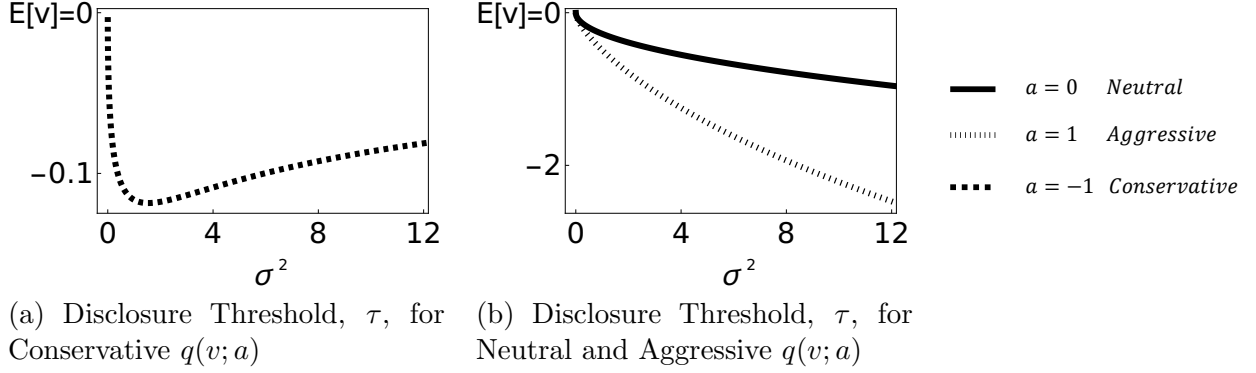
**Note:** Prior beliefs are normally distributed,  $f(v) \sim \mathcal{N}(0, 1)$ . The internal information environment is characterized by  $q(v; a, b) = \frac{b}{1+e^{-av}}$ . The parameter  $a$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones:  $a > 0$  indicates an aggressive environment,  $a < 0$  a conservative one and  $a = 0$  a neutral environment. In this graph  $b = 1$ .

manager who discloses less in equilibrium. This contrasts with the results of DJK, where a better informed manager always discloses more in equilibrium.

**Property 5** *Given prior beliefs  $f(v) \sim \mathcal{N}(0, \sigma^2)$  and an internal information environment  $q(v; a, b) = \frac{b}{1+e^{-av}}$ , if  $a \geq 0$ , then  $\frac{d\tau}{d\sigma^2} < 0$ . However, there exists an  $\bar{a} < 0$ , such that if  $a < \bar{a}$ , then  $\frac{d\tau}{d\sigma^2} > 0$ .*

*Property 5* directly stems from *Proposition 3*. A decrease in the *shape* parameter,  $a$ , increases the likelihood of the manager being uninformed about favorable outcomes (a more conservative internal information environment). When the dispersion of prior beliefs,  $\sigma^2$ , increases, countervailing forces emerge: there is a higher probability of no disclosure of extreme negative information, the *left-tail effect*, which decreases the disclosure threshold. On the other hand, the likelihood of the manager being uninformed about extreme positive developments also rises, the *right-tail effect*, which increases the disclosure threshold. For a sufficiently low  $a$  (sufficiently conservative), the *right-tail effect* prevails over the *left-tail effect*, resulting in an increase in the disclosure threshold.

Figure 6: Illustration of how  $\sigma^2$  affects  $\tau$ , when  $f(v) \sim \mathcal{N}(0, \sigma^2)$ .



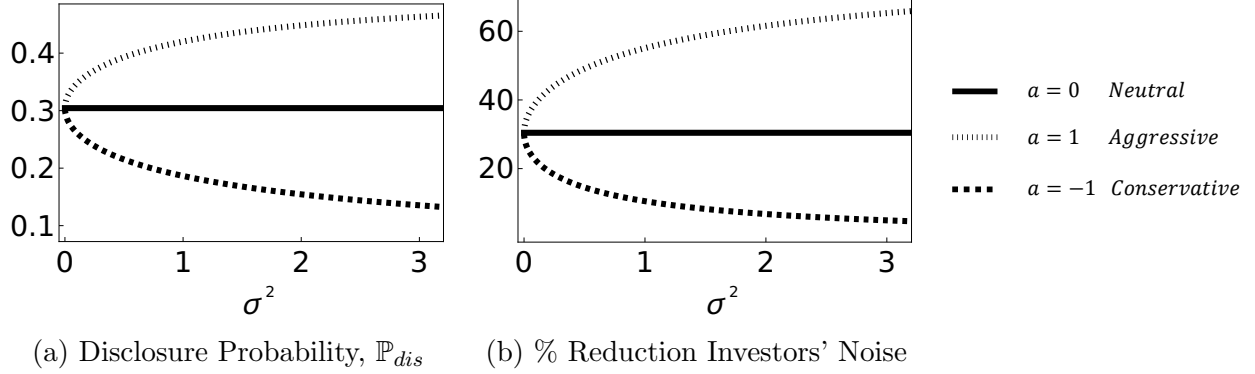
**Note:** Prior beliefs are normally distributed,  $f(v) \sim \mathcal{N}(0, \sigma^2)$ . The information asymmetry between the manager and investors is represented by  $\sigma^2$ . Higher  $\sigma^2$  indicates higher information asymmetry. The internal information environment is characterized by  $q(v; a, b) = \frac{b}{1 + e^{-av}}$ . The parameter  $a$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones:  $a > 0$  indicates an aggressive environment,  $a < 0$  a conservative one, and  $a = 0$  a neutral environment. In this graphic,  $b = 1$ .

In Figure 6(a), the disclosure threshold,  $\tau$ , exhibits a U-shaped relationship with the dispersion in prior beliefs,  $\sigma^2$ , when the internal information environment is conservative ( $a < 0$ ). This can be understood as follows: At lower levels of  $\sigma^2$ , the disclosure threshold approaches its upper bound, the unconditional expected firm value, 0. In this case, an increase in  $\sigma^2$  leads to a higher probability of extreme negative outcomes below the disclosure threshold, the *left-tail effect*, which decreases the disclosure threshold in equilibrium. However, when  $\sigma^2$  is sufficiently high, the disclosure threshold is already very low, and the *left-tail effect* by increasing  $\sigma^2$  weakens. Meanwhile an increase in  $\sigma^2$  results in a higher probability of the manager being uninformed about extreme positive outcomes, the *right-tail effect*, which raises the threshold. When the internal information environment is conservative, the *right-tail effect* becomes more important and causes the threshold to increase in equilibrium. Consequently, when  $\sigma^2$  is sufficiently high, the threshold increases in  $\sigma^2$ .

Examining Figure 7(a), we can see that the value of  $a$  determines how  $\sigma^2$  affects the probability of disclosure.<sup>13</sup> Specifically, for an internal information environment that is

<sup>13</sup>Similarly, in Figure 7(b), the value of  $a$  determines how  $\sigma^2$  impacts the percentage reduction of investor uncertainty, which is measured as the difference between their prior and posterior variances, scaled by their

Figure 7: Illustration of how  $\sigma^2$  affects the disclosure probability and % reduction in investors' noise, when  $f(v) \sim \mathcal{N}(0, \sigma^2)$ .



**Note:** Prior beliefs are normally distributed,  $f(v) \sim \mathcal{N}(0, \sigma^2)$ . The information asymmetry between the manager and investors is represented by  $\sigma^2$ . Higher  $\sigma^2$  indicates higher information asymmetry. The internal information environment is characterized by  $q(v; a, b) = \frac{b}{1+e^{-av}}$ . The parameter  $a$  indicates the relative probability of the internal information environment to provide information to the manager about positive outcomes versus negative ones:  $a > 0$  indicates an aggressive environment,  $a < 0$  a conservative one, and  $a = 0$  a neutral environment. In this graphic,  $b = 1$ .

monotonically increasing with respect to  $v$  ( $a > 0$ , aggressive), the effect is positive. When it is monotonically decreasing in  $v$  ( $a < 0$ , conservative), the effect turns negative. Another observation is that two common measures of voluntary disclosure, the disclosure threshold and the probability of disclosure, do not always align in terms of directionality. As shown in Figure 6(a) and Figure 7(a), when the internal information environment is conservative  $a < 0$ , for small values of  $\sigma^2$ , the disclosure threshold decreases and the probability of disclosure also decreases.

So far, the assumption has been that the manager receives a perfect signal upon being informed. Another way to interpret the result of *Property 5* is by allowing the signal observed by the manager to be noisy.<sup>14</sup> The precision of the signal (represented by  $\rho$ ) can be interpreted as information quality. By the properties of the normal distribution, increasing the prior variance and multiplied by 100. The investor's posterior variance is given by  $\int_{-\infty}^{\tau} (\tau - v)^2 f(v) dv + \int_{\tau}^{\infty} (\tau - v)^2 (1 - q(v)) f(v) dv$ , while prior variance is  $\sigma^2$ .

<sup>14</sup>Prior beliefs about firm value follow a normal distribution  $\tilde{v} \sim \mathcal{N}(0, \sigma^2)$ . With probability  $q(x)$ , the manager observes a noisy signal  $\tilde{x} = \tilde{v} + \tilde{\epsilon}$  and has the option to disclose this signal. The noisy term,  $\tilde{\epsilon}$ , is independent of  $\tilde{v}$  and normally distributed with a mean of zero and a precision parameter  $\rho$ . Consequently,  $\tilde{x}$  also has a normal distribution with a mean of 0 and variance  $\sigma_x^2 = \sigma^2 + \frac{1}{\rho}$ .

variance,  $\sigma^2$ , while keeping  $\rho$  constant is equivalent to decreasing  $\rho$  while holding  $\sigma^2$  constant. Consequently, *Property 5* indicates that how information quality,  $\rho$ , affects the disclosure threshold,  $\tau$ , depends on the characteristics of the internal information environment,  $q(v)$ .<sup>15</sup>

## 6 Empirical Predictions

The results of this paper apply to settings where disclosure frictions arise because managers may be uninformed. As a result, investors face uncertainty about whether nondisclosure reflects the manager’s lack of information or strategic withholding. More broadly, this type of disclosure friction can also be interpreted in contexts where managers refrain from disclosing for other reasons, for example, when they do not prioritize short-term stock prices, receive unverifiable information, or lack the time to prepare a credible disclosure (see Bertomeu et al., 2020).

The pharmaceutical and biotechnology industries provide natural examples. In these industries, the market often faces uncertainty about managers’ information endowment, as firms pursue R&D that yield verifiable outcomes at unpredictable times. At any given point, it is unclear whether a manager has information to disclose (see Banerjee et al., 2024). Another example is the banking industry, where banks have discretion over disclosing details about their financial positions (e.g., sovereign credit risk exposure). Access to this information often relies on sophisticated internal reporting systems—especially when handling complex derivative products (see Bischof and Daske, 2013)—which means that the absence of voluntary disclosure may reflect not just strategic withholding but also limitations in

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<sup>15</sup>This result provides an alternative explanation to that of Penno (1997) regarding the negative impact of information quality on voluntary disclosure. In Penno (1997), the manager’s probability of being informed is independent of  $v$  and instead depends on  $\rho$ , i.e.,  $q(\rho)$ . Additionally, the author assumes that the probability of the manager being informed decreases as the information becomes more precise, i.e.,  $\frac{dq(\rho)}{d\rho} < 0$ . According to the properties of the normal distribution, the probability of disclosure remains constant with changes in  $\rho$  if  $q$  is independent of  $\rho$ . However, because  $q(\rho)$  is assumed to decrease in  $\rho$ , an increase in  $\rho$  results in a higher probability that the manager is uninformed, leading to an increased nondisclosure price and ultimately less disclosure in equilibrium. In contrast, the present paper treats  $\rho$  and  $q$  as independent, demonstrating that  $\rho$  indeed impacts the probability of disclosure when  $q$  depends on the underlying firm value  $v$ , even within the context of a normal distribution.

internal reporting capabilities.

Certain external factors directly influence the internal information environments of firms. For example, litigation risk creates a fundamental asymmetry between positive and negative information (Marinovic and Varas, 2016), given that lawsuits are typically triggered by negative events. Therefore, industries with high litigation risk, such as pharmaceuticals, automobiles, and financial services, are likely to invest more in developing internal systems that detect negative information to preempt potential litigation. Another key factor is regulation; for example, the Sarbanes-Oxley Act (SOX) is designed to strengthen internal controls and reduce exposure to internal fraud. In addition, industries where safety is critical often operate under close regulatory oversight.<sup>16</sup> These regulators push firms to improve their internal systems to prevent safety failures. A recent example is Boeing, which, following a U.S. Department of Transportation order, published a detailed strategy to improve its production systems and encourage employees to report safety and quality concerns (BBC, 2024). Similarly, in the highly regulated banking sector, European banks must conduct stress tests to uncover potential vulnerabilities (European Central Bank, 2025).

The present paper predicts that regulations pushing firms to detect negative events—fostering conservative internal environments—may reduce managers’ incentives to voluntarily disclose information. In addition, in lightly regulated or low-risk industries, such as emerging sectors or entertainment, where firms face less pressure to detect negative outcomes (aggressive environments), expanding mandatory disclosure is more likely to *crowd out* voluntary disclosure. In contrast, in industries with heavy regulatory or litigation pressure, such as pharmaceuticals, automobiles, or financial services, mandatory disclosure requirements may actually *crowd in* additional voluntary disclosure, which is consistent with empirical evidence in banking settings (e.g., Bischof and Daske, 2013; Kleymenova and Zhang, 2019).

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<sup>16</sup>For instance, the U.S. Food and Drug Administration monitors pharmaceutical firms, while the U.S. Department of Transportation oversees airplane manufacturers.

## 7 Conclusion

This paper examines the impact of a firm’s internal information environment on its voluntary disclosure to external stakeholders, such as investors. To model the internal information environment, the paper introduces a richer information structure, where the probability of the manager being informed varies, depending on whether the information is favorable or unfavorable. Such lopsided internal information environments are commonplace in practice, and the results generate new empirical predictions.

The present study explores two key questions. First, how does the internal information environment influence a manager’s decision to voluntarily disclose to investors? Second, how does the interaction between the internal and external information environments impact the overall level of voluntary disclosure? The study finds that a more conservative internal information environment leads to less voluntary disclosure to investors. It also demonstrates that the internal information environment determines the impact of information asymmetry on voluntary disclosure. In an aggressive internal information environment, greater information asymmetry leads to increased voluntary disclosure, whereas in a conservative environment, this effect reverses. This finding is empirically relevant, because the canonical model where the information endowment is news-independent predicts a no-result.

One limitation of this analysis is that it focuses on comparing internal information environments based solely on how they convey favorable versus unfavorable information. However, other scenarios might require different types of comparisons. For instance, when firms use variance analysis, they aim to identify extreme abnormal events, making it more likely that the manager will be informed about these extreme events rather than moderate ones. While extreme negative events may still be treated differently than extreme positive ones and some insights from the main analysis may still apply, a natural next step would be to expand the analysis to encompass a broader range of comparisons. In the appendix, I present a simplified model comparing information environments based on how they convey information about extreme versus moderate events, but a more generalized analysis would

be a natural extension of this work.

In conclusion, this study demonstrates that a firm's internal information environment significantly impacts its manager's decision about whether to disclose to investors. This framework can potentially bridge the gap between the managerial accounting aspects of the firm and its financial reporting practices, offering a way to explore the connection between these two dimensions.

# Appendix A

## Proofs of the Main Results

**Proof of Lemma 1.**

$$\begin{aligned}
\mathbb{E}[\tilde{v} \mid ui, q(v)] &= \frac{1}{1-Q} \int_{-\infty}^{\infty} v(1-q(v))f(v) dv \\
&= \frac{1}{1-Q} \left( - \int_{-\infty}^{\infty} vq(v)f(v) dv \right) \\
&= \frac{1}{1-Q} \left( - \int_{-\infty}^0 vq(v)f(v) dv - \int_0^{\infty} vq(v)f(v) dv \right) \\
&= \frac{1}{1-Q} \left( - \int_0^{\infty} -vq(-v)f(-v) dv - \int_0^{\infty} vq(v)f(v) dv \right) \\
&= \frac{1}{1-Q} \left( - \int_0^{\infty} -v(2q(0) - q(v))f(v) dv - \int_0^{\infty} vq(v)f(v) dv \right) \\
&= \frac{2}{1-Q} \int_0^{\infty} v(q(0) - q(v))f(v) dv.
\end{aligned}$$

Thus, if we compare  $\mathbb{E}[\tilde{v} \mid ui, q_1(v)]$  to  $\mathbb{E}[\tilde{v} \mid ui, q_2(v)]$  we have that

$$\begin{aligned}
\mathbb{E}[\tilde{v} \mid ui, q_1(v)] - \mathbb{E}[\tilde{v} \mid ui, q_2(v)] &= \frac{2}{1-Q_1} \int_0^{\infty} v(Q_1 - q_1(v))f(v) dv \\
&\quad - \frac{2}{1-Q_2} \int_0^{\infty} v(Q_2 - q_2(v))f(v) dv.
\end{aligned}$$

From Definition 2 we have that  $Q_1 = Q_2 = Q$  and  $q_1(v) < q_2(v)$  for all  $v > 0$ , then

$$\mathbb{E}[\tilde{v} \mid ui, q_1(v)] - \mathbb{E}[\tilde{v} \mid ui, q_2(v)] = \frac{2}{1-Q} \int_0^{\infty} v(q_2(v) - q_1(v))f(v) dv > 0.$$

■

**Proof of Lemma 2.** For the family of internal information environments with the same  $Q$ :

$$Var(\tilde{v} \mid ui, q(v)) = \mathbb{E}(\tilde{v}^2 \mid ui, q(v)) - \mathbb{E}(\tilde{v} \mid ui, q(v))^2,$$

where

$$\begin{aligned}
\mathbb{E}(\tilde{v}^2 \mid ui, q(v)) &= \int_{-\infty}^{\infty} v^2 \frac{(1 - q(v)) f(v)}{1 - Q} dv \\
&= \frac{1}{1 - Q} \left( \int_{-\infty}^0 v^2 (1 - q(v)) f(v) dv + \int_0^{\infty} v^2 (1 - q(v)) f(v) dv \right) \\
&= \frac{1}{1 - Q} \left( \int_0^{\infty} (-v)^2 (1 - q(-v)) f(-v) dv + \int_0^{\infty} v^2 (1 - q(v)) f(v) dv \right) \\
&= \frac{1}{1 - Q} \left( \int_0^{\infty} (v)^2 (1 - 2q(0) + q(v)) f(v) dv + \int_0^{\infty} v^2 (1 - q(-v)) f(v) dv \right) \\
&= \frac{1 - q(0)}{1 - Q} \left( 2 \int_0^{\infty} v^2 f(v) dv \right) \\
&= \sigma^2.
\end{aligned}$$

We can see that the term  $\mathbb{E}(\tilde{v}^2 \mid ui, q(v))$  does not depend on  $q(v)$ . Thus, the effect of  $q(v)$  on  $Var(\tilde{v} \mid ui, q(v))$  is captured in term  $\mathbb{E}(\tilde{v} \mid ui, q(v))^2$ , which we have derived in Lemma 1. The variance can be expressed as

$$Var(\tilde{v} \mid ui, q(v)) = \sigma^2 - \left( \frac{2}{1 - Q} \int_0^{\infty} v f(v) (q(0) - q(v)) dv \right)^2.$$

Clearly, the highest variance occurs when  $q(0) = q(v)$  for all  $v$ , and it is equal to the prior variance,  $\sigma^2$ . In contrast, as the internal information environment leans more conservative or aggressive, the difference  $|q(0) - q(v)|$  increases, resulting in a lower variance. ■

**Proof of Proposition 1.** When no information is disclosed, investors price the firm as  $P_{\emptyset} = \mathbb{E}[\tilde{v} \mid \emptyset]$ . The set of  $v$  realizations the manager strategically chooses to withhold is

$$\Omega = \{v \mid v \leq \mathbb{E}[\tilde{v} \mid \emptyset]\}.$$

Suppose  $\Omega$  is non-empty, if the manager observes  $v_1$  and decides to withhold it in equilibrium, he would also want to conceal any realization below  $v < v_1$ . Let us define  $\tau$  as the maximum element within  $\Omega$ , thus  $\tau = \max \Omega$ . Consequently, any value  $v < \tau$  belongs to  $\Omega$ . On the

other hand, any value  $v > \tau$  cannot be in  $\Omega$  by definition of  $\tau$ . Therefore, in equilibrium,  $\Omega$  is characterized by a unique value  $\tau$  in which  $v$  is an element of  $\Omega$  if and only if  $v < \tau$ .

Therefore, if an equilibrium exists, it must take the form of a unique threshold. Managers above this threshold will disclose, while those below will withhold information. If the manager discloses if and only if  $v > \tau$ , the equilibrium condition  $\mathbb{E}[\tilde{v} \mid \emptyset] = \tau$  results in the following equation:

$$\begin{aligned} \tau = & \frac{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv}{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv + \int_{-\infty}^{\tau} q(v) f(v) dv} \cdot \frac{\int_{-\infty}^{\infty} v (1 - q(v)) f(v) dv}{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv} \\ & + \frac{\int_{-\infty}^{\tau} q(v) f(v) dv}{\int_{-\infty}^{\infty} (1 - q(v)) f(v) dv + \int_{-\infty}^{\tau} q(v) f(v) dv} \cdot \frac{\int_{-\infty}^{\tau} v q(v) f(v) dv}{\int_{-\infty}^{\tau} q(v) f(v) dv}, \end{aligned}$$

which can be simplified to

$$\tau \left( \int_{-\infty}^{\infty} (1 - q(v)) f(v) dv + \int_{-\infty}^{\tau} q(v) f(v) dv \right) = \int_{-\infty}^{\infty} v (1 - q(v)) f(v) dv + \int_{-\infty}^{\tau} v q(v) f(v) dv.$$

By the integral properties the previous expression is equivalent to

$$\tau \left( \underbrace{\int_{-\infty}^{\infty} f(v) dv}_{=1} - \int_{\tau}^{\infty} f(v) q(v) dv \right) = \underbrace{\int_{-\infty}^{\infty} v f(v) dv}_{\mathbb{E}[\tilde{v}]=0} - \int_{\tau}^{\infty} v f(v) q(v) dv,$$

which reduces to

$$\tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv = 0.$$

Now, I show that  $\tau$  exists and it is unique using the Theorem of Bolzano. Note that  $\tau \in \mathbb{R}$ ,

this means that  $\tau$  can take any real value. If  $\tau \rightarrow -\infty$ , then

$$\begin{aligned}
\lim_{\tau \rightarrow -\infty} \tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv &= \lim_{\tau \rightarrow -\infty} \tau + \int_{\tau}^{\infty} v f(v) q(v) dv - \tau \int_{\tau}^{\infty} f(v) q(v) dv \\
&= \lim_{\tau \rightarrow -\infty} \tau (1 - \int_{\tau}^{\infty} f(v) q(v) dv) + \int_{\tau}^{\infty} v f(v) q(v) dv \\
&= -\infty \underbrace{(1 - q(0))}_{\in (0,1)} + \text{constant} < 0.
\end{aligned}$$

If  $\tau \rightarrow \infty$ , then

$$\lim_{\tau \rightarrow \infty} \tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv = \infty + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv = \infty + 0 > 0.$$

This means that, by continuity there exists at least one  $\tau$  such that the equilibrium condition holds true. In order to show uniqueness, it will suffice to check that  $\tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv$  is increasing in  $\tau$ . By taking the derivative we can see that

$$\begin{aligned}
\frac{d}{d\tau} \left( \tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv \right) &= 1 + \frac{d\infty}{d\tau} (\infty - \tau) f(\infty) q(\infty) - \frac{d\tau}{d\tau} (\tau - \tau) f(\tau) q(\tau) \\
&\quad + \int_{\tau}^{\infty} \frac{d}{d\tau} (v - \tau) f(v) q(v) dv \\
&= 1 - \int_{\tau}^{\infty} f(v) q(v) dv > 1 - \int_{-\infty}^{\infty} f(v) q(v) dv = 1 - q(0) > 0.
\end{aligned}$$

Then, the threshold  $\tau$  is unique. Note that the equilibrium  $\tau$  is below  $\mathbb{E}[\tilde{v}] = 0$ . Suppose not, then

$$\begin{aligned}
\mathbb{E}[\tilde{v} \mid \emptyset] &= \mathbb{P}(\emptyset, v < -\tau) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, v < -\tau] \\
&\quad + \mathbb{P}(\emptyset, -\tau < v < \tau) \cdot \underbrace{\mathbb{E}[\tilde{v} \mid \emptyset, -\tau < v < \tau]}_{=0} + \mathbb{P}(\emptyset, \tau < v) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, \tau < v] \\
&= \mathbb{P}(\emptyset, v < -\tau) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, v < -\tau] + \mathbb{P}(\emptyset, \tau < v) \cdot \mathbb{E}[\tilde{v} \mid \emptyset, \tau < v] < 0,
\end{aligned}$$

which yields a contradiction. ■

**Proof of Lemma 3.** From Proposition 1 we know the left-hand side (LHS) equilibrium condition,

$$\underbrace{\tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv}_{LHS} = 0,$$

is increasing in  $\tau$ . Consider two internal information environments  $q_1(v)$  and  $q_2(v)$  in which  $q_1(v) > q_2(v) \forall v$ . Comparing the *LHS* for  $q_1(v)$  and  $q_2(v)$ ,

$$\begin{aligned} LHS_1 - LHS_2 &= \tau + \int_{\tau}^{\infty} (v - \tau) f(v) q_1(v) dv - \tau - \int_{\tau}^{\infty} (v - \tau) f(v) q_2(v) dv \\ &= \int_{\tau}^{\infty} (v - \tau) f(v) (q_1(v) - q_2(v)) dv. \end{aligned}$$

Given that in equilibrium,  $\tau < 0$ , we can decompose the previous expression as

$$\begin{aligned} LHS_1 - LHS_2 &= \int_{\tau}^0 \underbrace{(v + |\tau|) f(v)}_{+} \underbrace{(q_1(v) - q_2(v))}_{+} dv + \int_0^{|\tau|} \underbrace{(v + |\tau|) f(v)}_{+} \underbrace{(q_1(v) - q_2(v))}_{+} dv \\ &\quad + \int_{|\tau|}^{\infty} \underbrace{(v + |\tau|) f(v)}_{+} \underbrace{(q_1(v) - q_2(v))}_{+} dv > 0. \end{aligned}$$

For any given  $\tau$ , the left-hand side (LHS) for  $q_1(x)$  is higher than the LHS for  $q_2(x)$ . As a result, it intersects the X-axis at smaller values of  $\tau$ . This implies that the equilibrium threshold for  $q_2(v)$  exceeds that of  $q_1(v)$ , specifically  $\tau_2 > \tau_1$ . In equilibrium, the probability of disclosure under  $q(v)$  is expressed as:  $\mathbb{P}(dis) = \int_{\tau}^{\infty} q(v) f(v) dv$ . When contrasting the disclosure probabilities for  $q_1(v)$  and  $q_2(v)$ , represented by  $\mathbb{P}_1(dis)$  and  $\mathbb{P}_2(dis)$  respectively, we have that

$$\begin{aligned} \mathbb{P}_1(dis) - \mathbb{P}_2(dis) &= \int_{\tau_1}^{\infty} q_1(v) f(v) dv - \int_{\tau_2}^{\infty} q_2(v) f(v) dv \\ &= \underbrace{\int_{\tau_1}^{\tau_2} q_1(v) f(v) dv}_{+} + \underbrace{\int_{\tau_2}^{\infty} (q_1(v) - q_2(v)) f(v) dv}_{+} > 0. \end{aligned}$$

This implies that with the internal information environment  $q_1(v)$ , the disclosure threshold

is lower, and the likelihood of disclosure is greater compared to  $q_2(v)$ . ■

**Proof of Proposition 2.** From Proposition 1 we know the left-hand side (LHS) equilibrium condition,

$$\underbrace{\tau + \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv}_{LHS} = 0,$$

is increasing in  $\tau$ . Consider two internal information environments  $q_1(v)$  and  $q_2(v)$ , both having the same ex ante probability of providing information, denoted as  $Q$ . Among them, the environment  $q_1(v)$  is more conservative than  $q_2(v)$ , that is  $q_1(v) < q_2(v) \forall v : v > 0$ . Comparing the left-hand side (LHS) for  $q_1(v)$  and  $q_2(v)$ ,

$$\begin{aligned} LHS_1 - LHS_2 &= \tau + \int_{\tau}^{\infty} (v - \tau) f(v) q_1(v) dv - \tau - \int_{\tau}^{\infty} (v - \tau) f(v) q_2(v) dv \\ &= \int_{\tau}^{\infty} (v - \tau) f(v) (q_1(v) - q_2(v)) dv. \end{aligned}$$

Given that in equilibrium,  $\tau < 0$ , we can decompose the previous expression as

$$\begin{aligned} LHS_1 - LHS_2 &= \overbrace{\int_{\tau}^0 (v - \tau) f(v) (q_1(v) - q_2(v)) dv}^A + \overbrace{\int_0^{|\tau|} (v - \tau) f(v) (q_1(v) - q_2(v)) dv}^B \\ &\quad + \int_{|\tau|}^{\infty} (v - \tau) f(v) (q_1(v) - q_2(v)) dv. \end{aligned}$$

Given the symmetry properties of  $f(v)$  and  $q(v)$ :

$$\begin{aligned} A &= \int_{\tau}^0 (v - \tau) f(v) (q_1(v) - q_2(v)) dv \\ &= \int_0^{|\tau|} (-v - \tau) f(-v) (q_1(-v) - q_2(-v)) dv \\ &= \int_0^{|\tau|} (-v - \tau) f(v) (2Q - q_1(v) - 2Q + q_2(v)) dv \\ &= \int_0^{|\tau|} (v + \tau) f(v) (q_1(v) - q_2(v)) dv. \end{aligned}$$

Then,  $A + B$  can be simplified to  $\int_0^{|\tau|} 2vf(v)(q_1(v) - q_2(v)) dv$ , which means that

$$LHS_1 - LHS_2 = \int_0^{|\tau|} \underbrace{2vf(v)}_{+} \underbrace{(q_1(v) - q_2(v))}_{\text{conservative} -} dv + \int_{|\tau|}^{\infty} \underbrace{(v + |\tau|)}_{+} \underbrace{f(v)}_{+} \underbrace{(q_1(v) - q_2(v))}_{\text{conservative} -} dv < 0.$$

For any given  $\tau$ , the left-hand side (LHS) for  $q_1(v)$  is lower than the LHS for  $q_2(v)$ . Consequently, it intersects the X-axis at greater values of  $\tau$ . This implies that the equilibrium threshold for  $q_1(v)$  exceeds that of  $q_2(v)$ , specifically  $\tau_1 > \tau_2$ . When contrasting the disclosure probabilities  $\mathbb{P}_1(dis)$  and  $\mathbb{P}_2(dis)$ , we have that

$$\begin{aligned} \mathbb{P}_2(dis) - \mathbb{P}_1(dis) &= \int_{\tau_2}^{\infty} q_2(v)f(v) dv - \int_{\tau_1}^{\infty} q_1(v)f(v) dv \\ &= \int_{\tau_2}^{\tau_1} q_2(v)f(v) dv + \int_{\tau_1}^0 (q_2(v) - q_1(v)) f(v) dv + \int_0^{|\tau_1|} (q_2(v) - q_1(v)) f(v) dv \\ &\quad + \int_{|\tau_1|}^{\infty} (q_2(v) - q_1(v)) f(v) dv. \end{aligned}$$

By symmetry of  $f(v)$  and  $q(v)$

$$\begin{aligned} \mathbb{P}_2(dis) - \mathbb{P}_1(dis) &= \int_{\tau_2}^{\tau_1} q_2(v)f(v) dv + \int_{|\tau_1|}^{\infty} (q_2(v) - q_1(v)) f(v) dv \\ &\quad + \overbrace{\int_0^{|\tau_1|} (2Q - q_2(v) - 2Q + q_1(v)) f(v) dv}^{=0} + \int_0^{|\tau_1|} (q_2(v) - q_1(v)) f(v) dv \\ &= \underbrace{\int_{\tau_2}^{\tau_1} q_2(v)f(v) dv}_{+} + \underbrace{\int_{|\tau_1|}^{\infty} (q_2(v) - q_1(v)) f(v) dv}_{+} > 0. \end{aligned}$$

This implies that with the internal information environment  $q_2(v)$ , the disclosure threshold is lower, and the likelihood of disclosure is greater compared to  $q_1(v)$ . ■

**Proof of Proposition 3.** Recall the equilibrium condition from Proposition 1

$$\underbrace{\tau + \int_{\tau}^{\infty} (v - \tau)f(v)q(v)dv}_{LHS} = 0.$$

Using integration by parts the second term in  $LHS$  can be expressed in the following way

$$\begin{aligned} \int_{\tau}^{\infty} (v - \tau) f(v) q(v) dv &= (v - \tau) q(v) F(v) \Big|_{v=\infty} - (v - \tau) q(v) F(v) \Big|_{v=\tau} \\ &\quad - \int_{\tau}^{\infty} \left( (v - \tau) \frac{dq(v)}{dv} + q(v) \right) F(v) dv, \end{aligned}$$

in which  $F(v)$  is the cumulative distribution function of  $f(v)$ . If we consider two distributions such that  $f_1(v) \succ_{SOSD} f_2(v)$  and compare the  $LHS$  under each distribution we have

$$LHS_2 - LHS_1 = (v - \tau) q(v) (F_2(v) - F_1(v)) \Big|_{v=\infty} - \int_{\tau}^{\infty} \left( (v - \tau) \frac{dq(v)}{dv} + q(v) \right) (F_2(v) - F_1(v)) dv.$$

Note that  $\lim_{v \rightarrow \infty} v^2 f(v) = 0$ , then

$$\begin{aligned} \lim_{v \rightarrow \infty} (v - \tau) q(v) (F_2(v) - F_1(v)) &\sim \lim_{v \rightarrow \infty} v (F_2(v) - F_1(v)) \\ &\stackrel{H}{=} \lim_{v \rightarrow \infty} -v^2 (f_2(v) - f_1(v)) \sim \lim_{v \rightarrow \infty} v^2 f(v) = 0. \end{aligned}$$

Therefore,

$$LHS_2 - LHS_1 = \int_{\tau}^{\infty} \left( (v - \tau) \frac{dq(v)}{dv} + q(v) \right) (F_1(v) - F_2(v)) dv.$$

Given that both  $f_1(v)$  and  $f_2(v)$  are symmetric around 0 and  $f_1(v) \succ_{SOSD} f_2(v)$  we know that the following is true  $F_1(v) < F_2(v) \quad \forall v : v < 0$  and  $F_1(v) > F_2(v) \quad \forall v : v > 0$ . Also we have that  $\int_{\tau}^{\infty} F_1(v) dv > \int_{\tau}^{\infty} F_2(v) dv$  for any  $\tau$ . Consider an aggressive internal information

environment  $\frac{dq(v)}{dv} > 0$ , then

$$\begin{aligned}
LHS_2 - LHS_1 &= \int_{\tau}^{\infty} \left( (v - \tau) \frac{dq(v)}{dv} + q(v) \right) (F_1(v) - F_2(v)) dv \\
&= \overbrace{\int_{\tau}^0 (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv + \int_0^{|\tau|} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv}^A \\
&\quad + \underbrace{\int_{|\tau|}^{\infty} \underbrace{(v - \tau)}_{+} \underbrace{\frac{dq(v)}{dv}}_{+} \underbrace{(F_1(v) - F_2(v))}_{+} dv}_{+} + \underbrace{\int_{|\tau|}^{\infty} \underbrace{q(v)}_{+} \underbrace{(F_1(v) - F_2(v))}_{+} dv}_{+} \\
&\quad + \underbrace{\int_{\tau}^0 q(v) (F_1(v) - F_2(v)) dv + \int_0^{|\tau|} q(v) (F_1(v) - F_2(v)) dv}_B.
\end{aligned}$$

By symmetry,  $F(-v) = \int_{-\infty}^{-v} f(-v) dv = \int_v^{\infty} f(-v) dv = \int_v^{\infty} f(v) dv = 1 - F(v)$  and  $\frac{dq(v)}{dv} = \frac{d2q(0)}{dv} - \frac{dq(-v)}{dv} = \frac{dq(-v)}{dv}$ , then

$$\begin{aligned}
A &= \int_{\tau}^0 (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv + \int_0^{|\tau|} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv \\
&= \int_0^{|\tau|} (-v - \tau) \frac{dq(-v)}{dv} (F_1(-v) - F_2(-v)) dv + \int_0^{|\tau|} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv \\
&= \int_0^{|\tau|} (-v - \tau) \frac{dq(v)}{dv} (-F_1(v) + F_2(v)) dv + \int_0^{|\tau|} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv \\
&= \int_0^{|\tau|} \underbrace{2v \frac{dq(v)}{dv}}_{+} \underbrace{(F_1(v) - F_2(v))}_{+} dv > 0,
\end{aligned}$$

and,

$$\begin{aligned}
B &= \int_{\tau}^0 q(v) (F_1(v) - F_2(v)) dv + \int_0^{|\tau|} q(v) (F_1(v) - F_2(v)) dv \\
&= \int_0^{|\tau|} q(-v) (F_1(-v) - F_2(-v)) dv + \int_0^{|\tau|} q(v) (F_1(v) - F_2(v)) dv \\
&= \int_0^{|\tau|} (2q(0) - q(v)) (-F_1(v) + F_2(v)) dv + \int_0^{|\tau|} q(v) (F_1(v) - F_2(v)) dv \\
&= \int_0^{|\tau|} \underbrace{2(q(v) - q(0))}_{+} \underbrace{(F_1(v) - F_2(v))}_{+} dv > 0.
\end{aligned}$$

Thus, the difference  $LHS_2 - LHS_1 > 0$  is positive. This implies that for any given value of  $\tau$ , the left-hand side, LHS, corresponding to  $f_2(v)$  lies above the LHS for  $f_1(v)$ . Therefore, it will intersect the X-axis at smaller  $\tau$  values. Note that for a neutral internal information environment  $q(v) = q \quad \forall v$  we have that

$$LHS_2 - LHS_1 = \int_{\tau}^{\infty} \left( (v - \tau) \underbrace{\frac{dq(v)}{dv}}_0 + q \right) (F_1(v) - F_2(v)) dv = q \int_{\tau}^{\infty} F_1(v) - F_2(v) dv > 0$$

Lastly, consider a conservative internal information environment  $\frac{dq(v)}{dv} < 0$ , then

$$\begin{aligned} LHS_2 - LHS_1 &= \int_{\tau}^{\infty} \left( (v - \tau) \frac{dq(v)}{dv} + q(v) \right) (F_1(v) - F_2(v)) dv \\ &= \underbrace{\int_{\tau}^{\infty} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v))}_{A} + \underbrace{\int_{\tau}^0 q(v) (F_1(v) - F_2(v))}_{-} dv \\ &\quad + \underbrace{\int_0^{\infty} q(v) (F_1(v) - F_2(v))}_{+} dv. \end{aligned}$$

By symmetry

$$\begin{aligned} A &= \int_{\tau}^0 (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv + \int_0^{|\tau|} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv \\ &\quad + \int_{|\tau|}^{\infty} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv \\ &= \int_0^{|\tau|} \underbrace{2v}_{+} \underbrace{\frac{dq(v)}{dv}}_{-} \underbrace{(F_1(v) - F_2(v))}_{+} dv + \int_{|\tau|}^{\infty} \underbrace{(v - \tau)}_{+} \underbrace{\frac{dq(v)}{dv}}_{-} \underbrace{(F_1(v) - F_2(v))}_{+} dv < 0. \end{aligned}$$

We know a conservative  $q(v)$  implies that  $Q < q(v) < 1$  for any  $v < 0$ . This means that

$$\begin{aligned}
LHS_2 - LHS_1 &= \underbrace{\int_{\tau}^{\infty} (v - \tau) \frac{dq(v)}{dv} (F_1(v) - F_2(v)) dv}_{-} + \underbrace{\int_{\tau}^0 q(v) (F_1(v) - F_2(v)) dv}_{-} \\
&\quad + \int_0^{\infty} q(v) (F_1(v) - F_2(v)) dv \\
&< Q \int_{\tau}^0 (F_1(v) - F_2(v)) dv + \int_0^{\infty} q(v) (F_1(v) - F_2(v)) dv \\
&= K + \int_0^{\infty} q(v) (F_1(v) - F_2(v)) dv,
\end{aligned}$$

where  $K$  does not depend on  $q(v)$  and  $K < 0$ . Given a conservative  $q(v)$ , we have that  $0 < q(v) < Q$  for any  $v > 0$  which implies

$$0 < \int_0^{\infty} q(v) (F_1(v) - F_2(v)) dv < Q \int_0^{\infty} (F_1(v) - F_2(v)) dv.$$

Also note that, for any  $q(v)$  there exists a constant  $S$  such that

$$\int_0^{\infty} q(v) (F_1(v) - F_2(v)) dv = S \int_0^{\infty} (F_1(v) - F_2(v)) dv \quad \text{where } S \in (0, Q).$$

This means there exist a  $\bar{S} > 0$  such that

$$K + \bar{S} \int_0^{\infty} (F_1(v) - F_2(v)) dv = 0.$$

Therefore, there will be a set of functions  $q_i(\cdot)$  with corresponding  $S_i$ , such that

$$J \equiv \{ q_i(\cdot) \mid 0 < S_i < \bar{S} \}.$$

Thus, given any  $q_i(\cdot)$ :  $q_i(\cdot) \in J \implies LHS_2 - LHS_1 < 0$ . We also have that, given any two  $q_1(v)$  and  $q_2(v)$ : if  $q_1(v)$  is more conservative than  $q_2(v)$  then  $S_1 < S_2$ . This means that, for

any given  $\bar{q}(v)$  such that

$$\int_0^\infty \bar{q}(v) (F_1(v) - F_2(v)) dv = \bar{S} \int_0^\infty (F_1(v) - F_2(v)) dv,$$

every  $q(v)$  more conservative than  $\bar{q}(v)$  is in  $J$  and results in  $LHS_2 - LHS_1 < 0$ . Hence, if  $\frac{dq(v)}{dv} < 0$  and the internal information environment is sufficiently conservative, for any  $\tau$ , the  $LHS$  corresponding to  $f_1(v)$  is above the  $LHS$  for  $f_2(v)$ . As a result, it will intersect the X-axis at a smaller  $\tau$  value. ■

**Derivations of Properties 1 to 5.** Property 1: note that  $f$ , the p.d.f. of  $\tilde{v} \sim \mathcal{N}(0, \sigma^2)$ , is symmetric at  $v = 0$ , i.e.  $f(v) = f(-v)$ , and

$$q(v) = \frac{b}{1 + e^{-av}} = \frac{be^{av}}{1 + e^{av}} = \frac{b(1 + e^{av})}{1 + e^{av}} + \frac{be^{av} - b(1 + e^{av})}{1 + e^{av}} = b - \frac{b}{1 + e^{av}} = 2q(0) - q(-v).$$

Thus,  $Q = q(0) = \frac{b}{2}$ .

Property 2: consider  $q_1(v) = \frac{b_1}{1 + e^{-a_1 v}}$  and  $q_2(v) = \frac{b_2}{1 + e^{-a_2 v}}$  where  $a_1 = a_2 = a$  and  $b_1 > b_2$ , then

$$q_1(v) - q_2(v) = \frac{b_1}{1 + e^{-av}} - \frac{b_2}{1 + e^{-av}} = \frac{b_1 - b_2}{1 + e^{-av}} > 0.$$

Consider  $q_1(v) = \frac{b_1}{1 + e^{-a_1 v}}$  and  $q_2(v) = \frac{b_2}{1 + e^{-a_2 v}}$  where  $a_1 < a_2$  and  $b_1 = b_2 = b$ , then

$$q_1(v) - q_2(v) = \frac{b}{1 + e^{-a_1 v}} - \frac{b}{1 + e^{-a_2 v}} = \frac{b(e^{a_1 v} - e^{a_2 v})}{(1 + e^{a_1 v})(1 + e^{a_2 v})},$$

which means that  $q_1(v) - q_2(v) > 0$  for  $v < 0$  and  $q_1(v) - q_2(v) < 0$  for  $v > 0$ .

Given Properties 1 and 2, Properties 3 to 5 follow directly from Lemmas 2 and 3 and Propositions 2 and 3.

■

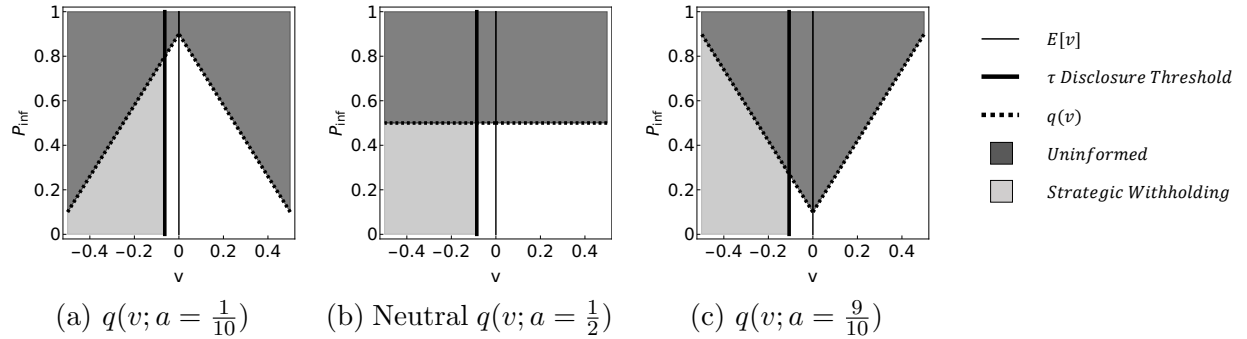
## Appendix B

### Example of a Non-Monotonic $q(v)$

In this section, I present a simple example illustrating a non-monotonic internal information environment. Throughout the paper, I assume the internal information environment is monotonic with respect to  $v$ . While this assumption aligns with numerous applications, there are scenarios in which the internal information environment might not be monotonic. For instance, if managers use variance analysis, the internal information environment might be inclined to relay information about extreme events more frequently than moderate ones. To capture this case, I consider the same setting as in Section 2 but I define  $q(v)$  using the following functional form:

$$q(v; a) = \begin{cases} 2(1 - 2a)v + 1 - a & v < 0 \\ -2(1 - 2a)v + 1 - a & v > 0 \end{cases} \quad \text{where } a \in [0, 1].$$

Figure 8: Graphical illustration of example in Appendix B.



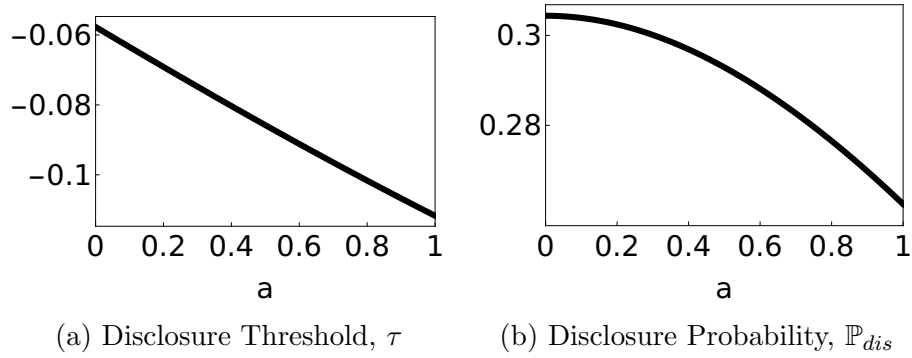
**Note:** Prior beliefs about firm value follow a uniform  $U[-\frac{1}{2}, \frac{1}{2}]$ . The parameter  $a \in [0, 1]$  indicates the relative probability of the internal information environment,  $q(v; a)$ , to provide information about moderate events versus extreme ones. If  $a < \frac{1}{2}$ , the manager is more inclined to be informed about moderate events than extreme ones. Conversely, if  $a > \frac{1}{2}$ , the manager is more likely to be informed about extreme events. When  $a = \frac{1}{2}$ , it corresponds to the scenario in which  $q(v) = \frac{1}{2}$  remains neutral.

In this context,  $a$  represents the propensity of the manager to be informed about extreme events compared to moderate events. By “moderate events,” I am referring to events close

to the mean of  $\tilde{v}$ , while “extreme events” are those that deviate significantly from this mean. When  $a > 1/2$ , the manager tends to receive more information about extreme events. Conversely, if  $a < \frac{1}{2}$ , the manager predominantly gets informed about moderate events. If  $a = \frac{1}{2}$ , it equates to a scenario in which  $q(v; a) = \frac{1}{2}$  for every possible outcome of  $v$ . Note that the ex ante probability of  $q(v; a)$  providing information does not depend on  $a$ . This implies that while we adjust the relative probability of receiving moderate outcomes compared to extreme outcomes, the manager’s initial likelihood of being informed remains unchanged.

As depicted in Figure 9, the threshold for disclosure diminishes as the internal information environment increasingly focuses on extreme events compared to moderate ones. Interestingly, the probability of disclosure also decreases. This indicates that these two metrics of voluntary disclosure, the threshold and the probability of disclosure, which are typically regarded as interchangeable, may not align when the internal information environment depends on  $v$ . This phenomenon is also highlighted and discussed in the main text.

Figure 9: Graphical illustration of example in [Appendix B](#).



**Note:** Prior beliefs about firm value follow a uniform  $U[-\frac{1}{2}, \frac{1}{2}]$ . The parameter  $a \in [0, 1]$  indicates the relative probability of the internal information environment,  $q(v; a)$ , to provide information about moderate events versus extreme ones. If  $a < \frac{1}{2}$ , the manager is more inclined to be informed about moderate events than extreme ones. Conversely, if  $a > \frac{1}{2}$ , the manager is more likely to be informed about extreme events. When  $a = \frac{1}{2}$ , it corresponds to the scenario in which  $q(v; a) = \frac{1}{2}$  remains neutral.

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