Silence Can Be Golden: On the Value of Allowing Managers to Keep Silent When Information is Soft

Tsahi Versano
Tel Aviv University

Abstract: Most of the information that firms in financial markets are required to disclose is relatively hard (e.g., sales and inventory count). In contrast, the disclosure of relevant information that is softer in nature (e.g., about the value of intangible assets) is typically left to firms' discretion. This paper studies the benefits of leaving disclosure unregulated (i.e., voluntary) when the information is soft and its disclosure can be manipulated. The analysis is conducted in a model where a manager's disclosure is used by the firm's owner to monitor the manager. The choice between mandatory and voluntary disclosure introduces a tradeoff between quantity and quality of disclosure: mandating disclosure increases the frequency of disclosure but when the information is soft this comes at the expense of reducing the quality of disclosure. The paper explores this tradeoff show that restricting mandatory disclosure requirements to verifiable information while allowing managers to voluntarily disclose estimates, projections and other forward-looking information may maximize the total information content of managerial disclosures.

Keywords: accounting; mandatory disclosure; voluntary disclosure; hard information; soft information; intangibles; principal-agent; moral hazard.

1. Introduction

Firms are not required to disclose in their financial statements all the information they deem relevant to the users of financial reports. In Statement of Financial Accounting Concepts (CON) 2, the Financial Accounting Standards Board (FASB) determines the primary qualities of accounting information and requires that the disclosed information be reliable. CON 2 suggests that the reliability of information rests upon the extent to which it is representationally faithful and verifiable, where verifiability is useful mainly in minimizing managerial misrepresentation.[1] In accordance with this view, firms' mandatory financial statements include mainly the disclosure of information that is relatively hard, in that it can be verified to a high degree of assurance, whereas the disclosure of information that is softer in nature and can be verified to only a limited degree of confidence, is typically left to the discretion of management.[2] For example, firms are required to disclose in their financial reports measures of tangible assets and traded securities, but not of intangible assets, such as research and development, human resources, customer relationships, and innovations that are developed internally and are much harder to objectively verify. As a result, some firms voluntarily supplement their financial reports with disclosures of softer information, while others do not. In light of the rapid increase in the intangibles intensity of firms in recent decades, there is an on-going debate about whether the disclosure of information about these soft value drivers should be mandated in the financial statements. Proponents of mandating these disclosures point to the consistent decline in the informativeness of financial reports in the last few decades (e.g., Collins, Maydew, and Weiss, 1997; Lev and Zarowin, 1999), and its strong relation to the absence of timely information about intangibles in the financial reports (e.g., Lev and Zarowin, 1999, Srivastava, 2014). Despite these arguments, current accounting regulation in the U.S. does not mandate

[1] CON 8 clarifies and replaces some of the terms used in CON 2, but does not change its spirit.

[2] The view that mandatory disclosure in the financial reports requires a higher degree of reliability than voluntary disclosure outside of the reports is reflected in CON 2 which states: "almost everyone agrees that criteria for formally recognizing elements in the financial statements call for a minimum level or threshold of reliability of measurement that should be higher than is usually considered necessary for disclosing information outside financial statements."

the disclosure of such soft information. Instead, regulators and Securities and Exchange Commission (SEC) directors emphasize the importance of such information and strongly encourage firms to voluntarily disclose the information.[3] Relatedly, there is an on-going discussion among U.S. researchers and practitioners regarding moving from the hard measures of historical cost accounting toward the softer measures of fair value accounting suggested by the International Financial Reporting Standards (IFRS). Despite the desire to converge toward one global accounting standard, there seems to be less support within the U.S. financial reporting community for adopting IFRS for use by U.S. firms (see, for example, SEC, 2012).

The objective of this paper is to explore the benefits of allowing for voluntary, rather than mandatory, disclosure of information that is not completely verifiable and whose disclosure can be manipulated. To do so, I construct a model of managerial disclosure in which the verifiability of the information is captured by the probability that the firm's internal control system is able to determine whether the manager's disclosure is truthful and can correct a manipulated disclosure. Ijiri (1975) refers to a measure that "can easily be pushed in one direction or another" as soft and to one that is "constructed in such a way that it is difficult for people to disagree" as hard. Consistent with this view, a higher (lower) probability of verification is interpreted as corresponding to harder (softer) information. The idea that some information is less verifiable (i.e., softer) than other information is rooted in the notion behind CON 2 and the debate about what information managers should be required to disclose (e.g., historical cost or fair value).[4]

I capture the notion that firms are agencies with self-interested managers by framing the analysis

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[3] See, for example, FASB (2001).

[4] CON 2 states: "Some accounting measurements are more easily verifies than others. Alternative measures of cash will be closely clustered together, with a consequently high level of verifiability. There will be less unanimity about receivables (especially about their net value), still less about inventories, and least about depreciable assets, for there will be disagreement about depreciation methods to be used, predictions of asset lives, and (if book values are based on cost) even which expenditure should be included in the investment base."

within the context of the general principal-agent model of Holmstrom (1979). This framework yields natural welfare implications of information sharing, which allows for a ranking of the information content of managerial disclosures when disclosure is voluntary and when it is mandatory. In the model, a risk-averse manager operates a firm on behalf of the firm's shareholders/owners, and his compensation is based on the disclosure (or the absence of such disclosure) that he provides about the performance of the firm. After contracting, the manager takes an unobservable and privately costly productive action, which impacts the firm's output. He then potentially observes a private signal of performance. If disclosure is voluntary, a manager observing the private signal (referred to as an informed manager) can voluntarily provide a (potentially biased) disclosure of it or disclose nothing. If disclosure is mandatory, an informed manager must provide disclosure. The ability of the manager to successfully bias his disclosure is limited by the verifiability of the information. Specifically, if the manager discloses his private signal, then with positive probability his disclosure is verified by the internal control system and adjusted (to the extent necessary) to reflect the true content of the signal.

The analysis begins by considering the case of mandatory disclosure, where an informed manager must provide disclosure and can exercise discretion only over the extent to which to bias that disclosure. Similar to Marinovic (2013) informed managers with less favorable information pool their disclosures with managers observing more favorable information at the right tail of the signal distribution in an attempt to maximize their compensation. Because verification (and thus separation) occurs with probability less than one, this pooling of disclosures leads to loss of efficiency.

When disclosure is voluntary, an informed manager exercises disclosure discretion along two dimensions. First, he decides whether to voluntarily provide disclosure of his private information. Second, if he does make a disclosure, he chooses the extent to which he will bias that disclosure relative to the true content of his private information. The analysis reveals that in this case only managers observing information above a certain threshold pool their disclosures with managers observing information at the right tail of the signal distribution. Managers observing signal realizations below the disclosure threshold withhold disclosure. Partial disclosure arises in this case even though the owner can induce full disclosure by fixing the level of compensation conditional on nondisclosure to be sufficiently low. The owner, though, opts not to do so for two reasons. First, fixing the compensation absent disclosure at a low level imposes excessive risk on the manager ex ante given the possibility that the manager will not receive information. As a result, the owner limits the penalty for silence and, consequently, managers observing sufficiently unfavorable information prefer to withhold disclosure and pool with uninformed managers. The inability of the owner to distinguish between uninformed managers and informed managers who keep silent leads to a loss of information that does not occur when informed managers are required to make a disclosure. Second, the owner can benefit from silence by managers with unfavorable information because any disclosure by these managers would be untruthful and would dilute the information content of the truthful disclosures of managers observing more favorable information. It would also expose the manager to verification risk.

The owner, therefore, sees a tradeoff between the quantity and the quality of disclosure when he compares voluntary and mandatory disclosure. On the one hand, when voluntary, disclosure occurs less frequently because managers with unfavorable information withhold it. Consequently, the owner cannot employ the unfavorable information to monitor the manager. On the other hand, because managers with unfavorable information have an incentive to bias their disclosures, by withholding their information they reduce the likelihood that reports containing a favorable disclosure are biased. As a result, favorable reports have higher information content under voluntary disclosure. When disclosures are verified with high probability, biases are likely to be eliminated from the report to the owner and the frequency of disclosure is more important than its quality. In this case, mandatory disclosure is preferred. When the probability of disclosure verification is relatively low, biases in disclosure are likely to remain and the quality of disclosure is more important. Consequently, voluntary disclosure is preferred.

Additional insights about the disclosure equilibrium arise from this analysis. It is shown that under a voluntary disclosure regime the threshold disclosure level is higher when the information is soft, rather than hard. The owner induces a higher disclosure threshold when the information is soft in order to fully utilize the effect of silence on the quality of disclosure. Consequently, it is predicted that the probability of disclosure will be higher when disclosure can be made in a credible manner than when it cannot. In addition, the analysis predicts that managers who voluntarily make a disclosure will bias their disclosure more than they would if disclosure were mandatory. This is because there is an incentive to bias the disclosure to a greater extent when the owner perceives that disclosures are of a higher quality.

The analysis discusses two special cases, where even the smallest degree of softness is sufficient to make voluntary disclosure the preferred regime. The first is the case where the owner is certain that the manager possesses private information. This case reflects a situation in which the information endowment of the manager is common knowledge or observable to the owner. In this case, an informed manager cannot disguise as uninformed and the negative effect of voluntary disclosure vanishes. Given that voluntary disclosure imposes no cost in this case, but offers a benefit as long as the information is not completely verifiable, voluntary disclosure is the preferred regime. The second case involves relaxation of the model's assumption that there are no restrictions on monetary transfers between the principal and the agent, so that the principal can extract the entire surplus from the relationship. (This is a standard assumption in the principal-agent literature with a risk-averse agent.) When instead it is assumed that the manager is sufficiently protected by limited liability, voluntary disclosure is weakly preferred. This is because, while the owner receives more information about the manager's favorable performance when disclosure is voluntary, he receives more information about the manager's unfavorable performance when disclosure is mandatory. As a result, the contract under mandatory disclosure relies more heavily on penalties. When the limited liability sufficiently shields the manager against high penalties, mandatory disclosure loses its relative advantage and voluntary disclosure weakly dominates.

The paper is related to those that use the principal-agent framework to study the welfare implications of accounting choices.[5] For example, Gigler and Hemmer (1998) explore the role of (verifiable) mandatory reports in confirming the truthfulness of more timely disclosures that are not directly verifiable. They show that requiring more frequent mandatory reports may aggravate the moral hazard problem between the owner and the manager.[6] Kwon, Newman, and Suh (2001) show that conservative financial reporting arises naturally in principal-agent models as a mean of improving efficiency when managers are subject to limited liability. Chen, Hemmer, and Zhang (2007) demonstrate that conservative accounting can be useful in alleviating accounting manipulations and in improving contract efficiency.[7] The current paper shows that allowing managers to keep silent can have a similar effect.

Similar to the results in Kanodia, Sapra, and Venugopolan (2004), the results in this paper are in line with the FASB requirement that accounting information be sufficiently reliable. Kanodia, Sapra, and Venugopolan (2004) take a "real effects" perspective to investigate whether intangibles should be measured and identified separately from operating expenses. They find that even if the relative

[5] In contrast to traditional models of disclosure that assume an exogenous objective function for the manager (in particular, the maximization of the market price of the firm), the principal-agent framework allows shareholders to contract with the manager and focuses on the use of information for efficient contracting and governance. Watts and Zimmerman (1986), Holthausen and Watts (2001), Ball (2001), Watts (2003a, 2003b, 2006), and Kothari, Ramanna, and Skinner (2010) conclude that the properties of GAAP are consistent with the primacy of efficient contracting perspective. Lambert (2010) agrees that stewardship is an important use of accounting numbers but disagrees that it dominates the valuation use of accounting information. Regardless of the primary role of financial reporting, recent empirical studies (Bushman, Engel, and Smith, 2006; Banker, Huang, and Natarajan, 2009) suggest that, as a practical matter, the distinction between contracting and valuation usefulness of information is not of significant importance. Drymiotes and Hemmer (2013) also demonstrate this point analytically in the context of accrual accounting information. Consistent with this, it can be shown in the current model that as long as the manager has an incentive to over-report his private information and is known to possess private information, it is possible to apply the Blackwell (1951) informativeness criterion to show that the welfare implications of the model for contracting purposes extends to any use of the information for decision making and, in particular, for valuation purposes.

[6] Requiring more frequent disclosures may also exacerbate managerial short-termism (see, Gigler, Kanodia, Sapra, and Venugopalan, 2014).

[7] For an analysis of the negative consequence of conservative accounting in the context of debt contracting see Gigler, Kanodia, Sapra, and Venugopalan (2009).

importance of intangibles in constituting the firm's capital stock is high, separately measuring intangibles stimulates a more efficient level of investment only if the measurement process is sufficiently precise. The analysis here highlights the possible intervention of managers in the measurement process as another rationale for employing the reliability criterion.

The paper is also related to Einhorn and Ziv (2012) which extends the discretionary disclosure models of Verrecchia (1983) and Dye (1985) to allow the manager to bias his disclosure. Similar to the current paper, Einhorn and Ziv (2012) explore a setting in which the manager has two tiers of disclosure discretion (whether to disclose and what to disclose). In their capital market setting, Einhorn and Ziv (2012) show that the disclosure threshold is not affected by the relaxation of the assumption that disclosure, if provided, must be truthful. The current paper shows that if the owner can form a contract with the manager, the owner will use that contract to raise the disclosure threshold in order to improve the overall information content of managerial disclosures.

The paper proceeds as follows. The next section describes the disclosure model. The issue of ex-post information revelation and the owner's problem are analyzed in section 3. Section 4 derives and analyzes the optimal contract when disclosure is mandatory, while section 5 provides a similar analysis when disclosure is voluntary. Section 6 demonstrates how preferences over the two disclosure regimes varies with the softness of the manager's private information. Section 7 summarizes and offers concluding remarks. Proofs appear in the appendix.

2. Model

A risk neutral firm owner (the principal) contracts with a risk-averse manager (the agent) to undertake an unobservable action (or effort) $a \in [0, \bar{a}] \subset \Re_+$ that yields a stochastic output θ. The output is realized and publicly observed after the contract ends. After the manager takes the action but before the contract ends, the manager observes a measure of performance, $x \in [\underline{x}, \overline{x}] \equiv X \subset \Re$ with probability $\beta \in (0,1)$. The model deviates from the standard moral hazard model in that information is available with a probability less than one and that the receipt of information and its content are private information to the manager. Therefore, for contracting purposes the owner must rely on the manager to disclose his information. The private information of the manager is represented by $s \in S \equiv X \cup \{\varnothing\}$, where $s = x$ with probability β, in which case the manager is said to be informed, and $s = \varnothing$ with probability $1-\beta$, in which case the manager is said to be uninformed. The manager then sends a message $m: S \to S$ about s to the firm's internal control system, which leads to a report to the owner $r: S \to S$. A message $m(s) \in X$ is referred to as a disclosure of information and a message $m(s) = \varnothing$ is referred to as no disclosure, silence, or a claim to being uninformed.

With probability $P \in (0,1)$ the manager's disclosure is verified and the true realization of the performance measure is reported to the owner (that is, $r(m(x)) = x$). With probability $1-P$ the disclosure is reported to the owner without verification (that is, $r(m(x)) = m(x)$). This modeling captures in a simple way a standard audit process where the manager submits a draft of a report to the auditor, the audit potentially generates audit evidence regarding the information that the manager discloses and, if the audit evidence indicates that the manager's disclosure is biased, the manager adjusts the disclosure to reflect the audit evidence in order to receive an unqualified opinion from the auditor.[8] Without such an indication, the manager's disclosure is not adjusted; that is, the audit process does not generate false negatives. The owner observes the final report of the manager and the auditor's opinion on whether the report faithfully represents the firm's performance, but not the process that led to that report (Aobdia and Shroff, 2017; PCAOB, 2015). In accordance with Ijiri's (1975) view of soft and hard information, and similar to Roger (2013) and Bertomeu and Marinovic (2015), the information in this model is considered soft in that it cannot be verified with probability one. Consistent with this, we interpret lower levels of P as corresponding to 'softer' information.[9]

As will be demonstrated below, in this setting the biasing activity of the manager leads to an efficiency loss, a feature that is central to the tradeoff between voluntary and mandatory disclosure that is analyzed in this paper. As long as this remains a feature of the model, the paper's results would not change qualitatively if the model allowed for the probability of verification to be a function of the manager's bias or if it allowed firms the flexibility to increase this probability at a low cost.[10]

If disclosure is voluntary, an informed manager can choose whether to disclose his information or issue a message containing no disclosure, $m(x)=\varnothing$. Following the disclosure literature (e.g., Dye, 1985), however, it is assumed that an uninformed manager has no disclosure discretion and must provide

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[8] Under securities regulation the manager is responsible for the content of the report to the owner and the auditor is responsible for expressing an opinion, based on his audit, on whether that report faithfully represents the firm's performance. When the audit detects a misstatement, the manager has no incentive to keep the misstatement in the report because the auditor's qualified opinion will reveal the discrepancy between the manager's disclosure and the audit evidence (Butler, Leone, and Willenborg, 2004).

[9] Laffont (1990) refers to the counterpart of $1-P$ in his analysis as an index for softness of information.

[10] While firms' ability to increase the level of P may be quite limited given the nature of the information (e.g., forward looking information), it can be expected that firms will have more discretion over the level of P when disclosure is voluntary (Marinovic and Sridhar, 2015; Minnis, 2011) than when it is mandatory. This is because mandatory disclosure rules typically impose a minimum auditing requirement. This generally reduces the efficiency of mandatory disclosure relative to that of voluntary disclosure because the owner can benefit from the greater freedom to choose the level of certification when disclosure is voluntary. It can be shown, though, that to the extent that certification costs are relatively low this additional advantage of voluntary disclosure has no effect on the welfare ordering of voluntary and mandatory disclosure regimes as presented in the paper.

a message containing no disclosure, $m(\varnothing)=\varnothing$. If the manager's message contains no disclosure, it is reported directly to the owner; that is, $r(\varnothing)=\varnothing$. The assumption that an uninformed manager must keep silent arises naturally in situations where the agent can falsify, but not manufacture, information. Einhorn and Ziv (2012) give the example of a market analysis, a lab test, or an FDA report whose content the manager can falsify, but whose existence cannot be fabricated. Another example is a transaction, an asset or a liability that the manager may choose to conceal, but, upon disclosure its *existence* can be verified (although not necessarily its value).

If disclosure is mandatory, an informed manager must provide a disclosure. Since the manager's information endowment is unobservable to the owner, enforcing mandatory disclosure may require effective legal institutions and governance systems. Securities regulation, such as the Sarbanes Oxley Act of 2002 and the Foreign Corrupt Practices Act of 1977, established a series of governance measures that make it harder for managers to withhold information that they are obliged to disclose.[11] As in Shavell (1994) and Polinsky and Shavell (2012), it is assumed here that compliance with mandatory disclosure can be enforced, so that informed managers provide a disclosure with probability one. Employing this assumption, the analysis provides insights into the conditions under which mandating disclosure is counterproductive even when it can be strictly enforced without cost. However, this assumption as well as the assumption that uninformed managers cannot successfully fabricate information are not necessary for the purpose of the analysis. The results would continue to hold qualitatively whether or not uninformed managers are allowed to fabricate information as long as mandating disclosure increases the

[11] These measures include an obligatory set of internal procedures designed to ensure better disclosure practices, a protection plan for internal whistleblowers (who played an important role in exposing some of the largest accounting scandals), the establishment of independent audit committees, and enhanced criminal accountability. Empirical work, such as Bushee and Leuz (2005) and Greenstone, Oyster, and Vissing-Jorgensen (2006), find evidence consistent with the notion that the regulatory measures are effective in enforcing mandatory disclosure requirements (see Leuz and Wysocki, 2016, for a survey of the related literature).

probability of disclosure by informed managers regardless of the nature of their information.[12]

The decision of an informed manager to disclose or withhold information is represented by the function $d:\Re \rightarrow \{0,1\}$, where $d(x)=0$ and $d(x)=1$ represent the decision of a manager observing signal x to withhold disclosure or to provide disclosure, respectively. Given the manager's message, $m(s)\in S$, the report to the owner is therefore $r(m)=\varnothing$ if $m=\varnothing$ and $r(m)=\begin{cases} x & \text{with probability } P \\ m & \text{with probability } 1-P \end{cases}$, if $m\in X$. Upon observing the report r, the owner makes a payment to the manager. The function $w:S\rightarrow \Re$ is used to represent the compensation to the manager conditional on report r. After the manager is compensated, the output is realized and distributed as a dividend to the firm's owner.

Figure 1 provides a timeline summarizing the main events in the model. At the beginning of the period, date 1, the owner and manager agree on a compensation contract and the manager chooses an unobservable action, a. At date 2, the manager privately observes a performance measure x with probability β and sends a message $m(x)$. When disclosure is mandatory, $m(x)$ must be a disclosure about the manager's private information. When disclosure is voluntary, the message can be that no information was received. If the message contains a disclosure of the manager's information, it is verified by the control system of the firm with probability P at date 3 and a report is issued to the owner. If the message contains no disclosure, that fact is reported to the owner. Based on the report, the manager is

[12] It is possible to interpret the mandatory disclosure regime as a regime where a message containing no disclosure is verified before it is reported. As noted here, the verification does not have to be perfectly effective.

compensated as specified in the contract. At the end of the period, date 4, the output of the firm is realized and distributed as a dividend to the firm's owner.

The manager's utility is given by $u(w)-v(a)$, where $u(w)$ is the manager's utility from payment w with $\lim_{w\to-\infty} u(w)\to-\infty$, and $v(a)\geq 0$ his disutility from taking action *a*. The standard assumptions that $u'>0$, $u''<0$, $v'>0$, and $v''\geq 0$ are made. As standard in the moral hazard literature (e.g., Grossman and Hart, 1983) the assumption that the agent's utility can be taken to be very low ensures that the *IR* constraint is binding at the optimum.[13] The implications of relaxing this assumption are discussed in the last part of section 6. The owner is risk neutral and receives a net payoff $\theta-w$. Given the manager's effort, the expected value of outcome θ is given by $\eta(a)=\begin{cases}\overline{\eta} & \text{if } a\geq a' \\ \underline{\eta} & \text{if } a<a'\end{cases}$, where $\overline{\eta}>\underline{\eta}$ and $a'\in(0,\overline{a})$. It is further assumed that $\overline{\eta}$ is sufficiently larger than $\underline{\eta}$ that the owner prefers to implement $a=a'$ rather than $a=0$. The simple mapping from effort to expected outcome allows the focus to shift from the specific level of effort that is optimal, which is not important for the purpose of this paper, to an analysis of conditions under which mandatory or voluntary disclosure increases the information content of the manager's report as well as reduce the cost of implementing any desired level of effort. Conditional on the action taken, the distribution function of *x*, $F(x|a)$, is assumed to be twice continuously differentiable and to exhibit the strict monotone likelihood ratio property (MLRP) with

[13] The additional assumption that the compensation is unbounded from below is not crucial. As in Grossman and Hart (1983), it can instead be assumed that the compensation cannot be lower than some $l\in\Re$ and that $\lim_{w\to l} u(w)\to-\infty$.

respect to action. This assumption implies that F satisfies first order stochastic dominance in action. The corresponding density function, $f\left(x|a\right)$, is assumed to be positive for all x and a. In order to avoid the non-existence of an optimal solution as in Mirrlees (1999), it is assumed that the likelihood ratio $\frac{f_a}{f}$ is bounded from below.

In designing the contract with the manager, the owner's objective is to minimize the cost of implementing the desired effort. Throughout the analysis it is assumed that the owner's problem and the manager's effort decision have optimal solutions that are characterized by the usual first order conditions.[14]

3. Information revelation and the owner's problem

The manager is the only potential source of information about the outcome of his effort in the current model. Therefore, the manager's disclosure strategy plays an important role in providing the manager incentive to exert effort. Given that the manager's disclosure is not completely verifiable, the Revelation Principle does not hold in this setting, and eliciting full and truthful disclosure is not necessarily optimal.[15] This section analyzes the owner's problem when disclosure is voluntary. In this case, the informed manager's disclosure decision is comprised of two parts. In the first part, he must decide whether to provide a disclosure of his private information. In the second part, if he makes a disclosure, the manager must determine its content. When disclosure is mandatory an informed manager must provide a disclosure and his disclosure decision is only with respect to the disclosure's content. The

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[14] See Rogerson (1985) and Jewitt (1988) for conditions under which the first-order approach for the manager's effort problem applies.

[15] Arya, Glover, and Sunder (1998) discuss the failure of the Revelation Principle when the information is only partially verifiable.

owner's problem in this case will be obtained by a simple adjustment to the owner's problem in the case of voluntary disclosure.

At the time of disclosure the manager's effort is sunk and the manager chooses a message $m(s) \in S$ to maximize his expected utility from wage $u(w)$. If the manager observes $s = x$ and decides to provide a disclosure, $m(x) \in X$, then his expected utility is $Pu\left(w(x)\right)+(1-P)u\left(w\left(m(x)\right)\right)$. The manager will set $m(x)$ to maximize $w\left(m(x)\right)$: $m(x) \in \arg\max_{m \in X} w(m)$; that is, he will choose his disclosure so as to provide him with the highest wage when the verification process fails. This highest wage is represented in the owner's program by the wage variable w_H along with the following highest wage (*HW*) constraint:

$$u(w_H) \geq u\left(w(x)\right), \ \forall x \in X. \tag{1}$$

Instead of providing a disclosure, an informed manager can withhold his information and receive $w(\varnothing)$. Therefore, to induce an informed manager observing realization $s = x' \in X$ to make a disclosure ($d(x')=1$) the owner must set the compensation conditional on report $r = x'$ to be high enough so that $Pu\left(w(x')\right)+(1-P)u(w_H) \geq u\left(w(\varnothing)\right)$.[16] In contrast, in order to induce a manager observing a realization $s = x' \in X$ to withhold disclosure ($d(x')=0$) the owner must set $w(x')$ to be low enough so that $Pu\left(w(x')\right)+(1-P)u(w_H) < u\left(w(\varnothing)\right)$. Notice that in this case the manager receives $w(\varnothing)$ and the

[16] The assumption that when indifferent between disclosure and nondisclosure the manager chooses to provide disclosure is purely for convenience, and does not affect the analysis.

conditional compensation $w(x')$ becomes an *off-equilibrium* threat. Therefore, for any x for which the owner wishes to induce $d(x)=0$ there is no loss of generality by setting $w(x)=-\infty$ in order to satisfy the inequality $Pu(w(x))+(1-P)u(w_H)<u(w(\varnothing))$.

A simple approach to solve the owner's problem is to find for every possible realization of the signal $s=x\in X$ the optimal compensation $w(x)$ that induces disclosure ($d(x)=1$), and then let the owner choose whether he prefers disclosure of that realization (in which case $w(x)$ is as calculated by the program) or not (in which case $w(x)=-\infty$). Employing this approach, the subsequent analysis will focus on determining for every *x* the optimal $w(x)$ that induces disclosure and the owner's preferred disclosure decision, $d(x)$. Therefore, in the owner's program $w(x)$ needs to elicit disclosure and the following incentive compatible disclosure (*ICD*) constraint must hold:

$$Pu(w(x))+(1-P)u(w_H)\geq u(w(\varnothing)),\ \ \forall x\in X. \tag{2}$$

Using this approach, the owner's problem in setting the manager's compensation to implement action a' is given by Program *V*:

Program V

$$\min_{w(.),w_H,d(.)\in\{0,1\},} \quad \beta\int_{\underline{x}}^{\overline{x}}\left(Pw(x)+(1-P)w_H\right)d(x)\,f\left(x|a'\right)dx + w(\varnothing)\left(1-\beta+\beta\int_{\underline{x}}^{\overline{x}}\left(1-d(x)\right)f\left(x|a'\right)dx\right)$$

$$s.t.\quad \beta\int_{\underline{x}}^{\overline{x}}\left(Pu\left(w(x)\right)+(1-P)u\left(w_H\right)\right)d(x)\,f\left(x|a'\right)dx + u\left(w(\varnothing)\right)\left(1-\beta+\beta\int_{\underline{x}}^{\overline{x}}\left(1-d(x)\right)f\left(x|a'\right)dx\right) - v(a') \geq \underline{u} \qquad (IR)$$

$$\beta\int_{\underline{x}}^{\overline{x}}\left(Pu\left(w(x)\right)+(1-P)u\left(w_H\right)\right)d(x)\,f_a\left(x|a'\right)dx + u\left(w(\varnothing)\right)\beta\int_{\underline{x}}^{\overline{x}}\left(1-d(x)\right)f_a\left(x|a'\right)dx - v'(a') = 0 \qquad (ICA)$$

$$Pu\left(w(x)\right)+(1-P)u\left(w_H\right) \geq u\left(w(\varnothing)\right), \qquad \forall x\in X \qquad (ICD)$$

$$u\left(w_H\right) \geq u\left(w(x)\right), \qquad \forall x\in X. \qquad (HW)$$

As reflected in the owner's program, the owner chooses { $w(.), w_H, d(.)$ } so as to minimize the expected compensation paid to the manager. The individual rationality, *IR*, constraint ensures that the manager accepts the contract given to him (his reservation utility is denoted by $\underline{u}$), while the incentive compatibility, *ICA*, constraint ensures that the manager prefers to choose the pre-specified action a'. For purposes of the ensuing analysis, denote by λ and μ the Lagrange multipliers for the *IR* and the *ICA* constraints, respectively. Using standard methods in the moral hazard literature it can be shown that both λ and μ are positive.[17] The likelihood ratio $\frac{f_a(x|a)}{f(x|a)}$ of the performance measure plays an important role in this literature, where a standard result is that the compensation to the manager is increasing in the likelihood ratio of the performance measure (and by the MLRP assumption also in the performance measure). I will therefore sometimes refer to the likelihood ratio of the performance measure as the manager's type. In the current setting, x is not observable to the owner, only the manager's report about

[17] See Holmstrom (1979) and Grossman and Hart (1983).

his potential observation of *x* is. The owner however can form expectations about $\frac{f_a(x|a)}{f(x|a)}$ based on his observation of the manager's report. Given an induced effort a, let $E\left[\frac{f_a(x|a)}{f(x|a)}|r\right]$ be the expected value of the likelihood ratio of x conditional on report r, based on the owner's rational expectations about the manager's disclosure strategy under the relevant contract. It is well know that the unconditional mean of the likelihood ratio of any signal is zero. Lastly, let C denote the expected cost to the owner of implementing action a'. The analysis first considers the case where disclosure is mandatory and then considers the case where disclosure is voluntary. Once the optimal contracts for these two disclosure regimes are characterized, the analysis turns to an exploration of these regimes' relative advantages.

4. The optimal contract when disclosure is mandatory

When disclosure is mandatory, the manager must choose $d(x)=1$ for every *x*. Therefore, the owner's problem in this case can be derived from Program *V* by setting $d(x)=1$ for all x and omitting the *ICD* constraint. The resulting program is referred to as Program *M*. The solution for Program *M* (Program *V*) is denoted by the superscript *M* (*V*).

PROPOSITION 1 (MANDATORY DISCLOSURE). *When disclosure is mandatory, under the optimal contract there is* $x_H^M \in (\underline{x}, \overline{x})$ *such that an informed manager observing* $s = x$ *picks a disclosure value from the interval* $\left[x_H^M, \overline{x}\right]$ *(that is,* $m^M(x) \in \left[x_H^M, \overline{x}\right]$*). The manager's compensation conditional on* $r \in S$ *satisfies* $\frac{1}{u'(w^M(r))} = \lambda^M + \mu^M \frac{f_a(\min(r, x_H^M)|a')}{f(\min(r, x_H^M)|a')}$, *if* $r \in X$ *; and* $\frac{1}{u'(w^M(r))} = \lambda^M$, *if* $r = \varnothing$. *In equilibrium,* x_H^M *satisfies* $\frac{f_a(x_H^M|a')}{f(x_H^M|a')} = E^M\left[\frac{f_a(x|a')}{f(x|a')}\middle| r \geq x_H^M\right]$, *and it is increasing in* P, *approaching* $\overline{x}$ *when* P *approaches 1. The cost of the contract,* C^M *, is decreasing in P.*

When disclosure is mandatory, a report $r = \varnothing$ reveals that the manager is uninformed and consequently his compensation is set according to the prior mean of likelihood ratio of the signal x, which is zero. Conditional on disclosure, the compensation is increasing in the report until the report reaches a critical value of $r = x_H^M$ and then stays constant for higher levels of reports ($r > x_H^M$). I refer to the interval $\left[x_H, \overline{x}\right]$ as the top signal interval or as the right tail of the signal distribution. In an attempt to receive the highest possible wage, informed managers pool their disclosures at the top signal interval $\left[x_H^M, \overline{x}\right]$. Since the compensation in that region is constant, the specific value that the manager's disclosure takes within that interval does not matter. Rather than imposing an arbitrary rule for choosing the level of disclosure from the top interval it is simply assumed that the specific level chosen has no informational value. For convenience, throughout the paper the manager's disclosure of a value within the top signal interval is referred to as truthful if the manager's signal indeed lies in the top signal interval, and as untruthful or biased if the signal lies below that interval (with a lower signal implying a greater level of bias). This pooling of disclosures is similar to the pooling of reports over the right tail of the earnings distribution in Marinovic (2013).[18] Since the owner cannot distinguish between truthful and untruthful top signal reports, he sets the compensation for reports in the top signal interval to reflect the average type in the top pool. This means that in the top disclosure pool, types higher than x_H^M are relatively under-compensated, whereas types lower than x_H^M are relatively over-compensated. Upon observing a report in the left tail of the signal distribution ($r < x_H^M$) the owner knows that the verification process was effective and $t(r)$ provides the correct compensation to the manager.

The owner sets the cutoff x_H^M such that in equilibrium $\frac{f_a\left(x_H^M \middle| a'\right)}{f\left(x_H^M \middle| a'\right)} = E^M\left[\frac{f_a\left(x \middle| a'\right)}{f\left(x \middle| a'\right)} \middle| r \geq x_H^M\right]$, so that $\frac{f_a\left(x_H^M \middle| a'\right)}{f\left(x_H^M \middle| a'\right)}$ reflects the average likelihood ratio (type) in the right tail of the signal distribution. It can be shown that this cutoff is the highest possible such that the compensation is non-decreasing in the manager's true type. As the level of verification P increases, right tail disclosures are more likely to be truthful and the average type in that region increases. Consequently, it becomes cheaper to induce the manager to adopt the desired action and the cost of the contract decreases.[19] In the limit, as P approaches

[18] The analysis in Marinovic (2013) is conducted in a capital market setting and the manager must randomize his disclosure within the top signal interval in order to prevent investors from detecting that the disclosure is manipulated. Such randomization is possible, but not necessary, under the contracting approach in this paper. Marinovic (2013) notes that the counterpart of x_H^M in the empirical literature is the documented kink in the distribution of reported earnings (see Hayn, 1995).

[19] As noted by Marinovic (2013), a higher level of verification P does not imply a higher level of informativeness according to the Blackwell (1951) criterion. This is because a higher probability of verification leads not only to a lower likelihood of a biased report, but also to a higher x_H^M, so that, on average, the bias is higher. In order to establish a notion of earnings quality, Marinovic (2013) applies the less restrictive informativeness criterion of Ganuza and Penalva (2010) and shows that, consistent with the ranking here, a higher probability of verification is associated with higher information content according to this criterion.

one, x_H^M approaches $\overline{x}$ and the compensation conditional on disclosure becomes everywhere increasing, as in the standard contract in the moral hazard literature with a public signal.

This equilibrium reveals that the softness of information has two important implications for efficiency. First, the biasing activity of the manager leads to loss of information. Second, an untruthful disclosure exposes the manager to an uncertain payment that depends on the success of the verification process, thereby imposing a deadweight cost on the owner in the form of inefficient risk sharing.

5. *The optimal contract when disclosure is voluntary*

This section analyzes the case of voluntary disclosure. The next proposition characterizes the solution to Program *V*.

PROPOSITION 2 (VOLUNTARY DISCLOSURE). *When disclosure is voluntary, under the optimal contract there are $\hat{x} \in X$ and $x_H^V \in X$, where $\underline{x} < \hat{x} < x_H^V < \overline{x}$, such that an informed manager observing $s = x$ withholds disclosure (that is, $m^V(x) = \varnothing$) if $x < \hat{x}$, and picks a disclosure value from the interval $\left[x_H^V, \overline{x}\right]$ (that is, $m^V(x) \in \left[x_H^V, \overline{x}\right]$) if $x \geq \hat{x}$. The manager's compensation conditional on report $r \in S$ satisfies $w^V(r) = -\infty$, if $r < \hat{x}$; $\frac{1}{u'\left(w^V(r)\right)} = \lambda^V + \mu^V \frac{f_a\left(\min\left(r, x_H^V\right)|a'\right)}{f\left(\min\left(r, x_H^V\right)|a'\right)}$, if $r \geq \hat{x}$; and*

$$\frac{1}{u'\left(w^V(r)\right)} = \lambda^V + \mu^V \frac{\beta\int_{\underline{x}}^{\hat{x}} f_a\left(x|a'\right)dx}{1-\beta+\beta\int_{\underline{x}}^{\hat{x}} f\left(x|a'\right)dx}$$

, if $r = \varnothing$. In equilibrium,

$$\frac{\beta\int_{\underline{x}}^{\hat{x}} f_a\left(x|a'\right)dx}{1-\beta+\beta\int_{\underline{x}}^{\hat{x}} f\left(x|a'\right)dx} = E^V\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}\Big|r = \varnothing\right],$$

and x_H^V satisfies

$$\frac{f_a\left(x_H^V|a'\right)}{f\left(x_H^V|a'\right)} = E^V\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}\Big|r \geq x_H^V\right].$$

The

disclosure threshold $\hat{x}$ *approaches* $\underline{x}$ *when* P *and* β *approach 1. Holding* $\hat{x}$ *constant,* x_H^V *is increasing in* P*, approaching* $\overline{x}$ *when* P *approaches 1. The cost of the contract,* C^V*, is decreasing in P.*

Under the optimal contract the owner sets the compensation for reports below the threshold disclosure $\hat{x}$ sufficiently low (as discussed above, it is set at $-\infty$ in the model for simplicity) so that the informed manager does not provide a disclosure when he observes a signal realization below $\hat{x}$. The compensation absent disclosure is determined according to the expected type of managers in the nondisclosure pool, $E^V\left[\frac{f_a(x|a')}{f(x|a')}|r=\varnothing\right]$, taking into account that the non-disclosing manager is either uninformed or his information is below the threshold disclosure $\hat{x}$. The compensation for reports above the threshold disclosure is increasing in the report until the report reaches a critical value of $r = x_H^V$ and then it stays constant for $r > x_H^V$. As in the case of mandatory disclosure, informed managers who provide a disclosure pool their disclosures at the right tail of the signal distribution, $\left[x_H^V, \overline{x}\right]$, and the compensation in that region reflects the average type in the pool, $E^V\left[\frac{f_a(x|a')}{f(x|a')}|r \geq x_H^V\right]$. The resulting disclosure strategy of an informed manager can therefore be divided into three regions based on the realization of his private information: for realizations below $\hat{x}$ the manager withholds disclosure, so that $m^V(x) = \varnothing$; for intermediate realizations $x \in \left(\hat{x}, x_H^V\right)$ the manager provides a biased disclosure that lies at the top signal interval, $m^V(x) \in \left[x_H^V, \overline{x}\right]$; and for realizations within the top signal interval, $x \in \left[x_H^V, \overline{x}\right]$

, the manager provides a truthful disclosure. As P increases, intermediate realizations are more likely to be separated from the right tail of the distribution so that, all else equal, a right tail disclosure will reflect more favorable information (that is, x_H^V will increase). As a result, it becomes cheaper to induce effort.

Under voluntary disclosure partial disclosure arises even though the owner can induce full disclosure by fixing the level of compensation conditional on nondisclosure, $w^V(\varnothing)$, to be sufficiently low. The owner, though, opts not to do so for two reasons. First, the owner cannot be sure whether nondisclosure is the result of the manager withholding disclosure or having no information to disclose. Consequently, setting the compensation absent disclosure sufficiently low to induce full disclosure would impose excessive risk on the manager ex-ante, given the possibility that the manager will not receive information. Instead, it is optimal to set the disclosure threshold equal to the expected type of a non-disclosing manager, $E^V\left[\frac{f_a(x|a')}{f(x|a')}|r=\varnothing\right]$, which leads to a similar threshold as in the standard voluntary disclosure model of Jung and Kwon (1988) (Versano, 2017).[20] The uncertainty over the manager's information endowment, therefore, leads to partial disclosure and information loss regardless of the softness of his information. Second, given that the information is soft, the owner can benefit from silence by managers with unfavorable information (information below the disclosure threshold). This is because any disclosure by these managers would be untruthful, and so would reduce the information content of the disclosures of managers with more favorable information. Further, an untruthful disclosure exposes the manager to an uncertain payment that depends on the success of the verification process and this risk needs to be compensated for ex-ante. The less favorable the information that the manager observes, the

[20] Here expectations are taken over the likelihood ratio of the signal whereas in the disclosure literature expectations are taken over the signal itself. If the likelihood ratio is linear in the signal, the disclosure threshold here is identical to that in Jung and Kwon (1988).

higher the bias that he introduces into his disclosure and the greater the adverse effect of the manager's disclosure on the information content of the disclosures made by other managers and on efficient risk sharing. Because managers with information below the disclosure threshold do not participate in the right tail disclosure pool, the higher that threshold, the more informative are right tail disclosures and the more efficient is the risk sharing between the manager and the owner. These positive effects of a higher disclosure threshold, which do not exist in the limit when the information becomes hard, leads the owner to set the disclosure threshold higher when the information is soft than when it is hard. This is formally stated in the next Corollary.

COROLLARY 1. *The disclosure threshold* $\hat{x}$ *approaches its minimum value when* P *approaches 1.*

The result in Corollary 1 can be compared to that of Einhorn and Ziv (2012), who extend the discretionary disclosure models of Verrecchia (1983) and Dye (1985) within a capital market setting and allow the manager to bias his disclosure. They show that the disclosure threshold is not affected by the relaxation of the assumption that disclosure, if provided, must be truthful. In contrast, here, the owner uses the contract with the manager in order to raise the disclosure threshold when the disclosure can be manipulated in order to improve the overall information content of the reports. Consequently, the probability of disclosure is higher when disclosure can be made in a credible manner than when it cannot.

6. Implications of voluntary disclosure when the information is soft

The previous analysis has established that allowing the manager to choose whether to provide a disclosure of his private information introduces a cost because informed managers can pool with uninformed managers. It also provides a benefit because allowing for unfavorable information to be withheld improves the quality of right tail disclosures and reduces the risk that the manager needs to bear. This section explores the conditions under which the net effect of allowing for voluntary disclosure is positive and the conditions under which it is negative.

A comparison of the manager's equilibrium disclosure strategy when disclosure is voluntary (as given in Proposition 2) and when it is mandatory (as given in Proposition 1) reveals that under voluntary disclosure, managers endowed with information below the disclosure threshold withhold their information, while they provide a disclosure in the top signal interval when disclosure is mandatory. Since under voluntary disclosure the top disclosure pool does not include managers who observe information below the disclosure threshold, the quality of the pool, as reflected by the average type in the pool, is higher when disclosure is voluntary than when it is mandatory. This is reflected in the following corollary.

COROLLARY 2. $x_H^M < x_H^V$.

An implication of Corollary 2 is that, conditional on the manager observing $x \geq \hat{x}$ (that is, conditional on his making a disclosure when disclosure is voluntary), the report under voluntary disclosure is more informative about the manager's private information than the report under mandatory disclosure. Another implication of Corollary 2 is that managers who make a disclosure when disclosure is voluntary bias their disclosure more than they would if disclosure were mandatory.

The informational advantage of voluntary disclosure over mandatory disclosure crucially depends on the magnitude of P. To see this, note that prior to verification the manager's disclosures have information content when they are provided voluntarily but not when they are mandatory. This is because a voluntary disclosure indicates that the manager's signal is above the disclosure threshold. In contrast, when disclosure is mandatory, all informed managers are required to make a disclosure and it is impossible to learn anything from a disclosure before it is verified. As a result, as the probability of verification approaches zero, it is not possible to extract any information from a managerial disclosure under mandatory disclosure and the cost of providing the manager with an incentive to work becomes very large. In contrast, under voluntary disclosure there is a separation between managers who observe information below the disclosure threshold and those observing information above the threshold, and the cost of inducing effort remains bounded even as P approaches zero. It follows that as P becomes negligibly small the benefit from allowing for voluntary disclosure becomes very large, so that it outweighs any cost that the pooling of informed managers with uninformed managers imposes. On the other extreme, as P approaches one, the magnitude of this benefit approaches zero. In the limit, the information content of the manager's disclosure prior to verification is unimportant because the disclosures are verified with certainty and adjusted to reflect the true content of the manager's signal. Consequently, allowing for voluntary disclosure imposes a cost, but does not yield any benefit. The following Proposition summarizes the above discussion.

PROPOSITION 3. *If the probability of verification,* P *, is sufficiently low (high),* $C^V < C^M$ *(*$C^V > C^M$*).*

The cost that is incurred under voluntary disclosure due to the strategic pooling of informed managers with uninformed managers becomes very small as the probability that the manager receives information, β, approaches one. In the limit, as $\beta \to 1$, an informed manager cannot disguise as uninformed. The owner knows that the manager is in possession of information and that nondisclosure is the result of information withholding. As a result the owner can impose a large penalty for no disclosure (in order to induce full disclosure) without the risk of adversely affecting an uninformed manager. Given that voluntary disclosure imposes no cost in this case, but offers a benefit in ameliorating the adverse consequences of the softness of the information, even the smallest degree of softness makes voluntary disclosure the preferred regime. It should be noted that the limiting case of $\beta = 1$ is of special interest because it reflects a situation in which the information endowment of the manager is common knowledge or observable to the owner (or to the firm's internal control system). Employing continuity, it is possible to show the following result.

COROLLARY 3. *For every P, $C^V < C^M$ if β is sufficiently close to one.*

The benefit from keeping silent implies that the manager will not adopt a full disclosure strategy when disclosure is voluntary regardless of whether there is uncertainty about his information endowment. Only when the probability of verification approaches one does the equilibrium disclosure converge to full disclosure (see Proposition 2). This highlights the role of softness of information as a separate factor in suppressing managers' disclosures.

As a final point, recall that inducing no disclosure of unfavorable realizations when the probability P is very low requires the owner to impose a heavy penalty for reports containing disclosure of these realizations. The unlimited liability assumption here is important and, similar to Grossman and Hart (1983) and the literature they initiated, it ensures that the *IR* constraint binds at the optimum even when the information system is marginally informative. If the manager is subject to limited liability, it is impossible to have the *IR* constraint bind at the optimum as P becomes arbitrarily small. With limited penalties for unfavorable reports, the owner must set the payment for favorable reports very large in order to convince the manager to exert effort when P is very small. Consequently, the cost of the contract becomes very large not only when disclosure is mandatory, but also when it is voluntary. It turns out that while a lower bound on the manager's compensation increases the cost of implementing the contract when disclosure is voluntary, it also increases that cost when disclosure is mandatory. In particular, if the minimum payment imposed by the limited liability constraint is sufficiently high that the *IR* constraint does not bind at the optimum, then voluntary disclosure is weakly preferred regardless of the value of P. This is formally stated in the following proposition.

PROPOSITION 4. *Suppose that compensation cannot fall below a certain lower bound* $l \in \Re$. *If under mandatory disclosure the expected compensation to the manager is higher than his reservation utility, then* $C^V \leq C^M$ *for every* P.

The intuition behind this result is that when disclosure is mandatory the owner receives more information about the manager's unfavorable performance, whereas when disclosure is voluntary he receives more information about the manager's favorable performance. As a result, the contract under mandatory (voluntary) disclosure relies more heavily on high penalties (rewards). When the limited liability sufficiently shields the manager against high penalties, mandatory disclosure loses its relative advantage. In this case, the contract must employ high rewards in order to induce effort also when disclosure is mandatory, and consequently the manager extracts an ex-ante rent. More generally, it is shown in the appendix that when the manager is protected by limited liability, the welfare implications of Proposition 3 continue to hold, although (given Proposition 4) only in a weak form. The welfare implications of Corollary 3, though, extend to the case of limited liability without change.

7. Summary and Conclusions

In the last few decades, as the economy has shifted from production-based to knowledge-based, corporate value and growth have become increasingly driven by intangible assets (such as patents, brands, human resources, and information technology) and less by tangible assets (such as plants, inventory, and machines). As a result, traditional accounting measures that are subject to the reliability criterion and thus reflect mainly physical and financial assets became less relevant for the users of the financial statements. This naturally raises the question of why not relax the reliability requirement and mandate that firms supplement their financial reports with projections, estimates and other forward looking information about the value of important intangible value drivers. This paper studies how the softness of information affects the desirability of mandating its disclosure in a model where the existence and the content of information is private knowledge of the manager.

It is shown that mandating disclosure of private information is desirable only when the information is verifiable with high probability. When the information is verifiable with low probability, mandating its disclosure leads to an overall decrease in the information content of the managerial disclosure. The intuition behind this result is that while mandating disclosure naturally solves the asymmetry of information regarding the existence of a private signal, allowing for voluntary disclosure provides a better solution for the asymmetry of information regarding the content of the signal. This is because when disclosure is voluntary managers with relatively unfavorable information withhold disclosure instead of participating in the right tail disclosure pool. As a result, they are exposed to less risk and the information content of right tail reports is improved. These effects are stronger when the right tail disclosure pool is not likely to be otherwise separated by the verification process. Consequently, if the information is verifiable with relatively low probability, voluntary disclosure yields higher welfare. If, instead, the information is verifiable with relatively high probability, mandatory disclosure is weakly preferred. Strict dominance of mandatory disclosure, though, can be achieved only if there is some uncertainty over the information endowment of the manager. Otherwise, if the manager is known to possess information, mandating disclosure yields no informational gains and even the smallest degree of softness makes voluntary disclosure the preferred regime.

Additional insights about the disclosure equilibrium arise from the analysis. It is shown that the threshold disclosure is higher when the information is soft than when it is hard. Consequently, it is predicted that the probability of disclosure will be higher when disclosure can be made in a credible manner than when it cannot. In addition, the analysis predicts that managers who voluntarily make a disclosure will bias their disclosure more than they would if disclosure were mandatory. Therefore, while under voluntary disclosure managers with unfavorable information choose silence over a very biased disclosure, managers with favorable information introduce larger biases into their disclosures.

Lastly, a relaxation of the standard assumption of unlimited liability, which ensures that the individual rationality constraint is binding at the optimum, is examined. With limited liability, it is impossible to keep the cost of the contract bounded as the probability of verification becomes negligible even when disclosure is voluntary. Nevertheless, the dominance of voluntary (mandatory) disclosure when the probability of verification is sufficiently low (high) is demonstrated in this case as well, albeit in a weak form under certain conditions. More surprisingly, when the limit on the manager's liability allows him to extract rents, it is weakly preferable to leave disclosure unregulated as long as the information is not completely verifiable. Overall, the results suggest that restricting mandatory disclosure requirements to verifiable information while allowing managers to voluntarily disclose estimates, projections and other forward-looking information may maximize the total information content of managerial disclosures.

APPENDIX - PROOFS

Proof of Proposition 1. Let $\gamma^M(x)$ be the Lagrange multiplier of the *HW* constraint in Program *M*.

The Lagrangian corresponding to Program *M* is given by

$$\begin{aligned}\mathcal{L} &= \beta\int_{\underline{x}}^{\overline{x}}\left(Pw(x)+(1-P)w_H\right)f\left(x|a'\right)dx+(1-\beta)w(\varnothing)\\ &-\lambda^M\left(\beta\int_{\underline{x}}^{\overline{x}}\left(Pu\left(w(x)\right)+(1-P)u\left(w_H\right)\right)d(x)\,f\left(x|a'\right)dx+(1-\beta)u\left(w(\varnothing)\right)-v(a')-\underline{u}\right)\\ &-\mu^M\left(\beta\int_{\underline{x}}^{\overline{x}}\left(Pu\left(w(x)\right)+(1-P)u\left(w_H\right)\right)d(x)\,f_a\left(x|a'\right)dx-v'(a')\right)\\ &-\int_{\underline{x}}^{\overline{x}}\gamma^M(x)\left(u\left(w_H\right)-u\left(w(x)\right)\right)dx.\end{aligned}$$

The first order conditions with respect to $w(x)$ (pointwise), $w(\varnothing)$, and w_H are

$$\frac{1}{u'\left(w^M(x)\right)}=\lambda^M+\mu^M\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}-\frac{\gamma^M(x)}{\beta Pf\left(x|a'\right)}, \tag{3}$$

$$\frac{1}{u'\left(w^M(\varnothing)\right)}=\lambda^M, \text{ and} \tag{4}$$

$$\frac{1}{u'\left(w_H^M\right)}=\lambda^M+\frac{\int_{\underline{x}}^{\overline{x}}\gamma^M(x)\,dx}{\beta(1-P)}. \tag{5}$$

Let $x_H^M\in X$ be the lowest realization of x for which the *HW* constraint is binding and $x_H^M=\overline{x}$ if the *HW* does not bind at the optimum. Since $x>(<)\,x_H^M$ implies that $\gamma^M(x)>(=)\,0$, we have

$$\frac{1}{u'\left(w^M(r)\right)} = \lambda^M + \mu^M \frac{f_a\left(\min\left(r, x_H^M\right)|a'\right)}{f\left(\min\left(r, x_H^M\right)|a'\right)}$$. It follows that the message solving $m(x) \in \arg\max_{m \in X} w(m)$,

lies within the interval $\left[x_H^M, \overline{x}\right]$. Also from (3) $\gamma^M(x) = \beta P f\left(x|a'\right)\left(\lambda^M + \mu^M \frac{f_a\left(x|a'\right)}{f\left(x|a'\right)} - \frac{1}{u'\left(w_H^M\right)}\right)$, and

integration yields

$$\int_{\underline{x}}^{\overline{x}} \gamma^M(x)\,dx = \int_{x_H^M}^{\overline{x}} \gamma^M(x)\,dx = \beta P \int_{x_H^M}^{\overline{x}} \left(\lambda^M + \mu^M \frac{f_a\left(x|a'\right)}{f\left(x|a'\right)} - \frac{1}{u'\left(w_H^M\right)}\right) f\left(x|a'\right)dx$$. Combining this with (5)

and rearranging gives $\frac{1}{u'\left(w_H^M\right)} = \lambda^M + \mu^M \frac{P\int_{x_H^M}^{\overline{x}} f_a\left(x|a'\right)dx}{1 - P + P\int_{x_H^M}^{\overline{x}} f\left(x|a'\right)dx}$. From (3) and the definition of x_H^M we

have $\frac{f_a\left(x_H^M|a'\right)}{f\left(x_H^M|a'\right)} = \frac{P\int_{x_H^M}^{\overline{x}} f_a\left(x|a'\right)dx}{1 - P + P\int_{x_H^M}^{\overline{x}} f\left(x|a'\right)dx}$. Notice that

$$\frac{P\int_{x_H^M}^{\overline{x}} f_a\left(x|a'\right)dx}{1 - P + P\int_{x_H^M}^{\overline{x}} f\left(x|a'\right)dx} = \frac{(1-P)0 + P\int_{x_H^M}^{\overline{x}} \frac{f_a\left(x|a'\right)}{f\left(x|a'\right)} f\left(x|a'\right)dx}{1 - P + P\int_{x_H^M}^{\overline{x}} f\left(x|a'\right)dx} = E^M\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}\middle| r \geq x_H^M\right].$$

Define the function $R^M : R^M(q, P) = \frac{f_a\left(q|a'\right)}{f\left(q|a'\right)} - \frac{P\int_q^{\overline{x}} f_a\left(x|a'\right)dx}{1 - P + P\int_q^{\overline{x}} f\left(x|a'\right)dx}$. Then,

$\frac{\partial q}{\partial P} = -\frac{\partial R^M}{\partial P} / \frac{\partial R^M}{\partial q}$. Where the equilibrium condition $R^M(q, P) = 0$ is satisfied we have

$$\frac{\partial R^M}{\partial P}=\frac{\int_{\underline{x}}^{q} f\left(x|a'\right)dx}{1-P+P\int_{q}^{\overline{x}} f\left(x|a'\right)dx}\left(\frac{\int_{\underline{x}}^{q} f_a\left(x|a'\right)dx}{\int_{\underline{x}}^{q} f\left(x|a'\right)dx}-\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}\right)<0$$ and $$\frac{\partial R^M}{\partial q}=\frac{\partial}{\partial q}\left[\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}\right]>0$$, where the

equalities follow from the MLRP assumption. Thus, $\frac{\partial q}{\partial P}=-\frac{\partial R^M}{\partial P}/\frac{\partial R^M}{\partial q}>0$. Therefore, x_H^M is

increasing in P. Notice that, $$R^M\left(q,1\right)=\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}-\frac{\int_{q}^{\overline{x}} f_a\left(x|a'\right)dx}{\int_{q}^{\overline{x}} f\left(x|a'\right)dx}=\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}-E\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}\middle| x\geq q\right]$$, and

therefore the equilibrium condition $R^M\left(q,1\right)=0$ can hold only for $q=\overline{x}$. Thus, $\lim_{P\to 1} x_H^M=\overline{x}$.

Finally, the derivative of the Lagrangian of Program *M* with respect to P is

$$\beta\int_{\underline{x}}^{\overline{x}}\left(\left(u\left(w_H^M\right)-u\left(w^M\left(x\right)\right)\right)\left(\lambda^M+\mu^M\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}\right)-\left(w_H^M-w^M\left(x\right)\right)\right)f\left(x|a'\right)dx$$. Using (3) and the fact

that the *HW* constraint binds for $x>x_H^M$, this becomes

$$\beta\int_{\underline{x}}^{x_H^M}\frac{1}{u'\left(w^M\left(x\right)\right)}\left(u\left(w_H^M\right)-u\left(w^M\left(x\right)\right)-u'\left(w^M\left(x\right)\right)\left(w_H^M-w^M\left(x\right)\right)\right)f\left(x|a'\right)dx<0$$, where the inequality

follows from the strict concavity of u. By the Envelope Theorem, it follows that C^M is decreasing in

P. □

Proof of Proposition 2. Let $\delta^V\left(x\right)$ and $\gamma^V\left(x\right)$ be the Lagrange multipliers of the *ICD* and *HW*

constraints, respectively, in Program *V*. The Lagrangian corresponding to Program *V* is given by

$$
\begin{aligned}
\mathcal{L} = & \beta\int_{\underline{x}}^{\overline{x}}\left(Pw(x)+(1-P)w_H\right)d(x)\, f(x|a')dx + w(\varnothing)\left(1-\beta+\beta\int_{\underline{x}}^{\overline{x}}(1-d(x))\, f(x|a')dx\right) \\
& -\lambda^V\left(\beta\int_{\underline{x}}^{\overline{x}}\left(Pu(w(x))+(1-P)u(w_H)\right)d(x)\, f(x|a')dx + u(w(\varnothing))\left(1-\beta+\beta\int_{\underline{x}}^{\overline{x}}(1-d(x))\, f(x|a')dx\right)-v(a')-\underline{u}\right) \\
& -\mu^V\left(\beta\int_{\underline{x}}^{\overline{x}}\left(Pu(w(x))+(1-P)u(w_H)\right)d(x)\, f_a(x|a')dx + u(w(\varnothing))\beta\int_{\underline{x}}^{\overline{x}}(1-d(x))\, f_a(x|a')dx - v'(a')\right) \\
& -\int_{\underline{x}}^{\overline{x}}\delta^V(x)\left(Pu(w(x))+(1-P)u(w_H)-u(w(\varnothing))\right)dx \\
& -\int_{\underline{x}}^{\overline{x}}\gamma^V(x)\left(u(w_H)-u(w(x))\right)dx.
\end{aligned}
$$

The first order conditions with respect to $w(x)$ (pointwise), $w(\varnothing)$, and w_H are

$$
\frac{1}{u'\left(w^V(x)\right)} = \lambda^V + \mu^V\frac{f_a(x|a')}{f(x|a')} + \frac{P\delta^V(x)-\gamma^V(x)}{\beta Pf(x|a)},\ \ \forall x\in X, \tag{6}
$$

$$
\frac{1}{u'\left(w^V(\varnothing)\right)} = \lambda^V + \frac{\mu^V\beta\int_{\underline{x}}^{\overline{x}}\left(1-d^V(x)\right) f_a(x|a')dx - \int_{\underline{x}}^{\overline{x}}\delta^V(x)dx}{1-\beta+\beta\int_{\underline{x}}^{\overline{x}}\left(1-d^V(x)\right) f(x|a')dx}, \text{ and} \tag{7}
$$

$$
\frac{1}{u'\left(w_H^V\right)} = \lambda^V + \mu^V\frac{\int_{\underline{x}}^{\overline{x}}d^V(x)\, f_a(x|a')dx}{\int_{\underline{x}}^{\overline{x}}d^V(x)\, f(x|a')dx} + \frac{\int_{\underline{x}}^{\overline{x}}\delta^V(x)dx + \frac{1}{1-P}\int_{\underline{x}}^{\overline{x}}\gamma^V(x)dx}{\beta\int_{\underline{x}}^{\overline{x}}d^V(x)\, f(x|a')dx}. \tag{8}
$$

The *HW* (*ICD*) sets an upper bound (a lower bound) for $w^V(x)$. To induce effort, the upper bound must be strictly higher than the lower bound; that is, it must be that $w_H^V > w^V(\varnothing)$. Let $x_H^V \in (\underline{x},\overline{x}]$ be the lowest realization of x for which the *HW* constraint is binding ($x_H^V = \overline{x}$ if the *HW* does not bind at the optimum), and let $x_\varnothing$ be such that $\frac{1}{u'\left(w^V(\varnothing)\right)} = \lambda^V + \mu^V \frac{f_a\left(x_\varnothing | a'\right)}{f\left(x_\varnothing | a'\right)}$. Then $x_H^V > x_\varnothing$. For every

$x \in \left[x_\varnothing, x_H^V\right)$ the *ICD* and *HW* do not bind and it follows from (6) that $w^V(x)$ is the solution to

$\frac{1}{u'\left(w^V(x)\right)} = \lambda + \mu \frac{f_a\left(x | a'\right)}{f\left(x | a'\right)}$. For $x \geq x_H^V$ the *HW* is binding and (6) implies that the compensation w_H^V

satisfies

$$\frac{1}{u'\left(w_H^V\right)} = \lambda^V + \mu^V \frac{f_a\left(x_H^V | a'\right)}{f\left(x_H^V | a'\right)}. \tag{9}$$

Let $k^V(x)$ be the coefficient of $\beta d^V(x) f\left(x | a'\right)$ in the Lagrangian. The expression for $k^V(x)$ is given

by

$$k^V(x) = \left(Pw^V(x) + (1-P)w_H^V - w^V(\varnothing)\right) - \left(Pu\left(w^V(x)\right) + (1-P)u\left(w_H^V\right) - u\left(w^V(\varnothing)\right)\right)\left(\lambda^V + \mu^V \frac{f_a\left(x | a'\right)}{f\left(x | a'\right)}\right).$$

Since the Lagrangian is linear in $d^V(x)$, the owner will set $d^V(x) = 1(0)$ for every x for which

$k^V(x) < (>) 0$. The first derivative of k is

$$k^V{}'(x) = Pw^V{}'(x)\left[1 - u'\left(w^V(x)\right)\left(\lambda^V + \mu^V \frac{f_a\left(x | a'\right)}{f\left(x | a'\right)}\right)\right] - \left(Pu\left(w^V(x)\right) + (1-P)u\left(w_H^V\right) - u\left(w^V(\varnothing)\right)\right)\mu^V \frac{d}{dx}\left(\frac{f_a\left(x | a'\right)}{f\left(x | a'\right)}\right).$$

Substituting (6) into $k'(x)$ yields

$$k^V{}'(x) = Pw^V{}'(x)u'\left(w^V(x)\right)\left(\frac{P\delta^V(x) - \gamma^V(x)}{\beta Pf\left(x | a\right)}\right) - \left(Pu\left(w^V(x)\right) + (1-P)u\left(w_H^V\right) - u\left(w^V(\varnothing)\right)\right)\mu^V \frac{d}{dx}\left(\frac{f_a\left(x | a'\right)}{f\left(x | a'\right)}\right).$$

Because either $w^V{}'(x) = 0$ (where the *ICD* or the *HW* are binding) or $P\delta^V(x) - \gamma^V(x) = 0$ (where both the *ICD* and the *HW* are not binding), we have

$$k^V{}'(x) = -\left(Pu\left(w^V(x)\right) + (1-P)u\left(w_H^V\right) - u\left(w^V(\varnothing)\right)\right)\mu^V \frac{d}{dx}\left(\frac{f_a(x|a')}{f(x|a')}\right) \le 0$$, where the inequality

follows from the *ICD* constraint and the *MLRP* assumption. It follows that there is an $\hat{x} \in X$ such that

$d^V(x) = 0$ ($d^V(x) = 1$) for every $x < \hat{x}$ ($x > \hat{x}$). It must be the case that $x_\varnothing < \hat{x} < x_H^V$, where $\lim_{P\to 1}\hat{x} = x_\varnothing$

, because using the strict concavity of u, $k^V\left(x_H^V\right) = \left(w_H^V - w^V(\varnothing)\right) - \left(u\left(w_H^V\right) - u\left(w^V(\varnothing)\right)\right)\frac{1}{u'\left(w_H^V\right)} < 0$,

$k^V(x_\varnothing) = (1-P)\left(w_H^V - w^V(\varnothing) - \left(u\left(w_H^V\right) - u\left(w^V(\varnothing)\right)\right)\frac{1}{u'\left(w^V(\varnothing)\right)}\right) > 0$, and we have $\lim_{P\to 1} k^V(x_\varnothing) = 0$.

Because the disclosure threshold lies above $x_\varnothing$ and at $x = x_\varnothing$ the *ICD* is slack, it follows that the *ICD*

does not bind at the optimum and $\delta(x) = 0$ for all $x \in X$. Employing the solution for $d^V(x)$ on (7)

yields $\frac{1}{u'\left(w^V(\varnothing)\right)} = \lambda^V + \mu^V \frac{\beta\int_{\underline{x}}^{\hat{x}} f_a(x|a')dx}{1-\beta+\beta\int_{\underline{x}}^{\hat{x}} f(x|a')dx}$. Notice that

$$\frac{\beta\int_{\underline{x}}^{\hat{x}} f_a(x|a')dx}{1-\beta+\beta\int_{\underline{x}}^{\hat{x}} f(x|a')dx} = \frac{(1-\beta)0 + \beta\int_{\underline{x}}^{\hat{x}} \frac{f_a(x|a')}{f(x|a')} f(x|a')dx}{1-\beta+\beta\int_{\underline{x}}^{\hat{x}} f(x|a')dx} = E^V\left[\frac{f_a(x|a')}{f(x|a')}|\varnothing\right]$$. Therefore,

$\frac{f_a(x_\varnothing|a')}{f(x_\varnothing|a')} = E^V\left[\frac{f_a(x|a')}{f(x|a')}|\varnothing\right]$. Also, because $\lim_{P\to 1}\hat{x} = x_\varnothing$, in the limit as P and β approach 1 we have

$$\frac{f_a(\hat{x}|a')}{f(\hat{x}|a')} = \frac{\int_{\underline{x}}^{\hat{x}} f_a(x|a')\,dx}{\int_{\underline{x}}^{\hat{x}} f(x|a')\,dx}$$, which can only be true for $\hat{x} = \underline{x}$.

Using (6) we have that for values of *x* for which the *HW* binds,

$$\gamma^V(x) = \beta P f(x|a')\left(\lambda^V + \mu^V \frac{f_a(x|a')}{f(x|a')} - \frac{1}{u'(w_H^V)}\right)$$. Integration yields

$$\int_{x_H^V}^{\bar{x}} \gamma^V(x)\,dx = \beta P \int_{x_H^V}^{\bar{x}} \left(\lambda^V + \mu^V \frac{f_a(x|a')}{f(x|a')} - \frac{1}{u'(w_H^V)}\right) f(x|a')\,dx$$. Using this and the solution for $d^V(x)$

along with (8) yields after some rearranging:

$$\frac{1}{u'(w_H^V)} = \lambda^V + \mu^V \frac{(1-P)\int_{\hat{x}}^{\bar{x}} f_a(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f_a(x|a')\,dx}{(1-P)\int_{\hat{x}}^{\bar{x}} f(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f(x|a')\,dx}$$, where

$$\frac{(1-P)\int_{\hat{x}}^{\bar{x}} f_a(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f_a(x|a')\,dx}{(1-P)\int_{\hat{x}}^{\bar{x}} f(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f(x|a')\,dx} = \frac{(1-P)\int_{\hat{x}}^{\bar{x}} \frac{f_a(x|a')}{f(x|a')} f(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} \frac{f_a(x|a')}{f(x|a')} f(x|a')\,dx}{(1-P)\int_{\hat{x}}^{\bar{x}} f(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f(x|a')\,dx}$$

$$= E\left[\frac{f_a(x|a')}{f(x|a')}\Big| r \geq x_H^V\right].$$

This together with $\frac{f_a(x_H^V|a')}{f(x_H^V|a')} = \frac{(1-P)\int_{\hat{x}}^{\bar{x}} f_a(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f_a(x|a')\,dx}{(1-P)\int_{\hat{x}}^{\bar{x}} f(x|a')\,dx + P\int_{x_H^V}^{\bar{x}} f(x|a')\,dx}$, which is implied by (9), yields

$$\frac{f_a\left(x_H^V|a'\right)}{f\left(x_H^V|a'\right)}=E^V\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}|r\geq x_H^V\right].$$

Define the function $R^V : R^V\left(q,P\right)=\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}-\frac{(1-P)\int_{\hat{x}}^{\bar{x}} f_a\left(x|a'\right)dx+P\int_{q}^{\bar{x}} f_a\left(x|a'\right)dx}{(1-P)\int_{\hat{x}}^{\bar{x}} f\left(x|a'\right)dx+P\int_{q}^{\bar{x}} f\left(x|a'\right)dx}$. Holding $\hat{x}$ constant, $\frac{\partial q}{\partial P}=-\frac{\partial R^V}{\partial P}/\frac{\partial R^V}{\partial q}$. Where the equilibrium condition $R^V\left(q,P\right)=0$ is satisfied we have

$$\frac{\partial R^V}{\partial P}=\frac{\int_{\hat{x}}^{q} f\left(x|a'\right)dx}{(1-P)\int_{\hat{x}}^{\bar{x}} f\left(x|a'\right)dx+P\int_{q}^{\bar{x}} f\left(x|a'\right)dx}\left(\frac{\int_{\hat{x}}^{q} f_a\left(x|a'\right)dx}{\int_{\hat{x}}^{q} f\left(x|a'\right)dx}-\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}\right)<0$$ and

$\frac{\partial R^V}{\partial q}=\frac{\partial}{\partial q}\left[\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}\right]>0$, where the equalities follow from the MLRP assumption. Thus,

$\frac{\partial q}{\partial P}=-\frac{\partial R^V}{\partial P}/\frac{\partial R^V}{\partial q}>0$. Therefore, x_H^V is increasing in P. Notice that,

$$R^V\left(q,1\right)=\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}-\frac{\int_{q}^{\bar{x}} f_a\left(x|a'\right)dx}{\int_{q}^{\bar{x}} f\left(x|a'\right)dx}=\frac{f_a\left(q|a'\right)}{f\left(q|a'\right)}-E\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}|x\geq q\right]$$, and $R^V\left(q,1\right)=0$ can hold only for

$q=\bar{x}$. Thus, $\lim_{P\to 1} x_H^V=\bar{x}$.

Finally, the derivative of the Lagrangian of Program *V* with respect to P (after employing the solution for $d^V\left(x\right)$) is

$$\beta\int_{\hat{x}}^{\bar{x}}\left(\left(u\left(w_H^V\right)-u\left(w^V(x)\right)\right)\left(\lambda^V+\mu^V\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}+\frac{\delta^V(x)}{\beta f\left(x|a'\right)}\right)-\left(w_H^V-w^V(x)\right)\right)f\left(x|a'\right)dx$$

. Using (6) and the fact that the HW constraint binds for $x > x_H^M$, this becomes

$$\beta\int_{\hat{x}}^{x_H^V}\frac{1}{u'\left(w^V(x)\right)}\left(u\left(w_H^V\right)-u\left(w^V(x)\right)-u'\left(w^V(x)\right)\left(w_H^V-w^V(x)\right)\right)f\left(x|a'\right)dx<0$$

, where the inequality follows from the strict concavity of u. By the Envelope Theorem, it follows that C^V is decreasing in P. □

Proof of Corollary 1. Recall that $E^V\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}|r=\varnothing\right]$ is the expected value of the likelihood ratio conditional on no disclosure, given that it is known that the manager withholds disclosure only of realizations that have likelihood ratio lower than $\frac{f_a\left(\hat{x}|a'\right)}{f\left(\hat{x}|a'\right)}$. Acharya, DeMarzo, and Kremer (2011) show that $E^V\left[\cdot|\varnothing\right]$ attains its minimum when the cutoff disclosure is set equal to $E^V\left[\cdot|\varnothing\right]$. From Proposition 2 we know that the likelihood ratio cutoff $\frac{f_a\left(\hat{x}|a'\right)}{f\left(\hat{x}|a'\right)}$ is set equal to $E^V\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}|r=\varnothing\right]$ if and only if $P=1$, and that otherwise $\frac{f_a\left(\hat{x}|a'\right)}{f\left(\hat{x}|a'\right)}>E^V\left[\frac{f_a\left(x|a'\right)}{f\left(x|a'\right)}|r=\varnothing\right]$. It follows that $\frac{f_a\left(\hat{x}|a'\right)}{f\left(\hat{x}|a'\right)}$ (and by MLRP also $\hat{x}$) takes its lowest value when $P=1$. □

Proof of Corollary 2. From the proof of Proposition 1, we have $\frac{f_a\left(x_H^M|a'\right)}{f\left(x_H^M|a'\right)}=\frac{P\int_{x_H^M}^{\overline{x}} f_a\left(x|a'\right)dx}{1-P+P\int_{x_H^M}^{\overline{x}} f\left(x|a'\right)dx}$,

which can be written as $\frac{f_a\left(x_H^M|a'\right)}{f\left(x_H^M|a'\right)}=\frac{(1-P)\int_{\underline{x}}^{\overline{x}} f_a\left(x|a'\right)dx+P\int_{x_H^M}^{\overline{x}} f_a\left(x|a'\right)dx}{(1-P)\int_{\underline{x}}^{\overline{x}} f\left(x|a'\right)dx+P\int_{x_H^M}^{\overline{x}} f\left(x|a'\right)dx}$, and from Proposition 2 we

have $\frac{f_a\left(x_H^V|a'\right)}{f\left(x_H^V|a'\right)}=\frac{(1-P)\int_{\hat{x}}^{\overline{x}} f_a\left(x|a'\right)dx+P\int_{x_H^V}^{\overline{x}} f_a\left(x|a'\right)dx}{(1-P)\int_{\hat{x}}^{\overline{x}} f\left(x|a'\right)dx+P\int_{x_H^V}^{\overline{x}} f\left(x|a'\right)dx}$. Define the function J,

$J\left(h,g\right)=\frac{f_a\left(h|a'\right)}{f\left(h|a'\right)}-\frac{(1-P)\int_{g}^{\overline{x}} f_a\left(x|a'\right)dx+P\int_{h}^{\overline{x}} f_a\left(x|a'\right)dx}{(1-P)\int_{g}^{\overline{x}} f\left(x|a'\right)dx+P\int_{h}^{\overline{x}} f\left(x|a'\right)dx}$. To prove the proposition it is sufficient to

show that the h that solves $J\left(h,g\right)=0$ is increasing in g for all $g<h$. Indeed, $\frac{dh}{dg}=-\frac{J_g'\left(h,g\right)}{J_h'\left(h,g\right)}>0$,

because by the MLRP $J_g'\left(h,g\right)=-\frac{(1-P)f\left(g|a'\right)}{(1-P)\int_{g}^{\overline{x}} f\left(x|a'\right)dx+P\int_{h}^{\overline{x}} f\left(x|a'\right)dx}\left(\frac{f_a\left(h|a'\right)}{f\left(h|a'\right)}-\frac{f_a\left(g|a'\right)}{f\left(g|a'\right)}\right)<0$ for

all $g<h$, and $J_h'\left(h,g\right)=\frac{d}{dh}\left[\frac{f_a\left(h|a'\right)}{f\left(h|a'\right)}\right]>0$. □

Proof of Proposition 3. The proof first shows that in the limiting case of $P=1$, $C^V>C^M$, and then that in the limiting case of $P \to 0$, $C^V < C^M = \infty$. The proposition then follows by continuity. In the limiting case of $P = 1$, the Revelation Principle holds and when disclosure is voluntary there is no loss of welfare by setting $d^V(x) = 1$ for all x. In this case Program *V* with the *ICD* constraint is a restricted version of Program *M*. Because the *ICD* constraint affects the optimal contract under the voluntary disclosure regime, in the limiting case of $P = 1$ it must be the case that $C^V > C^M$. By continuity, it follows that when P is high enough, $C^V > C^M$.

In order to show that $\lim_{P \to 0} C^M \to \infty$, note that using the solution $\frac{1}{u'\left(w^M(r)\right)} = \lambda^M + \mu^M \frac{f_a\left(\min\left(r, x_H^M\right)|a'\right)}{f\left(\min\left(r, x_H^M\right)|a'\right)}$ for the optimal compensation in Proposition 1, the *ICA* constraint can be written as $\int_{\underline{x}}^{x_H^M} \left(u\left(w^M(x)\right) - u\left(w_H^M\right)\right) f_a\left(x|a'\right) dx = \frac{v'(a')}{P\beta}$. As $P \to 0$ it must be that $u\left(w^M(x)\right) - u\left(w_H^M\right)$ becomes unbounded on a positive measure, suggesting that either $u\left(w^M(x)\right)$ or $u\left(w_H^M\right)$ (or both) becomes unbounded on a positive measure as $P \to 0$. Since the manager's expected utility, $E^M\left[u\left(w^M(r)\right)|a'\right]$, is bounded from below by the *IR* constraint, it follows from a result of Bertsekas (1974) that $E^W\left[w^M(r)|a'\right]$ becomes unbounded as P approaches zero.

To show that $\lim_{P\to 0} C^V < \infty$, consider the following contract under voluntary disclosure:

$$w^V(r) = \begin{cases} n & if\ r \geq E^V\left[x|a'\right] \\ j & if\ r = \varnothing \\ -\infty & if\ r < E^V\left[x|a'\right] \end{cases}$$

, where $-\infty < j < n < \infty$, and where j and n are determined such that the *IR* and *ICA* bind. Under this contract the manager reports $r = \varnothing$ when he is uninformed or when he observes a signal realization lower than the prior mean $E^V\left[x|a'\right]$, and he provides disclosure when he observes a signal realization equal to or higher than $E^V\left[x|a'\right]$. Substituting this contract into the *IR* and *ICA* constraints in Program V yields, after some algebra,

$$u(n) = \underline{u} + v(a') + v'(a')\frac{1-\beta \int_{E^V[x|a']}^{\overline{x}} f(x|a')dx}{\int_{E^V[x|a']}^{\overline{x}} f_a(x|a')dx} \text{ and } u(n) - u(j) = \frac{v'(a')}{\beta \int_{E^V[x|a']}^{\overline{x}} f_a(x|a')dx}.$$

Since the right hand sides of the two expressions are bounded, so are n and j, suggesting that the cost of implementing this contract is bounded. □

Proof of Corollary 3. In the limiting case of $\beta = 1$ the *ICD* constraint does not affect the solution of Program *V*. Therefore, in this case, Program *M*, in which $d^M(x)$ must take the value of 1 for all x, is a restricted version of Program *V*. Given that under voluntary disclosure the owner sets $d^V(x) = 0$ for a positive measure of *x*-values, it follows that in this case $C^V < C^M$. The proposition follows by continuity. □

<u>*The case of limited liability*</u>

Proof of Proposition 4. If the *IR* constraint is not binding, then $\lambda^M = 0$ and it follows from (4) that $w^M(\varnothing) = l$. This implies that the optimal contract when disclosure is mandatory can be replicated when disclosure is voluntary because $w^V(\varnothing)=l$ ensures that the *ICD* constraint is satisfied. □

In the following, Proposition 3a and Corollary 3a extend Proposition 3 (in a weak form) and Corollary 3, respectively, to the case where the manager is protected by limited liability. The Proposition and Corollary are followed by a proof.

PROPOSITION 3*a*. *Suppose that compensation cannot fall below a certain lower bound* $l \in \Re$*, and that* $0 < P \le 1$ *. Then, if the probability of verification,* P*, is sufficiently low (high),* $C^V \le C^M$ *(*$C^V \ge C^M$*).*

Proof of Proposition 3a. Using the same argument as in the proof of Proposition 3, in the limiting case of $P=1$, Program *V* is a restricted version of Program *M* and consequently $C^V \ge C^M$. The proof of Proposition 3 also shows that when disclosure is mandatory $u\left(w^M(x)\right)-u\left(w_H^M\right)$ must become unbounded on a positive measure as P approaches zero in order to satisfy the *ICA*. With the manager's utility bounded from below, it follows that $u\left(w_H^M\right)$ becomes unbounded as P approaches zero. Therefore, for sufficiently low P the *IR* constraint must be slack under mandatory disclosure and it follows from Proposition 4 that $C^V \le C^M$. □

COROLLARY 3*a*. *Suppose that compensation cannot fall below a certain lower bound* $l \in \Re$*. Then, for every* P*,* $C^V < C^M$ *if* β *is sufficiently close to one.*

Proof of Corollary 3a. As in the proof of Corollary 3, the proof here is established by showing that in the limiting case of $\beta=1$ the owner sets $d^V(x)=0$ for a positive measure of *x*-values. To show this, notice that in the limiting case of $\beta = 1$ the program in the voluntary disclosure case can be obtained by adding the following two constraints to Program *V*: $u\left(w\left(x\right)\right) \geq u\left(l\right),\ \forall x \in X$ and $u\left(w\left(\varnothing\right)\right) \geq Pu\left(l\right) + \left(1 - P\right)u\left(w_H\right)$. The first constraint is the limited liability constraint and the second constraint ensures that by setting $w\left(x\right) = l$ the owner can induce the manager to withhold the disclosure of realization x. The imposition of the second constraint is without loss of generality because if the owner wishes to induce full disclosure, he can set $u\left(w\left(\varnothing\right)\right) = Pu\left(l\right) + \left(1 - P\right)u\left(w_H\right)$ and this constraint is vacuous because then $w\left(\varnothing\right)$ is never paid on the equilibrium path. Following similar steps as in the proof of Proposition 2 it can be shown that the optimal cutoff disclosure $\hat{x}$ lies in the interval $\left(x_\varnothing, x_H^V\right)$, suggesting that partial disclosure occurs. □

REFERENCES

Acharya, V., P. DeMarzo, and I. Kremer. 2011. Endogenous Information Flows and the Clustering of Announcements. *The American Economic Review* 101: 2955-79.

Aobdia, D., and N. Shroff. 2017. Regulatory Oversight and Auditor Market Share. *Journal of Accounting and Economics* 63: 262-87.

Arya, A., J. Glover, and S. Sunder. 1998. Earnings Management and the Revelation Principle. *Management Science* 56: 645-58.

Ball, R. 2001. Infrastructure Requirements for an Economically Efficient System of Public Financial Reporting and Disclosure. *Brookings-Wharton Papers on Financial Services*, pp. 127-69.

Banker, R. D., R. Huang, and R. Natarajan. 2009. Incentive Contracting and Value Relevance of Earnings and Cash Flows. *Journal of Accounting Research* 47: 647-78.

Bertomeu, J., and I. Marinovic. 2015. A Theory of Hard and Soft Information. *The Accounting Review* 91:1-20.

Bertsekas, D. 1974. Necessary and Sufficient Conditions for Existence of an Optimal Portfolio. *Journal of Economic Theory* 8: 235-47.

Blackwell, D. 1951. Comparison of Experiments. Proceeding of the Second Berkeley Symposium on Mathematical Statistics and Probability. University of California Press.

Bushee, B., and C. Leuz. 2005. Economic Consequences of SEC Disclosure Regulation: Evidence from the OTC Bulletin Board. *Journal of Accounting and Economics* 39: 233-64.

Bushman, R., E. Engel, and A. Smith. 2006. An Analysis of the Relation between the Stewardship and Valuation Roles of Earnings. *Journal of Accounting Research* 44: 53-83.

Butler, M., A. Leone, and M. Willenborg. 2004. An Empirical Analysis of Auditor Reporting and Its Association with Abnormal Accruals. *Journal of Accounting and Economics* 37: 139-165.

Chen, Q., T. Hemmer, and Y. Zhang. 2007. On the Relation between Conservatism in Accounting Standards and Incentives for Earnings Management. *Journal of Accounting Research* 45: 541-65.

Collins, D., E. Maydew, and I. Weiss. 1997. Changes in the Value-Relevance of Earnings and Book Values over the Past Forty Years. *Journal of Accounting and Economics* 24: 39-67.

Drymiotes, G. and T. Hemmer. 2013. On the Stewardship and Valuation Implications of Accrual Accounting Systems. *Journal of Accounting Research* 51: 281-334.

Dye, R. A. 1985. Disclosure of Nonproprietary Information. *Journal of Accounting Research* 23: 123-45.

Einhorn, E., and A. Ziv. 2012. Biased Voluntary Disclosures. *Review of Accounting Studies* 17: 420-42.

Financial Accounting Standards Board. 2001. Improving Business Reporting: Insights into Enhancing Voluntary Disclosures. Business Reporting Research Project. Steering Committee report. Norwalk, CT.

Financial Accounting Standards Board. 1980. Statement of Financial Accounting Concepts No. 2:

Qualitative Characteristics of Accounting Information. Stamford, CT.

Financial Accounting Standards Board. 2010. Statement of Financial Accounting Concepts No. 8: Conceptual Framework for Financial Reporting. Norwalk, CT.

Ganuza, J. and J. Penalva. 2010. Signal Ordering Based on Dispersion and the Supply of Private Information in Auctions. *Econometrica* 78:1007-30.

Gigler, F., and T. Hemmer. 1998. On the Frequency, Quality, and Informational Role of Financial Reports. *Journal of Accounting Research* (Supplement) 36: 117-47.

Gigler, F., C. Kanodia, H. Sapra, and R. Venugopalan. 2009. Accounting Conservatism and the Efficiency of Debt Contracts. *Journal of Accounting Research* 47: 767-97.

Gigler, F., C. Kanodia, H. Sapra, and R. Venugopalan. 2014. How Frequent Financial Reporting Can Cause Managerial Short-Termism: An Analysis of the Costs and Benefits of Increasing Reporting Frequency. *Journal of Accounting Research* 52: 357-87.

Greenstone, M., P. Oyer, and A. Vissing-Jorgensen. 2006. Mandated Disclosure, Stock Returns, and the 1964 Securities Acts Amendments. *Quarterly Journal of Economics* 121: 399-460.

Grossman, S., and O. Hart.1983. An Analysis of the Principal-Agent Problem. *Econometrica* 51: 7-45.

Hayn, C. 1995. The Information Content of Losses. *Journal of Accounting and Economics* 20: 125-53.

Holmstrom, B. 1979. Moral Hazard and Observability. *The Bell Journal of Economics* 10: 74-91.

Holthausen, R., and R. Watts. 2001. The Relevance of the Value-Relevance Literature for Financial Accounting Standard Setting. *Journal of Accounting and Economics* 31: 3-75.

Ijiri, Y. 1975. Theory of Accounting Measurement. Sarasota, FL: American Accounting Association.

Jewitt, I. 1988. Justifying the First-Order Approach to Principal-Agent Problems. *Econometrica* 56: 1177-90.

Jung, W. and Y. Kwon. 1988. Disclosure when the Market is Unsure of Information Endowment of Managers. *Journal of Accounting Research* 26: 146-53.

Kanodia, C., H. Sapra, and R. Venugopalan. 2004. Should Intangibles be Measured: What Are the Economic Trade-Offs? *Journal of Accounting Research* 42: 89-120.

Kothari, S.P., K. Ramanna, and D. Skinner. 2010. Implications for GAAP from An Analysis of Positive Research in Accounting. *Journal of Accounting and Economics* 50: 246-86.

Laffont, J.J. 1990. Analysis of Hidden Gaming in a Three-Level Hierarchy. *Journal of Law, Economics, and Organization* 6: 301-24.

Lambert, R. 2010. Discussion of Implications of GAAP from an Analysis of Positive Research in Accounting. *Journal of Accounting and Economics* 50: 287-95.

Leuz, C. and P.D. Wysocki. 2016. The Economics of Disclosure and Financial Reporting Regulation: Evidence and Suggestions for Future Work. *Journal of Accounting Research* 54: 525-622.

Lev, B., and P. Zarowin. 1999. The Boundaries of Financial Reporting and How to Extend Them. *Journal* *of Accounting Research* 37: 353-85.

Marinovic, I. 2013. Internal Control Systems, Earnings Quality and the Dynamics of Financial Reporting. *RAND Journal of Economics* 44:145-67.

Marinovic, I., and S. Sridhar. 2015. Discretionary Disclosure Using a Certifier. *Journal of Accounting and Economics* 59: 25-40.

Minnis, M. 2011. The Value of Financial Statement Verification in Debt Financing: Evidence from Private U.S. Firms. *Journal of Accounting Research* 49: 457-506.

Mirrlees, J. 1999. The Theory of Moral Hazard and Unobservable Behavior: Part I. *Review of Economic Studies* 66: 3-21.

Kwon, Y., P. Newman, and Y. Suh. 2001. The Demand for Accounting Conservatism in Management Control. *Review of Accounting Studies* 6: 29-51.

Public Company Accounting oversight board (PCAOB). 2015. Concept Release on Audit Quality Indicators. PCAOB Release No. 2015-005.

Polinsky, M. and S. Shavell. 2012. Mandatory versus Voluntary Disclosure of Product Risks. *Journal of Law, Economics, and Organization* 28: 360-79.

Roger, G. 2013. Optimal Contract under Moral Hazard with Soft Information. *American Economic Journal: microeconomics* 5: 55-80.

Rogerson, W. 1985. The First-Order Approach to Principal-Agent Problems. *Econometrica* 53: 1357-67.

Securities and Exchange Commission. 2012. Work Plan for the Consideration of Incorporating International Financial Reporting Standards into the Financial Reporting System for U.S. Issuers. Final Staff Report.

Shavell, S. 1994. Acquisition and Disclosure of Information Prior to Sale. *RAND Journal of Economics* 25: 20-36.

Srivastava, A. 2014. Why Have Measures of Earnings Quality Changed Over Time? *Journal of Accounting and Economics* 57: 196-217.

Verrecchia, R. 1983. Discretionary Disclosure. *Journal of Accounting and Economics* 5: 365-80.

Versano, T. 2017. Corporate Governance and Disclosure. Working paper, Tel Aviv University.

Watts, R. 2003a. Conservatism in Accounting, Part I: Explanations and Implications. *Accounting Horizons* 17: 207-21.

Watts, R. 2003b. Conservatism in Accounting, Part II: Evidence and Research Opportunities. *Accounting Horizons* 17: 287-301.

Watts, R. 2006. What Has the Invisible Hand Achieved? *Accounting and Business Research* (Special Issue, International Accounting Policy Forum) 36: 51-61.

Watts, R., and J. Zimmerman. 1986. *Positive Accounting Theory*. Prentice-Hall, Englewood Cliffs, NJ.

FIGURES

FIGURE 1

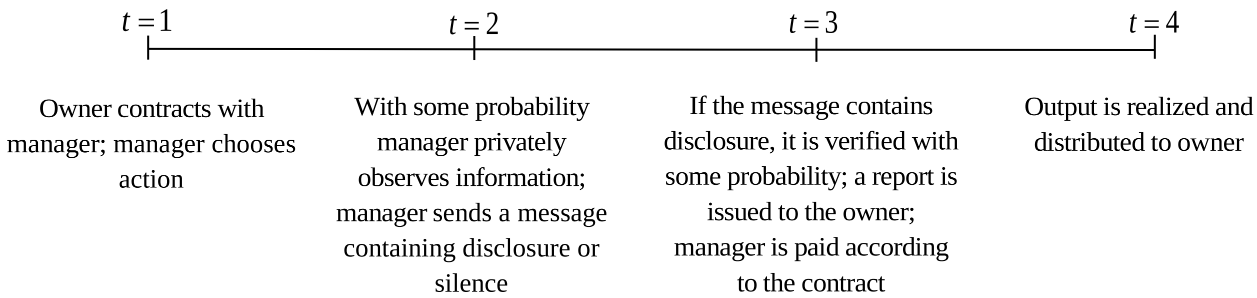

Figure 1 provides a timeline depicting the sequence of events in the model.