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The Interpretation of Information and Corporate Disclosure Strategies

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Abstract. This paper analyzes a setting in which a firm's manager can credibly disclose facts, but not their valuation implications. Consequently, he is uncertain as to how those disclosed facts will be interpreted by investors. Introducing such uncertainty affects the manager's disclosure strategy in two important ways. First, it becomes a function of the market's prior valuation of the firm since that valuation provides a clue as to how future disclosures are likely to be interpreted by investors. Second, the disclosure strategy is no longer characterized, in general, by a single good news/bad news partition of the manager's private information.

Keywords: voluntary disclosure, information interpretation, analyst forecast

JEL Classification: G0, G3, M4

Introduction

This paper analyzes the discretionary disclosure decision of a manager who possesses two types of private information: facts about his firm's operating results (which he can credibly reveal) and knowledge of the nature of the firm's operating environment (which he cannot credibly communicate). In contemplating a public disclosure, the manager must consider both the facts that will be released as well as the manner in which those facts will be interpreted by the market. While facts are objective, their interpretation is dependent upon investors' assessment of the environment within the firm which generated those facts. Since the manager cannot directly convey to the market his knowledge of the firm's operating environment, he may not be able to accurately predict the manner in which those facts will be seen by investors, nor the market impact of their disclosure.

Many types of disclosures are likely to have uncertain valuation implications. As an example, consider a firm's announcement of its order backlog. A higher order backlog will be interpreted favorably by investors if, based on their assessment of the firm's operating environment, they believe that this signals strong demand for the firm's product. However, if they believe that it reflects either problems with the firm's production facilities or a manager who is not in full control of operations, then it will be looked upon negatively, as it would likely presage a loss of future sales. A manager not knowing precisely how this order backlog information will be interpreted by investors will face uncertainty over the impact of that disclosure on the firm's market value.

Prior discretionary disclosure models set within a capital markets framework do not allow for uncertainties in the interpretation of information. These models implicitly assume that market participants agree with the manager on the valuation implications of his private information; consequently, he knows how investors will react to its disclosure. Under this assumption, a manager will reveal his information as long as its valuation implications are above some threshold, and will withhold it otherwise. This implies that the equilibrium disclosure set is characterized by a single partition of the manager's private information. It also implies that the nature of the disclosure strategy will be independent of the market's prior valuation of the firm. As shown here, once uncertainty is introduced over the manner in which information will be interpreted, the manager's disclosure strategy can change in significant ways.

To understand why, consider a setting in which the manager obtains private value-relevant information ('facts') about his firm's operating results with positive probability during the period. Assume also that the manager possesses private (perfect) knowledge of the nature of the firm's operating environment which allows him to correctly determine the implications of these facts for firm value. While the manager can credibly disclose his facts to the market, he is unable to credibly convey their impact on firm value. There is one security analyst covering the firm, whose role it is to formulate and disseminate her assessment of the firm's value, both before any managerial disclosure and then, once again, subsequent to any disclosure by the manager. Her disclosures are assumed to be truthful. The analyst relies on her own (imperfect) knowledge of the firm's operating environment to assess the valuation implications of any information released. As a result, the manager will not know the precise manner in which his disclosed information will be interpreted by the analyst, and, hence, by the market.[1] In making his disclosure decision, the manager is assumed to maximize his expectation for the firm's subsequent share price. Any disclosure made by the manager is assumed to be truthful.[2]

At this point it will help to make the setting somewhat more concrete. Suppose that the firm sells its goods through dealers and that the manager's private information is the level of inventory at the dealers' warehouses midway through the current period. In certain operating environments firm value will be increasing in the inventory level, such as when higher inventory signals higher anticipated demand. Under other conditions value will be decreasing in the inventory level, such as when higher inventory signals that the firm is unable to properly control its production process or is having difficulty selling its products. The dealer's inventory level is the 'fact' that the manager must decide whether to disclose. Assume that, prior to the manager's disclosure decision, the analyst had collected her own (imperfect) information about the inventory level and the firm's operating environment, and disclosed her resulting valuation of the firm. This valuation is either 'favorable' or 'unfavorable.'

Consider first the case where the analyst's valuation is favorable. The manager knows that there are two alternative ways the analyst could have arrived at this assessment: either (1) she estimated the dealers' inventory level to be high and interprets higher inventory levels as good news for the firm or (2) she estimated inventory to be low and interprets lower inventory levels as good news. If the actual inventory level is sufficiently high, the manager will believe it very likely that the analyst also estimated inventory to be high, and that alternative (1) underlies her assessment. Consequently, the manager will disclose his information, expecting the analyst to interpret the disclosure of a high inventory level in a favorable manner. If the actual inventory level is sufficiently low, the manager will believe it very likely that the analyst also estimated inventory to be low, and that alternative (2) governs the analyst's assessment. The manager will again disclose his information, as in this case he is expecting the analyst to interpret the firm's low inventory level favorably.

Thus, the manager reveals his information when it is either sufficiently high *or* sufficiently low, regardless of his own assessment of its valuation implications. This is because the manager does not base his disclosure decision on *his* own interpretation of his private information, but rather on his prediction of how the *analyst* will interpret it. Given that the analyst's prior valuation of the firm was favorable, the manager is willing to disclose information he personally finds unfavorable for the firm, as he expects the analyst to interpret it in a favorable manner.

Consider next the case where the analyst's initial valuation is unfavorable. The manager knows that there are again two alternative ways the analyst could have arrived at this assessment: either (1) she estimated the inventory level to be high and interprets higher inventory levels as bad news for the firm or (2) she estimated the inventory level to be low and interprets lower inventory levels as bad news. If the actual inventory level is sufficiently high, it will be very likely that the analyst also estimated inventory to be high and that alternative (1) governs the analyst's assessment of value. This will lead the manager to withhold his information with positive probability, due to his belief that the analyst would interpret the disclosure of a high inventory level in an unfavorable manner. If the actual inventory level is sufficiently low, it will be very likely that alternative (2) drives the analyst's assessment. Again, the manager's information will be withheld with positive probability, given his belief that the analyst would interpret the disclosure of a low inventory level in an unfavorable manner.

Consequently, when the analyst's prior valuation of the firm is unfavorable, news of both low and high inventory levels will be withheld with positive probability. Again, this is because the manager's disclosure decision is based on his prediction of how the *analyst* will interpret the information released.

This example illustrates the two fundamental ways in which the manager's disclosure strategy changes once uncertainty is introduced over how his disclosed facts will be interpreted in the marketplace. First, the disclosure strategy will now generally depend on the market's prior valuation of his firm, as it will be informative as to how investors will interpret future disclosures. Second, the strategy will no longer be characterized, in general, by a single partition of the manager's private information.

The analysis in this paper extends the extant discretionary disclosure literature in two significant ways. First, it considers a setting in which the manager has two pieces of private information, but can credibly disclose only one of them. Second, it allows for private information to be held by others in the marketplace, thus introducing two-sided asymmetric information into the analysis. The setting shares characteristics with Dye (1985), in that the manager is assumed to receive private information with probability less than one and makes his disclosure decision so as to maximize the firm's market value. It also shares characteristics with Feltham and Xie (1992) and Wagenhofer (1990). In those papers the manager considers the impact of his disclosure on both the capital and product markets; the manager would like to disclose only good news to the capital market and only bad news to the product market. These conflicting incentives result in disjoint disclosure regions. Here, the manager is focused solely on the capital market; however, he prefers to disclose only high (low) outcomes to an analyst who interprets high (low) outcomes as good news. The manager's uncertainty over analyst type leads to the existence of disjoint disclosure sets.

The plan of this paper is as follows. In Section 1 the economic setting is described. An introduction to the manager's disclosure strategy appears in Section 2. Section 3 derives the optimal strategy conditional on a favorable initial analyst forecast. The optimal strategy conditional on an unfavorable initial forecast is derived in Section 4. Section 5 concludes the paper. All proofs and derivations appear in the Appendix.

1. The Economic Setting

Consider a single-period, three-date economy with a risky firm run by a risk-neutral manager. There is a risk-neutral security analyst whose role is to generate private information, analyze any information released by the manager, and truthfully disclose her expectation for the firm's value (sometimes referred to below as her forecast of firm value). The analyst's publicly disclosed forecasts are assumed to be the only information investors have to price the firm. Consequently, the analyst can be thought of as representing the whole market and the firm's price at any point in time will equal the analyst's most recently disclosed forecast.[3]

The firm's end-of-period liquidating value, v (sometimes referred to below simply as the firm's value), is assumed to be given by

$$v = (2w - 1) \cdot x \tag{1}$$

where w is the realization of a binary random variable that takes on either the value 0 or 1, with equal probability, and x is the realization of a continuous and symmetrically distributed random variable with support on the interval $[-u, u]$, and density function $f(x)$ (so that it has a mean of zero).[4] Given these distributional assumptions, v is also symmetrically distributed around zero.

Expression (1) captures the notion that knowing the 'facts' about a firm (as represented by x in this setting) is not, by itself, sufficient to determine the firm's value. It is also necessary to know how to interpret the facts. The parameter w reflects the way in which the facts translate into firm value. When $w = 1$ a higher x implies a higher firm value; when $w = 0$ a higher x implies a lower firm value.[5] Moreover, without information about w, facts in this setting are completely uninformative, as the expected value of v conditional on x remains equal to the firm's unconditional expected value. That is, $E(v \mid x) = E(v) = 0$ for all x.[6,7]

The economy begins at date 1, when the analyst privately observes the realizations of two independent signals about the value of the firm. The first signal, denoted by $s_x \in \{L, H\}$, provides imperfect information about x. It is assumed that the higher the value of x, the more likely the signal's realization will by H. Specifically, $\text{prob}(s_x = H \mid x) = F(x)$, where $F(x)$ is the cumulative distribution function of x. The second signal, denoted by $s_w \in \{0, 1\}$, provides imperfect information about w. It is assumed that $\text{prob}(s_w = i \mid w = i) = p > \frac{1}{2}$ for each $i \in \{0, 1\}$. That the analyst cannot perfectly infer the value of w reflects the idea that, as an outsider, she is less familiar with the firm's operations, and so less able to assess the valuation implications of hard facts. An analyst who observes $s_w = 1$ ($s_w = 0$) will be referred to as a type 1 (type 0) analyst.

The analyst's date 1 forecast, denoted by $P_1(s_w, s_x)$, is given by:

$$P_1(s_w, s_x) = [2 \cdot \text{prob}(w = 1 \mid s_w) - 1] \cdot E(x \mid s_x) \tag{2}$$

Given the distributional assumptions on x and w, it can be shown that $P_1(1, H) = P_1(0, L)$ and $P_1(0, H) = P_1(1, L)$.[8] For brevity, let $P_{1H} \equiv P_1(1, H) = P_1(0, L)$ and $P_{1L} \equiv P_1(0, H) = P_1(1, L)$. In the analysis below P_{1H} (P_{1L}) will sometimes be referred to as the favorable (unfavorable) prior forecast. The above two equalities ensure that the analyst's public forecast does not perfectly reveal her private information and captures the notion that the market's prior valuation of the firm is not likely to fully reflect how investors will interpret future disclosures.

At date 2 the firm's manager privately observes x with probability $q < 1$.[9] The manager is assumed to know the value of w.[10] In the analysis below a manager observing $w = 1$ ($w = 0$) will be referred to as a type 1 (type 0) manager. If the manager does see x, he must decide whether to publicly disclose it. While the manager is assumed able to credibly release facts, x, he is not able to credibly convey to the market the value of w.[11] Furthermore, if he does not see x, he is assumed unable to credibly reveal that fact to the market.[12] Subsequent to the manager's date 2 disclosure decision the analyst publicly releases a revised forecast of firm value. Finally, at date 3 the firm is liquidated and the economy ends.

2. The Manager's Disclosure Strategy—Preliminaries

In deciding whether to publicly disclose x at date 2, the manager's goal is to maximize his expectation for the subsequent market price of the firm (which will be equal to the analyst's revised forecast).[13] In the analysis below let $d_w(x)$ denote the probability that a manager of type w, with private information x, makes a disclosure at date 2. A perfect Bayesian equilibrium consists of a disclosure strategy for the manager and updated beliefs for the analyst such that (a) taking the analyst's beliefs as given, the manager's disclosure strategy maximizes the expected price of the firm subsequent to the disclosure decision and (b) the analyst's beliefs are consistent with the manager's disclosure strategy and, where applicable, with Bayes' rule. As usual in games of imperfect information, there can be multiple equilibria depending on the nature of off-equilibrium-path beliefs. The analysis focuses on robust equilibria that can be sustained for *any* and *all* beliefs off the equilibrium path.[14] It also focuses on equilibria in which $d_1(x) = d_0(-x)$ for all x, referred to here as 'symmetric' equilibria. In words, a symmetric equilibrium is one in which the type 1 manager's disclosure strategy conditional on observing x is the same as that of the type 0 manager conditional on observing $-x$. It is natural to expect to find symmetry in equilibrium given that the type 1 manager's valuation of the firm conditional on observing x is identical to that of a type 0 manager who observes $-x$.

Conditional on having observed s_w at date 1 and the manager disclosing x at date 2, the analyst's revised forecast, denoted by $P_D(s_w, x)$, is given by

$$P_D(s_w, x) = [2 \cdot \text{prob}(w = 1 \mid s_w, x) - 1] \cdot x, \tag{3}$$

where the analyst's posterior beliefs, represented by $\text{prob}(w = 1 \mid s_w, x)$, are computed using Bayes' rule, where applicable, and knowledge of the manager's equilibrium disclosure strategy. Conditional on the manager not disclosing any information at date 2, the analyst's revised forecast, $P_{ND}(s_w, s_x)$, is given by[15]

$$P_{ND}(s_w, s_x) = [2 \cdot \text{prob}(w = 1 \mid s_w, s_x, ND) - 1] \cdot E(x \mid s_w, s_x, ND), \tag{4}$$

where the analyst's posterior beliefs, $\text{prob}(w = 1 \mid s_w, s_x, ND)$ and $E(x \mid s_w, s_x, ND)$, are again based on Bayes' rule and the equilibrium disclosure strategy.

The manager will disclose (withhold) his private information if his expectation for $P_D(s_w, x)$ is greater (less) than his expectation for $P_{ND}(s_w, s_x)$. The manager does not know the precise value of the analyst's revised forecast at the time he makes his disclosure decision because he does not directly observe s_w, the signal that guides the analyst's interpretation of information.[16] In calculating the probability that s_w equals 1 or 0, the manager relies on his private knowledge of x and w as well as his observation of the analyst's prior forecast. If the type w manager discloses his information, then his expectation for the analyst's date 2 forecast, denoted by $V_D(w, x, P_1)$, would be given by

$$V_D(w, x, P_1) = \text{prob}(s_w = 1 \mid w, x, P_1) \cdot P_D(1, x) + \text{prob}(s_w = 0 \mid w, x, P_1) \cdot P_D(0, x) \tag{5}$$

for $P_1 \in \{P_{1H}, P_{1L}\}$. If he withholds his information instead, his expectation for the analyst's date 2 forecast, denoted by $V_{ND}(w, x, P_1)$, would be given by

$$\begin{aligned} V_{ND}(w, x, P_{1H}) = {} & \text{prob}(s_w = 1 \mid w, x, P_{1H}) \cdot P_{ND}(1, H) \\ & + \text{prob}(s_w = 0 \mid w, x, P_{1H}) \cdot P_{ND}(0, L) \end{aligned} \tag{6}$$

for $P_1 = P_{1H}$ and

$$\begin{aligned} V_{ND}(w, x, P_{1L}) = {} & \text{prob}(s_w = 1 \mid w, x, P_{1L}) \cdot P_{ND}(1, L) \\ & + \text{prob}(s_w = 0 \mid w, x, P_{1L}) \cdot P_{ND}(0, H) \end{aligned} \tag{7}$$

for $P_1 = P_{1L}$.[17]

In a symmetric equilibrium the type 1 analyst's date 2 forecast conditional on nondisclosure is equal to that of the type 0 analyst, given that they issued the same date 1 forecast (that is, $P_{ND}(1, H) = P_{ND}(0, L)$ and $P_{ND}(1, L) = P_{ND}(0, H)$).[18] It immediately follows from expressions (6) and (7) that knowledge of w and x, while helping a nondisclosing manager to assess the analyst's type, has no bearing on his expectation for the analyst's revised forecast.[19] In the analysis below $V_{ND}(w, x, P_1)$ will be referred to simply as V_{ND}.

3. The Manager's Disclosure Strategy Conditional on a Favorable Prior Forecast

This section analyzes the manager's disclosure strategy conditional on a favorable date 1 analyst forecast. As discussed in the previous section, this strategy will be a function of the manager's expectation for the analyst's revised forecast. This forecast, in turn, will be based on the analyst's conjecture for the manager's disclosure strategy.

To understand the nature of the equilibrium disclosure strategy it will be useful to first calculate the manager's expectation for the analyst's revised forecast if the analyst conjectures that both manager types disclose their private information. In this case the disclosure decision will provide no incremental information to the analyst about manager type. Consequently, the analyst's posterior beliefs about manager type, given a disclosure of x, are identical to her prior beliefs (which are conditional only on s_w). The revised forecast thus becomes:

$$P_D(1, x) = (2p - 1) \cdot x \tag{8}$$

for the type 1 analyst and

$$P_D(0, x) = -(2p - 1) \cdot x \tag{9}$$

for the type 0 analyst. The type w manager's expectation for the analyst's revised forecast, denoted by $V_D^P(w, x)$, is then given by[20]

$$V_D^P(w, x) = [\text{prob}(s_w = 1 \mid w, x) - \text{prob}(s_w = 0 \mid w, x)] \cdot (2p - 1) \cdot x \tag{10}$$

(where the superscript P reflects the fact that this expectation is based on the conjecture that both manager types pool on the act of disclosure). The expectations $V_D^P(1, x)$ and $V_D^P(0, x)$ are depicted as the two curved lines in Figure 1. For reference, the analyst's revised forecast, conditional on a disclosure of x and the conjecture that only the type 1 (type 0) manager discloses, is drawn as the upward-sloping (downward-sloping) diagonal line in Figure 1. Under those conjectures, the manager would not face any uncertainty over the analyst's revised forecast.

The function $V_D^P(w, x)$ displays several important characteristics. First, $V_D^P(1, x) = V_D^P(0, -x)$ (that is, the manager has symmetric expectations). This is consistent with the fact that the manager's own valuation of the firm is the same whether he observed $w = 1$ and x or $w = 0$ and $-x$. Second, $V_D^P(1, x)$ is less (greater) than $V_D^P(0, x)$ when x is below (above) its mean value of zero. This property follows from the facts that (a) the type 1 manager assesses a greater probability that the analyst is of type 1 than does the type 0 manager, and (b) the type 1 analyst interprets low values of x as bad news and high values of x as good news.[21] Finally, $V_D^P(w, x)$ attains its maximum value at $x = -u$ and again at $x = u$. To understand why this is so, note that when the manager observes $x = -u$, he correctly infers that the analyst has seen $s_x = L$. Along with a favorable date 1 forecast, this implies that the analyst must have observed $s_w = 0$. Therefore, the analyst will interpret lower values of x more positively, and the lowest possible value of x, $x = -u$, most positively. Similar intuition holds for $x = u$.

With the use of Figure 1, the manager's equilibrium disclosure strategy can now be described.[22] For values of x below point $-\alpha_H$, $V_D^P(1, x)$ and $V_D^P(0, x)$ are both greater than V_{ND}. This means that disclosure for both manager types constitutes equilibrium behavior in this region. For x slightly greater than $-\alpha_H$ it can no longer be an equilibrium for both types to disclose their information. Under the conjecture that both disclose, the type 1 manager gains more by withholding his information. Choosing nondisclosure with probability one could not constitute equilibrium behavior for him either. If it was, then the analyst would know that all disclosures are coming from the type 0 manager. As long as the analyst's forecast under the conjecture that $w = 0$ is greater than V_{ND}, the type 1 manager would then have an incentive to mimic the disclosure decision of the type 0 manager, and release

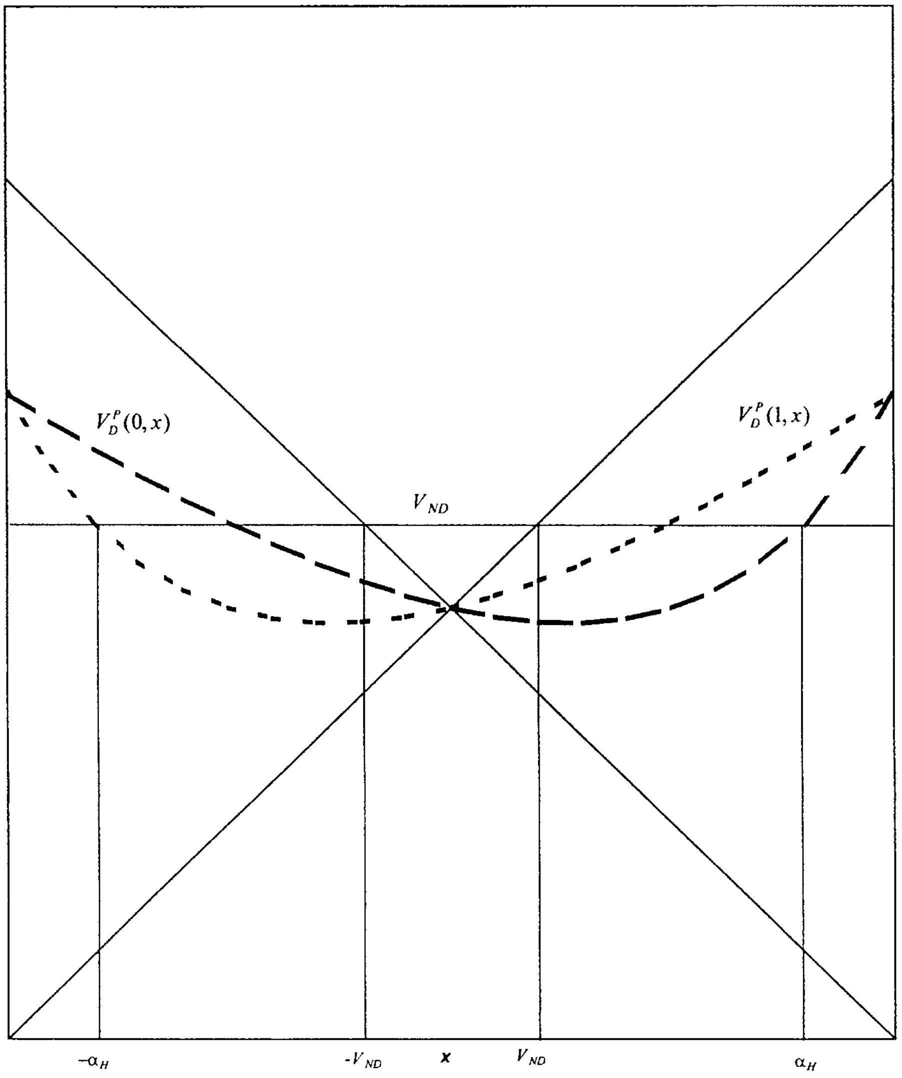


Figure 1. Expected date 2 price conditional on favorable initial forecast.

his information with positive probability. (As depicted in Figure 1, this region extends to point $-V_{ND}$, where the analyst's forecast, conditional on $w = 0$, is just equal to V_{ND}.) Consequently, the equilibrium disclosure strategy for the type 1 manager must involve mixing between disclosing and withholding his information, for x between $-\alpha_H$ and $-V_{ND}$.[23] The equilibrium disclosure probability will be such that the manager's expectation for the analyst's date 2 forecast, conditional on disclosure (and given rational conjectures on her part), will just equal V_{ND}. Since $V_D(0, x) > V_D(1, x)$ for all $x < 0$, the type 0 manager will continue to disclose his private information with probability one.

Between points $-V_{ND}$ and 0 neither manager type will disclose his information regardless of the analyst's off-equilibrium beliefs conditional on disclosure. This is because in this region the analyst's revised forecast, conditional on disclosure, is less than V_{ND}, for even the most favorable off-equilibrium beliefs. In a symmetric equilibrium the manager's disclosure strategies for $x > 0$ follow directly from those described for $x < 0$; the strategy of a type 1 (type 0) manager who observed $x > 0$ will be identical to that of a type 0 (type 1) manager who observed $-x$.

The manager's equilibrium disclosure strategy is formally stated in the following proposition.

Proposition 1 *Conditional on the analyst disclosing a favorable forecast at date 1, there exists an equilibrium in which* $d_1(x) = d_0(-x)$ *for each* x. *The manager's equilibrium disclosure strategies are depicted in the following diagrams:*

$-u$ disclosure $-\alpha_H$ randomization $-V_{ND}$ nondisclosure V_{ND} disclosure α_H disclosure u x

Disclosure strategy for type 1 manager

$-u$ disclosure $-\alpha_H$ disclosure $-V_{ND}$ nondisclosure V_{ND} randomization α_H disclosure u x

Disclosure strategy for type 0 manager

A standard result in discretionary disclosure models set within a capital markets framework (as exemplified by Verrecchia, 1983; Dye, 1985; Jung and Kwon, 1988) is that the manager will release his private information if, and only if, its valuation implications are above a threshold level.[24] The preceding analysis demonstrates that when the manager faces uncertainty over how disclosed data will be interpreted, the disclosure set may be disjoint, in that the manager will release information that is either sufficiently high or sufficiently low. This is because it is not the manager's interpretation of his information that is crucial in this setting; rather it is his belief about how the *analyst* will interpret it (with the manager's belief being a function of his private information, x) that determines his disclosure strategy.[25] Even if the manager knows that the valuation implication of his information is actually unfavorable, he will disclose it as long as the analyst is expected to interpret it favorably enough that the firm's date 2 market price will exceed its value without disclosure. For x close to u the manager believes it likely that the analyst who issued a favorable initial forecast is the type who interprets high values of x favorably. For x close to $-u$ the manager believes it likely that the analyst who issued a favorable forecast interprets low values of x favorably. In either case, the manager discloses his information because he expects the analyst to interpret it in a favorable manner.

4. Disclosure Strategy Conditional on an Unfavorable Prior Forecast

To analyze the case in which the analyst issued an unfavorable date 1 forecast it is again useful to calculate the manager's expectation for the analyst's revised forecast under the

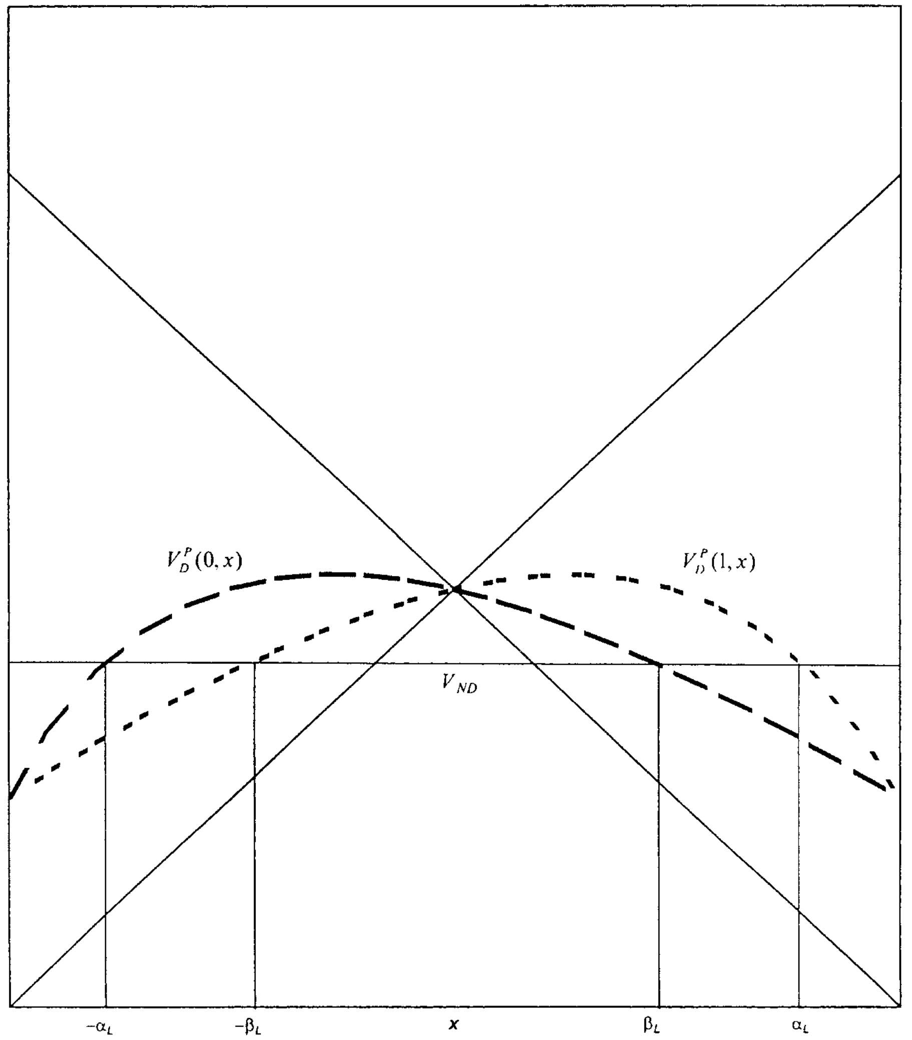


Figure 2. Expected date 2 price conditional on unfavorable initial forecast.

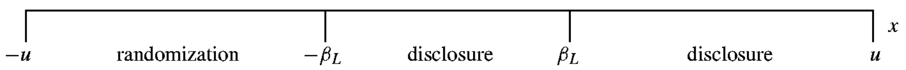
conjecture that both manager types disclose. These expectations are plotted as a function of x in Figure 2. As before, they are symmetric for the two types of managers. Moreover, the type 1 manager's expectation is less (greater) than that of the type 0 manager when x is below (above) its mean value of zero.

For each manager type $V_D^P(w, x)$ attains its minimum value at $x = -u$ and again at $x = u$. To understand why this is so, note that when the manager observes that $x = -u$, he knows that the analyst must have seen $s_x = L$. Along with an unfavorable date 1 forecast, this implies that she must have observed $s_w = 1$. This means that lower values of x will be interpreted more negatively by the analyst, and the lowest value of x, $x = -u$, will be interpreted most negatively. Similar intuition holds for $x = u$.

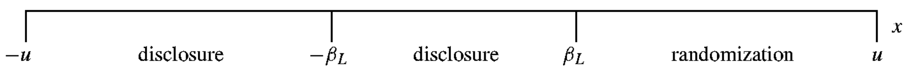
With this as introduction, the manager's equilibrium disclosure strategy can now be described. As depicted in Figure 2, for values of x below $-\alpha_L$, both $V_D^P(1, x)$ and $V_D^P(0, x)$ are less than V_{ND}. This does not mean, however, that both manager types will withhold their information in this region. Whether they do depends on the analyst's off-equilibrium-path beliefs. If the analyst conjectures, for example, that a disclosure in this region can only come from a type 0 manager, then both manager types would have an incentive to release their information, since the analyst's revised forecast under this conjecture is greater than V_{ND}. Thus, in this region, a strategy of nondisclosure cannot be robust to all off-equilibrium-path beliefs. An equilibrium that is robust up through point $-\beta_L$ is one in which the type 1 manager randomizes with a probability that equates his expectation for the analyst's revised forecast, conditional on disclosure, to V_{ND}. Since the type 0 manager's expectation is greater than that of the type 1 manager for all $x < 0$, he will disclose with probability one in this region. For all x between $-\beta_L$ and β_L, both $V_D^P(1, x)$ and $V_D^P(0, x)$ are greater than V_{ND}. Consequently, disclosure constitutes equilibrium behavior in this region. Finally, the strategies for x greater than β_L are just the mirror image of those for x less than $-\beta_L$.

The manager's equilibrium disclosure strategy is stated in the following proposition.

Proposition 2 *Conditional on the analyst disclosing an unfavorable forecast at date 1, there exists a robust equilibrium in which* $d_1(x) = d_0(-x)$ *for each* x*. The manager's equilibrium disclosure strategies are depicted in the following diagrams:*



Disclosure strategy for type 1 manager



Disclosure strategy for type 0 manager

These equilibrium strategies stand in sharp contrast to those which arise when the analyst issues a favorable initial forecast, in that there is now one disclosure and one randomization region for each manager type. The type 1 manager will withhold his information with positive probability for $x < -\beta_L$, while the type 0 manager will withhold it with positive probability when $x > \beta_L$. Once again, it is not the manager's interpretation of his information that is important in setting his disclosure strategy; rather it is his belief about the *analyst's* interpretation that matters.[26] For small (large) enough x the type 1 (type 0) manager believes that it is sufficiently likely that the analyst will interpret his information unfavorably, and so will choose to withhold it with positive probability.

At first glance, it might appear somewhat counterintuitive that the disclosure equilibrium described in Proposition 2 is not a 'mirror image' of that in Proposition 1. In particular, the equilibrium strategy following an unfavorable forecast might have been expected to entail the nondisclosure of extreme values of x with probability one. It can be shown that an alternative equilibrium having this characteristic does, in fact, exist. However, this equilibrium can only be sustained by certain off-equilibrium-path beliefs; it thus fails to satisfy the robustness criterion. It is perhaps not surprising that an appropriate 'fine-tuning' of the analyst's off-equilibrium-path beliefs is required to support this equilibrium, as the value implications of extreme news depend significantly on the nature of the analyst's beliefs. In contrast, the analyst's off-equilibrium-path beliefs play a much less crucial role in the equilibrium arising following a favorable forecast, as it is the more moderate values of x that are withheld in this case.

5. Conclusions

This paper has considered a setting in which a firm's manager can credibly disclose hard facts, but not their implications for firm value. Consequently, he faces uncertainty as to how those disclosed facts will be interpreted by investors. The analysis demonstrates that in the presence of such uncertainty, the manager's disclosure strategy changes in two significant ways. First, the strategy becomes conditional on the market's prior valuation of the firm since that valuation provides a clue as to how future disclosures are likely to be interpreted by investors. Second, the disclosure strategy can no longer be characterized, in general, by a single good news/bad news partition of the manager's private information. In the specific setting analyzed, it was shown that if the analyst covering the firm had previously released a favorable assessment of firm value, then the manager will disclose his information both when it is sufficiently low and when it is sufficiently high. In contrast, if the analyst had previously issued an unfavorable forecast, then information that is either sufficiently favorable or sufficiently unfavorable will be withheld with positive probability. These strategies are driven by the fact that it is the manager's assessment of the *analyst's* valuation of disclosed facts, not his own valuation, that determines whether private information will be disclosed.

The setting analyzed was one in which the fundamental value of the firm can be either an increasing or a decreasing function of factual information, depending on the firm's operating environment. While this assumption is a reasonable description of reality in many circumstances, there are other circumstances in which the relation can be only positive or only negative. In such settings, there will just be one disclosure region and one nondisclosure region. However, even in these cases the manager will condition his disclosure decision on the market's prior valuation of the firm as long as investors face *some* uncertainty about the value implications of his private information.

On a final note, consider briefly the impact on the manager's strategy of introducing additional analysts into the economy. While allowing for more than one analyst would make the analysis somewhat more complex, the basic forces driving the manager's disclosure decision should remain intact. In deciding whether to make a disclosure, the manager would now consider how each of the analysts would interpret it. Regardless of the manager's specific disclosure strategy, though, the two principal conclusions of this analysis would continue to hold, namely, that the manager's strategy will be impacted by the existence of uncertainty over the manner in which his information should be interpreted, and, as a consequence, it will be a function of the prior assessment of the firm's value in the marketplace.

Appendix

Some expressions which are useful in proving the results are first derived. Conditional on the manager having disclosed x, a type s_w analyst's ex-post probability that the disclosing manager is of type 1 is given by

$$\text{prob}(w = 1 \mid s_w, x) = \frac{pd_1(x)}{pd_1(x) + (1-p)d_0(x)} \tag{A.1}$$

for $s_w = 1$ and

$$\frac{(1-p)d_1(x)}{(1-p)d_1(x) + pd_0(x)} \tag{A.2}$$

for $s_w = 0$.[27]

For a type w manager who has observed a favorable date 1 forecast, the probability that the analyst saw $s_w = 1$ is given by:

$$\text{prob}(s_w = 1 \mid w, x, P_{1H}) = \frac{F(x)p}{F(x)p + (1 - F(x))(1-p)} \tag{A.3}$$

for $w = 1$ and

$$= \frac{F(x)(1-p)}{F(x)(1-p) + (1-F(x))p} \tag{A.4}$$

for $w = 0$.

Similarly, conditional on having observed an unfavorable date 1 forecast, this probability is given by:

$$\frac{(1-F(x))p}{(1-F(x))p + F(x)(1-p)} \tag{A.5}$$

for $w = 1$ and

$$\frac{(1-F(x))(1-p)}{(1-F(x))(1-p) + F(x)p} \tag{A.6}$$

for $w = 0$.

Lemma 1

a. $f(x \mid s_x = H) = f(-x \mid s_x = L)$ *and* $E(x \mid s_x = H) = E(-x \mid s_x = L)$.

b. $P_1(1, H) = P_1(0, L) > 0$ *and* $P_1(0, H) = P_1(1, L) < 0$.

Proof: To compute the posterior density function of x conditional on the signal $s_x = H$ note that

$$\text{prob}(s_x = H) = \int_{-u}^{u} F(x) f(x)\, dx.$$

Integrating the right hand side by parts reveals that $\text{prob}(s_x = H) = \frac{1}{2}$. Bayes' rule, therefore, yields

$$f(x \mid s_x = H) = 2F(x) f(x).$$

Similarly, it follows that

$$f(x \mid s_x = L) = 2(1 - F(x)) f(x).$$

Since $f(\cdot)$ is symmetric around $x = 0$, we have $f(x) = f(-x)$ and $F(x) = 1 - F(-x)$. This proves part (a).

To prove part (b), note that

$$P_1(0, L) = -(2p - 1) \cdot E(x \mid s_x = L),$$

and

$$P_1(1, H) = (2p - 1) \cdot E(x \mid s_x = H). \tag{A.7}$$

From part (a) of the lemma, $E(x \mid s_x = H) = -E(x \mid s_x = L)$, and hence it follows that $P_1(0, L) = P_1(1, H)$. Equation (A.7) reveals that $P_1(1, H) > 0$ since $p > \frac{1}{2}$ and $E(x \mid s_x = H) > E(x) = 0$. The second claim of part (b) follows similarly. ■

Lemma 2 *In a symmetric equilibrium:*

i. $V_D(0, x, P_1) = V_D(1, x, P_1)$ *for* $x \in \{-u, 0, u\}$*;*

ii. $V_D(0, x, P_1) > V_D(1, x, P_1)$ *for* $-u < x < 0$*, while* $V_D(0, x, P_1) < V_D(1, x, P_1)$ *for* $0 < x < u$*;*

iii. $V_D(0, x, P_1) = V_D(1, -x, P_1)$*;*

iv. $V_{ND}(w, x, P_1)$ *is independent of* w *and* x.

Proof: Only the proof for the case of $P_1 = P_{1H}$ will be presented here. The proof for $P_1 = P_{1L}$ follows along similar lines. For brevity, P_{1H} is not included as an argument of $V_D(\cdot)$ and $\text{prob}(s_w = 1 \mid w, x, \cdot)$. ■

Proof of parts (i), (ii), and (iii): Let $\Delta V \equiv V_D(1, x) - V_D(0, x)$. Then, combining (3) and (5) yields

$$\begin{aligned}\Delta V &= x \cdot (\text{prob}(w = 1 \mid 1, x) \\ &\quad - \text{prob}(w = 1 \mid 0, x)) \cdot (\text{prob}(s_w = 1 \mid 1, x) - \text{prob}(s_w = 1 \mid 0, x))\end{aligned} \tag{A.8}$$

Hence, $\Delta V = 0$ if $x = 0$. Note also that $\text{prob}(s_w = 1 \mid 1, x) = \text{prob}(s_w = 1 \mid 0, x)$ if $x = -u$ or $x = u$. Therefore, $\Delta V = 0$ for $x \in \{-u, u\}$. This proves part (i).

It is straightforward to verify that the second and third terms on the right hand side of (A.8) are strictly positive for all $x \in (-u, u)$. Therefore, $\text{Sign}[\Delta V] = \text{Sign}[x]$ for $x \in (-u, u)$. This proves part (ii).

Using the fact that $d_1(x) = d_0(-x)$ in a symmetric equilibrium, it can be shown from expressions (A.1) and (A.2) that $\text{prob}(w = 0 \mid 0, x) = \text{prob}(w = 1 \mid 1, -x)$. Substituting this into (3) reveals that $P_D(0, x) = P_D(1, -x)$. Furthermore, it follows from expressions (A.3) and (A.4) that $\text{prob}(s_w = 0 \mid 0, x) = \text{prob}(s_w = 1 \mid 1, -x)$. Hence (A.8) implies that $V_D(0, x) = V_D(1, -x)$. ■

Proof of part (iv): Expression (4) for the analyst's revised forecast (conditional on nondisclosure) can be written as:

$$P_{ND}(1, H) = p_{NI} \cdot E[v \mid s_w = 1, s_x = H, ND, NI] + (1 - p_{NI}) \cdot E[v \mid s_w = 1, s_x = H, ND, I], \quad \text{(A.9)}$$

where $I\,(NI)$ denotes the event that the manager has (has not) received information, and $q_R \equiv \text{prob}[NI \mid 1, H, ND]$ denotes the analyst's revised beliefs that the manager has not received any information. Straightforward calculations reveal that

$$q_R = \frac{1-q}{(1-q) + q\left[p\int_{-u}^{u}(1-d_1(x))f(x \mid s_x = H)\,dx + (1-p)\int_{-u}^{u}(1-d_0(x))f(x \mid s_x = H)\,dx\right]}$$

and

$$E[v \mid s_w = 1, s_x = H, ND, I] = \frac{p\int_{-u}^{u} x(1-d_1(x))f(x \mid s_x = H)\,dx - (1-p)\int_{-u}^{u} x(1-d_0(x))f(x \mid s_x = H)\,dx}{p\int_{-u}^{u}(1-d_1(x))f(x \mid s_x = H)\,dx + (1-p)\int_{-u}^{u}(1-d_0(x))f(x \mid s_x = H)\,dx}$$

Substituting these into (A.9) yields

$$P_{ND}(1, H) = \frac{(1-q)\cdot P_{1H} + q\left[p\int_{-u}^{u} x(1-d_1(x))f(x \mid s_x = H)\,dx - (1-p)\int_{-u}^{u} x(1-d_0(x))f(x \mid s_x = H)\,dx\right]}{(1-q) + q\left[p\int_{-u}^{u}(1-d_1(x))f(x \mid s_x = H)\,dx + (1-p)\int_{-u}^{u}(1-d_0(x))f(x \mid s_x = H)\,dx\right]} \quad \text{(A.10)}$$

Similarly, it can be shown that

$$P_2(0, L) = \frac{(1-q)\cdot P_{1H} + q\left[(1-p)\int_{-u}^{u} x(1-d_1(x))f(x \mid s_x = L)\,dx - p\int_{-u}^{u} x(1-d_0(x))f(x \mid s_x = L)\,dx\right]}{(1-q) + q\left[(1-p)\int_{-u}^{u}(1-d_1(x))f(x \mid s_x = L)\,dx + p\int_{-u}^{u}(1-d_0(x))f(x \mid s_x = L)\,dx\right]} \quad \text{(A.11)}$$

Using the facts that $d_1(x) = d_0(-x)$ and $f(x \mid s_x = H) = f(-x \mid s_x = L)$, (A.10) and (A.11) reveal that $P_{ND}(1, H) = P_{ND}(0, L)$. Therefore, it follows from expression (11) that $V_{ND}(1, x, P_{1H}) = V_{ND}(0, x, P_{1H})$ for each x, and that they are independent of x. This proves part (iv).

For future reference, note that the function $V_{ND}(P_1)$ is given by

$$V_{ND}(P_{1H}) = \frac{P_{1H} \cdot (1-q) + q \cdot \int_{-u}^{u} x(1-d_1(x))h(x)\,dx}{(1-q) + q \cdot \int_{-u}^{u}(1-d_1(x))h(x)\,dx} \tag{A.12}$$

for $P_1 = P_{1H}$, where

$$h(x) \equiv pf(x \mid s_x = H) + (1-p)f(x \mid s_x = L) \quad \text{and}$$

$$V_{ND}(P_{1L}) = \frac{P_{1L} \cdot (1-q) + q \cdot \int_{-u}^{u} x(1-d_1(x))l(x)\,dx}{(1-q) + q \cdot \int_{-u}^{u}(1-d_1(x))l(x)\,dx} \tag{A.13}$$

for $P_1 = P_{1L}$, where

$$l(x) \equiv (1-p)f(x \mid s_x = H) + pf(x \mid s_x = L).$$ ■

Proof: Substituting $d_1(x) = d_0(-x)$ and $f(x \mid s_x = H) = f(-x \mid s_x = L)$ into (A.10) and simplifying yields (A.12). (A.13) can be derived similarly. ■

Proof of Proposition 1: Before proceeding with the formal arguments, it will be useful to provide an outline of the steps to be followed. To show the existence of a symmetric disclosure equilibrium, the proof uses a fixed point argument. Recall from part (iv) of Lemma 2 that, in any symmetric disclosure equilibrium, the manager's expectation of the date 2 price (conditional on nondisclosure) will be independent of his type w as well as his information x. In step I of the proof the manager conjectures that the date 2 price conditional on nondisclosure will be some constant, denoted by V_{ND}. The manager's optimal disclosure strategy, given his conjecture V_{ND}, is then derived. In step II the analyst's response to the manager's disclosure strategy (from step I) is derived. In the process of doing so, the date 2 price conditional on nondisclosure, as implied by the manager's disclosure strategy in step I and expression (A.12) is computed. Let $\psi(V_{ND})$ denote this price. Step III of the proof then shows that there exists a conjecture that is self-fulfilling. That is, there is a V_{ND} such that $\psi(V_{ND}) = V_{ND}$.

For brevity, P_{1H} is suppressed as an argument of $V_D(\cdot)$. As in the text, let $V_D^P(w, x)$ denote the type w manager's expectation for the firm's date 2 market price, conditional on disclosure and the analyst's conjecture that both manager types disclose with probability one (that is, both managers pool on the act of disclosure). This expectation for any other disclosure strategy is simply written as $V_D(w, x)$. ■

Step I Substituting for $\text{prob}(s_w = 1 \mid 1, x)$ from expression (A.3) into (10) yields the type 1 manager's expectation for the firm's date 2 market price, conditional on disclosure and the analyst's conjecture that both manager types disclose with probability one. It is given by

$$V_D^P(1,x) = x \cdot (2p-1) \cdot \frac{F(x)-(1-p)}{F(x)p+(1-F(x))(1-p)} \tag{A.14}$$

Let $-x_c < 0$ denote the value of x for which $V_D^P(1,x) = 0$. Then differentiating (A.14) with respect to x shows that $V_D^P(1,x)$ is decreasing for all $x \in [-u, -x_c]$ and increasing for all x above 0.

Consider the following two cases:

Case I The manager conjectures that V_{ND} is in the interval $[0, P_{1H}]$. For a given conjecture V_{ND}, let $-\alpha_H$ denote the values of x (below 0) at which $V_D^P(1,x) = V_{ND}$.[28] Note that there exists a unique $-\alpha_H$ because (a) $V_D^P(1,-u) > P_{1H} \geq V_{ND}$, (b) $V_D^P(1,-x_c) = 0 < V_{ND}$, and (c) $V_D^P(1,x)$ is decreasing in x for all $x \in [-u,-x_c]$.

Consider now a given x in the interval $(-\alpha_H, -V_{ND})$. Holding the type 0 manager's disclosure strategy fixed at $d_0(x) = 1$, let $\delta(x)$ denote the probability of disclosure for the type 1 manager that will make him indifferent between disclosing and not disclosing his information. Such a $\delta(x)$ exists because (i) if $d_1(x) = 1$ (that is, if both manager types disclose with probability one), then $V_D(1,x) = V_D^P(1,x) < V_{ND}$ and (ii) if $d_1(x) = 0$ (that is, if only the type 0 manager discloses), the analyst will issue a forecast of $-x$ regardless of his prior information s_w. Thus, if $d_1(x) = 0$, then $V_D(1,x) = -x > V_{ND}$.

The next step is to show that, given the conjecture V_{ND}, the following symmetric disclosure strategy is optimal:

$$\begin{aligned}
&d_1(x) = d_0(x) = 1 \quad \text{if } x \in [-u, -\alpha_H] \\
&d_1(x) = \delta(x) \quad \text{and} \quad d_0(x) = 1 \quad \text{if } x \in [-\alpha_H, -V_{ND}] \\
&d_1(x) = d_0(x) = 0 \quad \text{if } x \in [-V_{ND}, V_{ND}] \\
&d_1(x) = 1 \quad \text{and} \quad d_0(x) = \delta(-x) \quad \text{if } x \in [V_{ND}, \alpha_H] \\
&d_1(x) = d_0(x) = 1 \quad \text{if } x \in [\alpha_H, u].
\end{aligned} \tag{A.15}$$

When $x \in (-V_{ND}, V_{ND})$, disclosure is an off-equilibrium action. In this case, let the analyst hold any off-equilibrium beliefs. For all other values of x, the analyst's posterior beliefs (conditional on disclosure) are uniquely determined by the disclosure strategy (A.15) and Bayes' rule.

To show that the disclosure strategy in (A.15) is optimal, consider the following four regions:

i. $x \in [-u, -\alpha_H]$

In this region it is optimal for both types of managers to disclose with probability one. To see this, note that $V_D^P(1,x) > V_{ND}$. Therefore, $d_1(x) = 1$ is optimal. For x below 0, $V_D^P(0,x) > V_D^P(1,x)$ by Lemma 1. This means that $d_0(x) = 1$ is also optimal.

ii. $x \in [-\alpha_H, -V_{ND}]$

In this region, by definition of $\delta(x)$ the type 1 manager is indifferent between disclosing and not disclosing (that is, $V_D(1, x) = V_{ND}$). Thus, it is an optimal strategy for the type 1 manager to randomize with probability $\delta(x)$. For x below 0, Lemma 1 implies that $V_D(0, x) > V_D(1, x)$, and hence $V_D(0, x) > V_{ND}$. This means that it is optimal for the type 0 manager to disclose with probability one.

iii. $x \in [-V_{ND}, 0]$
In this region, regardless of the analyst's off-equilibrium beliefs, both types of managers are better off by not disclosing. To see this, note that $-x$ is the upper bound on the analyst's date 2 forecast (conditional on disclosure of x). In this region, however, $V_{ND} > -x$. Hence, $d_1(x) = d_0(x) = 0$ is optimal.

iv. $x \in [0, u]$
Using the symmetry of the disclosure strategy, one can verify that it is also optimal in this region.

Case II The Manager Conjectures that $V_{ND} < 0$. For a given conjecture V_{ND} there are two values of x at which $V_D^P(1, x) = V_{ND}$.[29] Denote these values of x by $-\alpha_1$ and $-\alpha_2$. As before, for every x between $-\alpha_1$ and $-\alpha_2$, let the type 0 manager's disclosure strategy be fixed at $d_0(x) = 1$ and let $\delta(x)$ denote the probability of disclosure for the type 1 manager that makes him indifferent between disclosing and not disclosing. It can be verified that there exists such a $\delta(x)$. As before, it can be shown that, given the conjecture V_{ND}, the following symmetric disclosure strategy is optimal:

$$\begin{aligned}
&d_1(x) = d_0(x) = 1 \quad \text{if } x \in [-u, -\alpha_1] \\
&d_1(x) = \delta(x) \quad \text{and} \quad d_0(x) = 1 \quad \text{if } x \in [-\alpha_1, -\alpha_2] \\
&d_1(x) = d_0(x) = 1 \quad \text{if } x \in [-\alpha_2, \alpha_2] \\
&d_1(x) = 1 \quad \text{and} \quad d_0(x) = \delta(-x) \quad \text{if } x \in [\alpha_2, \alpha_1] \\
&d_1(x) = d_0(x) = 1 \quad \text{if } x \in [\alpha_1, u].
\end{aligned} \tag{A.16}$$

Step II Let $\psi(V_{ND})$ denote the date 2 forecast (conditional on nondisclosure) that is consistent with the disclosure strategy in step I (that is, the strategy (A.15) or (A.16)). Then (A.12) implies that

$$\psi(V_{ND}) = \frac{P_{1H} \cdot (1-q) + q \cdot \int_{-\alpha_H}^{V_{ND}} x(1 - d_1(x))h(x)\,dx}{(1-q) + q \cdot \int_{-\alpha_H}^{V_{ND}} (1 - d_1(x))h(x)\,dx}. \tag{A.17}$$

for $V_{ND} > 0$ and

$$\psi(V_{ND}) = \frac{P_{1H} \cdot (1-q) + q \cdot \int_{-\alpha_1}^{-\alpha_2} x(1 - d_1(x))h(x)\,dx}{(1-q) + q \cdot \int_{-\alpha_1}^{-\alpha_2} (1 - d_1(x))h(x)\,dx} \tag{A.18}$$

for $V_{ND} \leq 0$

Step III To complete the proof, it is shown that the function $\psi(\cdot)$ has a fixed point. Let $-V_m < 0$ denote the minimum value of $V_D^P(1, x)$. If the manager conjectures that $V_{ND} = -V_m$, then it will be optimal for the manager (of each type) to disclose with probability one. Consequently, substituting $d_1(x) = 1$ in expression (A.18) yields that $\psi(-V_m) = P_{1H}$. Expression (A.17) for $\psi(V_{ND})$ can be written as a convex combination of P_{1H} and $E_H(x)$, where $E_H(x)$ denotes the expected value of x with respect to the density function

$$H(x) \equiv \frac{(1 - d_1(x))h(x)}{\int_{-\alpha_H}^{V_{ND}} (1 - d_1(x))h(x)\,dx}$$

between the points $-\alpha_H$ and V_{ND}. Consequently, $E_H(x) < V_{ND}$. This implies that $y(V_{ND}) < P_{1H}$ for the conjecture $V_{ND} = P_{1H}$. That $\psi(-V_m) = P_{1H}$ and $\psi(P_{1H}) < P_{1H}$ imply that the function $\psi(\cdot)$ has a fixed point V_{ND} in $(-V_m, P_{1H})$. Therefore, if the fixed point V_{ND} is positive (negative), then the disclosure strategy (A.15, A.16) constitutes an equilibrium.

Proof of Proposition 2: The proof follows the same steps as that of Proposition 1. ■

Step I Substituting for prob$(s_w = 1 \mid 1, x)$ from expression (A.5) into (10) yields

$$V_D^P(1, x) = (2p - 1) \cdot x \cdot \frac{p - F(x)}{F(x) \cdot (1 - p) + (1 - F(x)) \cdot p}. \tag{A.19}$$

It is easy to verify that $V_D^P(1, x)$ increases in x for $x \in [-u, 0]$, achieves its minimum value at $x = -u$ and $x = u$, and reaches its maximum at some $x \in (0, u)$. Let $-V_m < 0$ denote the minimum value of $V_D^P(1, x)$.[30]

Given a conjecture V_{ND} in the interval $[-V_m, P_{1L}]$, let $-\beta_L$ denote the values of x (below 0) at which $V_D^P(1, x) = V_{ND}$. It can be verified that there exists a unique $-\beta_L$. Now consider a given x in the interval $[-u, -\beta_L]$. Holding the type 0 manager's disclosure strategy fixed at $d_0(x) = 1$, let $\delta(x)$ denote the probability of disclosure for the type 1 manager that will make him indifferent between disclosing and not disclosing. Such a $\delta(x)$ exists because: (i) when $d_1(x) = 1$, $V_D(1, x) = V_D^P(1, x) < V_{ND}$ and (ii) when $d_1(x) = 0$ (that is, only the type 0 manager discloses), each analyst type will issue a forecast of $-x$. Hence $V_D(1, x) = -x > V_{ND}$ when $d_1(x) = 0$.

Next it is easy to verify that, given the conjecture V_{ND}, the following symmetric disclosure strategy is optimal:

$$\begin{aligned} &d_1(x) = \delta(x) \quad \text{and} \quad d_0(x) = 1 \quad \text{if } x \in [-u, -\beta_L] \\ &d_1(x) = d_0(x) = 1 \quad \text{if } x \in [-\beta_L, \beta_L] \\ &d_1(x) = 1 \quad \text{and} \quad d_0(x) = \delta(-x) \quad \text{if } x \in [\beta_L, u] \end{aligned} \tag{A.20}$$

Step II Let $\psi(V_{ND})$ denote the date 2 price conditional on nondisclosure, as implied by the disclosure strategy (A.20) and expression (A.13). It is given by

$$\psi(V_{ND}) = \frac{P_{1L} \cdot (1 - q) + q \cdot \int_{-u}^{-\beta_L} x(1 - d_1(x))l(x)\,dx}{(1 - q) + q \cdot \int_{-u}^{-\beta_L} (1 - d_1(x))l(x)\,dx}. \tag{A.21}$$

Step III To complete the proof, it is next shown that the function $\psi(\cdot)$ has a fixed point. Suppose the manager conjectures that $V_{ND} = -V_m$. Then it will be optimal for the manager (of each type) to disclose with probability one. Consequently, substituting $d_1(x) = 1$ in expression (A.21) yields that $\psi(-V_m) = P_{1L}$. On the other hand, if the manager conjectures that $V_{ND} = P_{1L}$, then $\psi(V_{ND}) < P_{1L}$. To prove this, it suffices to show that $-\beta_L$ (which denotes the value of x at which $V_D^P(1, x) = V_{ND}$) is less than P_{1L}. Since $V_D^P(1, P_{1L}) > P_{1L}$ and $V_D(1, x)$ is increasing in x (for x below 0), it follows that $-\beta_L < P_{1L}$ for the conjecture $V_{ND} = P_{1L}$. Consequently, the function $\psi(\cdot)$ has a fixed point V_{ND} in $(-V_m, P_{1L})$.

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Notes

1. In this paper differences in the interpretation of information stem from differences in the prior information sets of market participants (as in Indjejikian, 1991; and Kim and Verrecchia, 1994) and not from irrationalities in the way that some investors revise their beliefs (as in Harris and Raviv, 1993; and Daniel, Hirshleifer, and Subramanayam, 1998).
2. The assumption of truth-telling is common in the literature and is justified, for example, by the existence of potentially large penalties for false disclosures.
3. The impact of introducing additional analysts into the economy is discussed in Section 5.
4. The assumption of symmetry is commonly employed in the literature and encompasses, among other distributions, the normal, beta, and uniform. Its use greatly simplifies the analysis. Dropping this assumption is not expected to change the qualitative nature of our conclusions.
5. There are many settings consistent with expression (1). Consider, for example, a firm that had previously undertaken some research and development activities and now receives updated information about the success of those efforts. In this example x is the expenditure on research and development activities, while w is the updated information as to whether these investments will be successful ($w = 1$) or not ($w = 0$). Higher values of x imply higher future payoffs (higher firm value) if the firm's research and development efforts have turned out to be successful. If they have failed, higher values of x imply lower payoffs (lower firm value).
6. Without affecting the analysis, v could have alternatively been set equal to $(2w - 1)x + k$, where k is a constant greater than or equal to u. This formulation would ensure that v is nonnegative for all possible values of w and x. Note that expression (1) is equivalent to θx, where $\theta \in \{-1, +1\}$.
7. As will become clear, the assumption that firm value can either increase or decrease with x, depending on the firm's operating environment, drives the finding of disjoint disclosure/nondisclosure regions. In settings where the relation between firm value and x can only be positive or only negative, there will be just one disclosure/nondisclosure partition. However, a key result of this analysis, that the manager will condition his disclosure decision on the market's prior valuation of the firm, will continue to hold as long as investors face *some* uncertainty about the value implications of his private information.
8. See Lemma 1 in the Appendix for a formal proof of this assertion.
9. If the manager observed x with probability 1, then the standard unraveling argument would apply: under the skeptical beliefs that nondisclosure implies the worst possible news (that is, $v = -u$), the manager would disclose his information regardless of its value.
10. Allowing the manager to learn the value of w only imperfectly (or not at all) would not affect the qualitative nature of the paper's results. This makes sense, as it is the manager's assessment of how the analyst will interpret information that determines his disclosure strategy.
11. The mechanism ensuring that only truthful disclosures of x are made is not formally modeled in the paper.

12. This is a standard assumption in the discretionary disclosure literature.
13. That the manager seeks to maximize the current market price is a common assumption in single-period disclosure models. It can be motivated, for example, by a need to issue shares to the market later in the period. In a repeated game, the manager is likely to also consider the effect of his actions on future periods' market prices in determining his disclosure strategy.
14. Standard equilibrium refinement concepts, such as the intuitive criterion of Cho and Kreps (1987) or the divinity condition of Banks and Sobel (1987), require that off-equilibrium-path beliefs should be 'reasonable.' A robust equilibrium will pass any such refinement test because it can be supported by *any* choice of off-equilibrium-path beliefs. It is for this reason that Rasmusen (1994, p. 151) refers to it as 'completely robust.'
15. In this case the analyst conditions her forecast on s_x since x has not been revealed to her.
16. That both the manager and analyst are making inferences about the private information of the other contrasts with standard disclosure models which assume that only one party is privately informed.
17. Expression (6) makes use of the fact that a favorable date 1 forecast must have come either from an analyst who observed $s_w = 1$ and $s_x = H$ or from one who observed $s_w = 0$ and $s_x = L$. Similarly, expression (7) reflects the fact that an unfavorable date 1 forecast could only have come from an analyst who observed either $s_w = 1$ and $s_x = L$ or $s_w = 0$ and $s_x = H$.
18. See Lemma 2 in the Appendix for a formal proof. The driving force behind this result is that the analyst's posterior beliefs remain symmetric (that is, $\text{prob}(w = 1 \mid 1, s_x, ND) = \text{prob}(w = 0 \mid 0, s_x, ND)$ for each s_x) in a symmetric equilibrium.
19. That the manager's expectation of the analyst's revised forecast (conditional on nondisclosure) does not depend on his private information in a symmetric equilibrium greatly simplifies the proofs. The assumptions necessary for the equilibrium to be symmetric are that (i) the manager's valuation is symmetric (that is, the type 0 manager's valuation when he observes x is the same as that of the type 1 manager when he observes $-x$) and (ii) x is symmetrically distributed. In more general settings, the manager's expectation of the analyst's revised forecast (conditional on both nondisclosure and disclosure) will depend on his private information (w, x). Though the derivation of the manager's equilibrium disclosure strategy will become significantly more complicated in such cases, the qualitative nature of the results is expected to be unaffected.
20. For notational simplicity the argument P_{1H} is suppressed in the expression for $V_D^P(\cdot, \cdot)$.
21. Lemma 2 in the Appendix provides a formal proof of these assertions.
22. There are two possible cases to consider, depending on whether V_{ND} is greater or less than 0 in equilibrium. Discussion here will focus on the case of $V_{ND} > 0$; the results for the case of $V_{ND} < 0$ are qualitatively similar and are presented in detail in the Appendix.
23. The nonexistence of a pure-strategy equilibrium is not surprising, given that there exist just a finite number of manager types. It is expected that a pure-strategy equilibrium would emerge in a more general setting, where the manager's type, w, takes a continuum of values. Though such a setting would be much more complex to analyze, it is likely to yield qualitatively similar insights.
24. Non-convex disclosure sets are obtained by Feltham and Xie (1992) and Wagenhofer (1990) in settings involving both the capital and product markets and Trueman (1997) in a setting where managers may be required to pay damages for withholding negative information.
25. It can be shown that even if the manager had no information about w, the equilibrium disclosure strategy would be qualitatively similar (though not identical) to that in Proposition 1. This observation further highlights the fact that the key determinant of the manager's disclosure strategy is his assessment of the market's valuation of his private information, rather than his own valuation.
26. It can be shown that if the manager did not have any information about w, he would withhold extreme information and disclose more moderate news. This disclosure strategy is qualitatively similar to that of Proposition 2.
27. These expressions apply only when disclosure is not an off-equilibrium-path strategy.
28. Referring to Figure 1 will be helpful in following the arguments of the proof.
29. To simplify the exposition, and without loss of generality, it is assumed that the function $V_D^P(1, x)$ is unimodal (that is, it achieves a unique local minimum). If it were not unimodal, then there could be more than two values of x at which $V_D^P(1, x) = V_{ND}$. However, the qualitative nature of the equilibrium as well as the logic of the proof would remain unchanged. It should be noted that if x is uniformly distributed, then the function $V_D^P(1, x)$ is indeed unimodal.
30. For the following arguments it will be helpful to refer to Figure 2.

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