Voluntary Disclosures and Analyst Feedback[1]

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Abstract

We study the resource allocation role of voluntary disclosures when feedback from financial markets is potentially useful to managers in undertaking value maximizing actions. Managers weigh the short-term price implications of disclosure against the long-term efficiency gains due to feedback while financial analysts strategically produce information. The model can explain why managers disclose *bad* information (e.g., grim outlook), that *reduces* the stock price, and why prices respond more strongly to bad news relative to good news. We find that not all firms enjoy the same quality of feedback, and that feedback, by itself, does not induce more disclosure but *less*.

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1 Introduction

Credible voluntary disclosures of forward looking information by firms (e.g., of financial conditions, expectations regarding sales growth, competitive position and so forth) are presumably useful to market participants in making their investment decisions. Such disclosures often trigger scrutiny and analysis, and provide the lens through which investors and financial analysts view future actions taken by management. In turn, such disclosures can potentially benefit managers seeking feedback from financial markets. Indeed, there is ample anecdotal evidence suggesting that firms and their boards carefully weigh market reactions to disclosures of proposed project initiatives (e.g., mergers) before entering into long-term commitments.[1]

The notion that firms learn from markets has received considerable attention in the academic literature— that capital market participants "collectively" possess information (via the aggregation of information) not known to the manager (Subrahmanyam and Titman [1999], Dye and Sridhar [2002]); that traders have access to information that managers do not (Dow and Gorton [1997], Goldstein and Guembel [2008]). There is also systematic empirical evidence on the resource allocation role of feedback from financial markets. For instance, Chen et al. [2007] and Bakke and Whited [2008] find that stock prices contain information that managers do not possess, and that managers use this information in their investment decisions, while Luo [2005] shows that managers *listen* to markets, so to speak, i.e., use information from capital market prices in assessing proposed takeovers.

Stock prices impound information from many sources, including financial analysts. The role that analysts play as information agents has received considerable attention in the literature. Market participants listen to analysts and prices move when analysts revise their forecasts (Givoly and Lakonishok [1979], Imhoff and Lobo [1984]).[2] In turn, more

[1] For example Coca-Cola's withdrawal from acquiring Quaker Oats due to a negative market reaction ($15B loss in market cap) to reports on talks between the two (see discussion in Kau, Linck, and Rubin [2004]). Similarly, Lucent stopped merger discussions with Alcatel because investors signaled their displeasure with it (Luo [2005]).

[2] It is important to note that analysts are not the only source of information to capital markets. Indeed, evidence indicates that prices contain information that analysts do not appear to incorporate (Lys and

efficient security prices can lead to more efficient investment decisions by firms (Fishman and Hagerty [1989]).[3] As a result, analysts' expertise and experience make them a valuable source of information for managers as well. For instance, Becher and Jeurgens [2007] provide evidence that analyst recommendations are linked to the outcome of mergers, through managerial actions by the target or acquirer.[4] By the same token, analysts also react to information released by firms and are often guided by management forecasts and disclosures in issuing their own forecasts (Cotter, Tuna and Wysocki [2006], Baik and Jiang [2006]).

In this paper, we examine the equilibrium implications of this two-way flow of information between firms and markets—in particular, analysts—for strategic voluntary disclosure decisions of managers and the quality of the consequent analyst feedback. We analyze an *informed* manager's *strategic* decision of whether to elicit feedback (via disclose of imperfect value-relevant information) when financial analysts strategically produce information. When will a manager disclose what she knows and trigger such a feedback, and when will a manager opt not to do so? When would the feedback from the analyst be more useful in directing the manager's subsequent action? How would the market react to the disclosure? These questions constitute the main focus of our analysis.

To explore the two-way flow of information between firms and markets, we study the voluntary disclosure decisions of managers that trigger information production and value-relevant feedback from financial analysts. In a direct antecedent to this paper, Dye and Sridhar [2002] examine the value of feedback from financial markets and show that capital market prices can indeed direct the manager's actions. In particular, they focus on the manager's equilibrium investment response to the reaction of market prices to the proposed investment.[5] In contrast, our focus is on firms' voluntary disclosures of forward looking in-

Sohn [1990]).

[3] In the model analyzed by Fishman and Hagerty [1989] the firm's transparency level, set by the manager, affects traders' incentives to study the firm and in turn affects the accuracy of the firm's stock price in equilibrium.

[4] Hewlett Packard is known to have dropped the bid for a consulting arm of PricewaterhouseCoopers due to objection from analysts and institutional investors (see discussion in Luo [2005]).

[5] In Dye and Sridhar [2002] the manager *always* makes an investment proposal to the capital markets, since it is never beneficial to forego feedback from the markets. In particular, Dye and Sridhar [2002] show the existence of an equilibrium with feedback where a negative stock price reaction to an announcement of a project need not imply that the project has a negative net-present-value.

formation, markets' interpretation of these disclosures, and the quality of analyst feedback they generate.

Specifically, we consider a model in which firm-value (or terminal payoff) is determined by the firm's value *potential* (i.e., growth in earnings/market-share, business alliances) and the manager's "real" actions (e.g., strategy, investment). While the manager may observe the firm's value potential, she is uncertain regarding the *state-appropiate* action, i.e., the action that would help realize the firm's full value potential for a given state of productivity (e.g., given the state of the economy, technological innovations, trends in the industry). This structure captures the notion that knowledge of firm-specific information alone is not enough for efficient decision making - the manager must also understand the implications of the environment that is external to his organization. Similarly, market participants such as analysts may be adept at analyzing and understanding external factors, but they need firm-specific information to assess a firm's full potential in that environment.

This setting permits a constructive role for a two-way flow of information between the firm and the market in a manner consistent with existing theory and evidence (as discussed above). By voluntarily disclosing the firm's value potential (e.g., Dye [1985]), the manager may trigger useful feedback from the market regarding the state of productivity and, in turn, make better decisions. Presumably, whether the manager would be desirous of market feedback regarding the productivity state would depend on what the manager already knows about the state i.e., the manager's own *ability* or *competence* to predict the state. And, if managers differ in their ability to predict the state, any disclosure not only reveals the value potential but also is suggestive of the manager's competence.[6]

Moreover, the manager will value such feedback *only* if she has a long-term stake in the firm. To this end, we depart from the standard voluntary disclosure models and assume that the manager weighs *both* the "short-term" price (set prior to the action) *and* the "long-term" price (the terminal payoff) in choosing a disclosure policy. This assumption is in keeping with the notion that managers stay with their firms long enough to give them a stake in their current as well as future performance.

With this structure, an interesting trade-off emerges between the short-term and long-

[6] We assume that the manager's predictive ability or competence is soft information, i.e., cannot be credibly communicated to markets.

term managerial incentives that has important implications for whether and what the manager will disclose and the way the market interprets and processes disclosures. In particular, markets rationally anticipate that managers with less predictive ability will be more desirous of feedback and therefore are more likely to disclose their firms' value potentials, all else equal. Thus, while highly favorable (unfavorable) value potential is disclosed (withheld) by all managers regardless of their predictive abilities, disclosures in the intermediate region are likely to come from managers with relatively lower predictive ability. Consequently, disclosures that cause a reduction in the short-term stock price may occur in equilibrium. That is, the model permits characterizations of disclosures as *bad* news and *good* news disclosures through their short-term price impacts, as, in equilibrium, voluntary disclosures might lead to both *lower* and *higher* short-term stock prices relative to the non-disclosure price.[7]

Moreover, since bad news disclosures reveal lower levels of managerial ability (relative to good news disclosures), we show that price responses to bad news and good news disclosures are asymmetric. That is, good news disclosures have less impact on the expected short-term stock price relative to bad news disclosures. This result is consistent with evidence documented in the empirical literature regarding stock price reactions to news disclosures (e.g., Kothari et al. [2008], Skinner [1994]).

While feedback is thought to be beneficial to firms, and is so in our model, it is unclear why some firms would trigger feedback of higher quality relative to others. We address this issue with a simple extension of the model that acknowledges that information production by financial analysts is *costly*. We find that firms that disclose a grim outlook are more likely to be directed by feedback, as financial analysts strategically allocate more resources to information production—financial analysts have a larger role in improving accuracy for firms that disclose bad news. That is, not all firms necessarily enjoy the same quality of feedback.

Finally, a surprising implication of feedback for managers' voluntary disclosure strategy

[7] Alternatively, it has also been suggested that managers may disclose bad news for strategic reasons when bargaining with labor unions (Liberty and Zimmerman [1986]), deterring competition (Darrough and Stoughton [1990]), or reducing the exercise price of the options they are given (Aboody and Kasznik, [2000]). Also, early disclosures of "bad" news can serve as a signal of a high chance of future "good" news (Teoh and Hwang [1991]).

is that it does not induce more disclosure but *less*. Indeed, we devote the last section of the paper to an analysis of voluntary disclosure by a *perfectly* informed manager. We find that even though the manager is perfectly informed, a partial disclosure equilibrium holds where managers of high ability but low value potential, by choosing silence, (credibly) signal their type to financial markets, as forgoing the possibility of feedback is too costly for low-ability managers.[8]

The paper proceeds as follows. Section 2 presents the model. Section 3 derives and characterizes the basic disclosure equilibrium with feedback. In Section 4, we derive the optimal level of feedback when market participants strategically produce information. In Section 5, we examine the case in which the pool of managers comprises only informed managers and show that a full disclosure equilibrium is not stable, but that there exists a partial disclosure equilibrium. In Section 6, we offer a conclusion.

2 Model

The model has two periods. A firm is established at the beginning of the first period (time $t = 0$) and liquidated at the end of the second period (time $t = 2$) with a terminal payoff v. The terminal payoff depends on the firm's *value potential*, represented by its current performance measurement $x \geq 0$ ($x \backsim F \in [0, \infty)$ with density function f), and on its management's *action*, $e \in \{a, b\}$. In particular, the terminal payoff is increasing in the value potential for a given action chosen by management, and is higher when management chooses the "*correct*" action, for a given value potential. Formally,

$$v = x\pi, \tag{1}$$

where $\pi \in \{\pi_\ell, \pi_h\}$, $\pi_h \equiv \pi > \pi_\ell = 0$; when management chooses the correct (incorrect) action, $\pi{=}\pi_h$ ($\pi{=}\pi_\ell$).[9]

To capture the notion of a "correct" versus an "incorrect" managerial action we in-

[8] There also exists a full disclosure equilibrium in this case (Grossman and Hart [1980]; and Dye [1985]). However, this full disclosure equilibrium is not robust to intuitive out-of-equilibrium beliefs (Cho and Kreps [1987]).

[9] The normalization $\pi_\ell = 0$ is done to simplify the exposition, since the qualitative results we obtain rely on the difference $\pi_h - \pi_\ell$ rather than the level of π_ℓ.

troduce the state variable s, where $s \in \{A, B\}$ with equal probabilities. We define the correct, or *state appropriate*, action to be $e = a$ ($e = b$) when the state of the world is $s = A$ ($s = B$).[10] For example, consider a division of a conglomerate, and the manager's decision of whether to further expand the division's operations and develop its products under current management ($e =$ Expand) or spin it off ($e =$ Spin off). Then x represents the value potential of the division conditional on the right action being taken given the state (note that π is just a scalar multiplier).

For analytical convenience, we assume that the terminal payoff is the same across states – $x\pi$ – when the state appropriate action is chosen (i.e., $e = a$ when $s = A$, and $e = b$ when $s = B$). Formally, the value of the firm depends on the value potential x, the state of the world s, and the manager's action e, in the following manner:

$$v(x, s, e) = \begin{cases} x\pi, \text{ if } \langle s, e \rangle \in \{\langle A, a \rangle, \langle B, b \rangle\} \\ 0, \text{ otherwise} \end{cases} \tag{2}$$

2.1 Voluntary Disclosure and Feedback

The true state of the world, s, is unobservable directly to management or market participants, and managers differ in their ability to predict s and therefore determine the state appropriate action. To model this differential predictive ability, the manager of type $\delta \in \left(\frac{1}{2}, 1\right)$ receives a signal $s^m \in \{A, B\}$ regarding the state s with precision, $\delta \sim G\left[\frac{1}{2}, 1\right]$ (with density function g). Managers privately know their type. A perfectly competent manager, of type $\delta = 1$, correctly predicts the correct action, and in general a manager (of type δ) receives signal $s^m \in \{A, B\}$ that predicts the correct action with probability δ. Since both actions are equally efficient ex-ante, the lowest probability of predicting the efficient action is $\delta = \frac{1}{2}$.

$$P(s = s^m | \delta, s^m) = \delta, \text{ for } s^m \in \{A, B\}. \tag{3}$$

We distinguish between *soft* and *hard* information as in Langberg and Sivaramakrishnan [2008]. Namely, while the manager cannot credibly disclose the information δ (*soft*

[10] That is, there is no ex-ante preferred action, as any action chosen has equal probability of turning out to be efficient.

information), she privately observes firm's value potential x (*hard* information) with probability $\lambda \in (0,1)$ and can credibly disclose it.[11] Intuitively, disclosing x is like disclosing firm value conditional on managers taking the appropriate action (because π is common knowledge). However, management's subjective assessments of which business/marketing strategy is likely to succeed is more difficult to credibly convey.

The manager's noisy estimate s^m of the true state s introduces a role for feedback from financial markets. To this end, we allow markets to generate information about the *true* state s, in particular, through the information production role of financial analysts. Disclosures by firms are news events that trigger information production and analysis by financial analysts. Specifically, following the voluntary disclosure of x, managers observe a *public* signal or *feedback*, $s^a \in \{A, B, NA\}$, regarding the true state s, with quality $\gamma \in (0,1)$:

$$s^a(s) = \begin{cases} s, \text{ w.p. } \gamma \\ NA, \text{ w.p. } 1-\gamma \end{cases}, \; s \in \{A, B\}. \tag{4}$$

The quality of feedback, γ, represents the probability that the public signal is informative and the manager is guided by analysts to take the state appropriate action. With probability $1-\gamma$, however, the public signal s^a is uninformative and is useless to the manager. Further, we assume that there is no feedback in the absence of disclosure. Intuitively, information provided by the firm helps analysts understand better the firm's operations and any desired actions that management can take to increase firm value.[12]

Initially, in Section 3, we analyze the voluntary disclosure equilibrium when the quality of feedback, γ, is fixed. However, since information acquisition, processing and analysis is costly, we extend our analysis in Section 4 and explore the endogenous quality of feedback as determined by a strategic analyst in equilibrium.

[11] We consider also the special case of a perfectly informed manager $\lambda = 1$ and obtain, for this case also, the *partial* disclosure equilibrium with feedback, in Section 5.

[12] It suffices to assume that absent disclosure by the manager it is more difficult for the analyst to learn about the strategy that the manager should follow in order to increase firm value. We further discuss this assumption in Section 6.

2.2 Prices and Manager's Preferences

Shares of the firm are dynamically traded over time in public security markets. In particular, shares are traded at price P_1 at time $t = 1$ after the manager discloses (or not) his private information x. A standard assumption in the voluntary disclosure literature is that managers maximize expected firm price following their voluntary disclosure. In these models, there are no future production decisions to consider, and therefore they do not fully address the voluntary disclosure incentives when markets provide feedback that can be useful to managers in undertaking value maximizing actions.

Our motivation here is to incorporate the aforementioned feedback and information production role of financial markets in identifying the state-appropriate action. For such a role to arise in equilibrium, managers must also care about firm value in the long-run, after the real action, e, has been chosen. To this end, we consider trade taking place after the terminal payoff is realized, time $t = 2$, at price P_2. We assume that managers, in choosing their voluntary disclosure strategy, weight both short-term and long-term prices, with the parameter $\beta \in [\underline{\beta}, \bar{\beta}] \subset (0, 1)$ representing the degree to which the manager is concerned with short-term prices (i.e., is myopic).[13] In other words, the objective function that dictates the disclosure strategy choice is

$$U_M(P_1, P_2) = \beta P_1 + (1 - \beta)P_2. \tag{5}$$

The sequence of events in the two-period model is as follows:

1. Manager of type δ learns x with probability λ.
2. Manager (informed) discloses x or not.
3. Analyst produces public signal s^a.
4. Short-term trade takes place at price P_1.
5. Manager chooses action e.
6. Terminal payoff is realized and long-term trade takes place at price P_2.

[13] For example, current shareholders might care about both short- and long-term prices since they might have to sell their shares early for liquidity reasons, or alternatively the manager might be compensated based on short- and long-term performance. We further discuss this assumption in Section 6.

3 Disclosure Equilibrium with Feedback

A disclosure equilibrium consists of the disclosure strategy (as a function of $\langle x, \delta \rangle$), action e (as a function of $\langle \delta, s^m, s^a \rangle$), and the prices set by markets (as a function of the manager's disclosure strategy and analysts' signal). Starting from time $t = 2$, after the terminal payoff $v(x, e, s)$ is realized (cf. (2)), it is straight forward that markets will price firms accurately, i.e.,

$$P_2 = v(x, e, s), \text{ according to (2).} \tag{6}$$

Next, we note that the manager of type δ will choose his action based on his information $\langle s^m, s^a \rangle$ to maximize expected firm value. In particular,

$$e^* = \arg \max_{e \in \{a,b\}} E(v|s^m, s^a). \tag{7}$$

If disclosure occurs and the analyst's signal is informative, i.e., $s^a \in \{A, B\}$, then firm value is maximized for $e^* = s^a$. Alternatively, the best response of manager of type δ is to choose $e = s^m$ (which is the efficient action with probability δ). To summarize, the manager's best response strategy is,

$$e^* = \begin{cases} s^a, & \text{if } s^a \in \{A, B\} \\ s^m, & \text{if } s^a \in NA \end{cases}. \tag{8}$$

Thus, when an informed manager (in possession of information about x) gets perfect state information, i.e., when $s^a \in \{A, B\}$, the manager's action is efficient, and the long-term price (i.e., second period/terminal payoff) is πx (regardless of his type). On the other hand, when the informed manager of type δ does not have perfect state information because the signal generated by the analyst is uninformative, i.e., $s^a = NA$, the consequent expected long-term price is $\pi x \delta$ – with probability δ the manager's action is efficient leading to value πx. Finally, the expected long-term price for the average uninformed manager is $\pi E(x)E(\delta)$.

These (expected) long-term prices determine the manager's voluntary disclosure strategy. To better understand the manager's intertemporal considerations, let $P(ND)$ represent the short-term (i.e., first period) non-disclosure price , and let $P(x)$ represent the short-term price following disclosure of x and signal $s^a \in NA$. Moreover, the short-term price following disclosure of x and signal $s^a \in \{A, B\}$ is trivially $x\pi$, as it is known to markets that the manager with value potential x will choose the correct action once the state of the world is known (see (8)).

The informed manager's expected utility will assume the following value given a disclosure of x (where D stands for disclosure):

$$\begin{aligned} E\left(U_M|\left\langle x,\delta\right\rangle,D\right) &= \beta\left[(1-\gamma)P(x)+\gamma x\pi\right]+(1-\beta)x\left[(1-\gamma)\pi\delta+\gamma\pi\right] \\ &= (1-\gamma)\left[\beta P(x)+(1-\beta)x\pi\delta\right]+\gamma x\pi. \end{aligned}$$

Now, the expected utility following non-disclosure of a manager of type δ and information x is,

$$E\left(U_M|\left\langle x,\delta\right\rangle,ND\right)=\beta P(ND)+(1-\beta)x\pi\delta \tag{9}$$

Lemma 1: *Voluntary disclosure increases (expected) long-term prices, for any firm* $\langle x, \delta\rangle$.

Specifically, there is *always* a long-term benefit from disclosure due to the efficiency gain that follows feedback. The less the manager is able to predict the correct action, i.e., the lower is δ, the higher the advantage of disclosure (for a given value potential x), because disclosure enables the manager to learn the true state through feedback from the public signal generated by the analyst. As long as managers are not completely competent in predicting the efficient action (i.e., $\delta < 1$), the expected firm output or long-term price is strictly lower following non-disclosure relative to disclosure. Formally, for any firm $\langle x, \delta\rangle$ with $\delta < 1$:

$$(1-\beta)x\left[(1-\gamma)\pi\delta+\gamma\pi\right]>(1-\beta)x\pi\delta \text{ (\textit{long-term} benefit from disclosure).} \tag{10}$$

Comparing the two alternatives of the informed manager $\langle x, \delta\rangle$ it follows that disclosure is optimal if and only if,

$$P(x)+\frac{\gamma}{\beta}\left[x\pi-\left(\beta P(x)+\left(1-\beta\right)x\pi\delta\right)\right]>P(ND). \tag{11}$$

A manager would be indifferent between disclosure and non-disclosure (i.e., if (11) holds with equality) only if the long-term benefit is balanced by lower short-term prices following disclosure. Therefore, (11) suggests that firms may jeopardize short-term prices for long-term efficiency. Indeed, in equilibrium, voluntary disclosures may lead to both higher and lower short-term prices relative to what can be achieved by non-disclosure, as we demonstrate below.

Condition (11) also highlights the role of the quality of feedback from financial markets, captured by γ, and the manager's intertemporal preferences, captured by β, in shaping the manager's voluntary disclosure strategy in equilibrium. To further clarify these issues, before proceeding with the equilibrium analysis we study the benchmark cases of a strictly myopic manager (i.e., $\beta = 1$), a manager that values long-term performance only (i.e., $\beta = 0$), and when there is no feedback from financial markets (i.e., $\gamma = 0$).

3.1 Important Benchmark Outcomes

When the manager is myopic and cares about short-term prices only (the case $\beta = 1$), his optimal disclosure strategy is *independent* of his ability to predict the state of the world, as measured by δ. To be sure, myopic managers would certainly benefit from feedback as it ensures *long-term* efficiency and increases the *short-term* price of the firm (set by forward looking market participants that incorporate this future efficiency gain in short-term prices). However, the manager's ability to predict the true state, δ, has only long-term implications, and myopic managers will not trade-off a short-term price reduction to benefit in the long-term. Therefore, δ does not alter the optimal disclosure strategy of a myopic manager. In particular, disclosure of x is optimal for the manager if and only if

$$(1-\gamma)P(x) + \gamma x\pi > P(ND) \text{ (\textit{benchmark}: } \beta = 1). \tag{12}$$

This benchmark equilibrium, in which the disclosure strategy is dictated by a myopic manager, is reminiscent of the cutoff voluntary disclosure equilibrium offered in Dye [1985].

On the other hand, when management maximizes long-term value (the case $\beta = 0$), only full disclosure will emerge in any equilibrium because of the strictly positive long-term benefit, and no off-setting short term cost. In particular, with $\beta = 0$, (10) yields (13) which always holds,

$$(1-\gamma)\pi\delta + \gamma\pi \geq \delta\pi \text{ (\textit{benchmark}: } \beta = 0). \tag{13}$$

Finally, when there is no feedback, i.e., no information production by the analyst, the model at hand coincides again with Dye [1985]. In particular, disclosure is optimal for manager $\langle x, \delta \rangle$ if and only if

$$P(x) > P(ND) \text{ } (\textit{benchmark}\text{: } \gamma = 0). \tag{14}$$

3.2 Disclosure Equilibrium

More generally, when the manager has a stake in both short- and long-term performance, feedback from financial analysts leads to a partial disclosure equilibrium that is starkly different from the benchmark cases mentioned above (cf. (12), (13), and (14)). Namely, as we demonstrate shortly, the manager's equilibrium disclosure strategy depends on his private information on the firm's value potential, x, and his ability to predict the state-appropriate action, δ.

Lemma 2: *In any disclosure equilibrium, for any given* $\gamma \in (0, 1)$*, managers with higher levels of state uncertainty (i.e., low* δ*) are more likely to disclose information (*x*). That is, for every* $x \geq 0$ *there exists a threshold* $\delta_x \in [\frac{1}{2}, 1]$*, such that firm* $\langle x, \delta \rangle$ *will disclose* x *if and only if* $\delta \in [\frac{1}{2}, \delta_x]$*.*

Intuitively, the benefit from disclosing x is that it triggers feedback with probability γ. As we know from Lemma 1, disclosure yields a long-term benefit that is strictly decreasing in δ; the lower is the manager's ability to predict the true state, the greater is the benefit from disclosure. Consequently, the proof of Lemma 2 establishes that for a given value potential x, if a manager of type δ finds it optimal to disclose x, then any manager with type $\delta' \leq \delta$ will also find it beneficial to disclose x. In other words, any partial disclosure region in equilibrium will be lower-tailed.

Lemma 2 allows us to characterize a firm's disclosure policy using the disclosure thresholds $\{\delta_x\}_{x \geq 0}$. It is useful to define three possible disclosure regions:

- A non-disclosure region, ND, consisting of all x for which the manager *never* discloses regardless of the value of δ. That is, $ND = \{x \geq 0 : \delta_x = \frac{1}{2}\}$.
- A full disclosure region, D, consisting of all x for which the manager *always* discloses regardless of the value of δ. That is, $D = \{x \geq 0 : \delta_x = 1\}$.

- A partial disclosure region, PD, for which the manager discloses only when $\delta \in \left(\frac{1}{2}, \delta_x\right)$. That is, $PD = \{x \geq 0 : \delta_x \in (\frac{1}{2}, 1)\}$.

We now define a disclosure equilibrium and show its existence. We are most interested in showing the existence of an equilibrium in which the manager's voluntary disclosure strategy depends on the firm's value potential x and the manager's type δ. To this end, we require an assumption which insures that changes in conditional expectations of δ are sufficiently smooth, and that the probability of feedback from the analyst, γ, is sufficiently material. Assumption A1 below ensures that this is in fact the case (recall that $\beta < 1$).

Assumption A1 $\frac{\partial E(\delta|\delta<z)}{\partial z} < \frac{\gamma}{1-\gamma}\frac{1-\beta}{\beta}$ for $z \in (\frac{1}{2}, 1)$.

This assumption is satisfied for a wide range of parameters and a wide family of distributions. For example, for $\gamma > \beta$ this assumption requires that $\frac{\partial E(\delta|\delta<z)}{\partial z} < 1$, a reasonable requirement that is satisfied by IFR distribution (see Dye [1986] for a similar assumption).

Proposition 1 ***[Disclosure Equilibrium with Feedback]:*** *Given assumption A1, there exists a voluntary disclosure equilibrium consisting of a set of thresholds* $\{\delta_x\}_{x\geq 0}$*, and a set of interim prices* $P(ND)$ *and* $\{P(x)\}_{x\geq 0}$ *such that:*

I. If the manager of type δ *learns* x*, then she discloses* x *only if* $\delta \in \left(\frac{1}{2}, \delta_x\right)$*, where*

$$\delta_x = \begin{cases} 1, & if \quad P(ND) < \gamma x\pi + (1-\gamma)P(x) \\ \frac{1}{2}, & if \quad P(ND) > \gamma x\pi\left(\frac{1+\beta}{2\beta}\right) + (1-\gamma)P(x) \\ \frac{\gamma\pi + \frac{\beta}{x}[(1-\gamma)P(x) - P(ND)]}{\gamma\pi(1-\beta)} & if \quad otherwise. \end{cases} \tag{15}$$

II. The market rationally sets interim prices $P(ND)$ *and* $P(x)$ *as*

$$P(ND) = \psi\left[(1-\lambda)E(x)E(\delta) + \lambda\int_0^\infty xf(x)\left(\int_{\delta=\delta_x}^1 \delta g(\delta)d\delta\right)dx\right] \tag{16}$$

where, $\psi \equiv \dfrac{\pi}{1-\lambda+\lambda\int_0^\infty [1-G(\delta_x)]\,f(x)dx}$.

$$P(x) = \begin{cases} x\pi E\left(\delta|\delta \in \left(\frac{1}{2}, \delta_x\right)\right) \ \ for\ \delta_x \in (\frac{1}{2}, 1] \\ x\frac{\pi}{2}\ for\ \delta_x = \frac{1}{2}. \end{cases} \tag{17}$$

Proposition 1 establishes the equilibrium disclosure strategy of the manager, and the equilibrium market prices $P(ND)$ and $\{P(x)\}_{x\geq 0}$. We provide an intuitive sketch of the proof next (a detailed proof is in the appendix).

To begin with, Lemma 2 allows us to specify the disclosure threshold levels $\{\delta_x\}_{x\geq 0}$, as in (15). The interim price of the firm, $P(ND)$, conditional on *non disclosure*, is given by (16), and the interim price of the firm, $P(x)$, conditional on the event of *disclosure of* x is given by (17).

We next establish a threshold function $\{\Delta_x(P(ND))\}_{x\geq 0}$, which yields disclosure thresholds $\delta_x = \Delta_x(P(ND))$ for *any* given non-disclosure price $P(ND)$. We show that this function $\Delta_x(P(ND))$ is unique, and continuous for any given $x \geq 0$. Consequently, for any given non-disclosure price, $P(ND)$, there exist three unique disclosure regions given by:

- $ND = \{x \geq 0 : \Delta_x(P(ND)) = \frac{1}{2}\}$.
- $D = \{x \geq 0 : \Delta_x(P(ND)) = 1\}$.
- $PD = \{x \geq 0 : \Delta_x(P(ND)) \in (\frac{1}{2}, 1)\}$.

Finally, because the price $P(ND)$ is determined by (16) in equilibrium, we show that there exists a solution $P(ND)$ satisfying (16) where the threshold δ_x is given by the function $\Delta_x(P(ND))$. That is, there exists a solution P^* to $\Theta(P) = 0$, where,

$$
\begin{aligned}
\Theta(P) &= \psi(P)\left(\lambda\int_0^\infty x\left(\int_{\Delta_x(P)}^1 \delta g(\delta)d\delta\right)f(x)dx + (1-\lambda)\,E(x)E(\delta)\right) - P \\
\psi(P) &\equiv \frac{\pi}{1-\lambda+\lambda\int_0^\infty f(x)(1-G(\Delta_x(P)))dx}.
\end{aligned}
$$

We next characterize the nature of the various disclosure regions in equilibrium and show that each of the three mutually exclusive disclosure regions are non-empty in equilibrium.

Corollary 1 *In the disclosure equilibrium of Proposition 1, the non-disclosure set ND is not empty. In particular, disclosure will not take place (i.e., $\delta_x = \frac{1}{2}$) if and only if $x \leq \underline{x}$ where*

$$\underline{x} = \frac{P(ND)}{\left(1+\frac{\gamma}{\beta}\right)\frac{\pi}{2}}.$$

Notice that according to Corollary 1, even managers of type $\delta = \frac{1}{2}$ will choose non-disclosure if x is sufficiently low. Intuitively, for firms with low value potential the short term cost of disclosure out-weights the long-term efficiency gain from feedback (which is itself proportional to the firm's value potential). Moreover, the higher the likelihood of feedback, γ, (and the less myopic is the manager) the more reluctant would the manager be to forgo disclosure, i.e., the lower $\underline{x}$, for a given non-disclosure price, $P(ND)$. Clearly, the non-disclosure price is also affected in equilibrium by these considerations. Next, we examine whether there would exist a region of x in which the firm *always* discloses (i.e., $\delta_x = 1$).

Corollary 2 *In the disclosure equilibrium of Proposition 1, the full disclosure set D is not empty. In particular, there exists a finite $\overline{x}$ such that disclosure occurs regardless of the value of δ if and only if $x \geq \overline{x}$ (i.e., $\delta_x = 1$), where*

$$\bar{x} = \frac{P(ND)}{[(1-\gamma)E(\delta) + \gamma]\,\pi}.$$

Corollary 2 confirms the intuition that for sufficiently favorable news, x, managers of all types (i.e., all δ) will find it beneficial to voluntary disclosure their information. Given Corollaries 1 and 2, we can now identify an intermediate region. In this partial disclosure region, disclosure occurs only if $\delta \in (\frac{1}{2}, \delta_x]$ for $\delta_x \in (\frac{1}{2}, 1)$.

Corollary 3 *In the disclosure equilibrium of Proposition 1, the partial disclosure set $PD = (\underline{x}, \overline{x})$ is not empty.*

The above intuition provided for the full disclosure of sufficiently favorable outcomes and the non-disclosure of sufficiently unfavorable outcomes extends to the partial disclosure region as well. Namely, there is a higher tendency to disclose, the higher is the firm's value potential x. That is, there exists a (monotonic) relation between the threshold uncertainty level δ_x and the information x.

Corollary 4 *If $x_1 > x_2$, then $\delta_{x_1} \geq \delta_{x_2}$. Moreover, if $x_1 \in PD$ or $x_2 \in PD$, and $x_1 > x_2$, then $\delta_{x_1} > \delta_{x_2}$.*

To see the intuition behind Corollary 4, consider any value potential x in the partial disclosure region, and the corresponding threshold firm $\langle x, \delta_x \rangle$. By definition, this firm is indifferent between disclosing and not disclosing because the long-term benefit from disclosing exactly offsets the expected short-term price reduction following disclosure. Consider now a firm with a marginally higher value potential $x + \Delta x$, $\Delta x > 0$. All else equal, this firm will enjoy a marginally higher expected short-term price following disclosure, and therefore can afford to disclose the value potential even if its ability to predict the true state is slightly higher (i.e., its type δ is higher), or the benefit from the feedback effect is slightly lower. In other words, the threshold level δ_x increases with x and the disclosure region expands. Figure 1 depicts the voluntary disclosure equilibrium with feedback and its properties, as summarized by the above discussion.

(Insert Figure 1 here)

3.3 Stock Price Response to Voluntary Disclosure

It follows from Proposition 1 and Corollary 4 that for intermediate value potential values, managers of higher competence forgo disclosure in order to maintain a higher short-term stock price, at the expense of long-term efficiency. Thus, an important implication of the equilibrium identified in Proposition 1 is the notion that "*no news is good news*." That is, in the partial disclosure region, disclosing firms will (on average) face a lower short-term price following disclosure than they would have had they not disclosed. To see why, note that managers trade off the long-term efficiency gains from feedback with the short-term price implications of disclosure. If, for a given x, the expected short-term price following disclosure is higher than the non-disclosure price, then all manager types would disclose. But, if only the managers with lower predictive ability choose to disclose, then, there must be a cost associated with disclosure in this region that deters disclosure by managers with higher predictive ability; in particular, the impact of disclosure on short-term price imposes a cost on managers. For the disclosing firms, this cost is more than offset by the expected efficiency gain from feedback. This intuition is formalized in the following proposition.

Proposition 2 ***[Bad News Disclosures]:*** *Voluntary disclosures in the partial disclosure region $x \in PD$ (i.e., $\underline{x} < x < \overline{x}$) are viewed as bad news by the market because they result in lower expected short-term stock prices relative to the non-disclosure short-term price (i.e., are* ***bad news disclosures****). Formally, $E[P_1|D, x] < P(ND)$ for $x \in PD = (\underline{x}, \overline{x})$.*

On the other hand, if all manager types, i.e., all δ's, choose to disclose in equilibrium (as in the full disclosure region), then, there must be no cost associated with disclosure in this region, in particular, the expected short-term price following disclosure should exceed the alternative non-disclosure price. To see this, consider the perfectly competent manager (with $\delta = 1$) that realizes no long-term efficiency gain from disclosure. But, for disclosure to be optimal for the perfectly competent manager, she must realize a short-term price gain by disclosing. Thus, the short-term price reaction to voluntary disclosures in the full disclosure region is favorable and is substantially different from that addressed in Proposition 2.

Proposition 3 ***[Good News Disclosures]:*** *Voluntary disclosures in the full disclosure region $x \in D$ (i.e., $x > \overline{x}$) are viewed as good news by the market because they result in higher expected short-term stock prices relative to the non-disclosure short-term stock price (i.e., are* ***good news disclosures****). Formally, $E(P_1|D, x) > P(ND)$ for $x \in D$.*

Propositions 2 and 3 highlight the different motives behind voluntary disclosure. Namely, in the partial disclosure region, managers voluntary disclose information despite the opportunity cost associated with the low short-term stock price, while in the full disclosure region, disclosure achieves a higher short-term stock price. Nevertheless, all disclosing managers benefit from feedback. Moreover, and unlike short-term prices, for any firm $\langle x, \delta \rangle$, the expected long-term price following disclosure is higher relative to the expected long-term price following non-disclosure (cf. Lemma 1).

We turn now to the equilibrium short-term price reaction to voluntary disclosures. We first note that short-term prices are increasing in the disclosure content. In particular, and according to Corollary 4, more competent managers (on average) disclose higher outcomes, x. As a result, disclosure of more favorable news indicates a higher value potential (i.e., higher x), but also higher managerial ability to predict the state-appropriate action, absent of feedback (i.e., higher $E(\delta|\delta < \delta_x)$). Therefore, the expected short-term stock price is increasing in x. This, natural, positive reaction to news, however, is not symmetric. Since, news about the firm's value potential x contains information also about the manager's type, market's short-term pricing schedule incorporates both informational components of the manager's disclosure decision. As a result, one should not (ex-ante) expect equal marginal reactions to news across the domain of outcomes.

In keeping with Propositions 2 and 3 consider the reference value potential $\bar{x}$, at which the expected short-term price, $E[P_1|D,\bar{x}] = \pi\bar{x}\left[(1-\gamma)E(\delta)+\gamma\right]$, equals the non-disclosure price, $P(ND)$ (cf. Corollary 2). In equilibrium, good news disclosures (i.e., $x > \bar{x}$) have less impact on the expected short-term stock price relative to comparatively bad news disclosures (i.e., $x < \bar{x}$) . Intuitively, bad news disclosures also reveal lower levels of managerial ability, i.e., further depressing the short-term stock price. However, this is not the case in the full-disclosure region, where *all* manager types disclose. Formally, the same percentage change in the value of the outcome, x, around the reference value $\bar{x}$ would lead to a stronger price response for a negative change (i.e., bad news) relative to a positive change (i.e., good news).

Proposition 4 ***[Asymmetric Price Responses to Disclosures]:*** *The expected short-term price following disclosure is increasing in the disclosure content x, for $x \in PD \cup D$. Moreover, the short-term price response to bad news disclosures is stronger, relative to good news disclosures (in the sense of Propositions 2 and 3). Formally, $E(P_1|D,\bar{x}+\rho) - E(P_1|D,\bar{x}) < E(P_1|D,\bar{x}) - E(P_1|D,\bar{x}-\rho)$.*

Figure 2 depicts the short-term price responses to voluntary disclosures, as summarized by the above discussion.

(Insert Figure 2 here)

4 Endogenous Feedback and Strategic Information Production

In this section, we focus on the feedback aspect of the model. So far, we have assumed that upon disclosure of the value potential x, financial analysts add value through the discovery of the underlying state variable with probability γ. As a result, managers are able to appropriate state-contingent actions and maximize firm value. However, we did not model the process by which, say, analysts gain access to the state information. We are assuming of course that financial analysts have access to multiple information sources and can inform both markets and managers with their information gathering and processing expertise. But financial analysts are rational economic agents as well and their actions have to be interpreted in the context of their incentives. In this section, we model a strategic analyst's decision with respect to the level of scrutiny following a disclosure of x, and its implications for the disclosure equilibrium.

In modeling the strategic analyst, we assume that analysts care about the accuracy of their forecasts, or, equivalently, about the level of uncertainty about the firm prospects, while taking into account their costs of conducting analysis (see, for example, Mikhail et al. [1999]).[14] The more accurate is the analyst's signal, the more informative will be the share price at date 1, and the less volatile is the firm's share price between date 1 and date 2. In particular, let r_x be the gross return on the stock of firm $\langle x, \delta \rangle$ between date 1 and date 2, following disclosure of x (r_x is discussed further below):

$$r_x = \frac{P_2}{P_1}.$$

Increasing the accuracy of the analyst's signal, however, requires greater (costly) effort on the part of the analyst. In particular, the information gathering effort as reflected in the state discovery probability, $\gamma \in \left(\underline{\gamma}, \bar{\gamma}\right)$, imposes a cost on the analyst $c(\gamma)$, with $c(\underline{\gamma}) = 0$, $c'(\underline{\gamma}) = 0$, $c''(\gamma) > 0$, and $c'(\bar{\gamma}) = \infty$.[15] In choosing the information gathering effort, the analyst will balance the accuracy improvement from state discovery against the cost of information acquisition and analysis. As in Langberg and Sivaramakrishnan [2008], we model the analyst's utility, $U_A(x, \gamma)$, following disclosure of x and the level of information gathering effort,γ, as

$$U_A(x, \gamma) = -Var(r_x | Disclosure\ of\ x,\, \gamma) - c(\gamma). \tag{18}$$

We now derive the distribution of the return r_x. Consider firm $\langle x, \delta \rangle$ that discloses x. Then, with probability γ the analyst's signal is accurate, and the manager consequently

[14] It has been suggested in the literature that analysts often bias their forecasts or recommendation for reasons that may or may not be related to the objective of improving accuracy e.g., (Lin and McNichols [1998], Dugar and Nathan [1995], Francis and Philbrick [1993], Das, Levine, and Sivaramakrishnan [1998], Lim [2001]). We discuss the consequent implications for our analysis after we present the main results of this section.

[15] In setting the interval $\gamma \in \left(\underline{\gamma}, \bar{\gamma}\right)$ we maintain assumption A1. That is, $\frac{\partial E(\delta | \delta < z)}{\partial z} < \frac{\underline{\gamma}}{1-\underline{\gamma}} \frac{1-\beta}{\beta}$ for $z \in (0, 1)$.

chooses the state appropriate action, and both the short-term and long-term prices equal the value of the firm $x\pi$. In this case, the gross return on the firm's stock is $r_x = \frac{P_2}{P_1} = 1$.

With probability $1-\gamma$, however, the analyst's signal is not informative, and the short-term price is given by $P(x) = \pi x E(\delta|\delta < \delta_x)$ — where, as before, $\delta_x \in [\frac{1}{2}, 1]$ is the threshold level of δ below which the management discloses x. In this case, the distributions of the long-term price P_2, and return r_x are derived from the conditional distributions given δ:

With probability $1-\gamma$,

$$P_2|_\delta = \begin{cases} x\pi, & w.p. \quad \delta \\ 0, & w.p. \quad 1-\delta \end{cases}, \text{ and}$$

$$r_x|_\delta = \begin{cases} \frac{1}{E(\delta|\delta<\delta_x)}, & w.p. \quad \delta \\ 0, & w.p. \quad 1-\delta \end{cases}, \text{ for } \delta < \delta_x.$$

Following disclosure of x, the analyst's best response choice, γ_x, to the manager's (cutoff) strategy of disclosing x when $\delta < \delta_x$ (for some $\delta_x \in (\frac{1}{2}, 1]$) is given by:

$$\gamma_x \in \arg \max_{\gamma \in (\underline{\gamma}, \bar{\gamma})} U_A(x, \gamma) = \arg \min_{\gamma \in (\underline{\gamma}, \bar{\gamma})} Var(r_x | x, \delta < \delta_x, \gamma) + c(\gamma). \tag{19}$$

With this structure, we proceed as in Proposition 1 to show the existence of a partial disclosure equilibrium with a strategic analyst and to derive the endogenous levels of feedback.

Proposition 5 ***[Disclosure Equilibrium with Strategic Information Production]:*** *Given assumption A1, there exists a voluntary disclosure equilibrium consisting of a set of thresholds $\{\delta_x\}_{x\geq 0}$, a set of prices $P(ND)$ and $\{P(x)\}_{x\geq 0}$, and the analyst's choice of the probability of state discovery $\{\gamma_x\}_{x\geq 0}$ such that:*
I. *If the manager of type δ learns x, then she discloses x only if $\delta \in \left(\frac{1}{2}, \delta_x\right)$, where δ_x is given by (15) with γ replaced by γ_x.*
II. *The market rationally sets interim prices $P(ND)$ as in (16) and $P(x)$ as in (17).*
III. *Disclosure of x induces feedback of quality γ_x as:*

$$\gamma_x = \begin{cases} c'^{-1}\left(\frac{1}{E(\delta|\delta<\delta_x)} - 1\right) \text{ for } \delta_x \in (1/2, 1] \\ c'^{-1}(1) \text{ for } \delta_x = 1/2. \end{cases} \tag{20}$$

Proving the existence of the equilibrium *with* a strategic analyst requires one additional step compared to proving its existence without the strategic analyst (Proposition 1). This step involves showing the existence of the analyst's response function that yields the equilibrium probability of state discovery as in (20), and is presented in the appendix; the rest of the proof is materially the same.

The disclosure equilibrium with a strategic analyst shares many of the same characteristics as the equilibrium identified in Proposition 1. In particular, Corollaries 1, 2, 3 apply under analogous conditions – the equilibrium non-disclosure, partial disclosure, and full disclosure regions are all non-empty. It is interesting to characterize *how* the analyst responds to the equilibrium disclosures, i.e., when the analyst would choose to engage in more information gathering effort and when not. The following corollary provides an important insight in this respect.

Corollary 5 *Consider any two values of disclosed information x_1, x_2 such that $x_1 \neq x_2$. If, in equilibrium, $\delta_{x_1} < (=)\ \delta_{x_2}$, then it must be that $\gamma_{x_1} > (=)\ \gamma_{x_2}$.*

Intuitively, a lower value of δ is indicative of a higher level of uncertainty regarding the state. Therefore, when the threshold level is *lower* ($\delta_{x_1} < \delta_{x_2}$), the average level of uncertainty is *higher* with any disclosure ($E[\delta|\delta \leq \delta_{x_1}] < E[\delta|\delta \leq \delta_{x_2}]$). Therefore, Corollary 5 implies that the larger is the state uncertainty associated with a disclosure, the greater is the effort expended by the analyst to discover the state, and the higher is the probability of receiving feedback following disclosure. This is because the analyst stands to gain more from the consequent improvement in accuracy (cf. (19)). In other words, there is more feedback whenever the demand for feedback is greater.

Now, according to Corollary 4 (which also applies to the disclosure equilibrium with a strategic analyst (cf. proof of Proposition 6)), managers with a *higher* value potential (higher x) are more willing to disclose this information. That is, the disclosure threshold δ_x is increasing in the value potential x. Consequently, it appears reasonable to expect that the analyst can contribute a lot more to minimizing return variance by choosing higher levels of information gathering effort when the firm discloses bad information (i.e., for lower values of x). Accordingly, the analyst strategically exerts more information gathering effort when she sees a lower value x being disclosed. This intuition underlies the following proposition.

Proposition 6 ***[Endogenous Feedback]:*** *In equilibrium, disclosures of bad news trigger more information production by analysts and lead to higher probabilities of feedback, relative to disclosures of good news. Formally, if $x_1 > x_2$, then $\gamma_{x_1} \leq \gamma_{x_2}$. Moreover, if $x_1 \in PD$ or $x_2 \in PD$, and $x_1 > x_2$, then $\gamma_{x_1} < \gamma_{x_2}$.*

4.1 Biased Analysts

Thus far, we have assumed that analysts are unbiased. With some probability the analyst learns the true state and announces it publicly. As we have seen above, the strategic analyst in our model trades off the benefits of accuracy and the cost of information production. The literature, however, points to strategic biases (e.g., optimism) in analysts' forecasts (O'Brien [1988]). It has been suggested that analysts have an incentive to inflate their recommendations or forecasts in order to (1) increase trade commissions to their employers (Jackson [2005]) and draw investment banking deals (Lin and McNichols [1998], Dugar and Nathan [1995]), and (2) obtain inside information from the firms they cover and improve their long-run forecast accuracy (Francis and Philbrick [1993], Das, Levine, and Sivaramakrishnan [1998]; Lim [2001]). Others have argued that analysts deliberately drop bad news firms and forecast only selectively for firms with relatively good prospects, leading to observed forecast optimism (McNichols and O'Brien [1997]). Since there is considerable evidence that suggest a possible bias in analysts' forecasts or recommendations, it is of interest to explore how it might affect the perceived quality of feedback that managers receive from analysts and consequently the voluntary disclosure equilibrium.

One way to incorporate the bias into our setting—without delving into its sources—is by assuming that analysts are biased in favor of one state over another (say, state A). That is, the analyst will reveal signal A when they identify the true state to be A, but will falsify the true state B by announcing signal A (i.e., falsify signal B) with some probability. The extent of this signal distortion or falsification captures the extent of the bias. Clearly, the current model corresponds to there being no distortion. At the other extreme, if the analyst always falsifies state B as state A, then managers will disregard the analyst's reported signal in their decision making process as it is not informative.

When facing a biased analyst, managers with greater ability to predict the state (i.e., high δ) will naturally put less weight on the analyst's reported signal. Thus, actions of managers beyond a certain level of predictive ability will not be affected by the analyst's reported signal, while other managers below that level will adjust their actions by factoring in the information supplied by the analyst. In other words, with biased analysts the high type managers will have lower demand for feedback for two reasons: first, they can predict the state well without the help of an analyst, and second, even when they observe the analyst's reported signal they might choose to disregard it due to the bias. The higher demand for feedback among the low type managers will support a voluntary disclosure equilibrium that is in the spirit of Proposition 1.

Thus, incorporating a biased analyst will not qualitatively affect our results, but the equilibrium disclosure thresholds will change. A more complete analysis of the impact of biased analysts on the nature of equilibrium disclosure regions would require one to model the forces that give rise to such a bias including conflicts of interest generated by under-writing/investment banking relationships, and brokerage-driven incentives. This is an avenue for future research.

4.2 Effects of Managerial Myopia and the Cost of Information Production

It is clear from our analysis thus far that the manager's intertemporal preferences together with the quality of feedback from financial markets play a central role in the nature of the partial disclosure equilibrium (cf. Propositions 1 and 5). To examine the extent to which the manager's relative stakes in current and future performances—as captured by the parameter β, and the quality of feedback — as determined by the cost of information production, might influence the disclosure equilibrium in an analytically tractable manner, we consider a simple binary version of our general model. This example also allows us to explore the implications of the likelihood that the manager is informed, λ, on the voluntary disclosure equilibrium and the level of the feedback. An interesting, and perhaps surprising, insight that emerges from the example is that the voluntary disclosure equilibrium does *not* collapse to a full disclosure equilibrium once the likelihood that the manager is informed approaches 1. In particular, non-disclosure serves as a *signal* of managerial ability δ to correctly predict the state-appropriate action. We pursue this signaling role of non-disclosure in greater detail subsequently in Section 5.

Specifically, we consider a setting in which the value potential is high, i.e., $x = x_h$, with probability μ_h, or low, i.e., $x = x_\ell$, with probability $\mu_\ell = 1 - \mu_h$ (for $0 < x_\ell < x_h$). The manager's ability to predict the state-appropriate action, δ, is uniformly distributed over the interval $\left[\frac{1}{2}, 1\right]$. Let the analyst's cost for information gathering to discover the underlying state with probability $\gamma \in [0,1]$ be given by $c(\gamma) = c\frac{\gamma^2}{2}$, $c > 0$.[16]

We construct a disclosure equilibrium in which the informed manager with high value potential, x_h, will always disclose, i.e., $\delta_{x_h} = 1$ (under the assumption that x_h is sufficiently high as in Assumption EX below), and the informed manager with low value potential, x_l, will disclose some of the times i.e., $\delta_{x_l} \in (0, \frac{1}{2})$.

Assumption EX: $x_h > \frac{x_\ell(1-\mu_\ell E(\delta))}{(1-\mu_\ell)E(\delta)} \Leftrightarrow E(x)E(\delta) > x_\ell$.

In particular, we have the following equilibrium.

- $\delta_{x_h} = 1, \delta_{x_l} \in (0, \frac{1}{2})$;
- Price associated with non-disclosure is given by

$$P(ND) = \psi\left[(1-\lambda)E(x)\frac{3}{4} + \lambda x_\ell \mu_\ell (1 - \delta_{x_l}^2)\right] \tag{21}$$
$$\text{where, } \psi \equiv \frac{\pi}{1 - \lambda + \lambda\mu_\ell 2(1-\delta_{x_l})};$$

- Prices following disclosure when state is not discovered by the analyst are given by

$$P(x_l) = \frac{x\pi}{2}\left(\delta_{x_l} + \frac{1}{2}\right), P(x_h) = x_h\pi\left(\frac{3}{4}\right);$$

- The analyst's equilibrium responses are given by

$$\gamma_{x_l} = \frac{1}{c}\left(\frac{3 - 2\delta_{x_l}}{1 + 2\delta_{x_l}}\right), \gamma_{x_h} = \frac{1}{3c}.$$

In the appendix, we derive this equilibrium and show its uniqueness. In the context of this equilibrium, we are now able to examine the impact of the analyst's information

[16] To ensure feasible levels of feedback in this example we assume that $c > 1$ (see the solution for the optimal level of feedback specified subsequently).

production cost on the disclosure threshold. Specifically,

Lemma E1: A less efficient analyst (i.e., higher cost of information production) leads to less voluntary disclosure in equilibrium. Formally, the disclosure threshold δ_{x_l} is decreasing in c.

Intuitively, as the analyst' effort in discovering the state becomes costlier, then, all else equal, the probability of state discovery goes down, and consequently the feedback benefit from disclosure is less pronounced. In turn, the manager at the margin who is indifferent between disclosing and not disclosing, will now opt to not disclose. In other words, the disclosure threshold level goes down, while managers with relatively greater uncertainty about the state will still be willing to disclose. Thus, this lemma clearly highlights the role of the feedback effect on the disclosure equilibrium.

We next turn to the question of the impact of the manager's short term price focus, represented by the parameter β, on the disclosure equilibrium. Recall that managers weigh the short-term price implications of disclosure against the long-term benefits from feedback in their voluntary disclosure decision. The following lemma characterizes this trade-off.

Lemma E2: A more myopic manager will be less likely to disclose information voluntarily and will receive higher quality feedback. Formally, the disclosure threshold δ_{x_l} is decreasing and the level of feedback γ_{x_l} is increasing in β.

The higher is the value of the parameter β, the higher the manager's incentive to increase short-term prices at the expense of long-term efficiency, e.g., by not disclosing unfavorable information or low x. This results in less disclosure and higher quality feedback in an equilibrium with a more myopic manager.

Finally, as the pool of informed managers expands, or as λ increases, the following lemma characterizes the consequent impact on the equilibrium.

Lemma E3: A better informed manager will be more likely to disclose information voluntarily and will receive lower quality feedback. Moreover, the equilibrium *does not* converge to a full disclosure equilibrium, as the likelihood that the manager is informed approaches 1. Formally, the disclosure threshold δ_{x_l} is increasing in λ, while $\lim_{\lambda \nearrow 1} \delta_{x_l} < 1$.

Intuitively, as λ increases, it is more difficult for the manager to opportunistically exploit her private information and the disclosure threshold increases. However, even though higher λ leads to more disclosure, it does not eliminate the incentive to withhold information in equilibrium. To illustrate that the partial disclosure region can remain economically substantial even for high values of λ, note that $\lim_{\lambda \nearrow 1} \delta_{x_l} = 0.75$ when we consider the parameter values $\beta = 0.5$, $c = 1.5$, $x_\ell = 1$, $x_h = 3$, $\pi = 2$, and $\mu_\ell = 0.3$. In order to understand this result, consider the low type manager (i.e., $x = x_l$) with a high ability to predict the state-appropriate action, i.e., high δ. This manager may have the incentive to withhold information from the market—*despite* the efficiency loss from not receiving feedback—in order to signal his/her ability δ. This is a credible signal, since the opportunity cost of silence is higher for managers with lower δ. In the next section, we formally analyze this signaling role of non-disclosure by considering the special case of $\lambda = 1$ in the general setting.

5 Non-Disclosure as a Signal of Managerial Ability

5.1 Full Disclosure Equilibrium (and its Instability)

In deriving the disclosure equilibrium in Proposition 1, we assumed that the manager is not always informed, i.e., the probability that the manager privately observes the firm's value potential x is strictly less that one ($\lambda < 1$). As noted earlier, this assumption is in the spirit of Dye [1985], who shows the existence of a partial disclosure equilibrium due to the pooling of informed and uninformed managers. In our model, however, there is an additional feature that plays a role in determining the nature of the disclosure equilibrium, and that is the ability (δ) of the manager to predict the state.

Indeed, an important characteristic of the equilibrium here is that the manager with a lower predictive ability stands to benefit more by disclosing and triggering feedback from financial markets (Lemma 2). A question that naturally arises is whether this feature *alone* can help sustain a partial disclosure equilibrium. Such a partial disclosure equilibrium would offer interesting signaling implications because disclosure of bad news would potentially convey manager's desire for feedback from financial markets. In other words, *non-disclosure* can serve as a signal of managerial ability to predict the state-appropriate action without feedback.

To explore this *signaling* implication of non-disclosure we consider the case in which the manager is always informed about x, i.e., $\lambda = 1$, analysts produce feedback with probability γ (exogenous), and simplify the analysis with the restriction that $x \in [x_l, x_h]$.[17] With this structure, and as pointed out by Dye (1985), there exists a trivial full disclosure equilibrium (i.e., $\delta_x = 1$ for all x). Namely, if non-disclosure results in the lowest possible short-term price (i.e., $P(ND) = \pi x_l \frac{1}{2}$), then disclosure is optimal for all managers $\langle x, \delta \rangle$, and the expected price following disclosure is $\pi [(1-\gamma)E(\delta) + \gamma] x$ (reflecting investors' correct belief that all manager types choose to disclose).[18]

In any perfect Bayesian Nash equilibrium (PBNE), there are no restrictions on how to specify out-of-equilibrium beliefs, or in our context, what $P(ND)$ might be. Thus, one can set an arbitrary non-disclosure price to support a full disclosure equilibrium, and in particular, any price from the full range of prices specified for $P(ND)$ in the proposed equilibrium below would support a full-disclosure equilibrium.[19]

$$\begin{aligned} P(ND) &\in \left[\frac{\pi}{2} x_\ell, \pi [(1-\gamma)E(\delta) + \gamma] x_\ell\right], \\ \delta_x &= 1 \text{ and } P(x) = \pi E(\delta) x \text{ for all } x \in [x_\ell, x_h]. \end{aligned} \tag{22}$$

We ask, next, whether the non-disclosure price that supports the full disclosure equilibrium is *reasonable*. In particular, since managers of higher competence (i.e., higher δ) stand to gain less from feedback, it does not appear reasonable to assume, for example, that the non-disclosure price reflects the deviation of manager of type $\langle x_\ell, \frac{1}{2} \rangle$. If the market were to rationally anticipate manager types that have the greatest incentive to defect from the full disclosure equilibrium, then the non-disclosure price ought to reflect those beliefs. The question then becomes, whether the full disclosure equilibrium is robust to such a rational/justifiable specification of the out-of-equilibrium price $P(ND)$?

In particular, we show below that the full disclosure equilibrium in (22) does not satisfy the *Intuitive Criterion* for stability of a PBNE (Cho and Kreps [1987]). The instability of the full-disclosure equilibrium stems from the aforementioned potential signaling role of

[17] As in Section 3, we do not consider strategic information production to keep our analysis simple. We also assume a bounded interval for x. However, the lower bound $x_\ell > 0$ can be arbitrarily close to 0, and the upper bound x_h can be arbitrarily high.

[18] Note that $\frac{\pi}{2} x_\ell$ correponds to the lowest possible expected firm output.

[19] For non-disclosure price $P(ND) = \pi [(1-\gamma)E(\delta) + \gamma] x_\ell$, the manager of type $\langle x_\ell, 1 \rangle$ is indifferent between disclosure of x_ℓ and non-disclosure, while all other manager types prefer disclosure to non-disclosure.

non-disclosure, i.e., in distinguishing between managers based on their demand for feedback, δ.

Proposition 7 ***[Full-Disclosure Equilibrium and its Instability]:*** *When the manager is fully informed, i.e., $\lambda = 1$, there exists a full disclosure equilibrium, as proposed in (22). However, the full disclosure equilibrium is not robust to intuitive (ala Cho and Kreps, 1987) off-equilibrium-path beliefs.*

The proof (presented in the appendix) essentially involves identifying a non-empty set of manager types, Dev, with the incentive to deviate from the full-disclosure equilibrium and choose non-disclosure (as a *signal*) over disclosure. Rationally anticipating this deviation behavior, the market would set the non-disclosure price as $\breve{P}(ND) = E(v|\langle x, \delta\rangle \in Dev)$ (while the expected short-term price following disclosure is $\pi\left[(1-\gamma)E(\delta)+\gamma\right]x$, as specified by the full disclosure equilibrium in (22)). To complete the proof of instability, we show that for all $\langle x, \delta\rangle \notin Dev$ deviation is not optimal.

Given that managers with greater ability to predict the correct state and the first-best action are more willing to forgo feedback, for any given non-disclosure price $\breve{P}(ND)$, we consider a Dev of the form:

$$Dev \equiv \left\{\langle x, \delta\rangle : \delta > \breve{\Delta}_x(\breve{P}(ND))\right\},$$

where $\breve{\Delta}_x(\breve{P}(ND))$ is the modified threshold, while using the expected price following disclosure $\pi\left[(1-\gamma)E(\delta)+\gamma\right]x$ (from (22)), as required by Cho and Kreps [1987]. In the appendix, we establish the instability of the full disclosure equilibrium by showing the existence of a non-disclosure price, $\breve{P}(ND)$, that satisfies the above conditions.

The lack of robustness of the full disclosure equilibrium immediately raises the possibility of a partial disclosure equilibrium in our model even when the manager is always fully informed (i.e., $\lambda = 1$), and we turn to this issue next.

5.2 Partial Disclosure Signaling Equilibrium

Thus far, we have established the existence of a partial disclosure equilibrium when there is pooling of informed and uninformed managers, i.e., whenever $0 < \lambda < 1$, in a manner specified in Dye [1985]. On the contrary, at $\lambda = 1$, i.e., when the manager is always fully informed, and there can be no such pooling, the possibility of a partial disclosure equilibrium is eliminated in the classic framework of Dye [1985]; only a full disclosure equilibrium emerges. However, as we have shown above, any full disclosure equilibrium in our model is not robust to the Intuitive Criterion of Cho and Kreps [1987] because of the additional information asymmetry with respect to ability of the manager, δ, and consequent signalling implications. In this section, we proceed further along these lines and identify a *partial* disclosure equilibrium even when the pool of managers consists of only those that are always informed (i.e., $\lambda = 1$). That is, the possible benefits from feedback introduce an incentive for some managers *not* to disclose information in equilibrium. Actually, the partial disclosure equilibrium here is very similar to that presented earlier in Proposition 1.

Proposition 8 ***[Partial Disclosure Signaling Equilibrium with Feedback]:*** *Assume that the manager is always informed ($\lambda = 1$). Given assumption A1, there exists a voluntary disclosure equilibrium consisting of a set of thresholds $\{\delta_x\}_{x\in[x_\ell,x_h]}$, and a set of interim prices $P(ND)$ and $\{P(x)\}_{x\in[x_\ell,x_h]}$ such that:*
I. If the manager of type δ learns x, then she discloses x only if $\delta \in \left(\frac{1}{2}, \delta_x\right)$, where δ_x is given by (15).
II. The market rationally sets interim prices $P(ND)$ and $P(x)$ as

$$P(ND) = \psi \int_{x_\ell}^{x_h} xf(x) \left(\int_{\delta_x}^{1} \delta g(\delta) d\delta\right) dx \text{ where, } \psi \equiv \frac{\pi}{\int_{x_\ell}^{x_h} \left[1 - G(\delta_x)\right] f(x) dx}. \quad (23)$$

$$P(x) = \begin{cases} x\pi E\left(\delta | \delta \in \left(\frac{1}{2}, \delta_x\right)\right) \text{ for } \delta_x \in (\frac{1}{2}, 1] \\ x\frac{\pi}{2} \text{ for } \delta_x = \frac{1}{2}. \end{cases} \quad . \quad (24)$$

$$\text{and } P(ND) > \pi x_\ell \left[\gamma + (1-\gamma) E(\delta)\right] \text{ (i.e., } \delta_{x_\ell} < 1\text{)}. \quad (25)$$

The intuition for this equilibrium follows directly from Proposition 7 which shows the lack of robustness of the full disclosure equilibrium. Condition (25) that is satisfied in equilibrium ensures that the non-disclosure region is not empty (i.e., that the proposed equilibrium is truly a one with *partial* disclosure). We do not offer a detailed proof here because it proceeds along the lines of the proofs of Propositions 1 and 7.

Thus, this proposition offers a surprising insight: While disclosure enables value enhancing feedback from analysts, its *absence* is a credible signal of managerial competence.

In particular, the potential feedback benefit from disclosure does not necessarily lead to *all* firms disclosing voluntarily in equilibrium.

6 Conclusion

In this paper, we set out to study the resource allocation role of voluntary disclosures when feedback from financial markets is potentially useful to managers in undertaking value maximizing actions. Our analysis is motivated by the growing evidence that participants in the financial markets often possess information relevant to firm value that managers do not, and that managers are guided, via feedback from capital markets, in their real decisions.

To this end, we consider a setting in which managers are privately informed about the value potential of their firms, but vary in their ability to predict the underlying unknown state of their firms in order to undertake state-appropriate value maximizing actions and realize the value potential. We assume that a voluntary disclosure from the manager regarding the firm's value potential triggers information gathering activities by financial analysts. We show that the equilibrium disclosure strategy of the manager is driven by an interesting trade-off she faces between generating favorable short-term price effects on the one hand, and gleaning efficiency gains from feedback on the other. In particular, we show that in equilibrium a low-ability manager is more willing to disclose relatively unfavorable information, trading off short-term price reduction to realize the long-term efficiency gains from feedback. On the other hand, a high-ability manager will forgo disclosure of unfavorable news because she need not rely as much on feedback from markets and is therefore less willing to suffer a short-term price reduction. Thus, the equilibrium disclosure strategy involves non-disclosure of extremely "bad-news", disclosure of "good-news", and disclosure of "intermediate-news" *only* by managers with relatively low ability to predict the state appropriate action.

Some interesting insights emerge from our model. Namely, our analysis helps explain why voluntary disclosures might lead to both lower and higher short-term stock prices relative to the non-disclosure price, and why prices in financial markets respond more strongly to bad news disclosures relative to good news disclosures. Both of these predictions are consistent with findings in the empirical literature on managers' voluntary disclosures. Our findings also suggest that the quality of feedback from strategic market participants (e.g., analysts) is lower for good news disclosures relative to bad news disclosures - a possible avenue for future empirical investigation. Finally, we demonstrate that the feedback from financial markets, by itself, sustains a partial disclosure equilibrium. That is, the benefits from feedback introduce an incentive for some managers to *withhold* information in equilibrium.

Two key structural aspects of our model have helped us analyze the two-way information flow between managers and markets in a parsimonious way. First, we have only focused on information production that is triggered in the market place when voluntary disclosures are made. This is not to say that analysts do not routinely produce information even in the absence of such disclosures. Indeed, analysts continuously gather, analyze, and process data about the firms they cover. This said, voluntary disclosures reveal potentially new information to analysts, and are likely to prompt analysts to process this information and guide their information gathering efforts. For example, disclosure by the manager of the details of a major transaction with a new client will guide analysts to direct their efforts in this direction to identify and assess any value implications. This utilization of voluntary disclosures in improving the accuracy of forecasts or recommendations is reflected in our assumption that disclosures lead to information production by analysts. More broadly (and as we have shown), by voluntarily disclosing information, managers can guide the resource allocation efforts of analysts in equilibrium by helping them devote more time and resources in gathering information about firms whose prospects are shrouded in greater uncertainty.

Second, we have assumed that the manager's objective function is shaped by both short-term and long-term considerations in an exogenously given manner, as determined by the parameter β. We have also set aside internal agency problems between managers and owners. Presumably, if the owners are long-term investors, they would value feedback from the market and would try to create longer-term incentives for managers thereby encouraging disclosure and increasing ex ante firm value. This can be done by tying compensation plans to long-term performance measures, by imposing vesting schedules for managers' stock option plans, and by limiting insider trading.

The possibility of insider trading introduces other interesting considerations as well. In particular, to the extent that insider trading is observable (e.g., due to firms' disclosure requirements), it could serve as a signal of managers' ability. Indeed, managers with above average competence levels will be more willing to hold on to their firms' stock (prior to knowledge of the realized value potential) since their firms will be undervalued by the market. That is, the possibility of insider trading will not only affect the manager's decision horizon but also may reveal the manager's type. Thus, endogenizing the decision horizon of the manager and incorporating insider trading can yield valuable insights and are promising avenues for future research.[20]

[20] We thank the anonymous referee for pointing out this potential extension.

Appendix

Proof of Lemma 1: $E\left(P_2|\left\langle x,\delta\right\rangle,D\right)=\gamma\pi x+(1-\gamma)x\pi\delta$, while $E\left(P_2|\left\langle x,\delta\right\rangle,ND\right)=x\pi\delta$. Clearly, for any $\delta\in\left[\frac{1}{2},1\right)$,

$$E\left(P_2|\left\langle x,\delta\right\rangle,D\right)>E\left(P_2|\left\langle x,\delta\right\rangle,ND\right).$$

■

Proof of Lemma 2: $E\left(U_M|\left\langle x,\delta\right\rangle,D\right)>E\left(U_M|\left\langle x,\delta\right\rangle,ND\right)$ is equivalent to

$$(1-\gamma)\left[\beta P(x)+(1-\beta)x\pi\delta\right]+\gamma x\pi>\beta P(ND)+(1-\beta)x\pi\delta,\text{ or}$$

$$P(x)+\frac{\gamma}{\beta}\left[x\pi-\left(\beta P(x)+(1-\beta)\,x\pi\delta\right)\right]>P(ND),$$

which is the same as the inequality (11) in the text. The LHS of the this inequality is decreasing in δ, while the RHS is invariant in δ. Therefore if the inequality is satisfied for some δ', it will certainly be satisfied for $\delta\leq\delta'$. In other words, if disclosure occurs for some δ' then it must also occur for all $\delta\in(\frac{1}{2},\delta']$. ■

Proof of Proposition 1: We start by showing that equations (15), (16), and (17) hold in equilibrium. It follows from Lemma 2 and (11) that for all x, the equilibrium cutoff δ_x is defined by (15), for given short-term prices $P(ND)$, and $P(x)$. The price $P(x)$, following a disclosure of x and a non-informative feedback signal s^a, reflects the manager's equilibrium disclosure strategy (see Lemma 2). In particular, we can compute $P(x)$ as,

$$P(x)=x\pi E\left(\delta|\delta\in\left(\frac{1}{2},\delta_x\right)\right),\tag{26}$$

which is specified in (17) in the equilibrium definition. We now address the non-disclosure price $P(ND)=E(v|ND)$. Let $Y\in\{0,1\}$, with $Y=0$ (1), represent the state in which the manager is uninformed (informed), i.e., $\Pr(Y=0)=1-\Pr(Y=1)=1-\lambda$. Thus,

$$\begin{aligned}P(ND)&=E(v|ND)\\&=\Pr(Y=1|ND)E(x\pi\delta|Y=1,ND)+\Pr(Y=0|ND)E(x\pi\delta|Y=0,ND).\end{aligned}$$

Now,

$$\Pr(Y=1|ND)=\frac{\Pr(Y=1,ND)}{\Pr(Y=0,ND)+\Pr(Y=1,ND)}=\frac{\lambda\int_x f(x)\Pr(\delta>\delta_x)dx}{1-\lambda+\lambda\int_x f(x)\Pr(\delta>\delta_x)dx}.$$

Note also that $E(x\pi\delta|Y=0,ND)=(1-\lambda)\,E(x)E(\delta)$. Before calculating the conditional expectation $E(x\pi\delta|Y=1,ND)$ we note that

$$\begin{aligned}
E(x\delta|Y &= 1,ND) = E(x\delta|Y=1,\delta>\delta_x) \\
&= E\left[E(x\delta|\tilde{x},\delta>\delta_{\tilde{x}})|\delta>\delta_{\tilde{x}}\right] \\
&= E\left[\tilde{x}E(\delta|\tilde{x},\delta>\delta_{\tilde{x}})|\delta>\delta_{\tilde{x}}\right] \\
&= E\left[\tilde{x}\left(\frac{\int_{\delta_{\tilde{x}}}^{1}\delta g(\delta)d\delta}{1-G(\delta_{\tilde{x}})}\right)\middle|\,\delta>\delta_{\tilde{x}}\right].
\end{aligned}$$

We need to compute the distribution of x conditional on non-disclosure by an informed manager, i.e., $\delta > \delta_{\tilde{x}}$. In particular, let $\hat{F}(\cdot)$ be the C.D.F of this conditional distribution, i.e.,

$$\hat{F}(x) \equiv \Pr(\tilde{x}<x|\delta>\delta_{\tilde{x}}) = \frac{\Pr(\tilde{x}<x,\delta>\delta_{\tilde{x}})}{\Pr(\delta>\delta_{\tilde{x}})} = \frac{\int_0^x f(z)\Pr(\delta>\delta_z)dz}{\int_0^\infty f(x)\Pr(\delta>\delta_x)dx}.$$

The conditional density function is

$$\hat{f}(x) \equiv \hat{F}'(x) = \frac{f(x)(1-G(\delta_x))}{\int_0^\infty f(y)(1-G(\delta_y))dy}.$$

With the notation at hand we calculate,

$$\begin{aligned}
E(x\delta|Y &= 1,ND) = E\left[\tilde{x}\left(\frac{\int_{\delta_{\tilde{x}}}^{1}\delta g(\delta)d\delta}{1-G(\delta_{\tilde{x}})}\right)\middle|\,\delta>\delta_{\tilde{x}}\right] \\
&= \frac{1}{\int_0^\infty f(y)(1-G(\delta_y))dy}\int_0^\infty x\left(\int_{\delta_x}^1 \delta g(\delta)d\delta\right)f(x)dx.
\end{aligned}$$

We can now obtain equilibrium condition (16) and express the equilibrium non-disclosure short-term price, for a given voluntary disclosure strategy $\{\delta_x\}_{x\geq 0}$,

$$\begin{aligned}
P(ND) &= \psi\left[\lambda\int_0^\infty x\left(\int_{\delta_x}^1 \delta g(\delta)d\delta\right)f(x)dx + (1-\lambda)E(x)E(\delta)\right], \\
\text{where } \psi &\equiv \frac{\pi}{1-\lambda+\lambda\int_0^\infty f(y)(1-G(\delta_y))dy}.
\end{aligned}$$

Next, we show existence of the voluntary disclosure equilibrium defined by (15), (16), and (17). For any x, define the function $\Delta_x : (0,\infty) \to [\frac{1}{2},1]$, representing the disclosure threshold in terms of δ for a given non-disclosure short-term price $P(ND) > 0$, as follows (in this definition, according to (26) we substitute $P(x) = \frac{x\pi}{2}$ for $x \in ND$,[21] $P(x) = x\pi E(\delta)$

[21] The beliefs regarding δ following a disclosure of $x \in ND$ represent the fact that the type with the highest incentive to deviate (that is, disclose x) is type $\delta = \frac{1}{2}$.

for $x \in D$, and $P(x) = x\pi E(\delta|\delta < \Delta_x(P(ND)))$ otherwise, in (15)):

$$\Delta_x(P(ND)) = \begin{cases} 1, \text{ if } P(ND) < x\pi\left[\gamma + (1-\gamma)E(\delta)\right] \\ \frac{1}{2}, \text{ if } P(ND) > x\pi\left[\gamma\left(\frac{1+\beta}{2\beta}\right) + (1-\gamma)\frac{1}{2}\right] \\ \frac{\beta}{x\pi\gamma(1-\beta)}\left(\begin{array}{c} x\pi\left[\gamma\frac{1}{\beta} + (1-\gamma)E(\delta|\delta < \Delta_x(P(ND)))\right] \\ -P(ND)\end{array}\right), \text{ otherwise.}\end{cases} \tag{27}$$

We will show next that for any non-disclosure price, $P(ND)$, the threshold $\Delta_x(\cdot)$ is uniquely defined and continuous. To show uniqueness of the solution $\Delta_x(P(ND))$ for any x and price $P(ND) > 0$, we apply **Assumption A1**. In particular, note that,

$$\begin{aligned} E(\delta) &= E(\delta|\delta = \frac{1}{2}) + \int_{\frac{1}{2}}^{1}\left(\left.\frac{\partial E(\delta|\delta < y)}{\partial y}\right|_{y=z}\right)dz \\ &< \frac{1}{2} + \int_{\frac{1}{2}}^{1}\left(\frac{\gamma}{1-\gamma}\frac{1-\beta}{\beta}\right)dz = \frac{1}{2} + \frac{1}{2}\left(\frac{\gamma}{1-\gamma}\frac{1-\beta}{\beta}\right). \end{aligned} \tag{28}$$

Equation (28) implies that the RHS of the first condition in (27):

$$x\pi\left[\gamma + (1-\gamma)E(\delta)\right] < x\pi\left[\gamma\left(\frac{1+\beta}{2\beta}\right) + (1-\gamma)\frac{1}{2}\right],$$

which is the RHS of the second condition in (27). This implies that the regions defined by the conditions $P(ND) < x\pi\left[\gamma + (1-\gamma)E(\delta)\right]$ and $P(ND) > x\pi\left[\gamma\left(\frac{1+\beta}{2\beta}\right) + (1-\gamma)\frac{1}{2}\right]$ are mutually exclusive. It remains to show uniqueness of $\Delta_x(\cdot)$ in the third region listed in equation (27). In this region,

$$\begin{aligned} &\Delta_x(P(ND)) - \\ &\frac{\beta}{x\pi\gamma(1-\beta)}\left(x\pi\left[\gamma\frac{1}{\beta} + (1-\gamma)E(\delta|\delta < \Delta_x(P(ND)))\right] - P(ND)\right) = 0, \end{aligned}$$

or,

$$\begin{aligned} &P(ND) - x\pi E\left(\delta|\delta \in \left(\frac{1}{2}, \Delta_x(P(ND))\right)\right) = \\ &\frac{\gamma}{\beta}\left[x\pi - \left(\beta x\pi E\left(\delta|\delta \in \left(\frac{1}{2}, \Delta_x(P(ND))\right)\right) + (1-\beta)\,x\pi\Delta_x(P(ND))\right)\right]. \end{aligned}$$

Indeed, we show next that for any $x \geq 0$ and for $P \in (\underline{P}, \bar{P}) \equiv (x\pi\left[\gamma + (1-\gamma)E(\delta)\right],$ $x\pi\left[\gamma\left(\frac{1+\beta}{2\beta}\right) + (1-\gamma)\frac{1}{2}\right])$ there is a unique solution $z = z^* \in \left(\frac{1}{2}, 1\right)$ to the equation

$\Phi(z^*, P) = 0$, where

$$\Phi(z,P) \equiv x\pi E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right) + \frac{\gamma}{\beta}\left[x\pi - \left(\beta x\pi E\left(\delta|\delta\in\left(\frac{1}{2},z\right)\right) + (1-\beta)\,x\pi z\right)\right] - P. \tag{29}$$

It can be shown that $\lim_{z \searrow \frac{1}{2}} \Phi(z,P) > 0 > \Phi(1,P)$ for $P \in (\underline{P}, \bar{P})$. Uniqueness follows from noting that

$$\begin{aligned}\frac{\partial\Phi(z,P)}{\partial z} &= x\pi\left(\frac{\partial E\left(\delta|\delta\in\left(\frac{1}{2},z\right)\right)}{\partial z} - \frac{\gamma}{\beta}\left[\beta\frac{\partial E\left(\delta|\delta\in\left(\frac{1}{2},z\right)\right)}{\partial z} + (1-\beta)\right]\right)\\ &= x\pi\left(\frac{\partial E\left(\delta|\delta\in\left(\frac{1}{2},z\right)\right)}{\partial z}(1-\gamma) - \frac{\gamma(1-\beta)}{\beta}\right) < 0 \text{ (from \textbf{Assumption A1})}.\end{aligned}$$

Thus, we conclude that$\{\Delta_x(P(ND))\}_{x\geq 0}$ is uniquely defined by (27).

To show continuity of $\Delta_x(P)$ in P we consider three regions: $P < \underline{P}$, $P > \bar{P}$, and $P \in (\underline{P}, \bar{P})$. Clearly, when $\Delta_x(\cdot)$ is constant then it is also continuous, i.e., for $P < \underline{P}$, $P > \bar{P}$. Now, in the interval $P \in (\underline{P}, \bar{P})$ the solution $\Delta_x(P)$ is continuous and is monotonic (using the Implicit Function Theorem),

$$\frac{\partial \Delta_x(P)}{\partial P} = -\left.\frac{\partial\Phi(z,P)}{\partial P}\right/\frac{\partial\Phi(z,P)}{\partial z} < 0.$$

Now, continuity at the points $P \in \{\underline{P}, \bar{P}\}$, follows since $P \downarrow \underline{P}$ implies that $z^* \uparrow 1$, and $P \uparrow \bar{P}$ implies that $z^* \downarrow \frac{1}{2}$.

Finally, it follows from the above that an equilibrium non-disclosure short-term price $P(ND) = P^*$ is the solution to $\Theta(P^*) = 0$, where,

$$\begin{aligned}\Theta(P) &= \psi(P)\left(\lambda\int_0^\infty x\left(\int_{\Delta_x(P)}^1 \delta g(\delta)d\delta\right) f(x)dx + (1-\lambda)\,E(x)E(\delta)\right) - P\\ \psi(P) &\equiv \frac{\pi}{1-\lambda+\lambda\int_0^\infty f(x)(1-G(\Delta_x(P)))dx}.\end{aligned}$$

The existence of $P^* > 0$ follows from the Intermediate Value Theorem. In particular, note that $\Theta(P)$ is continuous (from the continuity of $\Delta_x(P)$ and $G(\cdot)$), and that,

$$(1-\lambda)\,\pi E(x)E(\delta) - P \leq \Theta(P) \leq \frac{\pi E(x)E(\delta)}{1-\lambda} - P.$$

Thus, $\Theta(P) < 0$ for $\frac{\pi E(x)E(\delta)}{1-\lambda} < P$, and $\Theta(P) > 0$ for $(1-\lambda)\,\pi E(x)E(\delta) > P$, and consequently the solution lies in the interval $P^* \in \left((1-\lambda)\,\pi E(x)E(\delta), \frac{\pi E(x)E(\delta)}{1-\lambda}\right)$. ■

Proof of Corollary 1

This follows from (27) in the proof of Proposition 1, as

$$P(ND) > x\pi\left[\gamma\left(\frac{1+\beta}{2\beta}\right) + \ (1-\gamma)\frac{1}{2}\right]$$

if and only if $x < \underline{x}$. ■

Proof of Corollary 2

This follows from (27) in the proof of Proposition 1, as

$$P(ND) < x\pi\left[\gamma + (1-\gamma)E(\delta)\right]$$

if and only if $x > \bar{x}$. ■

Proof of Corollary 3

This follows from Corollary 1, Corollary 2, and Assumption A1. Namely,

$$\begin{aligned} E(\delta) &= E(\delta|\delta = \frac{1}{2}) + \int_{\frac{1}{2}}^{1}\left(\left.\frac{\partial E(\delta|\delta < y)}{\partial y}\right|_{y=z}\right)dz \\ &< \frac{1}{2} + \int_{\frac{1}{2}}^{1}\left(\frac{\gamma}{1-\gamma}\frac{1-\beta}{\beta}\right)dz = \frac{1}{2}\left[1 + \left(\frac{\gamma}{1-\gamma}\frac{1-\beta}{\beta}\right)\right]. \end{aligned}$$

This implies that $\bar{x} - \underline{x} > 0$, since

$$\begin{aligned} \bar{x} - \underline{x} &= \frac{P(ND)}{\left[(1-\gamma)E(\delta)+\gamma\right]\pi} - \frac{P(ND)}{\left[1+\frac{\gamma}{\beta}\right]\frac{\pi}{2}} \\ &\propto \frac{1}{\left[(1-\gamma)E(\delta)+\gamma\right]} - \frac{1}{\left[1+\frac{\gamma}{\beta}\right]\frac{1}{2}} \\ &> \frac{1}{\left[(1-\gamma)\frac{1}{2}\left[1+\left(\frac{\gamma}{1-\gamma}\frac{1-\beta}{\beta}\right)\right]+\gamma\right]} - \frac{1}{\left[1+\frac{\gamma}{\beta}\right]\frac{1}{2}} \\ &= 0. \ ■ \end{aligned}$$

Proof of Corollary 4 (Disclosure Informativeness)

From the proof of Proposition 1, we know that the threshold δ_x for $x \in PD$ for any given non-disclosure price P is a unique solution $\delta_x = z^* \in \left(\frac{1}{2}, 1\right)$ to the equation $\Phi(z^*, P) = 0$, where $\Phi(z,P)$ is given in (29). It immediately follows from the Implicit Function Theorem, that

$$\delta'_x \equiv \frac{\partial \Delta_x(P)}{\partial x} = -\left.\frac{\partial \Phi(z,P)}{\partial x}\right/\frac{\partial \Phi(z,P)}{\partial z} > 0. \blacksquare$$

Proof of Proposition 2 Note that for manager $\langle x, \delta \rangle$ the expected short-term price following disclosure of $x \in PD$ does not depend on δ but only on the equilibrium threshold δ_x. In particular,

$$E\left(P_1|D,x\right) = x\pi\left[\gamma + (1-\gamma)E(\delta|\delta < \delta_x)\right].$$

But, from (27) $x \in ND \Longrightarrow$

$$\begin{aligned} P(ND) &> x\pi\left[\gamma + (1-\gamma)E(\delta)\right] \\ &> x\pi\left[\gamma + (1-\gamma)E(\delta|\delta < \delta_x)\right] \\ &= E\left(P_1|D,x\right). \end{aligned}$$

The last inequality follows because $E(\delta) > E(\delta|\delta < \delta_x)$ for $\delta_x \in (\frac{1}{2}, 1)$. $\blacksquare$

Proof of Proposition 3 Note that for manager $\langle x, \delta \rangle$ the expected short-term price following disclosure of $x \in D$ does not depend on δ. In particular,

$$E\left(P_1|D,x\right) = x\pi\left[\gamma + (1-\gamma)E(\delta)\right].$$

But, from (27) in the proof of Proposition 1, $x \in D \Longrightarrow P(ND) < x\pi\left[\gamma + (1-\gamma)E(\delta)\right]$. $\blacksquare$

Proof of Proposition 4 Monotonicity in x of the expected short-term price following disclosure, $x\pi\left[\gamma + (1-\gamma)E(\delta|\delta < \delta_x)\right]$, follows from the monotonicity of $E(\delta|\delta < \delta_x)$ in x. In particular, it follows from Corollary 4 that $\frac{\partial E(\delta|\delta<\delta_x)}{\partial \delta_x}\frac{\partial \delta_x}{\partial x} > 0$.

Next consider the short-term price responses to good and bad news. In particular, we compare the expected short-term change in price following a marginal increase and decrease of $\rho \in (0, \bar{x})$ around the level $\bar{x}$. Indeed,

$$\begin{aligned} E(P_1|D,\bar{x}+\rho) - E(P_1|D,\bar{x}) &= \pi(\bar{x}+\rho)\left[\gamma + (1-\gamma)E(\delta)\right] \\ &\quad -\pi\bar{x}\left[\gamma + (1-\gamma)E(\delta)\right] \\ &= \pi\rho\left[\gamma + (1-\gamma)E(\delta)\right] \end{aligned}$$

Note also that

$$\begin{aligned}
E(P_1|D,\bar{x}) - E(P_1|D,\bar{x}-\rho) &= \pi\bar{x}\left[\gamma + (1-\gamma)E(\delta)\right] \\
&\quad -\pi\left(\bar{x}-\rho\right)\left[\gamma + (1-\gamma)E(\delta|\delta < \delta_{\bar{x}-\rho})\right] \\
&= \pi\rho\left[\gamma + (1-\gamma)E(\delta)\right] \\
&\quad +\pi\left(\bar{x}-\rho\right)(1-\gamma)\left[E(\delta) - E(\delta|\delta < \delta_{\bar{x}-\rho})\right] \\
&> E(P_1|D,\bar{x}+\rho) - E(P_1|D,\bar{x}).
\end{aligned}$$

The last inequality follows because $E(\delta) - E(\delta|\delta < \delta_{\bar{x}-\rho})$. ■

Proof of Proposition 5 As in the proof of Proposition 1, equations (15)-(17) hold in equilibrium. We start by showing that the analyst's best response level of scrutiny is given by (20). To start with, the conditions for optimality that define the solution to (19) are,

$$\frac{\partial Var(r_x|x,\delta<\delta_x,\gamma)}{\partial\gamma} + c'(\gamma) = 0, \text{ and } \frac{\partial^2 Var(r_x|x,\delta<\delta_x,\gamma)}{\partial\gamma^2} + c''(\gamma) > 0.$$

To calculate the variance of the return, we condition on whether information is produced by the analysts. Namely,

$$V(r|x,\delta<\delta_x) = E_{s^a}\left(V(r|x,\delta<\delta_x,s^a)|x,\delta<\delta_x\right) + V_{s^a}\left(E(r|x,\delta<\delta_x,s^a)|x,\delta<\delta_x\right).$$

Now from above,

$$\begin{aligned}
V(r|x,\delta &< \delta_x, NA) = E_\delta\left(V(r|x,\delta,NA)|x,\delta<\delta_x,NA\right) \\
&\quad +V_\delta\left(E(r|x,\delta,NA)|x,\delta<\delta_x,NA\right)
\end{aligned}$$

Thus, we compute,

$$\begin{aligned}
V(r|x,\delta,NA) &= \delta\left(\frac{1}{E^2(\delta|\delta<\delta_x)}\right) - \delta^2\left(\frac{1}{E^2(\delta|\delta<\delta_x)}\right) \\
E_\delta\left(V(r|x,\delta,NA)|x,\delta<\delta_x,NA\right) &= \frac{1}{E(\delta|\delta<\delta_x)} - \left(\frac{E(\delta^2|\delta<\delta_x)}{E^2(\delta|\delta<\delta_x)}\right) \\
E(r|x,\delta,NA) &= \delta\left(\frac{1}{E(\delta|\delta<\delta_x)}\right) \\
V_\delta\left(E(r|x,\delta,NA)|x,\delta<\delta_x,NA\right) &= \left(\frac{1}{E^2(\delta|\delta<\delta_x)}\right)V_\delta\left(\delta|x,\delta<\delta_x,NA\right) \\
&= \left(\frac{1}{E^2(\delta|\delta<\delta_x)}\right)\left(E(\delta^2|\delta<\delta_x) - E^2(\delta|\delta<\delta_x)\right) \\
&= \frac{E(\delta^2|\delta<\delta_x)}{E^2(\delta|\delta<\delta_x)} - 1
\end{aligned}$$

Thus,

$$\begin{aligned}
V(r|x,\delta &< \delta_x, NA) = \left(\frac{1}{E(\delta|\delta<\delta_x)}\right) - \left(\frac{E(\delta^2|\delta<\delta_x)}{E^2(\delta|\delta<\delta_x)}\right) + \left(\frac{E(\delta^2|\delta<\delta_x)}{E^2(\delta|\delta<\delta_x)}\right) - 1 \\
&= \left(\frac{1}{E(\delta|\delta<\delta_x)}\right) - 1 \\
V(r|x,\delta &< \delta_x, A\cup B) = 0
\end{aligned}$$

We can now compute,

$$\begin{aligned}
E_{s^a}\left(V(r|x,\delta<\delta_x,s^a)|x,\delta<\delta_x,\right) &= \gamma V(r|x,\delta<\delta_x,A\cup B) + (1-\gamma)V(r|x,\delta<\delta_x,NA) \\
&= (1-\gamma)\left[\frac{1}{E(\delta|\delta<\delta_x)} - 1\right] \\
V_{s^a}\left(E(r|x,\delta<\delta_x,s^a)|x,\delta<\delta_x,\right) &= 0
\end{aligned}$$

Thus,

$$\begin{aligned}
V(r|x,\delta &< \delta_x) = E_{s^a}\left(V(r|x,\delta<\delta_x,s^a)|x,\delta<\delta_x,\right) \\
&= (1-\gamma)\left[\frac{1}{E(\delta|\delta<\delta_x)} - 1\right].
\end{aligned}$$

Consequently, we obtain the optimality condition (20) since,

$$\frac{\partial Var(r_x|x,\delta<\delta_x,\gamma)}{\partial\gamma} = -\left[\frac{1}{E(\delta|\delta<\delta_x)} - 1\right].$$

Moreover the above second order optimality condition is satisfied,

$$\frac{\partial V(r|x,\delta<\delta_x)}{\partial\gamma} = -\left[\frac{1}{E(\delta|\delta<\delta_x)} - 1\right] < 0 \text{ and } \frac{\partial^2 V(r|x,\delta<\delta_x)}{\partial\gamma^2} = 0.$$

This, together with the properties of $c(\cdot)$ ensure a unique interior response $\gamma_x = \Upsilon(\delta_x)$ where $\Upsilon(z)$ is the solution to $\Gamma(z,\gamma)=0$ where,

$$\Gamma(z,\gamma) = -\left[\frac{1}{E(\delta|\delta<z)} - 1\right] + c'(\gamma) \Longrightarrow \Upsilon(z) = c'^{-1}\left(\frac{1}{E(\delta|\delta<z)} - 1\right). \tag{30}$$

Thus,

$$\frac{\partial\Gamma(\gamma,z)}{\partial\gamma} = c''(\gamma) > 0, \text{ and } \frac{\partial\Gamma(\gamma,z)}{\partial z} = \frac{\frac{\partial(E(\delta|\delta<z))}{\partial z}}{E^2(\delta|\delta<z)} > 0.$$

And, using the Implicit Function Theorem,

$$\Upsilon'(\cdot) = -\left. \frac{\partial \Gamma(\gamma, z)}{\partial z} \middle/ \frac{\partial \Gamma(\gamma, z)}{\partial \gamma} \right. < 0.$$

Moreover, $\Upsilon(\cdot)$ is continuous over the interval $\left[\frac{1}{2}, 1\right]$.[22]

One can proceed exactly as in the proof of Proposition 1 by replacing the exogenous assumed γ_x in that proof by the analyst's response function $\Upsilon(\delta_x)$ as characterized above. It is worth noting, however, that the solution $\Delta_x(x; P)$ is unique and continuous in P for the case of endogenous analyst's scrutiny. We show this property explicitly. Namely, let $\hat{\Delta}_x(x; P)$ be the solution to,

$$\hat{\Delta}_x(P(ND)) = \begin{cases} 1, \text{ if } P(ND) < x\pi\left[\Upsilon(1) + (1 - \Upsilon(1))E(\delta)\right] \\ 1/2, \text{ if } P(ND) > x\pi\left[\Upsilon(\frac{1}{2})\left(\frac{1+\beta}{2\beta}\right) + (1 - \Upsilon(\frac{1}{2}))\frac{1}{2}\right] \\ \frac{\beta}{x\pi\Upsilon(\delta_x)(1-\beta)}\left(\begin{array}{c} x\pi\left[\begin{array}{c} \Upsilon(\delta_x)\frac{1}{\beta} + \\ (1 - \Upsilon(\delta_x))E(\delta|\delta < \Delta_x(P(ND))) \end{array} \right] \\ -P(ND) \end{array} \right), \text{ otherwise.} \end{cases} \tag{31}$$

To show uniqueness of the solution $\hat{\Delta}_x(P(ND))$ for any x and price $P(ND) > 0$, we apply **Assumption A1**. In particular, note that,

$$\begin{aligned} E(\delta) &= E(\delta|\delta = \frac{1}{2}) + \int_{\frac{1}{2}}^{1} \left(\left. \frac{\partial E(\delta|\delta < y)}{\partial y} \right|_{y=z} \right) dz \\ &< \frac{1}{2} + \int_{\frac{1}{2}}^{1} \left(\frac{\underline{\gamma}}{1 - \underline{\gamma}} \frac{1-\beta}{\beta} \right) dz \\ &< \frac{1}{2} + \int_{\frac{1}{2}}^{1} \left(\frac{\Upsilon(\frac{1}{2})}{1 - \Upsilon(\frac{1}{2})} \frac{1-\beta}{\beta} \right) dz = \frac{1}{2} + \frac{1}{2} \left(\frac{\Upsilon(\frac{1}{2})}{1 - \Upsilon(\frac{1}{2})} \frac{1-\beta}{\beta} \right). \end{aligned} \tag{32}$$

Equation (32) implies that the RHS of the first condition in (31):

$$x\pi\left[\Upsilon(1) + (1 - \Upsilon(1))E(\delta)\right] < x\pi\left[\Upsilon(\frac{1}{2})\left(\frac{1+\beta}{2\beta}\right) + (1 - \Upsilon(\frac{1}{2}))\frac{1}{2}\right],$$

which is the RHS of the second condition in (31). This implies that the regions defined by the conditions $P(ND) < x\pi\left[\Upsilon(1) + (1 - \Upsilon(1))E(\delta)\right]$ and $P(ND) > x\pi[\Upsilon(\frac{1}{2})\left(\frac{1+\beta}{2\beta}\right) + (1 - \Upsilon(\frac{1}{2}))\frac{1}{2}]$ are mutually exclusive. It remains to show that there is a unique solution

[22] Any beliefs regarding δ following a disclosure of $x \in ND$ would imply scrutiny at level less than $\Upsilon(\frac{1}{2})$. This high level of scrutiny is most supportive of a deviation (i.e., disclosure of $x \in ND$), and thus, our equilibrium is robust to any other out of equilbrium beliefs on δ following disclosure of $x \in ND$.

to the equation $\hat{\Phi}(z^*, P) = 0$ where $z^* \in \left(\frac{1}{2}, 1\right)$, for any $x \geq 0$ and for $P \in (\underline{P}, \bar{P}) \equiv (x\pi\left[\Upsilon(1) + \ (1-\Upsilon(1))E(\delta)\right]\ ,\ [x\pi\Upsilon(\frac{1}{2})\left(\frac{1+\beta}{2\beta}\right) + (1-\Upsilon(\frac{1}{2}))\frac{1}{2})]$,

$$\begin{aligned}\hat{\Phi}(z, P) \ &\equiv \ x\pi E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right) \\ &+\frac{\Upsilon(z)}{\beta}\left[x\pi - \left(\beta x\pi E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right) + (1-\beta)\, x\pi z\right)\right] - P.\end{aligned} \tag{33}$$

As in the proof of Proposition 1, it can be shown that $\lim_{z\searrow\frac{1}{2}} \hat{\Phi}(z, P) > 0 > \hat{\Phi}(1, P)$ (for $P \in (\underline{P}, \bar{P})$) and that,

$$\begin{aligned}\frac{\partial\hat{\Phi}(z, P)}{\partial z} \ &= \ x\pi\left(\frac{\partial E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right)}{\partial z} - \frac{\Upsilon(z)}{\beta}\left[\beta\frac{\partial E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right)}{\partial z} + (1-\beta)\right]\right) \\ &\quad +x\pi\left(\frac{\Upsilon'(z)}{\beta}\left[1 - \left(\beta E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right) + (1-\beta)\, z\right)\right]\right) \\ &< \ x\pi\left(\frac{\partial E\left(\delta|\delta \in \left(\frac{1}{2}, z\right)\right)}{\partial z}(1-\Upsilon(z)) - \frac{\Upsilon(z)\,(1-\beta)}{\beta} + \frac{\Upsilon'(z)(1-z)}{\beta}\right) \\ &< \ 0 \text{ (from } \textbf{Assumption A1} \text{ and } \Upsilon'(z) < 0).\end{aligned}$$

Thus, we conclude that $\left\{\hat{\Delta}_x\right\}_{x\geq 0}$ is uniquely defined by (31). Continuity of $\hat{\Delta}_x$ in P, and the existence of the equilibrium follows as in the proof of Proposition 1. For the sake of brevity we do not present these proofs here again. ■

Proof of Corollary 5 The result follows from $\Upsilon'(z) < 0$ as derived in the proof of Proposition 5 (see (30) for definition of the function Υ). Thus, for any $x,\ y \geq 0$ we have $\delta_x > \delta_y \Leftrightarrow \gamma_x < \gamma_y$. ■

Proof of Proposition 6 (Endogenous Feedback) It follows from Corollary 5 that for any $x,\ y \geq 0$ we have $\{\delta_x > \delta_y\} \Leftrightarrow \{\Upsilon(\delta_x) < \Upsilon(\delta_y)\}$. Now, since $\frac{\partial\hat{\Delta}_x}{\partial x} = -\frac{\partial\hat{\Phi}(z,P)}{\partial x}\Big/\frac{\partial\hat{\Phi}(z,P)}{\partial z}$ > 0 (see proof of Proposition 5) it follows that for any $y > x \geq 0$ we have $\delta_x \leq \delta_y$ which then leads to $\gamma_x = \Upsilon(\delta_x) \geq \Upsilon(\delta_y) = \gamma_y$, thus the level of analyst scrutiny is weakly decreasing in the disclosure x. Moreover, if $y > x > z \geq 0$ for some $x \in PD$ then it follows that $\delta_z < \delta_x < \delta_y$ which then leads to $\gamma_y = \Upsilon(\delta_y) < \gamma_x = \Upsilon(\delta_x) < \Upsilon(\delta_z) = \gamma_z$. ■

Example: Derivation of the equilibrium

Disclosure is optimal if and only if,

$$E\left(U_M|\left\langle x, \delta\right\rangle, D\right) \geq E\left(U_M|\left\langle x, \delta\right\rangle, ND\right).$$

Or equivalently,

$$(1-\gamma_x)\left[\beta P(x)+(1-\beta)x\pi\delta\right]+\gamma_x x\pi \geq \beta P(ND)+(1-\beta)x\pi\delta.$$

Now,

$$P(x)=x\pi E(\delta|\delta\leq\delta_x)=\frac{x\pi}{2}\left(\delta_x+\frac{1}{2}\right).$$

Consider the equilibrium $\delta_{x_h}=1$. Then,

$$P(x_h)=x\pi E(\delta)=x_h\pi\left(\frac{3}{4}\right).$$

For $\delta_{x_h}=1$ to be optimal from the manager's perspective it must be that,

$$(1-\gamma_{x_h})\left[\beta E(\delta)+(1-\beta)\right]+\gamma_{x_h}\geq\beta\left(\frac{P(ND)}{x_h\pi}\right)+(1-\beta).$$

We can calculate,

$$\left(\frac{1}{E(\delta|\delta<z)}-1\right)=c'(\Upsilon(z))\Leftrightarrow\Upsilon(z)=\frac{1}{c}\left(\frac{3-2z}{1+2z}\right). \tag{34}$$

Thus,

$$\left(1-\frac{1}{3c}\right)E(\delta)+\frac{1}{3c}\geq\left(\frac{P(ND)}{x_h\pi}\right)\ \text{(condition for } x_h\in D). \tag{35}$$

Next, the cutoff $\delta_{x_\ell}\equiv z\in\left(\frac{1}{2},1\right)$ is given by (using (34)),

$$\pi x_\ell\left(\frac{1}{2}\left(z+\frac{1}{2}\right)\left(1-\frac{1}{c}\left(\frac{3-2z}{1+2z}\right)\right)+\left(1-(1-\beta)\,z\right)\frac{1}{c\beta}\left(\frac{3-2z}{1+2z}\right)\right)=P(ND). \tag{36}$$

Now from the equilibrium condition for $P(ND)$ we have,

$$P(ND)=\psi\left[(1-\lambda)E(x)\frac{3}{4}+\lambda x_\ell\mu_\ell(1-z^2)\right]$$
$$\text{where, }\psi\equiv\frac{\pi}{1-\lambda+\lambda\mu_\ell 2(1-z)}.$$

To further explore this equilibrium, we note that the distribution of x is sufficiently wide (as specified by Assumption EX in the text). This assumption ensures uniqueness of the equilibrium, as we will see below. Let the solution be $\delta_{x_\ell} \equiv z$. It is convenient to write

$$
\begin{aligned}
\tilde{D}(z) &= \pi x_\ell \left(\frac{1}{2}\left(z + \frac{1}{2}\right)(1 - \Upsilon(z)) + \left(\frac{1}{\beta} - \left(\frac{1-\beta}{\beta}\right) z\right)\Upsilon(z)\right) \qquad (37)\\
&\equiv \pi x_\ell \left(\frac{1}{2}\left(z + \frac{1}{2}\right)\left(1 - \frac{1}{c}\left(\frac{3-2z}{1+2z}\right)\right) + (1-(1-\beta)z)\frac{1}{c\beta}\left(\frac{3-2z}{1+2z}\right)\right), \text{ and}\\
\tilde{S}(z) &\equiv \frac{\pi}{1-\lambda+\lambda\mu_\ell 2(1-z)}\left[(1-\lambda)E(x)\frac{3}{4} + \lambda x_\ell \mu_\ell (1-z^2)\right].
\end{aligned}
$$

Now, consider the derivative

$$
\begin{aligned}
\frac{\tilde{D}'(z)}{\pi x_\ell} &= \left(E(\delta|\delta < z)(1-\Upsilon(z)) + \left(\frac{1}{\beta} - \left(\frac{1-\beta}{\beta}\right) z\right)\Upsilon(z)\right)'\\
&= E'(\delta|\delta < z)(1-\Upsilon(z)) - \left(\frac{1-\beta}{\beta}\right)\Upsilon(z) + \Upsilon'(z)\left[\frac{1}{\beta} - E(\delta|\delta<z)\right]\\
&< 0 \text{ (given } \textbf{Assumption A1}\text{)}.
\end{aligned}
$$

On the other hand,

$$
\begin{aligned}
\tilde{S}'(z) &= \frac{\lambda\mu_\ell 2}{1-\lambda+\lambda\mu_\ell 2(1-z)} S(z) + \frac{\pi}{1-\lambda+\lambda\mu_\ell 2(1-z)}\left[-2\lambda x_\ell \mu_\ell z\right]\\
&\propto S(z) - \pi x_\ell z
\end{aligned}
$$

It can be shown that given **Assumption EX**, $S(z) - \pi x_\ell z > 0$, establishing that if δ_{x_l} exists, it is unique. To show existence, let $\mathcal{F}(z) \equiv \tilde{D}(z) - \tilde{S}(z)$. Then, $\mathcal{F}'(z) \equiv \tilde{D}'(z) - \tilde{S}'(z) < 0$. Thus, it suffices to show that $\mathcal{F}(\frac{1}{2}) > 0 > \mathcal{F}(1)$. In particular,

$$
\begin{aligned}
\mathcal{F}(\frac{1}{2}) &= \pi x_\ell \left(\frac{1}{2}\left(1 - \Upsilon\left(\frac{1}{2}\right)\right) + \frac{1}{2}\left(\frac{1}{\beta}+1\right)\Upsilon\left(\frac{1}{2}\right)\right)\\
&\quad -\frac{\pi}{1-\lambda+\lambda\mu_\ell}\frac{3}{4}\left[(1-\lambda)E(x) + \lambda x_\ell \mu_\ell\right]\\
&\propto x_\ell \left(1 + \frac{\Upsilon\left(\frac{1}{2}\right)}{\beta}\right) - \frac{1}{1-\lambda+\lambda\mu_\ell}\frac{3}{2}\left[(1-\lambda)E(x) + \lambda x_\ell \mu_\ell\right].
\end{aligned}
$$

Now, $\mathcal{F}(\frac{1}{2}) > 0$ requires that,

$$
\frac{\Upsilon\left(\frac{1}{2}\right)}{\beta} > \left(\left(\frac{1-\lambda}{1-\lambda+\lambda\mu_\ell}\right)\frac{E(x)\frac{3}{2}}{x_\ell} + \left(\frac{\lambda\mu_\ell}{1-\lambda+\lambda\mu_\ell}\right)\frac{3}{2}\right) - 1.
$$

On the other hand, $\digamma(1) < 0$ requires that,

$$\begin{aligned} Z(1) &= \pi x_\ell \left(\frac{3}{4} + \frac{1}{4}\Upsilon(1)\right) - \pi\left[E(x)\frac{3}{4}\right] \\ &\propto x_\ell\left(3 + \Upsilon(1)\right) - 3E(x) \\ &< 0 \text{ (given } \textbf{Assumption EX}) \end{aligned}$$

Now, lets go back to verify condition (35),

$$\left(1 - \frac{1}{3c}\right)E(\delta) + \frac{1}{3c} \geq \left(\frac{P(ND)}{x_h \pi}\right) \text{ (given } \textbf{Assumption EX} \text{ and } E(x)E(\delta) \geq P(ND)). \blacksquare$$

Proof of Lemma E1

We refer to the derivation of the equilibrium to establish this lemma. In particular, Because $\digamma(\delta_{x_\ell}; c) \equiv \tilde{D}(\delta_{x_\ell}; c) - \tilde{S}(\delta_{x_\ell}; c)$ for all c,

$$\digamma'(\delta_{x_\ell}; c)\frac{\partial \delta_{x_\ell}}{\partial c} + \frac{\partial F(\delta_{x_\ell}; c)}{\partial c} = 0.$$

Because we know that $\digamma'(\delta_{x_\ell}; c) \equiv \tilde{D}'(\delta_{x_\ell}; c) - \tilde{S}'(\delta_{x_\ell}; c) < 0$, $\frac{\partial \delta_{x_\ell}}{\partial c} < 0$ if $\frac{\partial F(\delta_{x_\ell}; c)}{\partial c} < 0$. Thus, we need to show that the partial derivative (w.r.t c) of the expression $F(z; c)$ is negative. This is indeed the case because

$$\begin{aligned} \frac{\partial \tilde{D}(\delta_{x_\ell}; c)}{\partial c} &= \frac{\partial \Upsilon(\delta_{x_\ell})}{\partial c}\pi x_\ell\left(-\frac{1}{2}\left(\delta_{x_\ell} + \frac{1}{2}\right) + \left(\frac{1}{\beta} - \left(\frac{1-\beta}{\beta}\right)\delta_{x_\ell}\right)\right) \\ &= \underbrace{\frac{\partial \Upsilon(\delta_{x_\ell})}{\partial c}}_{<0}\pi x_\ell \underbrace{\left(\frac{\delta_{x_\ell}}{2} - \frac{1}{4} + \frac{1}{\beta} - \frac{\delta_{x_\ell}}{\beta}\right)}_{>0} < 0 \\ \frac{\partial \tilde{S}}{\partial c} &= 0 \Longrightarrow \frac{\partial \delta_{x_\ell}}{\partial c} < 0. \blacksquare \end{aligned}$$

Proof of Lemma E2 Proceeding as in Lemma E1, the partial derivative for the expression $\digamma(\delta_{x_\ell}; \beta)$ with respect to β is negative because

$$\begin{aligned} \frac{\partial \tilde{D}(\delta_{x_\ell}; \beta)}{\partial \beta} &= \pi x_\ell\left(-\frac{1}{\beta^2} + \frac{\delta_{x_\ell}}{\beta^2}\right)\Upsilon(\delta_{x_\ell}) < 0 \\ \frac{\partial \tilde{S}}{\partial \beta} &= 0 \Longrightarrow \frac{\partial \delta_{x_\ell}}{\partial \beta} < 0. \blacksquare \end{aligned}$$

Proof of Lemma E3 Again, proceeding as in Lemmas E1 and E2, the partial derivative for the expression $\digamma(\delta_{x_\ell};\lambda)$ with respect to λ is negative because

$$\begin{aligned}
\frac{\partial \tilde{D}}{\partial \lambda} &= 0, \text{ and} \\
\frac{\partial \tilde{S}}{\partial \lambda} &= -\pi \frac{\partial}{\partial \lambda}\left(\frac{\lambda \mu_\ell 2(1-\delta_{x_\ell})}{1-\lambda+\lambda\mu_\ell 2(1-\delta_{x_\ell})}\right)\left[E(x)\frac{3}{4}-\frac{x_\ell(1+\delta_{x_\ell})}{2}\right] < 0 \\
&\Longrightarrow \frac{\partial \delta_{x_\ell}}{\partial \lambda} > 0.
\end{aligned}$$

Moreover, $\lim_{\lambda \nearrow 1} \delta_{x_l} < 1$ follows from the continuity of $\digamma(\delta_{x_\ell};\beta)$ and since $\digamma\left(\delta_{x_\ell}=\frac{1}{2};\lambda=1\right) > 0 > \digamma(\delta_{x_\ell}=1;\lambda=1)$.

Proof of Proposition 7 To prove the instability of the full-disclosure equilibrium (ala Cho and Kreps, 1987) we establish the existence of a deviation set $Dev \subset [x_\ell, x_h] \times [1/2, 1]$, such that (1) the non-disclosure short-term price is $\breve{P}(ND) = E(v|\langle x,\delta\rangle \in Dev)$, (2) as per the full disclosure equilibrium, the short-term price following disclosure is $P(x) = \pi x E(\delta)$, (3) non-disclosure is optimal for $\langle x,\delta\rangle \in Dev$, and (4) disclosure is optimal for $\langle x,\delta\rangle \notin Dev$.

In order to have a non-empty deviation set, $Dev \neq \phi$, it must be that,

$$\breve{P}_L \equiv [(1-\gamma)E(\delta)+\gamma]\,\pi x_\ell < \breve{P}(ND).$$

Otherwise, the best response of all managers is to disclose x. The modified disclosure thresholds, given the non-disclosure price $\breve{P}(ND)$ associated with such a deviation, can be expressed as

$$\breve{\Delta}_x(\breve{P}(ND)) = \begin{cases} 1, \text{ if } \breve{P}(ND) < x\pi\left[\gamma+(1-\gamma)E(\delta)\right] \\ 1/2, \text{ if } \breve{P}(ND) > x\pi\left[\gamma\left(\frac{1+\beta}{2\beta}\right)+(1-\gamma)E(\delta)\right] \\ \frac{\beta}{x\pi\gamma(1-\beta)}\left(x\pi\left[\gamma\frac{1}{\beta}+(1-\gamma)E(\delta)\right]-\breve{P}(ND)\right), \text{ otherwise.} \end{cases}$$

It can be seen that $\breve{\Delta}_x(\breve{P}(ND))$ is *decreasing* in $\breve{P}(ND)$ and *increasing* in x. Now, we define the (deviation) non-disclosure set as,

$$Dev \equiv \left\{\langle x,\delta\rangle : \delta > \breve{\Delta}_x(\breve{P}(ND)); \breve{P}(ND) > \breve{P}_L\right\}.$$

From the requirement $\breve{P}(ND) = E(v|\langle x_\ell,\delta\rangle \in Dev)$, we are looking for a short-term price following non-disclosure $Z > \breve{P}_L$ such that $\breve{\Theta}^I(Z) = 0$, where:

$$\begin{aligned}
\breve{\Theta}^I(Z) &= \pi E(x\delta|\delta > \breve{\Delta}_x(Z)) - Z \\
&= \frac{\pi}{\int_{x_\ell}^{x_h} f(x)(1-G(\breve{\Delta}_x(Z)))dx}\left(\int_{x_\ell}^{x_h}\left(\int_{\breve{\Delta}_x(Z)}^{1}\delta g(\delta)d\delta\right)f(x)dx\right) - Z.
\end{aligned}$$

To start with, the *largest* possible firm value for the non-disclosure short-term price is πx_h. Note that,

$$\breve{\Theta}^I(\pi x_h) = \pi E(x\delta|\delta > \breve{\Delta}_x(\pi x_h)) - \pi x_h < 0.$$

On the other hand, as the non-disclosure price approaches the lower bound $\breve{P}_L$ from above, the disclosure threshold for x_ℓ approaches 1, that is, $\breve{\Delta}_{x_\ell}(Z) \to 1$ as $Z \searrow \breve{P}_L$. Now, since $\breve{\Delta}_x(Z) \geq \breve{\Delta}_{x_\ell}(Z)$ for all $x \in [x_\ell, x_h]$ and Z we have,

$$\breve{\Delta}_{x_\ell}(Z)x_\ell < E(x\delta|\delta > \breve{\Delta}_x(Z)) < \bar{x} = \frac{Z}{[(1-\gamma)E(\delta)+\gamma]\,\pi}.$$

The right-hand side follows since disclosure is optimal for all $x > \bar{x}$. Moreover, as the non-disclosure price approaches the lower bound $\breve{P}_L$ from above, both the right-hand side and left-hand side converge to x_ℓ i.e.,

$$\breve{\Delta}_{x_\ell}(Z)x_\ell \to x_\ell \text{ and } \frac{Z}{[(1-\gamma)E(\delta)+\gamma]\,\pi} \to x_\ell, \text{ as } Z \searrow \breve{P}_L.$$

Thus, we conclude that

$$\pi E(x\delta|\delta > \breve{\Delta}_x(Z)) \to \pi x_\ell, \text{ as } Z \searrow \breve{P}_L.$$

But this implies that,

$$\breve{\Theta}^I(Z) \to \pi x_\ell - \breve{P}_L = \pi x_\ell - [(1-\gamma)E(\delta)+\gamma]\,\pi x_\ell > 0, \text{ as } Z \searrow \breve{P}_L.$$

Thus, from the continuity of $\breve{\Theta}^I(Z)$ over the interval $Z > \breve{P}_L$, there exists $Z^* \in (\breve{P}_L, \pi x_h)$ such that $\breve{\Theta}^I(Z^*) = 0$.

Finally, note that for $\langle x, \delta\rangle \notin Dev$, disclosure with price $x\pi\gamma + (1-\gamma)P(x)$ dominates non-disclosure with price $\breve{P}(ND)$ from the definition of $\breve{\Delta}_x(\breve{P}(ND))$ above. ■

References

Aboody, D., and R. Kasznik. "Ceo Stock Option Awards and Corporate Voluntary Disclosure." *Journal of Accounting and Economics* 29 (2000): 73–100.

Baik, B., and G. Jiang, "The Use of Management Forecasts to Dampen Analysts' Expectations." *Journal of Accounting and Public Policy* 25 (2006): 531–553.

Bakke, T. E., and T. M. Whited. "Which Firms Follow the Market? An Analysis of Corporate Investment Decisions." *Review of Financial Studies* (2008):. Forthcoming.

Becher, D. A., and J. L. Juergens. "Analyst Recommendations and Mergers: Do Analysts Matter?" (2008): Working paper.

Chen, Q.; I. Goldstein; and W. Jiang, "Price Informativeness and Investment Sensitivity to Stock Price." *Review of Financial Studies* 20 (2007): 619–650.

Cho, I., and D. Kreps, "Signaling Games and Stable Equilibria." *Quarterly Journal of Economics* 102 (1987): 179–221.

Cotter, J.; I. Tuna; and P. Wysocki. "Expectations Management And Beatable Targets: How do Analysts React to Explicit Earnings Guidance." *Contemporary Accounting Research* 23 (2006): 593–624.

Darrough, M., and N. Stoughton, "Financial Disclosure Policy in an Entry Game." *Journal of Accounting and Economics* 12 (1990): 219–243.

Das, S.; C. B. Levine; and K. Sivaramakrishnan. "Earning Predictability and Bias in Analysts' Earnings Forecasts." *Accounting Review* 73 (1998): 277–294.

Dow, J., and G. Gorton "Stock Market Efficiency and Economic Efficiency: Is There A Connection?" *Journal of Finance* 52(3) (1997): 108–1129.

Dugar, A., and S. Nathan, "The Effect of Investment Banking Relationships on Financial Analysts' Earnings Forecasts and Investment Recommendations." *Contemporary Accounting Research* 12(1) (1995): 131-160.

Dye, R. A. "Disclosure of Nonproprietary Information." *Journal of Accounting Research* 23 (1985): 123–145.

Dye, R. A. "Proprietary and Nonproprietary disclosures." *Journal of Business* 59 (1986): 331–336.

Dye, R. A., and S. Sridhar. "Resource Allocation Effects of Price Reactions to Disclosures." *Journal of Accounting Research* 19 (2002): 385–410.

Fishman, M., and K. Hagerty. "Disclosure Decisions by Firms and the Competition for Price Efficiency." *The Journal of Finance* 44 (1989): 633–646.

Francis, J., and D. R. Philbrick. "Analysts' Decision As Products of a Multi-Task Environment." *Journal of Accounting Research* 31 (1993): 216–230.

Givoly, D., and J. Lakonishok. "The Information Content of Financial Analysts' Forecasts of Earnings." *Journal of Accounting and Economics* 1 (1979): 165–185.

Goldstein, I., and A. Guembel. "Manipulation and The Allocational Role of Prices." *Review of Economic Studies* 75 (2008): 133–164.

Grossman, S. J., and O. D. Hart. "Disclosure Laws and Takeover Bids." *Journal of Finance* 35 (1980): 323–334.

Imhoff, E. A., and G. J. Lobo. "Information Content of Analysts' Composite Forecast Revisions." *Journal of Accounting Research* 22 (1984): 541–554.

Jackson, A. "Trade Generation, Reputation, and Sell-Side Analysts." *Journal of Finance* 60 (2005): 673–717.

Kau, J. B.; J. S. Linck; and P. H. Rubin. "Do Managers Listen to the Market?" *Journal of Corporate Finance* 14 (2008): 347–362.

Kothari, S.; S. Shu.; and P. Wysocki. "Do Managers Withhold Bad News?" *Journal of Accounting Research* 47 (2009): 241–276.

Langberg, N., and K. Sivaramakrishnan. "Voluntary Disclosures and Informaton Production by Analysts." *Journal of Accounting and Economics* 26 (2008): 78–100.

Liberty, S., and J. L. Zimmerman. "Labor Union Contract Negotiations and Accounting Choices." *The Accounting Review* 61 (1986): 692–712.

Lim, T. "Rationality and Analyst Forecast Bias." *Journal of Finance* 56 (2001): 369–385.

Lin, H., and M. McNichols. "Underwriting Relationships, Analysts' Earnings Forecasts and Investment Recommendations." *Journal of Accounting and Economics* 25 (1998): 101–127.

Luo, Y. "Do Insiders Leam from Outsiders? Evidence from Corporate Takeovers." *Journal of Finance* 60 (2005): 1951–1982.

Lys, T., and S. Sohn. "The Association between Revisions of Financial Analysts' Earnings Forecasts and Security-Price Changes." *Journal of Accounting and Economics* 13 (1990): 341-363.

McNichols, M., and P. O'Brien. "Self-Selection and Analyst Coverage." *Journal of Accounting Research* 37 (1997): 167–199.

Mikhail, B. M.; B. R. Walther; and R. H. Willis. "Does Forecast Accuracy Matter to Security Analysts?" *The Accounting Review* 74 (1999): 185–200.

O'Brien, P. "Analysts' Forecasts as Earnings Expectations." *Journal of Accounting and Economics* (1987): 53–83.

Skinner, D. "Why Firms Voluntarily Disclose Bad News." *Journal of Accounting Research* 32 (1994): 38–60.

Subrahmanyam, A., and S. Titman. "The Going-Public Decision and the Development of Financial Markets." *Journal of Finance* 54 (1999): 1045–1082.

Teoh, S. H., and C. Y. Hwang, "Nondisclosure and Adverse Disclosure as Signals of Firm Value." *The Review of Financial Studies* 4 (1991): 283–313.

Figure 1: Voluntary Disclosure with Feedback

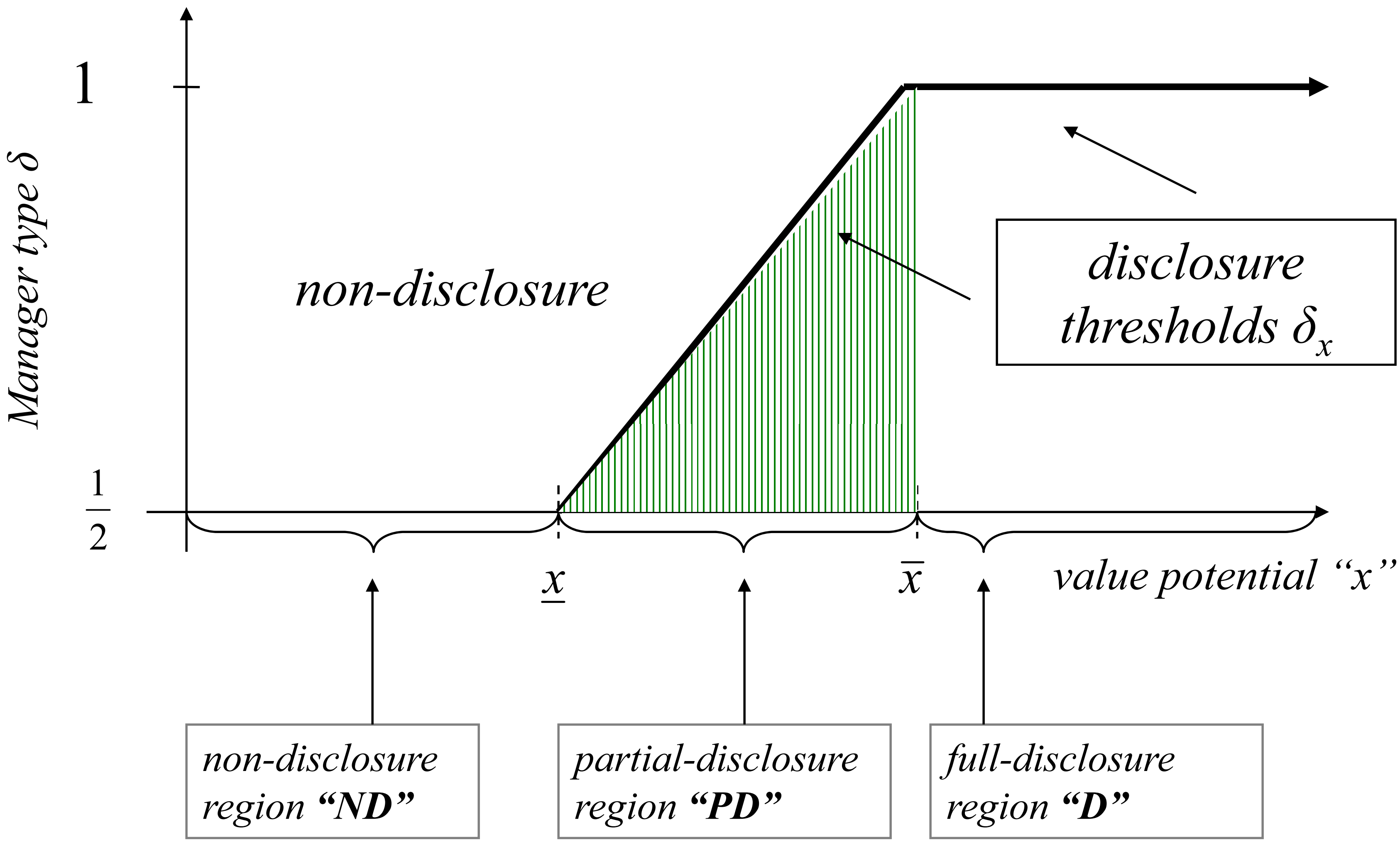

Figure 2: Price Response to Disclosure