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Disclosure of Nonproprietary Information

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1. *Introduction*

In this paper, I provide two theories about why management might withhold information which is not proprietary, together with an analysis of the consequences of altering various assumptions underlying these theories. Proprietary information is considered here as any information whose disclosure potentially alters a firm's future earnings gross of senior management's compensation.[1] Even if a manager's private information is proprietary, shareholders may benefit occasionally from having this information disclosed (see Verrecchia [1983] and Dye [1984*a*]), although obvious explanations exist for the rarity of such disclosures. However, it is commonly believed that managers possess information about the firms they run, such as annual earnings' forecasts, whose release would affect the prices of their firms, but not the distribution of their firms' future

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[1] This includes information whose disclosure could generate regulatory action, create potential legal liabilities, reduce consumer demand for its products, induce labor unions or other suppliers to renegotiate contracts, or cause revisions in the firm's credit standing in addition to that information which is, in the traditional sense, strategically valuable. Obviously, the characterization of some information as proprietary and other information as nonproprietary is a simplification introduced to facilitate the analysis, given this broad view of proprietary information. Also, what constitutes nonproprietary information must be defined in reference to a particular set of expectations about a particular firm's future earnings. In the succeeding discussion, all market participants share the common belief that the private information contemplated to be released by the firm being studied is nonproprietary.

earnings. The reluctance of managers to disclose such nonproprietary information is the subject of this paper.

The withholding of nonproprietary information is puzzling for two reasons. First, there seems to be considerable agreement among researchers in accounting, economics, and finance that if investors know that managers possess nonproprietary information, then they will release it. This claim (which I call the disclosure principle) is based on a simple, but compelling, adverse selection argument. Current (wealth-maximizing) shareholders prefer managers who adopt policies designed to increase the market value of their shares. Since the market value of the firm before and after each management disclosure is publicly observable, in principle, shareholders could design incentive contracts which encourage managers to suppress information unfavorable to the firm's value and release information which increases the price of the firm. But if investors know that a manager has information which has not been released, they correctly will infer that the current market price of the firm overstates the firm's values, based on the (unfavorable) information withheld by the manager. Accordingly, investors will revise downward their demands for the firm's shares, and the price of the firm will fall precipitously until the manager releases the information. In effect, the manager is encouraged to disclose the information to distinguish it from the worst information he could possibly have. Managers disclose all of their nonproprietary information, good and bad, to prevent the price of their firms' securities from plummeting. Of course, in practice, security prices do not cascade downward when a manager fails to disclose nonproprietary information.

In the succeeding sections I present several reasons that the disclosure principle does not hold in this instance, although it seems to in other contexts (e.g., in consumer goods markets—see Grossman [1981*a*; 1981*b*] and Milgrom [1981], and with takeover bids—see Grossman and Hart [1980]).

A second reason the nondisclosure of nonproprietary is puzzling stems from the revelation principle (see Myerson [1979] and Harris and Townsend [1981]). According to that principle, any contract can be rewritten in a way which induces full revelation of all private information held by the parties to it without affecting the payments they receive. Although this principle seems to explain a variety of economic phenomena, including the construction of accounting-based contracts, it gives rise to a major enigma when applied to the study of voluntary disclosure since it implies that full disclosure is always compatible with optimal resource allocation. Legitimate theories of the nondisclosure of nonproprietary information, therefore, must assume either (1) that shareholders whimsically choose to contract with their managers in a way which induces managers not to disclose nonproprietary information (i.e., they ignore possibilities of full disclosure made available by the construction of contracts in accordance with the revelation principle) or (2) that the hypotheses of the revelation principle are not satisfied in most contexts involving management compensation. The first explanation is unsatisfactory; the second is explored in more detail below.

In section 2, I amend the disclosure principle verbally by adding to it several qualifications in an attempt to make it a "true" proposition. This attempt turns out to be futile because of the inherent ambiguity of prose. Then, I propose a simple taxonomy for theories of disclosure based on this attempt to qualify the disclosure principle. In section 3, I present one simple disclosure theory which leads to a nondegenerate disclosure policy to illustrate one class of disclosure theories. The model on which this theory is based hinges on the assumption that investors may be uncertain about the nature of the information a manager possesses.

Section 4 is devoted to an illustration of another class of disclosure theories. There, I establish that it may be to the mutual benefit of both managers and shareholders not to have managers disclose information which investors know they have and which does not affect the firm's earnings (exclusive of management compensation). Under such conditions, the only situation in which a disclosure problem can arise is in a principal–agent context where the manager's contract depends on the value of the firm. I show that, in some cases, the manager's release of his private information may adversely affect the contractual relationship between the shareholders and managers of a firm. The model in section 4 highlights the distinction between information which is useful for forecasting purposes and information which is useful for contracting purposes. Related distinctions may be found in Gjesdal [1981]. The model also establishes that, even though writing contracts with a manager over the price of the firm may be desirable when investors' information is impounded in the firm's price (as suggested by Diamond and Verrecchia [1982]), such contracts may be subverted when the manager makes disclosures which affect the firm's price. In section 5, the relationship between disclosure theories and the revelation principle is discussed. Finally, section 6 provides conclusions.

2. *Amended Disclosure Principle*

One reason the disclosure principle may not adequately characterize a management's disclosure policy is that the manager's information may not be verifiable. Actually, even if a manager's information is completely unauditable, compensation schemes which encourage the manager to divulge his information truthfully are easy to construct, simply by making the manager's compensation independent of his disclosure.[2]

A second possible justification for the absence of disclosure is that unresolvable "tension" exists between managers (insiders) and other

[2] In fact, strict gains to both managers and shareholders may exist by having the manager disclose his nonverifiable, private information; see, e.g., Baiman and Evans [1983], Dye [1983], and Penno [1984].

shareholders which discourages managers from releasing information which investors want. The arguments contained in Baiman and Evans [1983], Dye [1983; 1984*c*], and Penno [1984] establish that this claim, which presumes that managers and shareholders are in effect engaged in a zero-sum game, is unfounded.

A third possible explanation for a manager's nondisclosure of nonproprietary information is that its release would be costly either directly or indirectly. However, this too is not an acceptable explanation since, by definition, the release of nonproprietary information incurs no direct or indirect dissemination costs, except possibly through its effect on the manager's compensation.[3]

A legitimate explanation for the nondisclosure of management's nonproprietary information arises from the fact that investors are often unsure whether the manager has any such information—or, more generally, are uncertain about the kind of information held by management. This is an important qualification to the disclosure principle and can lead managers to suppress some information which they possess. A formal model of this possibility is presented in section 3.

Other qualifications to the disclosure principle are also appropriate.

(1) The nonproprietary information managers hold must be relevant (i.e., the release of which might alter the price of the firm with positive probability) and capable of transmission.

(2) Risk-averse investors must be allowed to take positions on markets so as to ensure themselves against the information the manager discloses. Otherwise, they may prefer suppression of this information (see section 4). However, without a compelling argument for the absence of such markets this qualification is unimportant.

(3) Managers possess a variety of private information, and not simply one particular piece of information. If all of this information is nonproprietary, and its release would not affect management's compensation, then the disclosure principle would apply, and all of this information would be released. But if a manager possesses both proprietary and nonproprietary information, then the failure to release the latter would not induce the price of the firm to fall precariously simply because the price of the firm depends on the market's estimates of both the nonproprietary and proprietary components of the manager's information. A theory based on this observation is developed in Dye [1984*b*].

The preceding discussion may be summarized by the following amended statement of the disclosure principle.

[3] I do not wish to include in the definition of proprietary information that information which affects the firm's earnings only through alterations in the manager's compensation because shareholders may select a particular management compensation scheme to induce a particular disclosure policy. If such information is labeled as proprietary, then no compensation scheme which depends on the manager's disclosures can be studied within the context of nonproprietary disclosures.

2.1 THE DISCLOSURE PRINCIPLE

If investors know a manager is endowed with one particular bit of nonproprietary, relevant, effable information, the release of which does not alter the manager's compensation, and investors can take positions on markets prior to this information's release, then this information will be disclosed.

Further qualifications of the disclosure principle are possible, but it is pointless to continue listing them since any resulting verbal statement of this principle will continue to rely on implicit assumptions whose violation would render the statement incorrect. Rather than follow this futile route, I shall proceed by examining the consequences of relaxing three critical qualifications to the preceding amended statement of the disclosure principle—two here and one in a companion paper (Dye [1984*b*]). Specifically, here I consider disclosure policies when (*i*) the investors may be unaware that the manager has nonproprietary information (see section 3 below) and (*ii*) the release of the manager's information affects the future earnings of the firm only through its effect on the manager's compensation (see section 4 below). The case in which the manager is endowed both with proprietary and nonproprietary information is examined in Dye [1984*b*].

3. *Disclosure Policies When Managers' Endowment(s) of Information Are Unknown*

A formal model of the case in which managers suppress bad news because investors are unaware of their endowment(s) of information can be constructed as follows.

A firm is in operation for several periods and investors are risk-neutral. The expected present value of the firm is assumed to be beyond the control of the manager (so moral hazard problems do not arise here). With probability $(1 - p)$, which is exogenous, the manager receives updated information superior to the information held by any other investor regarding the expected present value of the firm. The unconditional expected value of this information is $\mu = E\tilde{x}$, and this is known to all investors. However, the value of any realization, denoted by x (if obtained), is known only to the manager. The manager can make credible announcements regarding the value of this information, when he receives it. Consequently, if he announces x, the equilibrium price of the firm becomes x. If the manager announces nothing, the investors cannot discern whether he has received information but chosen not to release it or whether he has not received information. In particular, the manager is assumed to be incapable of making a credible announcement that he has not received new information.[4] This asymmetry (in credible an-

[4] Alternatively, suppose that the manager *can* respond credibly to the question—"Have you received any information this period?"—but there is a positive probability q (because

nouncements) could arise from the ease in auditing a particular announced value of x, as compared to the difficulty in verifying that the manager has not received any information. Since there are no moral hazard problems, the manager will be paid a wage and will adopt any disclosure policy chosen by the firm's period-one shareholders. In a world with incomplete markets, agreement by the firm's shareholders to a disclosure policy poses the same difficulties as does agreement to an investment policy. I shall assume that the current shareholders prefer a disclosure policy which maximizes the first-period price of the firm.[5] Assuming this disclosure policy is adopted, the manager will not reveal x (when obtained) if x belongs to the following set, D:

$$D = \{x \mid p\mu + (1 - p)E[\tilde{x} \mid \tilde{x} \in D] \geq x\}.$$

In words, D is the set of realizations of x for which the period-one price of the firm in the event of no disclosure, $p\mu + (1 - p)E[\tilde{x} \mid \tilde{x} \in D]$ exceeds the price of the firm x if disclosure were to occur. Notice that D is defined in terms of itself. Whether D is well defined—whether an equilibrium disclosure policy exists—depends upon assumptions underlying the distribution of $\tilde{x}$. The following theorem provides one set of conditions sufficient to ensure the existence of an equilibrium disclosure policy.

3.1 THEOREM 1

If the density $f(\cdot)$ of $\tilde{x}$ exists and is positive throughout its support $[0, \bar{x}]$ with $\bar{x} > 0$, then an equilibrium nondegenerate disclosure policy exists, and no policy of complete disclosure is an equilibrium.

3.1.1. Proof. For any fixed D, define $D' = \{x \geq 0 \mid p\mu + (1 - p)E[\tilde{x} \mid D] \geq x\}$. Notice that, by definition of D', if $x \in D'$ and $0 \leq x' \leq x$, then $x' \in D'$. Hence, there exist some x, denoted $\underset{\sim}{x}$, such that $D' = [0, \underset{\sim}{x}]$. Clearly,

of the costs of repeat inquiries) that this question was not posed this period. Also suppose that, in addition to making voluntary public announcements (without being questioned) when such announcements increase the firm's value, the manager publicly announces his information when he (1) has information and (2) is asked about it, but privately (and credibly) responds when he is asked but does not have information. (Public announcements that managers do not have information waste media resources.) Then, the lack of an announcement could be due to the possibility that he has no information or that he has information but was not asked about it. If value-maximization is still the manager's objective, then the set D over which he does not disclose information, given that he has information but was not asked about it, is defined by:

$$D = \{x \mid (1 - q)\mu + q[p\mu + (1 - p)E[\tilde{x} \mid \tilde{x} \in D]] \geq x\}$$
$$= \{x \mid (1 - q + pq)\mu + q(1 - p)E[\tilde{x} \mid \tilde{x} \in D] \geq x\}.$$

Clearly, the scenario above is completely consistent with the formal model in the text, so even if the manager can make credible announcements that he does not have information, he may nevertheless *not* always disclose his information.

[5] Of course, this does not require shareholders to be indifferent toward future consumption (cf. literature on unanimity regarding firms' investment policies), though it may imply some restrictions on shareholders' preferences for the resolution of uncertainty.

an equilibrium exists iff for some $\underset{\sim}{x}$:

$$p\mu + (1-p)E[\tilde{x} \mid \tilde{x} \in [0, \underset{\sim}{x}]] = \underset{\sim}{x}, \tag{1}$$

(in which case disclosure occurs iff $x \geq \underset{\sim}{x}$). Straightforward manipulation shows that (1) is equivalent to (2) (where F is the cumulative distribution function of $\tilde{x}$):

$$p\left[\bar{x} - \underset{\sim}{x} - \int_{\underset{\sim}{x}}^{\bar{x}} F(\tilde{x})\, d\tilde{x}\right] = \left(\frac{1-p}{F(\underset{\sim}{x})} + p\right) \int_0^{\underset{\sim}{x}} F(\tilde{x})\, d\tilde{x}. \tag{2}$$

At $\underset{\sim}{x} = 0$, *LHS* of (2) equals $p\mu > 0$ and the *RHS* equals (by applying L'Hospital's rule) zero. At $\underset{\sim}{x} = \bar{x}$, *LHS* of (2) equals zero and the *RHS* equals $\int_0^{\bar{x}} F(\tilde{x})\, d\tilde{x} > 0$. Both sides of (2) are continuous in $\underset{\sim}{x}$, so there exists some $\underset{\sim}{x} \in (0, \bar{x})$ satisfying (2), which establishes the existence of a nondegenerate equilibrium disclosure policy. To complete the proof, note that a policy of complete disclosure corresponds to $\underset{\sim}{x} = 0$, which (as was noted above) does not satisfy (2), and is hence not an equilibrium.

The economically interesting conclusion of Theorem 1 is that no policy of full disclosure is an equilibrium when investors may be unaware that managers have received any private information, given that (as assumed above) managers cannot make credible announcements that they have not received information.

An example may clarify Theorem 1. Suppose $\tilde{x}$ is uniformly distributed on $[0, b]$. The set D is of the form $[0, \underset{\sim}{x}]$ for some $\underset{\sim}{x}$ satisfying:

$$pb/2 + (1-p)E[\tilde{x} \mid \tilde{x} \in [0, \underset{\sim}{x}]] = \underset{\sim}{x}$$

or:

$$pb/2 + (1-p)\underset{\sim}{x}/2 = \underset{\sim}{x}.$$

Clearly:

$$\underset{\sim}{x} = pb/(1+p)$$

so the probability of no disclosure, given that $\tilde{x}$ is received, is $p/(1+p) > 0$.

According to Theorem 1, the manager may suppress the release of bad news because investors are unaware that the manager has any news. But it seems unlikely that even very bad news can be suppressed by the manager indefinitely, even in the absence of organizational "leaks" or investigations by financial analysts. All that is required is that investors believe the probability that the manager has received private information increases over time. The following corollary demonstrates this result formally in the case where, given that news is received, good news is less likely than bad news.[6]

3.2 COROLLARY 1

Under the hypotheses of Theorem 1, if the density f is nonincreasing throughout its support, then the set of $\tilde{x}$'s over which disclosure does not

[6] Counterexamples to this result can be generated if restrictions, such as this one, are not imposed on the density of $\tilde{x}$.

occur shrinks as the probability $1 - p$ of receiving private information increases.

3.2.1. Proof. Let $\underset{\sim}{x} = \underset{\sim}{x}(p)$ solve (1). The derivative of *LHS* of (1) with respect to $\underset{\sim}{x}$ equals:

$$(1 - p) \int_0^{\underset{\sim}{x}} [F(\tilde{x})/F(\underset{\sim}{x})^2] f(\underset{\sim}{x})\, d\tilde{x} < \frac{1 - p}{2} < 1, \tag{3}$$

so $\underset{\sim}{x}(p)$ is differentiable in p by the implicit function theorem. Differentiate (1) totally with respect to p to obtain:

$$\mu - E[\tilde{x} \mid \tilde{x} \in [0, \underset{\sim}{x}]] = \left(1 - \frac{(1 - p) f(\underset{\sim}{x})}{F(\underset{\sim}{x})^2} \int_0^{\underset{\sim}{x}} F(\tilde{x})\, d\tilde{x}\right) \underset{\sim}{x}'(p). \tag{4}$$

Since $\underset{\sim}{x} = \underset{\sim}{x}(p) \in (0, \bar{x})$, *LHS* of (4) is positive. The coefficient of $\underset{\sim}{x}'(p)$ is positive by (3), so $\underset{\sim}{x}'(p) > 0$, as claimed.

Also note equation (1) above implies that, as the probability of receiving information approaches one, almost all information is disclosed. In contrast, when this probability approaches zero, information is disclosed only if it is above the unconditional mean μ.

Unfortunately, models such as this do not explain the nondisclosure of information, such as annual forecasts, which investors know that managers possess. This leads to an alternative model, which is presented in section 4.

4. *Disclosure Policies When Managers Are Known to Possess Nonproprietary Information*

The model described below is designed to be as simple as possible while satisfying the following criteria: (*a*) the manager has but does not release information not held by other investors; (*b*) investors know that he has this information, but they do not know its value; (*c*) this information would, if disclosed, alter the price of the firm with positive probability, while (still) not altering the earnings of the firm gross of the manager's compensation. The conjunction of these three conditions implies that the release of the information held by the manager must alter his compensation (with positive probability). This in turn requires that there must be a moral hazard problem between the manager and the firm's shareholders (otherwise the manager could be paid a constant wage, independent of what he disclosed). Moreover, the optimal contract between the manager and the shareholders must depend on the price of the firm which will be affected by the disclosure. If the manager's contract did not depend on the value of the firm, his contract could be rewritten so as to be independent of his disclosure. Thus, if conditions (*a*)–(*c*) are to be satisfied, there must be a principal–agent problem between shareholders and management, the resolution of which is best accomplished by means of a contract which depends on the value of the firm.

I proceed with a brief sketch of the model, and then I provide the detail needed for a formal analysis.

One manager works for many owners of a firm. His unobservable action stochastically affects the firm's output. Subsequent to taking his action, he receives information regarding the likely value of the firm's output before anyone else does. If he releases that information before the output's value becomes public knowledge, the trajectory of prices of the firm becomes completely determined from the time of the announcement to the end of the period by the value of his announcement. If that information is not disclosed publicly, the firm's price at any time will be determined by the information investors have about the likely values of output up to that time. This information may contain imperfect estimates of the manager's actions. Including the price of the firm (which has this information impounded into it) in the manager's contract therefore may be desirable for contracting purposes. Now on to the formal model.

The manager's utility function $U(c) - g(a)$ provides for diminishing marginal utility from income ($U(c)$) and positive, increasing marginal disutility from effort ($g(a)$). The manager's action affects output $x = x(a, \theta)$, where x increases in a, and θ is some exogenous random factor. All n of the firm's owners are risk-neutral, and neither the manager nor the owners discount future consumption. These owners offer the manager a contract, which provides him with some minimum utility ($\bar{U}$) at time zero. Based on the contract offered, the manager selects his optimal action, and subsequently receives advanced information about the realized value of output at time t_0. At time $t_1 > t_0$, investor i receives private information z_i about the manager's action $i = 1, \ldots, n$. The distributional relationship between $x, z_1, \ldots, z_n$, and a is specified next. The joint density $f(x, z_1, \ldots, z_n, a)$ satisfies $f(x, z_1, \ldots, z_n, a) = f(x \mid z_1, \ldots, z_n) h(\bar{z} \mid a)$, where $\bar{z} = 1/n \sum z_i$, $f(x \mid z_1, \ldots, z_n) > 0$ for all $x \in X$ and all $z_i \in Z^i(a)$, and $E[\tilde{x} \mid z_1, \ldots, z_n] = \bar{z}$. (As the notation indicates, z_i's support $Z^i(a)$ and hence the support $Z(a)$ of $\bar{z}$ is allowed to vary with the manager's action a.) This condition stipulates that $\bar{z}$ is sufficient for $(x, z_1, \ldots, z_n)$ with respect to a, and that x is never sufficient for $(x, z_1, \ldots, z_n)$ with respect to a. This formulation does not require different investors to have statistically independent information.

To motivate this distributional assumption, suppose that investor i receives forecast z_i from a financial analyst. (Different investors employ different analysts.) In making a forecast of the firm's earnings, each analyst investigates the earnings' prospects of the firm. For example, $\tilde{x} = a + \tilde{\theta}$ could denote the true distribution of the firm's earnings, and analyst i could estimate $z_i = a + \epsilon_i$ as the expected value of $\tilde{x}$. The consensus forecast, $\bar{z} = a + 1/n \sum \epsilon_i$, may contain much more information about the manager's action than does the realized value of earnings x. The distributional assumption made above would be satisfied if $\tilde{\theta} = 1/n \sum_1^n \tilde{\epsilon}_i + \tilde{\delta}$, where $\tilde{\epsilon}_i$ and $\tilde{\delta}$ are independent. While it is unlikely to be literally true that x provides no information about the manager's action not already contained in the consensus forecast $\bar{z}$ (as is assumed above), it is unnecessary for this distributional relationship to be literally correct to obtain the principal result of this section that disclosures do not unambiguously ameliorate agency relationships (see remarks below, Theorem 3).

At time $\bar{T}$, output occurs, and consumption takes place. Each investor's consumption is proportional to his wealth, which depends on his market position in the firm and the manager's contract. Markets in the firm's shares open at t_0 and t_1. The manager's contract may depend on all publicly available information: the trajectory of the firm's price, the realized value of output, and the time of disclosure of the information.

The following time line summarizes the sequence of events.

Time 0		t_0	t_1	$\bar{T}$
Contract $s(\cdot)$ offered	Manager takes action a	Manager discovers realized output x	Investors get private information z_i about manager's action	x becomes public; manager is compensated; consumption occurs

Reducing the number of dates on which securities are traded may eliminate the desirability of disclosure. To illustrate this, consider an economy in which an *unknown* fraction of the population will receive broken legs by a (publicly known) prespecified date. If markets in "broken leg" insurance are forbidden to exist before this date, then no insurance market will exist at *any* date, since the only people demanding insurance will be people who have broken legs. Hence, the market-clearing price of insurance for those people must equal the medical costs attending the necessary repairs, so each such person would be indifferent to the acquisition of "insurance." As a result, any study undertaken to calculate the fraction of the population which would obtain this injury would produce results of no use to the market. But if the sanctions on "broken leg" insurance were lifted, allowing anyone to purchase this insurance prior to the prespecified date, there would be a demand for the disclosure of such a study's results, since the insurance market then would be active. Thus, disclosures which are desirable when there are no restrictions on the operation of markets may not be valuable when some markets are eliminated.

To avoid attributing the nondesirability of disclosure in this model to the nonfunctioning of some markets, I could proceed by assuming that markets in the firm's shares operate continuously and the manager's contract depends on the entire trajectory of the firm's prices, the timing of his disclosure, and the realized value of earnings. However, it is possible to show that there is no loss of insight in assuming that (*i*) markets exist only at dates t_0 and t_1,[7] (*ii*) the manager either discloses his information immediately upon its receipt or else never discloses it, and (*iii*) the manager's contract can be split into two separate contracts $s(x)$ and $s(x, P_{t_1})$ such that $s(x)$ is his compensation if he discloses that the firm's

[7] Additional markets would have to be opened if investors are risk-averse.

earnings are x at time t_0, and $s(x, P_{t_1})$ is his compensation if he does not disclose x at t_0 and P_{t_1} is the period t_1 value of the firm.[8] The intuition behind this result is simple. Information is received only at times t_0, t_1, $\bar{T}$. Hence, prices will change at most at these times, so the contract will depend at most on the time series of prices at these times. However, if x is announced at t_0, the equilibrium price from then on is completely specified by x, so a contract depending on only x will be equivalent to any more exotic contract in that event. If x is not announced at t_0, then the additional information obtained at t_1 will be impounded into the price P_{t_1}, so P_{t_1} becomes a potentially valuable price to include in the contract when no disclosure occurs at t_0. All other prices occur at times during which no information is generated, and so such prices are inconsequential for contracting purposes.

Apart from simplifying the subsequent analysis, the following extension of this observation is easily verified. Among optimal contracts, there need not be any information content associated with the late release of information, at least for those releases in the interval (t_0, t_1). That is, an optimal contract can be designed so that (short) delays in disseminating information signify nothing regarding output. Alternatively, a contract can be designed so that information is released either immediately upon its receipt or is never disclosed without adversely affecting any of the contracting parties. Note that this implication differs from that associated with the model in section 3, provided (in that model) investors then believe that the probability the manager acquires information is strictly increasing over time.

As the preceding remarks indicate, an equilibrium is defined relative to a pair of contracts $s(x)$, $s(x, P_{t_1})$.

4.1 DEFINITION

An equilibrium relative to contract pair $s(\cdot)$, $s(\cdot, \cdot)$ consists of an action a and an announcement policy $t^*(\cdot)$ for the manager, together with prices $\hat{P}_{t_0}$, $\hat{P}_{t_1}$ such that:

(*i*) The disclosure policy is utility-maximizing for the manager, i.e.: $t^*(x) = t_0$ iff $x \in B \equiv \{x' \mid U(s(x')) \geq E[U(s(x', \tilde{P}_{t_1})) \mid x', a]\}$.[9]

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[8] There is no loss in generality in assuming that if x is disclosed at t_0, the manager is paid with a contract $s(x)$ depending on x rather than with a contract, say $s^D(x, P_{t_1})$, which depends on both x and P_{t_1}, since (with the latter contract) the disclosure of x at t_0 results in a market-clearing period t_1 price of $P_{t_1} = x - s^D(x, P_{t_1})$ which is independent of $z_1, \ldots, z_n$. If $P_{t_1} = P_{t_1}(x)$ is the equilibrium price, given announcement of x at t_0, then the manager's compensation is solely a function of x, specifically $s^D(x, P_{t_1}(x))$, which can be defined to equal $s(x)$.

[9] $\tilde{P}_{t_1}$ denotes the (random) period-one price of the firm, given that the manager does not disclose x at t_0. At t_0, the manager does not know what information investors will receive at t_1, although his private information (x) is correlated with theirs, so his expectation of the period t_1 price is conditioned on x. Also note that B (and hence t^*) depends on a. Any manipulations performed will account for these dependences, even though these dependences are suppressed notationally.

(*ii*) The manager's action is utility-maximizing, i.e.:

$$a \in \arg\max_{\hat{a}} E[U(s(\tilde{x})) \mid \hat{a}, \tilde{x} \in B]\Pr(\tilde{x} \in B \mid \hat{a})$$
$$+ E[U(s(\tilde{x}, \tilde{P}_{t_1})) \mid \hat{a}, \tilde{x} \notin B]\Pr(\tilde{x} \notin B \mid \hat{a}) - g(\hat{a}).$$

(*iii*) Investors have rational expectations: the disclosure policy and action they expect the manager to employ correspond to the disclosure policy and action the manager does employ.

(*iv*) If the manager does not disclose x at t_0:

$$\tilde{P}_{t_0} = E[\tilde{x} - s(\tilde{x}, \tilde{P}_{t_1}) \mid a, \tilde{x} \notin B].$$

If the manager does disclose x at t_0:

$$\tilde{P}_{t_0} = x - s(x).$$

(*v*) If the manager does not disclose x at t_0, and investor i receives private information z_i, $i = 1, \ldots, n$, then:

$$P_{t_1} = P_{t_1}(z_1, \ldots, z_n) \text{ satisfies}$$

$$P_{t_1} = E[\tilde{x} - s(\tilde{x}, P_{t_1}) \mid a, z_1, \ldots, z_n, \tilde{x} \notin B].$$

If the manager does disclose x at t_0:

$$P_{t_1} = x - s(x).$$

This equilibrium is straightforward: (*i*) and (*ii*) assert that the manager acts in a self-interested fashion. (*iii*) states that even though investors do not directly observe the disclosure policy or action the manager selects, they correctly infer the one he employs. (*iv*) and (*v*) state that the market-clearing prices of the firm are the prices that would clear the market if all investors' private information were made public. However, since I have assumed that z_i represents information private to investor i, these last two conditions are appropriate only if the equilibrium market price at t_1 fully reveals all investors' private information. (For further comments on this equilibrium construct, see, e.g., Grossman [1981*b*].) It is possible to demonstrate, with a more "primitive" definition of equilibrium, that when the contract pairs are chosen optimally, the equilibrium is generally fully revealing. (Details of this result are available upon request.) All subsequent references to "equilibrium" refer to the equilibrium just defined.

The following definition and lemma are preparatory to establishing conditions under which it is undesirable to have any disclosures at t_0.

4.2 DEFINITION

A contract $s^*(x, z)$ when $z = (z_1, \ldots, z_n)$ is publicly observable is *second best* relative to $\bar{U}$ if it solves the following program:

$$\max_{s} E[x - s(x, z) \mid a]$$

$$\text{subject to } E[U(s(x, z)) \mid a] - g(a) \geq \bar{U}$$

$$a \in \arg\max_{\hat{a}} E[U(s(x, z)) \mid \hat{a}] - g(\hat{a}).$$

A second-best contract is Pareto-optimal subject to the information restrictions that a is not observable, but x and z are. Since all investors have the same (risk-neutral) preferences, for each contract $s(x, z)$ which is not second best, there exists a second-best contract $s^*(x, z)$ which they would unanimously prefer to implement over $s(x, z)$. Thus, when both x and z are publicly observable, we would expect to observe second-best contracts.

It is easy to characterize second-best contracts.

4.2.1. Lemma 1. If $s^*(x, z)$ is second best, then $s^*(x, z)$ is independent of x and depends on z only through $\bar{z} = 1/n \sum z_i$.

4.2.2. Proof. Recall that $\bar{z}$ is sufficient for (x, z) with respect to a. The decision to contract on x, when z (and $\bar{z}$) are publicly observable, only serves to introduce noise in the (risk-averse) manager's contract and will not be Pareto-optimal. Since $\bar{z}$ is sufficient for z with respect to a, a second-best contract depends on z only through $\bar{z}$.

The following theorems specify conditions under which the allocations corresponding to an equilibrium with a nondegenerate disclosure policy relative to a contract pair $s(x)$, $s(x, P_{t_1})$ are or are not (constrained) Pareto-optimal.(The proofs are in Appendixes A and B.)

THEOREM 2. Given any contract pair $s(\cdot)$, $s(\cdot, \cdot)$ which results in the manager disclosing his information at t_0 with positive probability, there exists another contract pair which provides everyone with at least as high expected utility as does $s(\cdot)$, $s(\cdot, \cdot)$, and, under this contract, the manager never discloses anything.

THEOREM 3.[10] Suppose there is an equilibrium with a nondegenerate disclosure policy relative to the contract pair $s(x)$, $s(x, P_{t_1})$, which generates Pareto-optimal allocations (and expected utility $\bar{U}$ for the manager). If a second-best contract $s^*(\bar{z})$ relative to $\bar{U}$ exists which is differentiable with derivative bounded (strictly) above by one then either:

(*i*) the manager's optimal action under $s^*(\bar{z})$ is his lowest possible action, or

(*ii*) the support of $\bar{z}$ shifts with the manager's action.

Conversely, when X, $Z_1(a), \ldots, Z_n(a)$ are compact, $f_{z_i}(x \mid z_1, \ldots, z_n)$ is continuous, and either (*i*) above or (*iii*) holds (where: (*iii*) the endpoints of the support $Z(a) \equiv [l(a), u(a)]$ of $\bar{z}$ are strictly monotonic in a), then there exists an equilibrium with a nondegenerate disclosure policy relative to some contract pair whose allocations are Pareto-optimal.

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[10] Theorems 2 and 3 hold when this derivative of s^* exists almost everywhere, provided that, where the derivative does not exist, the contract $s^*(\bar{z})$ is nonincreasing. Thus, if $\bar{z}$ represents good news about a (Milgrom [1981]), then $s^*(\bar{z})$ is monotonic and hence differentiable almost everywhere. If s^* is not differentiable at $\bar{z}$, then s^* must be constant on some right-neighborhood of $\bar{z}$.

THEOREM 4. Suppose an equilibrium with a nondegenerate disclosure policy relative to a contract pair $s(x)$, $s(x, P_{t_1})$ generates expected utility $\bar{U}$ for the manager. If a second-best contract $s^*(\bar{z})$ relative to $\bar{U}$ is nonconstant on $Z(a)$ and differentiable with derivative bounded above by one, then there exists an equilibrium relative to another contract pair which strictly Pareto-dominates the equilibrium relative to $s(x)$, $s(x, P_{t_1})$ for which the manager never discloses anything. Conversely, if $s^*(\bar{z})$ is constant on $Z(a)$, X, $Z_1(a), \ldots, Z_n(a)$ are compact, and $f_{z_i}(x \mid z_1, \ldots, z_n)$ is continuous, then there exists an equilibrium with a nondegenerate disclosure policy relative to some contract pair whose allocations are Pareto-optimal.

Theorem 2 establishes that all investors and the manager always weakly prefer contracts which encourage the manager not to disclose his information. Under the condition that the derivative of second-best contracts is bounded (strictly) above by one, Theorem 3 provides necessary and sufficient conditions for a contract pair which induces the manager to choose a nontrivial disclosure policy to generate (constrained) Pareto-optimal allocations. The conclusion is that unless the set of possible realizations of $\bar{z}$ shifts with the manager's actions, all such contract pairs generate Pareto-inferior allocations (this ignores the unimportant case (i) where investors encourage the manager to do as little as possible). In Theorem 4 these conditions are phrased in another way: if all optimal second-best contracts are not constant over the feasible range of realizations of $\bar{z}$ corresponding to the action investors desire the manager to take, then the equilibrium associated with any contract pair which induces a nondegenerate disclosure policy is inferior to other attainable equilibria. The converses of these statements are also valid.

The intuition behind these results is simple. The price of the firm at t_1, absent the manager's disclosure, is based on the aggregation of information investors hold regarding the firm and its manager's actions. The assumption that the derivative of $s^*(\bar{z})$ is less than one ensures that there exists an equilibrium relative to some contract pair such that the price at t_1 reveals $\bar{z}$, the average value of investors' private information.[11]

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[11] This condition is satisfied as follows. If $\bar{z}$ provides an extremely noisy signal of the manager's effort level, then $s^{*\prime}(\bar{z})$ is likely to be less than one (as is obviously the case if $\bar{z}$ is independent of the manager's actions). The following nonrigorous discussion is suggestive.

Let $s^*(\bar{z}; \sigma^2)$ denote the agent's optimal contract when the distribution of $\bar{z}$, conditional on the agent's action a and variance σ^2, is normal with mean a and variance σ^2. Suppose that $\lim_{\sigma \to \infty} s^*(\bar{z}, \sigma^2)$ exists and equals $s^*(\bar{z})$. Then:

$$\lim_{\sigma \to \infty} \frac{1}{\sigma\sqrt{2\pi}} \int U(s^*(\bar{z}; \sigma))e^{-(\bar{z}-a)/\sigma^2} \, d\bar{z} = 0 \tag{A1}$$

where RHS(A1) is independent of a, i.e., as σ gets large, the manager's expected utility from consumption is independent of his action, so his optimal choice of action is the one which minimizes his disutility from effort. Consequently, as σ gets large, the optimal contract converges to a pure risk-sharing contract. When the derivative $\partial/\partial\bar{z}\, s^*(\bar{z}; \sigma)$ is

Thus, the price of the firm contains information useful for contracting purposes. If the manager discloses the firm's output prior to the time this information (held by investors) is received, then the price of the firm will be determined by this announcement and will reveal little about the information held by investors. In short, the manager's release of information destroys other information, and this is the reason that the early release is undesirable. In effect, this is one source for the failure of the revelation principle (a point on which I expand in section 5).

The fact that disclosure may have adverse effects on both the owners and managers of a firm is not an artifact of this simple model. Rather it is a general problem which arises whenever the manager's contract usefully depends on the firm's price, the manager has some information, denoted by y, not held by investors, and the investors obtain private information about the manager's actions *after* the manager has acquired y. If the equilibrium is fully revealing and the manager discloses nothing, then the price at t_1 contains all information $z_1, \ldots, z_n$ held by the individual investors regarding the firm's income. This can be stated alternatively as "P_{t_1} is sufficient for $(z_1, \ldots, z_n)$ with respect to earnings." If, instead, the manager discloses his information y prior to t_1, then P_{t_1} is sufficient for $z_1, \ldots, z_n$, and y with respect to earnings. Thus, with the announcement, the price at t_1 contains additional information about earnings. But it does not follow that, by having the manager disclose his information, the price will contain more information *about the manager's action* than it would without disclosure. This is because the firm's price aggregates information about the firm's net income, which is not necessarily equivalent to aggregating information about the manager's action, as Theorem 3 demonstrates. This is similar, but not equivalent, to Gjesdal's [1981] observation that rankings of information systems differ when considered in terms of their ability to aid in controlling an agent (stewardship value) or selecting an action (decision value). Here, information which is useful for forecasting net income may be detrimental for contracting purposes, and vice versa, so policies which encourage unselective management disclosure of private information may produce superior forecasts of the firm's earnings, but inferior measures of the manager's actions.

Although the results of this one-period model are sensitive to the sequencing of the receipt of investors' and the manager's information,

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continuous in σ:

$$\lim_{\sigma \to \infty} \frac{\partial}{\partial \bar{z}} s^*(\bar{z}; \sigma) = 0,$$

since the optimal risk-sharing contract is a wage contract (as the principal is risk-neutral and the agent is risk-averse). Thus, for distributions of $\bar{z}$ which provide little information about the manager's actions (i.e., high variance distributions), the slope of the contract $s^*(\bar{z})$ is likely to be less than one.

the import of this model is unaltered by such sequencing. To illustrate, if the manager were to receive his information *after* the investors received theirs, then there would be no adverse effects associated with disclosure (see section 5 below). However, in actual markets, investors receive a (nearly) continuous stream of information about each firm in which they hold shares, and therefore, they receive information about each firm *after* its manager obtains some information which may be useful to them. Hence, in order for managers to adopt policies of disclosing information only after all investors' information has been impounded in the firm's price (to avoid the adverse effects of disclosure identified in the model here), managers would have to perpetually postpone (i.e., never disclose) the information they hold.

Though Theorem 3 illustrates that there may be strict gains to incomplete disclosure, we should not conclude that the uniform nondisclosure of information is desirable. Policies which induce management to disclose private information selectively may be superior to policies which either uniformly prohibit or uniformly require disclosure, as is indicated in the example below. The frequency of disclosures corresponding to an optimal compensation policy depends on the distributional relationships between the manager's and other investors' private information. By appropriate specification of these distributions, empirically testable implications regarding the frequency of voluntary disclosure may be derived.

This example differs from the model of section 3 in only the following respects: the manager's action is drawn from a two-element set $\{a_1, a_2\}$. After taking his action, the manager receives a two-dimensional signal which can be costlessly audited, if announced (but is unauditable otherwise). The first dimension of the signal is x, the actual output, and the second signal y takes on values in the set $\{y_1, \ldots, y_{m-1}\}$ if action a_1 were taken, and $y \in \{y_1, \ldots, y_m\}$ if action a_2 were taken. Conditional on $y \neq y_m$, $(z_1, \ldots, z_n)$ is sufficient for $y, z_1, \ldots, z_n$ with respect to a (by assumption). Of course, since y_m occurs only if action a_2 were taken, y_m is sufficient for $y_m, z_1, \ldots, z_n$ with respect to a_1.

Suppose the owners wish the manager to take action a_2. Then, it is clear that for a fully revealing rational expectations equilibrium the optimal contract will induce the manager to disclose his signal only if $y = y_m$ occurs. Thus, a management policy of selective disclosure is mutually beneficial to both the manager and the shareholders.

The point here is that there may be strict contractual gains to both investors and managers in having some, but not all, information obtained by management released. Hence, it may not be possible to redesign contracts to obtain full disclosure (or no disclosure) without decreasing the utilities of some of the contracting parties, apparently in contradiction to the revelation principle. In the next section, I juxtapose sources for the revelation principle's "failure" and explanations for the nondisclosure of management's information.

5. *The Revelation Principle and the Disclosure of Nonproprietary Information*

The revelation principle simply consists of the observation that optimal contracts can be designed so that each contracting party has no incentive to make distorted claims regarding his private information (Myerson [1979]).

There are at least three situations in which this principle may not be applicable. First, suppose that, subsequent to one agent's announcement of the true value of his private information, the other agents could recontract so as to take advantage of this newly revealed information. Recognizing this possibility, each agent may fail to disclose his private information completely. Hence, the inability to make binding commitments to contracts is one reason the revelation principle may not hold. A second situation leading to a failure of the revelation principle occurs when agents are incapable of communicating all dimensions of their private information (see Green [1982] and Demski and Sappington [1983]). As an illustration, suppose that (for some exogenously specified reason) a contract with a financial analyst cannot depend on his claimed financial interests in the companies he recommends acquiring. Then it may not be possible to rewrite a given contract in a way which both reveals his true opinion of these companies and which leaves him and his clients at the same utility levels as provided by the original contract. A third instance in which the revelation principle fails occurs when rewriting contracts is costly or when sending messages is costly (Dye [1985]). If contract specification costs exist, the contract which yields truth-telling as an optimal strategy may be more costly to write than the original contract and so may not be worth implementing. Alternatively, if it is more costly to reveal true information than false information, then truth-inducing contracts may not be desirable.

These three sources of the failure of the revelation principle are not independent. For example, it may be costly to reveal truthful information only because this will induce some agents to renegotiate their contracts with the agent revealing this information. The potential to renegotiate subsequent to the revelation of information in turn is due to the nonbinding nature of some contracts. But a principal reason for some contracts being nonbinding is that it is too costly to write the contracts in a way which covers all possible contingencies.

I now discuss why the revelation principle does not apply to section 4's model. There I noted that the release of the manager's information "destroys" information contained in the market price. But, the only reason that this release destroys information is because investors respond to the release. If each investor had an enforceable contract with the manager which specified that each would disregard the manager's disclosure in calculating his demand for the firm's shares, then the revelation principle could be applied in the model of section 4, and the disclosure issue would then be moot. But there are three problems with implementing these contracts. First, we would have to modify the definition of equilibrium in a way which most accountants and economists would find objectionable. Current prices, especially in securities' markets, are widely believed to be based at least on all currently available public information. If these contracts were implemented successfully, then prices would not reflect the manager's public disclosure. Any alternative definition of equilibrium compatible with these contracts could be criticized for arbitrarily disregarding some information useful in forecasting the firm's future earnings. So, either these contracts must be disallowed (making the revelation principle inapplicable) or securities' prices must not be allowed to reflect publicly available information. A second problem with these contracts is that they may be inherently unenforceable. Since each investor's demand for the firm's shares depends on his own private information, it is impossible to verify whether an investor has disregarded the manager's announcement in calculating his own demand function. This problem becomes particularly severe when there are a large number of investors. Each investor may acknowledge that honoring the contract (cited above) produces superior control over the manager, but the investor may gain more by violating the contract and optimally adjusting his position in the firm's shares in response to the manager's disclosure than he gains by honoring this contract. Thus, free-rider problems (here, as elsewhere) contribute to making these contracts difficult to enforce. Finally, since some investors who are not currently owners of the firm may possess information about the manager's actions, contracts would have to be written between such investors and the firm to apply the revelation principle. As the identities of these investors might be difficult to determine, such contracts would be difficult to implement.

The timing of disclosure matters because the ability to apply the revelation principle (which was originally developed in the context of a simultaneous multiplayer game) depends on the timing of announcements of the economic agents' private information. If the manager discloses his information first, investors who are also endowed with private information cannot thereafter sincerely commit themselves to disregard the manager's disclosure in calculating their demands for the firm's shares.

While others (e.g., Crawford and Sobel [1982] and Wilson [1978]) have demonstrated that an inability to make commitments prior to the receipt of information (either private or public) may result in the lack of complete disclosure, it is important to recognize that the sources for incomplete disclosure in these other models may be eliminated either by opening up additional markets (in Wilson's case) or by allowing contracts based on publicly reported variables to be enforced (in the Crawford and Sobel case). In contrast, no such remedy for incomplete disclosure in the model of section 4 exists, because both the manager and the investors are endowed with private information. Indeed, it is easy to verify that if investors did not have any private information of their own, then publicly enforceable contracts could be constructed to generate full disclosure.

Every other logically consistent model (of which I am aware) of financial disclosure which implies that the full disclosure of management's information is not always desirable is based on the violation of some assumption underlying the revelation principle. For example, in the model presented in section 3, full disclosure of bad news does not occur because investors who are not current shareholders in the firm would not honor contracts to disregard the information disclosed when determining their demands for the firm's shares. Hence, the hypotheses of the revelation principle are not satisfied in this model and so it is not surprising that full disclosure does not occur.

As a second example, consider why proprietary or strategically valuable information is often not disclosed. The main reason is that such information provides competitors with some market advantage. Of course, if contracts existed between a firm and its current and potential competitors which specified that competitors had to ignore strategically valuable disclosures, the revelation principle's hypotheses would be met. However, such contracts are not enforceable.

Finally, if the dissemination of information results in the incurrence of direct or indirect costs, the revelation principle would not apply, in which case we would again not expect full disclosures.

6. *Conclusions*

The relatively recent literature on the consequences of imperfect and incomplete information has uncovered many surprises. Akerloff's [1970] original analysis suggested that informational asymmetries could destroy the operation of otherwise viable markets. Subsequent studies on disclosure reversed that conclusion by using the assumption that firms can make credible statements about their private information. With this assumption, virtually every firm will disclose its information completely to distinguish itself from other firms with worse information. In this case, there is no substantive distinction between economies in which all information about firms is public and economies in which all information is private. The point made in this paper is that, even when such credible announcements of private information are possible, there are distinctions between the amount of information disclosed in these polar cases.

In the preceding sections, I considered three reasons for management's failure to disclose their nonproprietary information. The first one is based on the condition that investors' knowledge of management's information is incomplete, in which case managers may successfully suppress bad information. The second reason follows from the observation that managers possess a vast array of private information, some of which may be proprietary. Nonproprietary information may not be disclosed if it is part of such an array (Dye [1984b]). The third reason stems from the existence of a principal–agent problem between shareholders and managers, the best resolution of which requires management's reticence. The model supporting this last reason establishes that disclosures may actually exacerbate principal–agent problems between management and shareholders. This may be one of the reasons Leftwich, Watts, and Zimmerman [1981] could not identify a relationship between disclosures and other variables which they interpret as proxies for the existence of a moral hazard problem.

Additional research on disclosures may produce internally consistent theories with more explanatory power than those which thus far have been tested.

APPENDIX A

Proof of Theorem 2

Let $P_{t_1}(\tilde{z})$ denote the equilibrium price of the firm at time t_1 when the contract pair $s(\cdot)$, $s(\cdot, \cdot)$ is employed if the manager does not disclose x at t_0; let B denote the set of x's for which the manager discloses x at t_0.

Define:

$$\hat{P}_{t_1}(\tilde{z}) = \Pr(\tilde{x} \in B \mid \tilde{z})E[\tilde{x} - s(\tilde{x}) \mid \tilde{x} \in B, \tilde{z}] + \Pr(\tilde{x} \notin B \mid \tilde{z})P_{t_1}(\tilde{z}).$$

$$\text{For } x \in B, \text{define } \hat{s}(x) = \begin{cases} s(x), & \text{if } \ x \text{ is not disclosed at } t_0 \\ -K, & \text{if } \ x \text{ is disclosed at } t_0. \end{cases}$$

$$\text{For } x \notin B, \text{define } \hat{s}(x, \hat{P}_{t_1}(\tilde{z})) = \begin{cases} s(x, P_{t_1}(\tilde{z})), & \text{if } \ x \text{ is not disclosed at } t_0 \\ -K, & \text{if } \ x \text{ is disclosed at } t_0. \end{cases}$$

For K sufficiently large, disclosure never occurs at t_0. Since $P_{t_1}(\tilde{z}) = E[\tilde{x} - s(\tilde{x}, P_{t_1}(\tilde{z})) \mid \tilde{x} \notin B, \tilde{z}]$, it follows that:

$$\hat{P}_{t_1}(\tilde{z}) = \Pr(\tilde{x} \notin B \mid \tilde{z})E[\tilde{x} - \hat{s}(\tilde{x}) \mid \tilde{x} \in B, \tilde{z}] +$$

$$\Pr(\tilde{x} \notin B \mid \tilde{z})E[\tilde{x} - \hat{s}(x, \hat{P}_{t_1}(\tilde{z})) \mid \tilde{x} \notin B, \tilde{z}].$$

Since $\hat{s}(x) \equiv s(x)$, $\hat{s}(x, \hat{P}_{t_1}(\tilde{z})) \equiv s(x, P_{t_1}(\tilde{z}))$, everyone is indifferent toward the replacement of $s(\cdot)$, $s(\cdot, \cdot)$ by $\hat{s}(\cdot)$, $\hat{s}(\cdot, \cdot)$, proving Theorem 2.

APPENDIX B

Proof of Theorems 3 and 4

I begin by supposing that the allocations generated by the equilibrium relative to $s(x)$, $s(x, P_{t_1})$ are Pareto-optimal given the information asymmetries.

Let $s^*(\tilde{z})$ be a second-best (i.e., [constrained] Pareto-optimal) contract which generates utility $\bar{U}$ for the agent. By hypotheses, $s^*(\tilde{z})$ is differentiable, with derivative bounded above strictly by one. Thus, $\bar{z}(P)$, the inverse of:

$$P(\bar{z}) = \bar{z} - s^*(\bar{z}),$$

is well defined, as is the contract:

$$\bar{s}(P) \equiv s^*(\bar{z}(P)).$$

It is easy to show that an equilibrium relative to $\bar{s}$ exists and that the expected utilities generated by $\bar{s}$ are identical to those generated by s^*(as $s^*(\bar{z}) \equiv \bar{s}(P(\bar{z}))$). Hence, to be Pareto-optimal, $s(x), s(x, P_{t_1})$ must produce the same utilities for the investors and the manager as does any such $s^*(\bar{z})$.

If $s(x)$ is not almost surely constant on B, the set of x's for which the manager discloses x, then $s(x), s(x, P_{t_1})$ cannot generate the same utilities as does $s^*(\bar{z})$: if $s(x)$ varies on B (where $\tilde{x} \in B$ with positive probability because the disclosure policy is nondegenerate), then there is a positive probability that $s(x) \neq s(x^1)$ where $f(x, z_1, \ldots, z_n, a^*) > 0$, $f(x^1, z_1, \ldots, z_n, a^*) > 0$. By Lemma 1, this is not optimal. For $x \in B$, let $s(x) \equiv w$.

By assumption of the Pareto-optimality of $s(x), s(x, P_{t_1})$:

$$s^*(x, z) = \begin{cases} w, x \in B \\ s(x, P_{t_1}(\bar{z})), x \notin B, \bar{z} = \frac{1}{n} \sum z_i, \bar{z} \in Z(a^*) \end{cases}$$

is second best, and hence (almost surely) independent of x (by Lemma 1). This implies that, since B is neither a probability-zero nor a probability-one event, $s(x, P_{t_1}(\bar{z})) \equiv w$ (a.s.), so there exists a second-best contract which is constant on $Z(a^*)$. As $s^*(\bar{z})$ takes this form only if either (*i*) a^* is the minimum possible action the agent can take or (*ii*) the support of $\bar{z}$ shifts with a^*, the first half of Theorem 3 is proved.

To prove the converse, note that in event (*i*) the manager optimally must be paid a wage, and all investors are indifferent among all disclosure policies. So consider event (*iii*). To be specific, set the manager's utility at $\bar{U}$. Since the support of $\bar{z}$ moves with a, the second-best contract $s^*(\bar{z})$ takes the following form:

$$s^*(\bar{z}) = \begin{cases} w, \ \bar{z} \in [l(a^*), \ u(a^*)] \\ -K, \quad \text{otherwise} \end{cases}$$

where a^* is the action investors desire the manager to take. Since

$$\frac{d}{dz} E[\tilde{x} \mid \bar{z}] = 1 \quad \text{for all} \quad \bar{z} \in Z(a^*),$$

there exists some $\hat{x} \in (\underline{x}, \bar{x})$ (near $\bar{x}$) such that $E[\tilde{x} \mid \tilde{x} < \hat{x}, \bar{z}]$ is strictly increasing in $\bar{z}$ for all $\bar{z} \in Z(a^*)$.[12]

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[12] Define $\delta(\hat{x}, z_1, \ldots, z_n) = \dfrac{1}{F(\hat{x} \mid z_1, \ldots, z_n)} \displaystyle\int_{\underline{x}}^{\hat{x}} x f(x \mid z_1, \ldots, z_n)\, dx.$

$\delta(\bar{x}, z_1, \ldots, z_n) \equiv E[\tilde{x} \mid z_1, \ldots, z_n] = \bar{z}$, where $\bar{z} = 1/n \sum z_i$. Therefore, $\delta_{z_i}(\bar{x}, z_1, \ldots, z_n) \equiv 1/n$. $\delta_{z_i}(x, z_1, \ldots, z_n)$ is jointly continuous, since $f_{z_i}(x \mid z_1, \ldots, z_n)$ is continuous. On $X \times Z_1(a^*) \times \cdots \times Z_n(a^*)$, a compact set, $\delta_{z_i}(\hat{x}, z_1, \ldots, z_n)$ is uniformly continuous, so there exists some $\hat{x} < \bar{x}$ such that $\delta_{z_i}(x, z_1, \ldots, z_n) > 0$ for all $\hat{x} \leq x \leq \bar{x}$, and all $z_1, \ldots, z_n$.

Define $B = [\hat{x}, \bar{x}]$, and let the manager's compensation if he does disclose x at t_0 be:

$$s(x) = \begin{cases} w, \ x \in B \\ -K, \text{ otherwise.} \end{cases}$$

Then $P_{t_1}(\tilde{z}) \equiv E[\tilde{x} \mid \tilde{x} \notin B, \tilde{z}] - w$ is strictly increasing in $\tilde{z}$ and is invertible, with inverse $\tilde{z}(P_{t_1})$. Define the manager's compensation if he does not disclose x at t_0 by:

$$s(x, P_{t_1}) = \begin{cases} w, & \text{if } \ P_{t_1} \in [\underline{P}, \bar{P}] \\ -K, & \text{otherwise} \end{cases}$$

where $\tilde{z}(\underline{P}) = l(a^*)$, $\tilde{z}(\bar{P}) = u(a^*)$. With the contract pair $s(x)$, $s(x, P_{t_1})$ as defined above, the manager will select action a^* if K is sufficiently large, he will not disclose x at t_0 on a set with positive probability, and the manager and all investors are as well off under this contract pair as they would be if $\tilde{z}$ were publicly observable and $s^*(\tilde{z})$ were implemented. This completes the proof of the converse.

Proof of Theorem 4

From the proof of Theorem 3, a necessary condition for the contract pair $s(x)$, $s(x, P_{t_1})$ to be Pareto-optimal is that there exist a second-best contract $s^*(\tilde{z})$ which is constant over the range of $\tilde{z}$'s consistent with the action investors expect the manager to take. By the hypotheses of Theorem 4, the derivative of any second-best contract is nonzero, so $s(x)$, $s(x, P_{t_1})$ cannot be Pareto-optimal.

The converse follows from the argument used to prove Theorem 3. This completes the proof.

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