INFORMATION BIAS AND DISCLOSURE *

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Abstract

We examine the impact of biases in managerial judgment and in accounting reports on the voluntary disclosure of private managerial information. We show that any biased managerial judgment in interpreting private information that is voluntarily disclosed, and negatively biased accounting (conservatism), reduce voluntary timely disclosure by firms. Only positively biased (less conservative) accounting increases voluntary disclosure by firms. Contrary to conventional wisdom, negative accounting biases, instead of counteracting positive managerial bias, act to further reduce voluntary disclosure, and thus the supply of timely information to capital markets. Consequently, we find that freedom from bias, both in managerial judgment and in accounting, is generally desirable in that it makes firms more likely to make timely voluntary disclosures.

KEYWORDS: managerial bias; accounting bias; voluntary disclosure; neutrality.

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I Introduction

Is neutrality a desirable characteristic of accounting information? Regulators, such as the IASB emphasize neutrality in financial reporting and stewardship in revising the Conceptual Framework for Financial Reporting (IASB 2015b). The May 2015 Exposure Draft of the Conceptual Framework (IASB 2015a, 2.17) defines neutrality as follows: "A neutral depiction is without bias in the selection or presentation of financial information. A neutral depiction is not slanted, weighted, emphasized, de-emphasized or otherwise manipulated to increase the probability that financial information will be received favourably or unfavourably by users." Freedom from bias, both negative and positive, is to be achieved through prudence (IASB 2015b, 2.18): "Prudence is the exercise of caution when making judgements under conditions of uncertainty. The exercise of prudence means that assets and income are not overstated and liabilities and expenses are not understated. Equally, the exercise of prudence does not allow for the understatement of assets and income or the overstatement of liabilities and expenses [...]"

Accounting researchers, on the other hand mostly support the idea that conservatism is an efficient form of bias and thus desirable, a view summarized by Watts (2003, p. 210): "[...] conservatism has a productive role in financial reports providing information to capital market investors."[1] Penman (2017, p. 2) takes a slightly different approach from Watts (2003), and addresses directly the emphasis of the IASB Conceptual Framework (2015a, 2.17) on neutrality in accounting, but equates prudence and conservatism and reaches a similar conclusion: "conservative accounting indeed implies bias, but (constrained) bias is a desirable feature of accounting information."

Mostly overlooked in this debate is that *bias may reduce the supply of information in capi-*

[1] Watts (2003) has been followed by a significant body of work on the efficiency effects of either accounting conservatism or liberalism. Examples are Kirschenheiter and Ramakrishnan (2009), Chen, Mittendorf, and Zhang (2010), Kwon (2005), Kwon, Newman, and Suh (2001), Gao (2013), Gigler, Kanodia, Sapra, and Venugopalan (2009), and Glover and Lin (2016). For example, Kwon et al. (2001) and Kwon (2005) show that accounting conservatism is efficient in an agency model with contracting on accounting-based performance measures. Gao (2013) shows that conservative accounting rules may be necessary to achieve neutral accounting reports when managers can manipulate these reports. Glover and Lin (2016) examine the intertemporal efficiency of conservative accounting in providing managerial incentives. As opposed to the control settings of Kwon et al. (2001) and Kwon (2005), Chen et al. (2010) show that in the presence of both decision making and control problems, liberal, as opposed to conservative bias, may be efficient. A similar conclusion is reached by Gigler et al. (2009), who show the efficiency of debt contracting declines as accounting becomes more conservative.

tal markets. This oversightstems from a focus on accounting as the single information channel to markets. But "the accounting system is not the only information system in the world" (Christensen 2010) and we need to consider instead the firms' endogenous information environment, including not only mandatory disclosures (accounting reports), but also voluntary disclosures and analyst forecasts as discussed by Beyer, Cohen, Lys, and Walther (2010). For example, Beyer et al. (2010) estimate that, of the accounting-based information supplied to capital markets, approximately 66% comes from voluntary disclosures, 22% comes from information intermediaries (such as analysts), and only 12% comes from mandatory disclosures (accounting). Considering only voluntary and mandatory disclosures, Gigler and Hemmer (2001) show that "firms with relatively more conservative accounting are less likely to make timely voluntary disclosures." An implication of their finding is that, considering the supply of information to capital markets through both voluntary and mandatory disclosures, firms with conservative accounting (mandatory disclosures) supply less information through voluntary disclosures relative to firms with less conservative accounting. This runs contrary to the intuition in both Watts (2003) and Penman (2017), but also suggests the IASB (2015b) emphasis on neutrality might be misplaced.

How does bias affect the supply of information to capital markets? In this study, we show that any biased managerial judgment in interpreting private information that is voluntarily disclosed, and negatively biased accounting, reduce voluntary timely disclosure by firms. Only positively biased accounting increases voluntary disclosure by firms, as in Gigler and Hemmer (2001). As positively biased managerial judgment in interpreting private information also reduces voluntary disclosure, negatively biased accounting will only make matters worse by further reducing the range of voluntary disclosure, and thus the supply of timely information to capital markets. Contrary to conventional wisdom, once we separate the two information channels, we do not find support for the idea that negative accounting bias can counter managerial positive bias improving the supply of information in markets (Watts 2003). Consequently, we find that freedom from bias, both in managerial judgment and in accounting, is generally desirable in that it makes firms more likely to make timely voluntary disclosures.

Managers may be biased in how they interpret the private information they receive. They may be positively biased due to self-serving interest, or they may be optimistic by nature (Laux and Stocken 2012 and the references therein); alternatively managers may be negatively biased because they were taught conservatism, or because they are inherently pessimistic in their judgment. Thus, even without deliberate manipulation by managers, their truthful voluntary disclosures of private information can be subject to bias.

Accounting reports may be biased by measurement errors (Christensen 2010) and subsequent cherry-picking in what to correct (Arya and Glover 2008), or by conservatism (Watts 2003). Managers and auditors also exercise their judgment while translating transactions to summary financial statistics. For example, judgment is required for whether to capitalize expenditures and when to recognize revenue. Thus, the final reported financial outcome may be biased in reflecting the economic substance of transactions (Dechow and Dichev 2002).[2]

In this study we introduce both managerial private information bias and accounting bias in a model of soft information disclosure such as that in Şabac and Tian (2015). The managerial voluntary disclosures we study are more timely than the accounting reports, but are soft information because they are hard to verify. [3] By contrast, verifiable accounting reports are hard information.[4]

The focus of our study is the impact of biases in either the soft or the hard information on

[2]Negative bias may arise because auditors, incentivized by audit standards and legal liability, would allow low accounting earnings reports to pass but challenge high earnings. This would shift upwards the probability of low accounting earnings. Positive bias may arise because managers, incentivized by their compensation contract, would leave high reported accounting earnings to pass but challenge low reported earnings. This would shift upwards the probability of high accounting earnings. Our model captures the net effect of the two forces. Depending on auditor expertise, managerial power, verification costs and other exogenous factors, some firms' accounting reports may exhibit negative bias, but others' may exhibit positive bias. We do not attempt to disentangle intentional choices from unintentional measurement errors because both imply biased accounting reports. Instead, our characterization of accounting bias is a reduced form of actual measurement and cherry-picking processes, and is determined exogenously.

[3]Such disclosures are forward looking in nature and require specialized knowledge to interpret them; in many cases it is impossible or very costly for other parties (supervisors, auditors) to verify. For example, the General Motors MD&A section inside the 2014 annual report states: "(1) Continued strong net income margins at our China JVs (joint ventures), with plans to invest approximately $14 billion in China through 2018 and increase vehicle sales volumes by nearly 40% by 2018. (2) Expected continued improvement of our core operations in General Motors South America (GMSA) through product launches and material and logistics optimization, with a long-term objective of single digit EBIT-adjusted margins."

[4]This is Ijiri's (1975, p. 32–36) definition that we use henceforth: "The lack of room for disputes over a measure may be expressed as the *hardness* of the measure. A 'hard' measure is one constructed in such a way that it is difficult for people to disagree. A 'soft' measure is one that can be easily pushed in one direction or another."

the disclosure of soft information. As in Şabac and Tian (2015), the soft information provides managerial effort incentives, while the hard information provides both managerial incentives and reporting incentives, i.e. also plays a confirmatory role with respect to the soft managerial report. Information biases affect both the confirmatory power of the hard information and the tradeoff between using the hard signal for effort and reporting incentives, thus affecting the key factors determining voluntary disclosure in Şabac and Tian (2015).

For the soft managerial information disclosure to have value, the confirmatory power of the accounting report has to be high enough to offset the negative spillover effect on reporting incentives from providing effort incentives (Şabac and Tian 2015). We find that managerial bias decreases the range of managerial disclosure. The underlying forces are different depending on the direction of the bias. The manager's incentives are always to over-report the observed private information. Consequently, an optimistic manager adding a positive bias in interpreting the private information, clouds the accounting report's power to confirm good news. The confirmatory power is reduced but the incentive spillover effect is unchanged. A pessimistic manager (interpreting the accounting report with a negative bias) does not change the confirmatory power but increases the relative informativeness of the accounting report that intensifies the negative incentive spillover effect. As a result, any managerial bias decrease the range of managerial disclosure.

Accounting bias reduces the confirmatory power of the accounting report, but also reduces its incentive power. However, negative accounting bias reduces the confirmatory power of the accounting report relatively more than it reduces its incentive power. Thus, it becomes increasingly costly to trade off using the accounting report to confirm the soft managerial disclosure at the expense of using the accounting report to provide effort incentives. Consequently, the soft managerial report is used less often. Positive accounting bias reduces the incentive power of the accounting report relatively more than it reduces its confirmatory power. Thus, it becomes less costly to trade off using the accounting report to confirm the soft managerial disclosure at the expense of using the accounting report to provide effort incentives, and the soft managerial report is used more often.

Our main contribution is to show managerial and accounting biases influence the firms' decision to disclose soft managerial information. Our study is most closely related to the literature on managerial disclosure for stewardship purposes, such as Dye (1983), Gigler and Hemmer (2001), and Şabac and Tian (2015). Gigler and Hemmer (2001) address the link between accounting conservatism and disclosure. However, in their setting, as in Dye (1983), the manager's private information is a sufficient statistic for the accounting report, and disclosure is always optimal. Their main result, that firms having relatively more liberal accounting systems are likelier to make voluntary disclosures than those with conservative accounting, requires an exogenous cost of disclosure that is the same for all firms in order to obtain no disclosure.

In contrast, we introduce bias in the model of Şabac and Tian (2015) so that we have an endogenous cost of disclosure that varies across firms without the private managerial information being a sufficient statistic, thus making disclosure a real choice. Moreover, abandoning the sufficient statistic restriction allows us to consider biases in the manager's private information as well, an issue not previously considered.

In our setting, managerial and accounting biases are not improving the efficiency of contracting, as there are no additional contracting frictions. The only issue under consideration is whether these information biases reduce or enlarge the range of firms making voluntary disclosures of soft information. This is unlike most of the literature on accounting conservatism referred to above, but similar to Gigler and Hemmer (2001).

II Agency disclosure model

The basic model (without bias) is the same as that used by Şabac and Tian (2015, p. 1686–1689). A risk-neutral principal owns a production technology that requires employing a manager. The manager has separable utility of consumption and effort $u(c, a) = u(c) - v(a)$, where $u(c)$ is strictly increasing and concave and represents the manager's utility of consumption. We assume there is no lower bound on consumption and that the utility of consumption is likewise unbounded (for example, exponential utility). The manager chooses an action from a binary set $a \in \{a_l, a_h\}$.

We use "action" and "effort" interchangeably throughout. Since we assume a binary action choice and are only interested in the least cost contract that induces $a = a_h$, we can assume without loss of generality that $v(a_l) = 0, v(a_h) = v$.

There are two signals available for performance evaluation. First, there is a publicly observable and verifiable signal $y \in \{H, L\}$, such as the final outcome or an audited accounting report. This is "hard" information in that the principal and the manager agree on the observed y and neither party can affect its reported value. Second, the manager observes privately a signal $z \in \{g, b\}$ and then can report $m(z)$. This managerial report is "soft" information as the manager can freely choose what to report (we do not restrict the manager to disclose truthfully).

The sequence of events is as follows. The principal offers a contract to the manager. If the manager accepts the contract, she selects action a. Then, the manager observes the signal z and issues the report $m(z)$. Finally, the public signal y is observed and the manager is compensated. Both the principal and the manager commit to the contract at the initial date. The time-line of events is summarized in Figure 1.

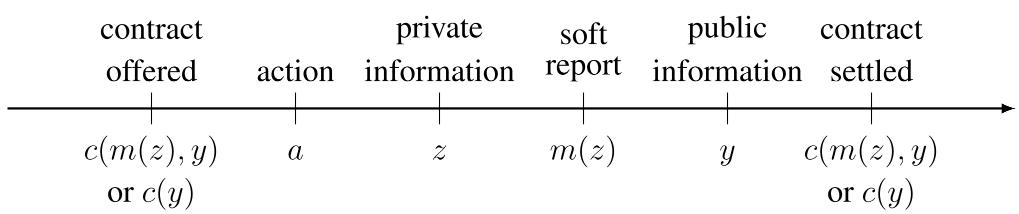


Figure 1: Time line of events: the manager observes z after choosing a.

The manager always observes z and can report $m(z)$ at no cost. The principal chooses ex ante whether to use the manager's report and offers a compensation contract of either $c(y)$ or $c(m(z), y)$. A contract $c(y)$ is equivalent to one with equal payments $c(m(z), y) = c(y)$ for all reports $m(z)$ and all $y \in \{H, L\}$.

Our focus is on the stewardship or control value of the "soft" performance report $m(z)$. The manager observes the signal after having chosen a, but before the public signal y becomes available; thus, the manager's action does not depend on the information z. Consequently, the manager's unverifiable information z will only be used for control purposes through the report $m(z)$.

The information structure is given by the joint probabilities $\phi(z, y|a) = \phi(z|a)\phi(y|z, a)$. These are characterized by the prior probabilities of "good news" $z = g$, $\phi(z = g|a_h) = q_h$, $\phi(z = g|a_l) = q_l$ and by the conditional probabilities of high reported performance $\phi(y = H|z, a = a_h) = q_{zh}$, $\phi(y = H|z, a = a_l) = q_{zl}$. We denote by p_h, p_l the prior (unconditional) probabilities of high reported performance $\phi(y = H|a_h) = p_h = q_h q_{gh} + (1 - q_h)q_{bh}$ and $\phi(y = H|a_l) = p_l = q_l q_{gl} + (1 - q_l)q_{bl}$. The posterior (conditional) probabilities of reported performance are $\phi(y|z, a)$. Finally, we define the likelihood ratios

$$LR(z, y) = \frac{\phi(z, y|a_h) - \phi(z, y|a_l)}{\phi(z, y|a_h)} = 1 - \frac{\phi(z, y|a_l)}{\phi(z, y|a_h)}. \tag{1}$$

We assume the following:

$$0 < q_{bl} \leq q_{bh}, q_{gl} \leq q_{gh} < 1 \tag{A1}$$

$$LR(g, H) \geq LR(b, H) \quad \text{and} \quad LR(g, L) \geq LR(b, L) \tag{A2}$$

The first assumption (A1) captures the idea of $z = g$ being "good news" and $z = b$ being "bad news" in that the high outcome is (weakly) more likely given $z = g$ that given $z = b$ for any action $a = a_h, a_l$, that is $q_{bh} \leq q_{gh}$ and $q_{bl} \leq q_{gl}$. In addition, we assume that a_h (weakly) increases the likelihood of a high outcome regardless of whether $z = g, b$, that is $q_{bl} \leq q_{bh}$ and $q_{gl} \leq q_{gh}$. While our post-decision information setting is similar to Dye (1983), Berg et al. (1990), and Gigler and Hemmer (1998, 2001), we do not assume z is a sufficient statistic for (z, y) with respect to a; this is only a particular case under (A1), when $q_{bl} = q_{bh}$ and $q_{gl} = q_{gh}$.

In (A2) we assume monotonicity of the likelihood ratios in z for a given y. By (A1), the likelihood ratios are also monotone in y for a given z. Indeed, $LR(z, H) \geq LR(z, L)$ if, and only if $q_{zh} \geq q_{zl}$, because

$$
\begin{aligned}
LR(g,H) &= 1 - \frac{\phi(g,H|a_l)}{\phi(g,H|a_h)} = 1 - \frac{q_l q_{gl}}{q_h q_{gh}} \\
LR(g,L) &= 1 - \frac{\phi(g,L|a_l)}{\phi(g,L|a_h)} = 1 - \frac{q_l(1-q_{gl})}{q_h(1-q_{gh})} \\
LR(b,H) &= 1 - \frac{\phi(b,H|a_l)}{\phi(b,H|a_h)} = 1 - \frac{(1-q_l)q_{bl}}{(1-q_h)q_{bh}} \\
LR(b,L) &= 1 - \frac{\phi(b,L|a_l)}{\phi(b,L|a_h)} = 1 - \frac{(1-q_l)(1-q_{bl})}{(1-q_h)(1-q_{bh})}
\end{aligned} \tag{2}
$$

Since the principal can commit to the contract and the manager can freely communicate, we can consider direct revelation mechanisms without loss of generality, Myerson (1979, 1981), see also Laffont and Martimort (2002) and Christensen and Feltham (2005). That is, we can confine our attention to the reports on z directly $m(z) = \hat{z}$, where the manager's reports $\hat{z} \in \{\hat{g}, \hat{b}\}$ are denoted by $\hat{z}$ in order to distinguish them from the manager's private information z. The manager's possible reporting strategies are $m \in \{T, G, B, F\}$. Here $T(z) = \hat{z}$ is the truth-telling strategy; $G(z) = \hat{g}$ and $B(z) = \hat{b}$ are the strategies of always reporting "good" and "bad" news, respectively; and $F(g) = \hat{b}, F(b) = \hat{g}$ is the strategy of always reporting the opposite of what is observed. To summarize, T stands for truth, G for good, B for bad, and F for false.

We denote by $I_{\hat{z}y}$ the payment made to the manager for the reported $\hat{z}$ and the observed public performance measure y, and we denote by $U_{\hat{z}y} = u(I_{\hat{z}y})$ the manager's utility corresponding to that payment.

The manager's expected utility for strategy $(a, m) \in \{a_h, a_l\} \times \{T, G, B, F\}$ is $EU(a, m)$. The principal's contracting problem is to induce the manager to choose the "high effort" $a = a_h$ at minimum cost. The principal optimizes over the menu of four possible payments $c = \{I_{\hat{z}y}\}$, for $(\hat{z}, y) \in \{\hat{g}, \hat{b}\} \times \{H, L\}$, and over the manager's reporting strategy m. The Revelation Principle also implies that any optimal direct mechanism is equivalent to one where the manager reports truthfully, $m = T$. Since we require a_h to be the manager's choice in equilibrium, that means incentive compatibility requires truth telling only conditional on having chosen $a = a_h$. Thus, the principal's program with communication is

$$\min_{c} \left[q_h q_{gh} I_{\hat{g}H} + q_h(1-q_{gh}) I_{\hat{g}L} + (1-q_h) q_{bh} I_{\hat{b}H} + (1-q_h)(1-q_{bh}) I_{\hat{b}L}\right] , \tag{P-$\hat{z}y$}$$

subject to the participation constraint

$$EU(a_h, T) \geq \bar{U} , \tag{IR}$$

the reporting constraints

$$EU(a_h, T) \geq EU(a_h, m) \text{ for } m = G, B , \tag{Tm}$$

and the effort-selection constraints

$$EU(a_h, T) \geq EU(a_l, m) \text{ for } m = T, G, B, F . \tag{ICm}$$

The value of communicating the manager's information is evaluated against the benchmark of no communication. In this case, the principal offers a contract based only on the hard signal $c(y)$, with payments I_H, I_L. The principal's program for this case is

$$\max_{I_H, I_L} -[p_h I_H + (1-p_h) I_L] , \tag{P-y}$$

subject to the participation constraint

$$p_h U_H + (1-p_h) U_L - v \geq \bar{U} \tag{IR}$$

and the incentive compatibility constraint

$$p_h U_H + (1-p_h) U_L - v \geq p_l U_H + (1-p_l) U_L . \tag{IC}$$

The principal is no worse off with communication of the manager's information because any contract that does not make use of the manager's information can be offered in the communication setting: $c(\hat{g}, y) = c(\hat{b}, y) = c(y)$ for $y \in \{H, L\}$.

The question for this benchmark model without accounting bias is, when will communication strictly lower the compensation cost? That is, when is the soft managerial report valuable? A necessary condition is that the hard signal has some confirmatory power with respect to the manager's report, that is z, y are correlated conditional on $a = a_h$:

$$\phi(z, y|a_h) \neq \phi(z|a_h)\phi(y|a_h) \, , \tag{A3}$$

or, equivalently given (A1), $q_{bh} < q_{gh}$ and $0 < q_h < 1$, see Şabac and Tian (2015, Proposition 1).

The benchmark result for the case of no accounting bias is provided by the necessary and sufficient condition (LR) in Proposition 2 of Şabac and Tian (2015) for communication to have value under assumptions (A1), (A2) and (A3):

$$\frac{\phi(g|H, a_h)}{\phi(g|L, a_h)} > \frac{LR_\mu(g, L) - LR_\mu(b, L)}{LR_\mu(g, H) - LR_\mu(b, H)} \, . \tag{LR}$$

Here $LR_\mu(\hat{z}, y)$ denote the appropriate likelihood ratios corresponding to the binding incentive compatibility constraints in different cases. If $q_{gl} \geq q_{bh}$, (ICT) is binding and $LR_\mu(\hat{z}, y) = LR(\hat{z}, y)$ are the usual likelihood ratios defined in (2). If $q_{gl} < q_{bh}$, (ICB) is binding and the likelihood ratios $LR_\mu(\hat{z}, y)$ are

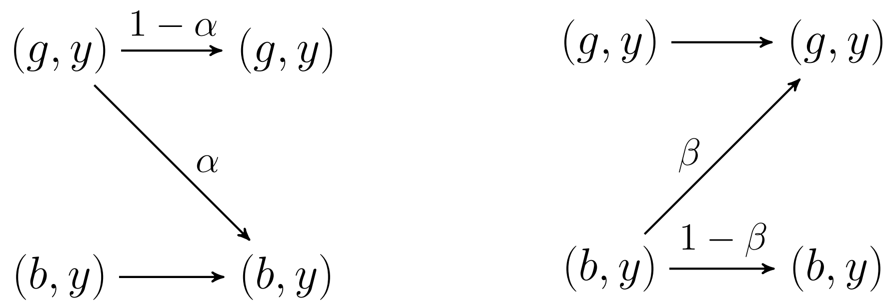
$$\begin{aligned}
LR_\mu(\hat{g}, H|B) &= 1 - \frac{\phi(B(z) = \hat{g}, H|a_l)}{\phi(\hat{g}, H|a_h)} = 1 \\
LR_\mu(\hat{g}, L|B) &= 1 - \frac{\phi(B(z) = \hat{g}, L|a_l)}{\phi(\hat{g}, L|a_h)} = 1 \\
LR_\mu(\hat{b}, H|B) &= 1 - \frac{\phi(B(z) = \hat{b}, H|a_l)}{\phi(\hat{b}, H|a_h)} = 1 - \frac{q_l q_{gl} + (1 - q_l) q_{bl}}{(1 - q_h) q_{bh}} \\
LR_\mu(\hat{b}, L|B) &= 1 - \frac{\phi(B(z) = \hat{b}, L|a_l)}{\phi(\hat{b}, L|a_h)} = 1 - \frac{q_l(1 - q_{gl}) + (1 - q_l)(1 - q_{bl})}{(1 - q_h)(1 - q_{bh})} \, .
\end{aligned} \tag{3}$$

The left-hand side (LHS) of condition (LR) captures the confirmatory power of the hard signal with respect to the manager's private information, given that the binding reporting constraint is (TG). The right-hand side (RHS) of condition (LR) captures the magnitude of the tradeoff in using the hard signal simultaneously for effort and for reporting incentives, given the respective binding effort-selection constraints, (ICT) or (ICB), respectively. The key intuition on the RHS is about how changes in the likelihood ratios affect the magnitude of this tradeoff. A higher likelihood of one of the consistent states (g, H) or (b, L) makes it easier to simultaneously provide both effort and reporting incentives by reducing the tension between the two incentive roles of the hard signal. A higher likelihood of one of the inconsistent states (g, L) of (b, H) makes it harder to simultaneously provide both effort and reporting incentives by increasing the tension between the two incentive roles of the hard signal.

Our main focus in what follows is on how bias changes the value of communication, or, equivalently, on how bias affects when the soft managerial report is valuable.

III Managerial bias

In this section we introduce a one-sided bias on the manager's private information. Such a bias arises independently of the manager's action and is the result of the manager's judgement and interpretation of good or bad news. The private information the manager initially receives needs to be summarized and interpreted so it can ultimately be disclosed. But the manager might making biased judgments relative to an assumed neutral benchmark. A pessimistic manager (negative bias) will sometimes read good news as bad. In this case, what a neutral manager would read as good news $z = g$, the pessimistic manager reads as bad news $\bar{z} = b$, with probability α. Bad news to a neutral manager are also interpreted as bad news. Our modelling of negative bias on a binary signal is similar to the way Glover and Lin (2016) model conservatism. The private information of a pessimistic manager is depicted in Figure 2a.



(a) Negative private bias

(b) Positive private bias

Figure 2: Negatively and positively biased private information

An optimistic manager (positive bias) will sometimes read bad news as good. In this case, what a neutral manager would read as bad news $z = b$, the optimistic manager reads as good news $\bar{z} = g$, with probability β. Neutrally good news are interpreted as good news. The private information of an optimistic manager is depicted in Figure 2b.

Private information bias affects the information environment as characterized by the joint probabilities $\phi(z, y|a)$, or equivalently the parameters q_h, q_l, q_{zh}, q_{zl}. Maintaining the same notation for the unbiased information system as earlier, denote by $\bar{\phi}(z, y|a)$ and $\bar{q}_h, \bar{q}_l, \bar{q}_{zh}, \bar{q}_{zl}$ the corresponding joint probabilities and parameters for the biased information system so that $\bar{\phi}(g, H|a_h) = \bar{q}_h\bar{q}_{gh}$, $\bar{\phi}(b, H|a_h) = (1-\bar{q}_h)\bar{q}_{bh}$, etc. Thus, for each of the biases depicted in Figure 2, we can calculate the corresponding probabilities $\bar{\phi}(z, y|a)$ as a function of the parameters q_h, q_l, q_{zh}, q_{zl} and the bias α or β. Both the unbiased probabilities and the biased probabilities are listed in Table 1 in Appendix A.

Note that we assume private information bias is independent of everything else in the agency. We do not model the manager's judgement bias as an endogenous outcome. We only assume the manager is pessimistic or optimistic in a consistent, exogenously specified way.

For the results in Şabac and Tian (2015) to be applicable, we require that the new parameters that characterize $\bar{\phi}(z, y|a)$ under biased private information continue to satisfy assumptions (A1), (A2), and (A3). The first and third assumptions can be easily verified by solving for the parameters $\bar{q}_h, \bar{q}_l, \bar{q}_{zh}, \bar{q}_{zl}$ from the biased probabilities given in Table 1 to obtain the corresponding parameters listed in Table 2, also in Appendix A. The second assumption can be easily verified by calculating the likelihood ratios as listed in Table 3 in Appendix A.

Proposition 1 *Under assumptions* (A1)*,* (A2)*, and* (A3)*, bias in the manager's private information reduces the range of parameters over which communication has value.*

Specifically, as shown in the proof of Proposition 1 presented in the Appendix, either the private managerial bias does not change whether disclosure is optimal; or there is a threshold α^* (or β^*) such that, for bias smaller than the threshold, disclosure is optimal, and for bias larger than the threshold, no disclosure is optimal.

To see the intuition behind Proposition 1, recall that the necessary and sufficient condition for soft information z to have value when $q_{gl} \geq q_{bh}$ and (ICT) is binding is

$$\frac{\phi(g|H, a_h)}{\phi(g|L, a_h)} > \frac{LR(g, L) - LR(b, L)}{LR(g, H) - LR(b, H)} . \tag{LR}$$

The key tension determining whether disclosure is valuable is that between the confirmatory role of the hard signal with respect to the soft signal and the effort and reporting incentive roles of the hard signal. The left-hand side (LHS) captures the confirmatory power of the hard information y with respect to the soft report; the right-hand side (RHS) captures the incentive power of both y and z in motivating the manager's effort and truthful reporting at the same time.

The RHS does not simply represent the spread of likelihood ratios, a measure of the performance variables' informativeness (Kim 1995). Instead, the RHS captures the relative informativeness of soft information z given L (the numerator) and given H (the denominator). Thus, increasing overall informativeness will not necessarily lower the RHS, relax the condition, and increase the use of soft information. Instead, increasing the likelihood ratios of consistent states, $LR(g, H)$ and $LR(b, L)$, will lower the RHS, relax the condition, and increase the use of soft information; increasing the likelihood ratios of inconsistent states, $LR(g, L)$ and $LR(b, H)$ will have the opposite effect and reduce the use of soft information. Offering higher payments when likelihood ratios are higher (indicating a higher likelihood of managerial effort) enhances effort incentives but destroys incentives for truthful reporting. Having high likelihood ratios at inconsistent states exacerbates the tension between using the hard information for providing effort and reporting incentives.

We now examine how managerial biases affect each side of the (LR) condition, starting with negative bias. First, we note that the LHS is independent of negative bias because it does not change the relative likelihood of good news given the hard signal. Indeed, the LHS is about using the hard information realization $y = H, L$ to confirm whether the manager truthfully reports good news, because the manager has incentives to over-report not under-report, the binding reporting constraint being (TG). The confirmatory power of the hard signal lies in the correlation between the two sources of information y and z. That is, g is more associated with H and b is more associated with L: $\phi(g, H|a_h)\phi(b, L|a_h) > \phi(g, L|a_h)\phi(b, H|a_h)$. Managerial bias can weaken the correlation, thus lowering the confirmatory power, as is the case with positive bias. However, a *pessimistic* manager always biases away from good news by the same proportion, and this bias is independent of y and a. Consequently, negative managerial bias does not change the confirmatory power of the hard information and any effect of negative bias on the value of communication is through the RHS.

We now turn to the RHS. A *pessimistic* manager interprets good news with a *negative* bias, making the reported bad news $\bar{b}$ relatively less negative. Indeed, both $LR(\bar{b}, H)$ and $LR(\bar{b}, L)$ increase, while $LR(\bar{g}, H)$ and $LR(\bar{g}, L)$ are unaffected. This increases the spread of the likelihood ratios and thus the overall informativeness of the soft information z decreases because of the bias. At the same time, the spread of $LR(\bar{b}, H)$ and $LR(\bar{b}, L)$ increases, and thus the relative informativeness of hard information is increased when $\bar{b}$ is observed. Consequently the hard information y becomes more important for providing effort incentives. This makes it costlier to use the same information for reporting incentives, and increases the RHS.

To illustrate the effect of negative managerial bias, we consider the case where the unbiased ($\alpha = 0$) soft information z is a sufficient statistic for the hard information y. That is, $q_{gh} = q_{gl}$, $q_{bh} = q_{bl}$, $LR(g, H) = LR(g, L)$, $LR(b, H) = LR(b, L)$, and the RHS $= 1$. If the manager is negatively biased with $\alpha > 0$, $LR(g, H) = LR(g, L)$ but $LR(\bar{b}, H) > LR(\bar{b}, L)$, and the soft information z is no longer a sufficient statistic for y, as its overall informativeness is lowered due to the bias. When z is no longer a sufficient statistic for y, the hard signal becomes valuable for effort incentive purposes making it costlier to use it for reporting incentives. This is reflected in an increased RHS > 1, and the (LR) condition is harder to satisfy.

With positive managerial bias, the LHS decreases because positive bias reduces the relative likelihood of good news given the hard signal. At the same time, positive managerial bias, that is an *optimistic* manager, also reduces the RHS by the same factor. As a result, condition (LR) is unaffected by positive bias and the value of communication is unchanged. [5]

For the other case when $q_{gl} < q_{bh}$ and (ICB) is binding, the intuition is similar to the cases discussed above. With negative managerial bias, the LHS is unchanged and the RHS is decreasing. With positive bias, the LHS is decreasing but the RHS is unchanged, making condition (LR) harder to satisfy and reducing the range of communication.[6]

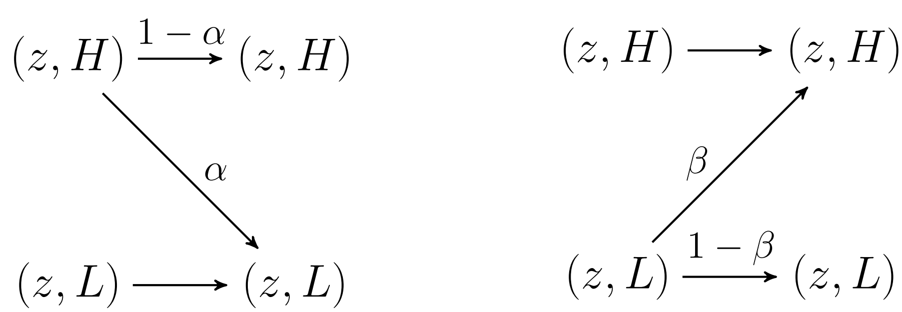
To summarize, managerial bias decreases the range of disclosure, but the underlying forces are different depending on the nature of the bias. For a pessimistic manager (negative bias), the main effect is the change in the tradeoff between using the hard signal for reporting incentives and using it for effort incentives; the confirmatory power of the hard signal is unaffected. For an optimistic manager (positive bias), the main effect is the reduction in the confirmatory power of the hard signal with respect to the manager reporting good news; the tradeoff above on the hard signal is either unaffected by bias or perfectly offsetting the reduction in confirmatory power.

[5] The intuition for the RHS is similar to that for the negative bias case discussed above. With an optimistic manager, the reported good news $\bar{g}$ become less positive about the manager's effort: both $LR(\bar{g}, H)$ and $LR(\bar{g}, L)$ decrease ($LR(b, H)$ and $LR(b, L)$ are not changed by the bias). The overall informativeness of the soft information z decreases with bias, thus the relative informativeness of hard information increases when $\bar{g}$ is observed: the spread between $LR(\bar{g}, H)$ and $LR(\bar{g}, L)$ increases. As a result, the likelihood ratio of consistent states $LR(\bar{g}, H)$ decreases less than that of inconsistent states $LR(\bar{g}, L)$, despite the fact that both likelihood ratios decrease. Consequently, the RHS decreases.

[6] In this case the RHS is unchanged because reporting bad news all the time ($m = B$) is the manager's off-equilibrium reporting strategy, the likelihood ratios of good news $LR_\mu(\bar{g}, y) = 1$ are unaffected by the bias, and the likelihood ratios of bad news $LR_\mu(\bar{b}, y)$ are decreasing in the bias but perfectly offsetting each other, see Table 3 in Appendix A.

IV Accounting bias

In this section we introduce a one-sided bias on accounting reports. Such a bias arises independently of the manager's action and is the result of challenges to high or low accounting reports. Preliminary accounting reports can contain errors from both sides. But the manager has incentives to appeal the low reading and the auditor has incentives to challenge the high reading. Due to costly verification, the final accounting report is always left with some one-sided bias. A negative bias arises when a high reading is successfully challenged by the auditor. In this case, a high accounting report $y = H$ becomes a low accounting report $y = L$, with probability α. Low reports are unaffected. Negative bias on the accounting report is depicted in Figure 3a.



(a) Negative accounting bias

(b) Positive accounting bias

Figure 3: Negatively and positively biased accounting

A positive bias arises when a low reading is successfully appealed by the manager. In this case, a low accounting report $y = L$ becomes a high accounting report $y = H$, with probability β. High reports are unaffected. Positive bias on the accounting report is depicted in Figure 3b.

Accounting bias affects the information environment as characterized by the joint probabilities $\phi(z, y|a)$, or equivalently the parameters q_h, q_l, q_{zh}, q_{zl}. Maintaining the same notation for the unbiased information system as introduced in the previous section, denote by $\bar{\phi}(z, y|a)$ and $\bar{q}_h, \bar{q}_l, \bar{q}_{zh}, \bar{q}_{zl}$ the corresponding joint probabilities and parameters for the biased information system so that $\bar{\phi}(g, H|a_h) = \bar{q}_h \bar{q}_{gh}$, $\bar{\phi}(b, H|a_h) = (1 - \bar{q}_h)\bar{q}_{bh}$, etc. Thus, for each of the biases depicted in Figure 3, we can calculate the corresponding probabilities $\bar{\phi}(z, y|a)$ as a function of the parameters q_h, q_l, q_{zh}, q_{zl} and the bias α or β. Both the unbiased probabilities and the biased probabilities are listed in Table 4 in Appendix A.

Note that we assume accounting bias is independent of everything else in the agency. We do not model accounting bias as an endogenous outcome. We only assume it arises in a way that is overall consistent with the incentives of both managers or auditors. For the results in Şabac and Tian (2015) to be applicable, we will require that the new parameters that characterize $\bar{\phi}(z, y|a)$ under biased accounting continue to satisfy assumptions (A1), (A2), and (A3). Under these maintained assumptions, in equilibrium payments are always monotonic in the accounting report y, that is $I_{\hat{z}H} \geq I_{\hat{z}L}$, so that the manager's incentive contract should not change the cherry-picking incentives of either managers or auditors for different levels of bias.

Solving for the parameters $\bar{q}_h, \bar{q}_l, \bar{q}_{zh}, \bar{q}_{zl}$ from the biased probabilities given in Table 4, we obtain the corresponding parameters listed in Table 5 in Appendix A.

For tractability, when $q_{gl} \geq q_{bh}$ and (ICT) is binding, we make the additional assumption that the accounting report y is conditionally uninformative given good news, that is $q_{gl} = q_{gh}$. When $q_{gl} < q_{bh}$ and (ICB) is binding, we make no additional assumptions.

Unlike negative or positive private information bias, negative or positive accounting bias affects disclosure asymmetrically: negative bias reduces the range of disclosure, whereas positive bias increases the range of disclosure.

Proposition 2 *Under assumptions* (A1)*,* (A2)*, and* (A3)*, if either* $q_{gl} < q_{bh}$*, or* $q_{gl} = q_{gh}$*, then negative bias in the accounting report reduces the range of parameters over which communication has value.*

Specifically, as shown in the proof of Proposition 2 presented in Appendix A, either accounting bias does not change whether disclosure is optimal; or, there is a threshold α^* (that depends on the unbiased probability parameters) such that, for $\alpha < \alpha^*$ disclosure is optimal, and for $\alpha^* \leq \alpha$ no disclosure is optimal.

In Figure 4 below we illustrate the case when negative bias above a certain threshold α^* will eliminate the value of using the soft signal z. In this example, the LHS of condition (LR) is

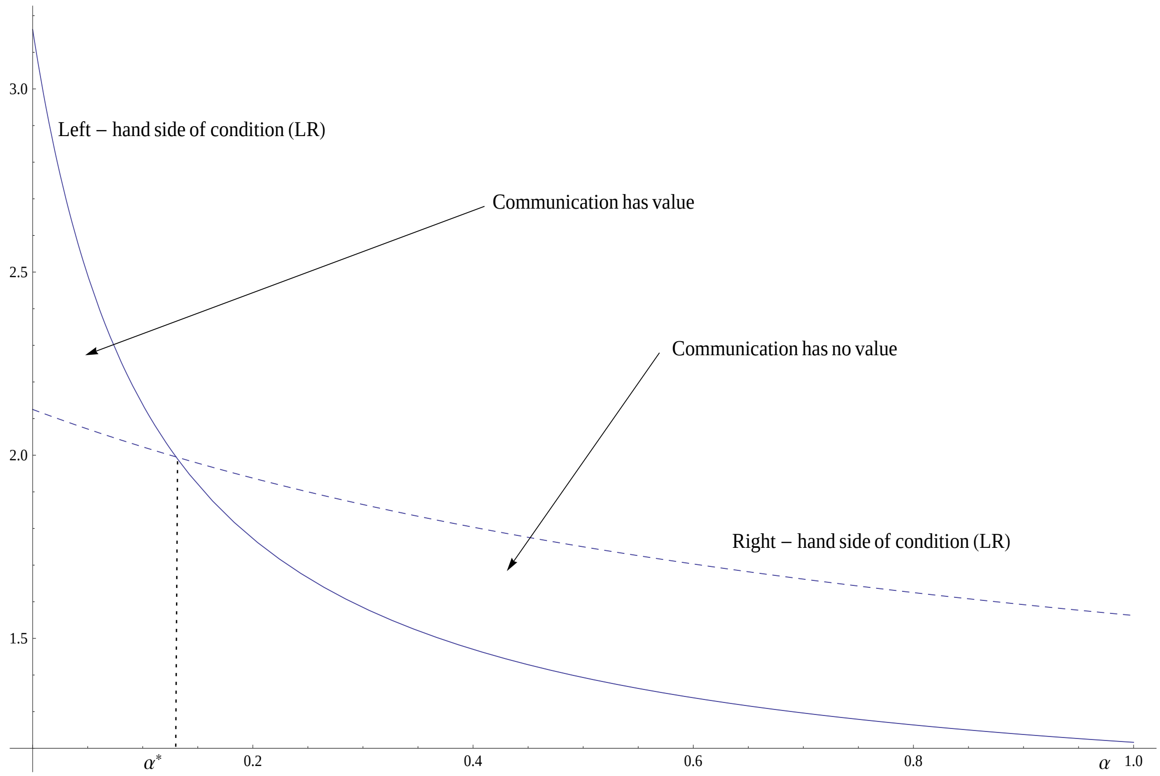


Figure 4: Negative bias and disclosure: $q_h = 0.6, q_l = 0.4, q_{gh} = q_{gl} = 0.9, q_{bh} = 0.5, q_{bl} = 0.4$.

declining, being driven by an increasing $\phi(g|L, a_h)$, as $\phi(g|H, a_h)$ does not change with negative bias α. On the RHS, only $LR(b, L)$ is increasing, the other likelihood ratios being independent of negative bias α. Consequently, the RHS of condition (LR) also declines with α because increasing the likelihood of the one consistent state (b, L) while holding the other likelihoods constant makes it easier to simultaneously provide effort and reporting incentives. But the first-order effect is that of declining confirmatory value for the hard signal y, as shown by the fast declining left-hand side of condition (LR). As the negative bias increases, the confirmatory value of y with respect to z declines faster than its effort incentive value. Thus, the incremental contribution of z to effort incentives comes at an increasing cost of reporting which is in conflict with using y for incentive purposes. Beyond α^* it is less costly to provide effort incentives using y alone because the reporting cost is too high.

Proposition 3 *Under assumptions* (A1)*,* (A2)*, and* (A3)*, if either $q_{gl} < q_{bh}$, or $q_{gl} = q_{gh}$, then positive bias in the accounting report enlarges the range of parameters over which communication* *has value.*

Specifically, as shown in the proof of Proposition 3 presented in Appendix A, either accounting bias does not change whether disclosure is optimal; or, there is a threshold β^* (that depends on the unbiased probability parameters) such that, for $\beta < \beta^*$ no disclosure is optimal, and for $\beta^* \leq \beta$ disclosure is optimal.

In Figure 5 below we illustrate the case when positive bias above a certain threshold β^* will make using the soft signal z valuable.[7] In this example, the LHS of condition (LR) also declines with β, due to a declining $\phi(g|H, a_h)$, as $\phi(g|L, a_h)$ does not change with positive bias β. But the first-order effect is that of the fast declining RHS of condition (LR), which is driven by the decreasing likelihood of an inconsistent state $LR(b, H)$, the other likelihood ratios being independent of positive bias β. As the positive bias increases, the incentive value of y with respect to z declines

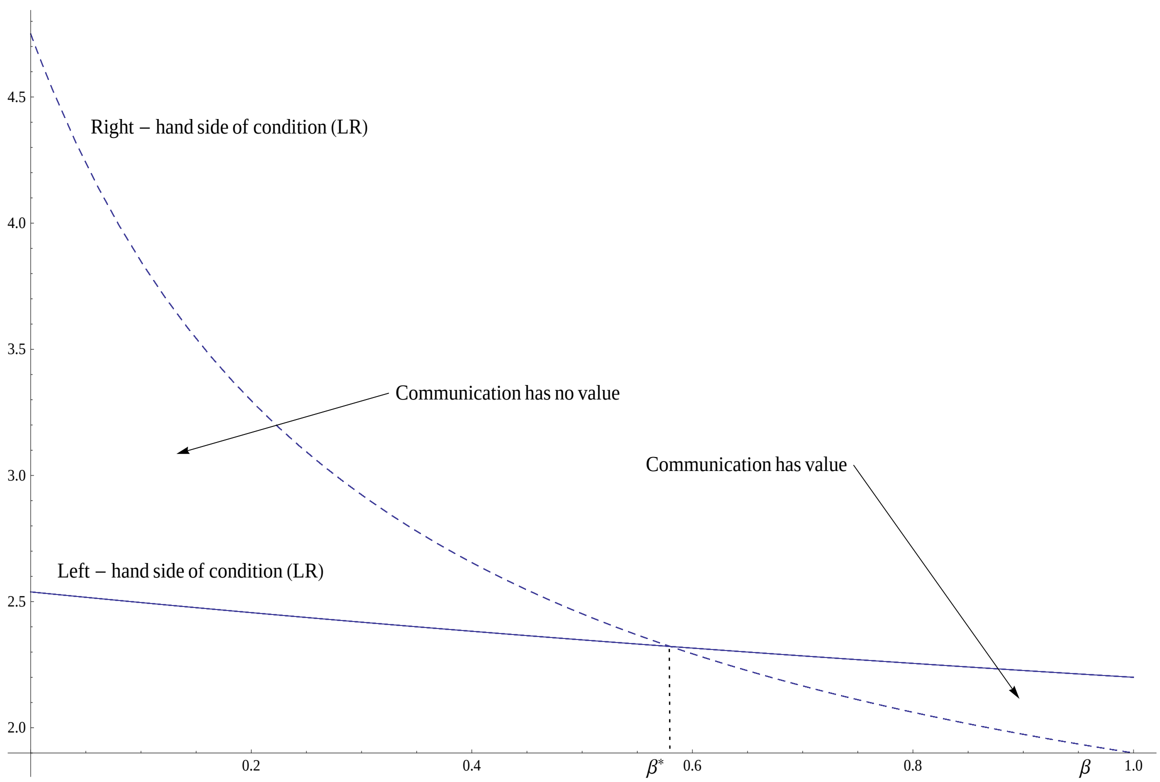


Figure 5: Positive bias and disclosure: $q_h = 0.6, q_l = 0.4$, $q_{gh} = q_{gl} = 0.9$, $q_{bh} = 0.6, q_{bl} = 0.4$.

faster than its confirmatory value. Thus, the incremental contribution of y to effort incentives,

[7]In both Figures 4 and 5, we only present the case when (ICT) is binding. But the case of (ICB) binding is similar and the figures presented here are representative.

which is in conflict with using y for reporting incentives becomes small enough that the negative incentive spillover effect from using y for reporting incentives is less than the incremental effort incentive value of z. Beyond β^* it is less costly to provide effort incentives using y and z because the reporting cost is low enough.

The intuition for the effect of hard information bias on the LHS (confirmatory power) and the RHS (incentive power) is largely the same as in the case of private information. The confirmatory power of the hard information with respect to the private information lies in the correlation between the two variables (y and z), and adding noise to one variable will lower the correlation, reducing the confirmatory power. Thus, both negative (conservative) and positive (liberal) biases reduce the LHS of the (LR) condition. The effect on the RHS is similar, in that both positive and negative accounting bias lower the RHS due to an easing of the tension between using the hard signal simultaneously for effort and reporting incentives.

However, unlike in the case of private information bias, where either side of condition (LR) is tightening as a result of bias, in the case of accounting bias, the LHS is tightening while the RHS is relaxing with bias. The asymmetric effect of negative and positive accounting bias comes from the relative magnitudes of the changes: with negative accounting bias, the decline in the confirmatory power of the hard signal is the first-order effect; with positive accounting bias, easing the tension on the dual role of the hard signal is the first-order effect.

In Appendix B we also provide a detailed analysis of the asymmetric effect of negative and positive accounting bias when the manager's private information is a sufficient statistic for the hard accounting signal. Without an exogenous disclosure cost, disclosure is always optimal in this case. But negative bias is relatively more costly than the same amount of positive bias. Thus, we confirm the findings of Gigler and Hemmer (2001) in our setting where biases are exogenously determined in a similar way to Glover and Lin (2016).

V Conclusions

We examine the impact of information bias on voluntary disclosure of timely private information by managers. We consider both managers' biases in interpreting their private (unverifiable) information and biases in verifiable accounting information. We find that private managerial biases always reduce voluntary disclosure, whereas accounting biases have an asymmetric effect: negative accounting biases reduce voluntary disclosure; positive accounting biases increase voluntary disclosure.

Our findings on managerial bias are new, while the findings on accounting bias generalize those in Gigler and Hemmer (2001). The main distinguishing feature of our study is that we do not assume that managers' private information is a sufficient statistic for the verifiable accounting reports. Our model is based on that in Şabac and Tian (2015), where the cost of voluntary disclosure is endogenous. This allows us to consider managerial biases because biased private managerial information ceases to be a sufficient statistic for the verifiable accounting reports. In the case of accounting biases, we obtain a more general model than Gigler and Hemmer (2001), and we focus on how information bias affects the endogenous cost of disclosure.

If disclosure of managers' private information is a significant source of timely accounting-based information in capital markets (as estimated by Beyer et al. 2010 to be almost 66% of the total as opposed to only 12% for mandatory accounting disclosure), our findings speak to the effect of information biases on the supply of accounting-based information to capital markets. In our setting, managerial biases in interpreting private information always reduce the range of firms disclosing private managerial information. Negative accounting biases also reduce the range of firms disclosing private managerial information, whereas positive accounting biases increase the range of disclosing firms. But information biases also reduce the content of the information being disclosed. Freedom from bias is then desirable because information is more likely to be disclosed and because what is disclosed is more informative. Overall, although we do not explicitly model the informativeness of disclosures, freedom from bias should increase the information supply to capital markets, consistent with the position taken by the IASB on neutrality as freedom from bias.

Watts (2003, pp. 212–213) proposes that conservatism is efficient by counteracting managers' upward biases in their private information and Gao (2013) shows that conservative accounting rules may be necessary to achieve neutral accounting reports when managers can manipulate these reports. However, in Watts (2003) and in Gao (2013), the focus is on managerial bias and accounting bias affecting *the same accounting report*, and not on the whole information environment (Beyer et al. 2010).

In our model, managerial and accounting biases impact two distinct information channels, unverifiable managerial disclosure and an accounting report, respectively. If managers exhibit (non-strategic) judgment biases and accounting is conservative, the result is not neutral accounting, but less disclosure of the manager's biased information. However, we do not consider the two kinds of bias simultaneously and how they interact. An interesting question for future research is to examine this interaction when the disclosing manager's biases are also endogenous and to determine the combined effect of manipulation and efficient disclosure on the information supply in capital markets.

Appendix A: Proofs

Private managerial bias

Probability	Unbiased ϕ	Negative bias $\bar{\phi}$	Positive bias $\bar{\phi}$
$\phi(g, H\|a_h)$	$A = q_h q_{gh}$	$(1-\alpha)A$	$A + \beta C$
$\phi(g, L\|a_h)$	$E = q_h(1-q_{gh})$	$(1-\alpha)E$	$E + \beta M$
$\phi(b, H\|a_h)$	$C = (1-q_h)q_{bh}$	$C + \alpha A$	$(1-\beta)C$
$\phi(b, L\|a_h)$	$M = (1-q_h)(1-q_{bh})$	$M + \alpha E$	$(1-\beta)M$
$\phi(g, H\|a_l)$	$B = q_l q_{gl}$	$(1-\alpha)B$	$B + \beta D$
$\phi(g, L\|a_l)$	$F = q_l(1-q_{gl})$	$(1-\alpha)F$	$F + \beta N$
$\phi(b, H\|a_l)$	$D = (1-q_l)q_{bl}$	$D + \alpha B$	$(1-\beta)D$
$\phi(b, L\|a_l)$	$N = (1-q_l)(1-q_{bl})$	$N + \alpha F$	$(1-\beta)N$

Table 1: Joint probabilities for the unbiased and the biased private information

Parameter	Negative bias	Positive bias
$\bar{q}_h$	$(1-\alpha)(A+E)$	$A + E + \beta(C+M)$
$\bar{q}_{gh}$	$\dfrac{A}{A+E}$	$\dfrac{A+\beta C}{A+E+\beta(C+M)}$
$\bar{q}_{bh}$	$\dfrac{C+\alpha A}{C+M+\alpha(A+E)}$	$\dfrac{C}{C+M}$
$\bar{q}_l$	$(1-\alpha)(B+F)$	$B + F + \beta(D+N)$
$\bar{q}_{gl}$	$\dfrac{B}{B+F}$	$\dfrac{B+\beta D}{B+F+\beta(D+N)}$
$\bar{q}_{bl}$	$\dfrac{D+\alpha B}{D+N+\alpha(B+F)}$	$\dfrac{D}{D+N}$

Table 2: Conditional probabilities and private information bias

Likelihood ratio	Negative bias	Positive bias
$LR(g,H) = 1 - \frac{B}{A}$	$1 - \frac{B}{A}$	$1 - \frac{B + \beta D}{A + \beta C}$
$LR(g,L) = 1 - \frac{F}{E}$	$1 - \frac{F}{E}$	$1 - \frac{F + \beta N}{E + \beta M}$
$LR(b,H) = 1 - \frac{D}{C}$	$1 - \frac{D + \alpha B}{C + \alpha A}$	$1 - \frac{D}{C}$
$LR(b,L) = 1 - \frac{N}{M}$	$1 - \frac{N + \alpha F}{M + \alpha E}$	$1 - \frac{N}{M}$
$LR_\mu(g,y\|B) = 1$	1	1
$LR_\mu(b,H\|B) = 1 - \frac{B + D}{C}$	$1 - \frac{B + D}{C + \alpha A}$	$1 - \frac{B + D}{(1-\beta)C}$
$LR_\mu(b,L\|B) = 1 - \frac{F + N}{M}$	$1 - \frac{F + N}{M + \alpha E}$	$1 - \frac{F + N}{(1-\beta)M}$

Table 3: Likelihood ratios and private information bias

Proof of Proposition 1. In the unbiased information case, condition (LR) can be written as

$$\frac{A(E+M)}{E(A+C)} > \begin{cases} \dfrac{AC(EN - FM)}{EM(AD - BC)} & \text{when (ICT) is binding} \\[2ex] \dfrac{C(F+N)}{M(B+D)} & \text{when (ICB) is binding.} \end{cases}$$

With negatively biased private information (pessimistic manager), condition (LR) becomes

$$\frac{A(E+M)}{E(A+C)} > \begin{cases} \dfrac{A(C+\alpha A)(EN - FM)}{E(M+\alpha E)(AD - BC)} & \text{when (ICT) is binding} \\[2ex] \dfrac{(C+\alpha A)(F+N)}{(M+\alpha E)(B+D)} & \text{when (ICB) is binding.} \end{cases}$$

Because the left-hand side is independent of the bias $\alpha \in [0,1]$, and the right-hand side is increasing in the bias α, it follows that negative private information bias is associated with a smaller range of disclosure.

With positively biased private information (optimistic manager), condition (LR) becomes

$$\frac{(A+\beta C)(E+M)}{(E+\beta M)(A+C)} > \begin{cases} \dfrac{C(A+\beta C)(EN-FM)}{M(E+\beta M)(AD-BC)} & \text{when (ICT) is binding} \\ \dfrac{C(F+N)}{M(B+D)} & \text{when (ICB) is binding.} \end{cases}$$

When (ICT) is binding, condition (LR) is independent of positive bias β. In this case, positive bias in private information does not change the disclosure range. When (ICB) is binding, the left-hand side of condition (LR) is decreasing in the positive bias β, whereas the right-hand side is independent of the bias. In this case, positive private information bias is associated with a smaller range of disclosure. □

Accounting bias

Probability	Unbiased	Negative bias	Positive bias
$\phi(g,H\|a_h)$	$q_h q_{gh}$	$q_h(1-\alpha)q_{gh}$	$q_h[q_{gh}+\beta(1-q_{gh})]$
$\phi(g,L\|a_h)$	$q_h(1-q_{gh})$	$q_h[\alpha q_{gh}+(1-q_{gh})]$	$q_h(1-\beta)(1-q_{gh})$
$\phi(b,H\|a_h)$	$(1-q_h)q_{bh}$	$(1-q_h)(1-\alpha)q_{bh}$	$(1-q_h)[q_{bh}+\beta(1-q_{bh})]$
$\phi(b,L\|a_h)$	$(1-q_h)(1-q_{bh})$	$(1-q_h)[\alpha q_{bh}+(1-q_{bh})]$	$(1-q_h)(1-\beta)(1-q_{bh})$
$\phi(g,H\|a_l)$	$q_l q_{gl}$	$q_l(1-\alpha)q_{gl}$	$q_l[q_{gl}+\beta(1-q_{gl})]$
$\phi(g,L\|a_l)$	$q_l(1-q_{gl})$	$q_l[\alpha q_{gl}+(1-q_{gl})]$	$q_l(1-\beta)(1-q_{gl})$
$\phi(b,H\|a_l)$	$(1-q_l)q_{bl}$	$(1-q_l)(1-\alpha)q_{bl}$	$(1-q_l)[q_{bl}+\beta(1-q_{bl})]$
$\phi(b,L\|a_l)$	$(1-q_l)(1-q_{bl})$	$(1-q_l)[\alpha q_{bl}+(1-q_{bl})]$	$(1-q_l)(1-\beta)(1-q_{bl})$

Table 4: Joint probabilities in the unbiased and the biased accounting systems

Parameter	Negative bias	Positive bias
$\bar{q}_h$	q_h	q_h
$\bar{q}_{gh}$	$(1-\alpha)q_{gh}$	$\beta+(1-\beta)q_{gh}$
$\bar{q}_{bh}$	$(1-\alpha)q_{bh}$	$\beta+(1-\beta)q_{bh}$
$\bar{q}_l$	q_l	q_l
$\bar{q}_{gl}$	$(1-\alpha)q_{gl}$	$\beta+(1-\beta)q_{gl}$
$\bar{q}_{bl}$	$(1-\alpha)q_{bl}$	$\beta+(1-\beta)q_{bl}$

Table 5: Conditional probabilities and bias

Proof of Proposition 2. With negative bias α, when $q_{gl} < q_{bh}$ and (ICB) is binding, condition (LR) is equivalent to

$$(1-q_h)(q_{gh}-q_{bh})(q_l q_{gl}+(1-q_l)q_{bl})(1-q_{bh}(1-\alpha))$$
$$> (q_h q_{gh}+(1-q_h)q_{bh})(q_{bh}-q_l q_{gl}-(1-q_l)q_{bl})(1-q_{gh}(1-\alpha))$$

To prove the proposition in this case, it suffices to show that, if (LR) holds at $\alpha = 1$, then it also holds at $\alpha = 0$.

At $\alpha = 1$ we have

$$(1-q_h)(q_{gh}-q_{bh})(q_l q_{gl}+(1-q_l)q_{bl})$$
$$> (q_h q_{gh}+(1-q_h)q_{bh})(q_{bh}-q_l q_{gl}-(1-q_l)q_{bl}) > 0 ,$$

where the last factor is positive because $q_{bh} > q_{gl}, q_{bl}$.

At $\alpha = 0$ we have

$$(1-q_h)(q_{gh}-q_{bh})(q_l q_{gl}+(1-q_l)q_{bl})(1-q_{bh})$$
$$> (q_h q_{gh}+(1-q_h)q_{bh})(q_{bh}-q_l q_{gl}-(1-q_l)q_{bl})(1-q_{gh}) > 0 .$$

If (LR) holds at $\alpha = 1$, we can multiply the left-hand side by $1-q_{bh}$ and the right-hand side by $1 - q_{gh}$ and we obtain (LR) at $\alpha = 0$ because $q_{bh} < q_{gh}$ (note that $a > b > 0$ and $x > y > 0$ imply $ax > ay > by > 0$).

With negative bias α, when $q_{gl} = q_{gh}$ and (ICT) is binding, the left-hand side of (LR) becomes

$$\text{LHS} = 1 + \frac{(q_{gh} - q_{bh})(1 - q_h)}{(q_h q_{gh} + (1 - q_h)q_{bh})(1 - (1 - \alpha)q_{gh})}$$

and the right-hand side becomes

$$\text{RHS} = 1 + \frac{(q_{bh} - q_{bl})q_h(1 - q_l)}{(q_h(1 - q_l)q_{bl} - q_l(1 - q_h)q_{bh})(1 - (1 - \alpha)q_{bh})} \ .$$

Under the additional assumption that y is conditionally uninformative given good news, that is $q_{gl} = q_{gh}$, for any bias $\alpha, \beta \in [0, 1)$, conditions (A1) and (A2) are equivalent to

$$0 < q_{bl} \leq q_{bh} \leq q_{gl} = q_{gh} < 1 \tag{B1}$$

$$q_h(1 - q_l)q_{bl} \geq q_l(1 - q_h)q_{bh} \ . \tag{B2}$$

We also note that (B2) is equivalent to $LR(g, H) \geq LR(b, H)$. Now denote by A and B, respectively,

$$A = (q_{gh} - q_{bh})(1 - q_h)(q_h(1 - q_l)q_{bl} - q_l(1 - q_h)q_{bh})$$

$$B = (q_{bh} - q_{bl})q_h(1 - q_l)(q_h q_{gh} + (1 - q_h)q_{bh}) \ .$$

From (B1) and (B2), we have that $A, B \geq 0$ and consequently (LR) is equivalent to

$$A(1 - (1 - \alpha)q_{bh}) > B(1 - (1 - \alpha)q_{gh}) \ . \tag{LRα}$$

If $A > B$, then $(1 - (1 - \alpha)q_{bh}) \geq (1 - (1 - \alpha)q_{gh})$ for all $\alpha \in [0, 1)$, so that (LRα) is satisfied for all α and communication has value no matter the bias.

If $A \leq B$ and $A(1 - q_{bh}) \leq B(1 - q_{gh})$, then (LR$\alpha$) is not satisfied at either $\alpha = 0$ or at $\alpha = 1$. Because both sides of (LRα) are linear in α it follows that (LRα) is not satisfied for all $\alpha \in [0, 1)$

and communication has no value no matter the bias.

Finally, if $A < B$ and $A(1-q_{bh}) > B(1-q_{gh})$, then (LR$\alpha$) is satisfied at $\alpha = 0$ but not at $\alpha = 1$. Because both sides of (LRα) are linear in α it follows that there is an $\alpha^* \in [0,1)$ such that (LRα) is satisfied for all $0 \leq \alpha < \alpha^*$ and not satisfied for all $\alpha^* \leq \alpha < 1$. In other words, communication has value for sufficiently small bias and no value for sufficiently large bias. □

Proof of Proposition 3. Condition (LR) can be written as $LHS > RHS > 0$ and that is equivalent to $1/RHS > 1/LHS > 0$. With negative bias α, when $q_{gl} < q_{bh}$ and (ICB) is binding, the above is equivalent to

$$
\begin{aligned}
0 < (1-q_h q_{gh} - (1-q_h)q_{bh})(q_{bh} - q_l q_{gl} - (1-q_l)q_{bl})(q_{gh} + \beta(1-q_{gh})) \\
< (1-q_h)(q_{gh} - q_{bh})(1 - q_l q_{gl} - (1-q_l)q_{bl})(q_{bh} + \beta(1-q_{bh}))\ .
\end{aligned}
$$

To prove the proposition in this case, it suffices to show that, if (LR) is not satisfied at $\beta = 1$, then it also not satisfied at $\beta = 0$.

At $\beta = 1$, the above inequality becomes

$$
\begin{aligned}
0 < (1-q_h q_{gh} - (1-q_h)q_{bh})(q_{bh} - q_l q_{gl} - (1-q_l)q_{bl}) \\
< (1-q_h)(q_{gh} - q_{bh})(1 - q_l q_{gl} - (1-q_l)q_{bl})\ .
\end{aligned}
$$

At $\beta = 0$ we have

$$
\begin{aligned}
0 < (1-q_h q_{gh} - (1-q_h)q_{bh})(q_{bh} - q_l q_{gl} - (1-q_l)q_{bl})q_{gh} \\
< (1-q_h)(q_{gh} - q_{bh})(1 - q_l q_{gl} - (1-q_l)q_{bl})q_{bh}\ .
\end{aligned}
$$

If (LR) does not hold at $\beta = 1$, we can multiply the left-hand side by q_{gh} and the right-hand side by q_{bh} and get that (LR) does not hold at $\beta = 0$ because $q_{bh} < q_{gh}$ (note that $a > b > 0$ and $x > y > 0$ imply $ax > ay > by > 0$).

With positive bias β, when $q_{gl} = q_{gh}$ and (ICT) is binding, the left-hand side of (LR) becomes

$$1/\text{LHS} = 1 - \frac{(q_{gh} - q_{bh})(1 - q_h)}{(1 - q_h q_{gh} - (1 - q_h)q_{bh})(\beta + (1 - \beta)q_{gh})}$$

and the right-hand side becomes

$$1/\text{RHS} = 1 - \frac{(q_{bh} - q_{bl})q_h(1 - q_l)}{(q_h(1 - q_l)(1 - q_{bl}) - q_l(1 - q_h)(1 - q_{bh}))(\beta + (1 - \beta)q_{bh})} .$$

Under the additional assumption that y is conditionally uninformative given good news, that is $q_{gl} = q_{gh}$, for any bias $\alpha, \beta \in [0, 1)$, conditions (A1) and (A2) are equivalent to

$$0 < q_{bl} \leq q_{bh} \leq q_{gl} = q_{gh} < 1 \tag{B1}$$

$$q_h(1 - q_l)q_{bl} \geq q_l(1 - q_h)q_{bh} . \tag{B2}$$

We also note that (B2) is equivalent to $LR(g, H) \geq LR(b, H)$. Now denote by C and D, respectively,

$$C = (q_{gh} - q_{bh})(1 - q_h)(q_h(1 - q_l)(1 - q_{bl}) - q_l(1 - q_h)(1 - q_{bh}))$$

$$D = (q_{bh} - q_{bl})q_h(1 - q_l)(1 - q_h q_{gh} - (1 - q_h)q_{bh}) .$$

From (B1), we have that $C, D \geq 0$ and consequently (LR) is equivalent to

$$C(\beta + (1 - \beta)q_{bh}) > D(\beta + (1 - \beta)q_{gh}) . \tag{LRβ}$$

If $C \leq D$, because $(\beta + (1 - \beta)q_{bh}) \leq (\beta(1 - \beta)q_{gh})$ for all $\beta \in [0, 1)$, then (LRβ) is not satisfied for any β and communication has no value no matter the bias.

If $C > D$ and $Cq_{bh} > Dq_{gh}$, then (LRβ) is satisfied at both $\beta = 0$ and $\beta = 1$. Because both sides of (LRβ) are linear in β it follows that (LRβ) is satisfied for all $\beta \in [0, 1)$ and communication has value no matter the bias.

Finally, if $C > D$ and $Cq_{bh} \leq Dq_{gh}$, then (LRβ) is satisfied at $\beta = 1$ but not at $\beta = 0$. Because both sides of (LRβ) are linear in β it follows that there is a $\beta^* \in [0, 1)$ such that (LRβ) is not satisfied for all $0 \leq \beta < \beta^*$ and satisfied for all $\beta^* \leq \beta < 1$. In other words, communication has no value for sufficiently small bias and value for sufficiently large bias. □

Appendix B: Accounting bias in the sufficient statistic case

In this section we consider accounting bias in the benchmark case when the manager's private information z is a sufficient statistic for y with respect to a. This case is particularly interesting in that, if the bias affects only the accounting report y, then z continues to be a sufficient statistic for y with respect to a. Thus, independent of the bias, we know that effort incentives are provided by z whereas y only plays a confirmatory role with respect to z. Moreover, independent of the bias, disclosure of the soft signal z is valuable as long as the hard accounting report y remains correlated with z. In this case, the disclosure condition (LR) becomes $\phi(g|H, a_h)/\phi(g|L, a_h) > 1$ and is always satisfied. In the sufficient statistic case, we can also explicitly characterize the efficient contract that induces $a = a_h$.

Following Şabac and Tian (2015), Gigler and Hemmer (2001), and Berg, Daley, Gigler, and Kanodia (1990), the efficient contract that induces $a = a_h$ can be characterized as a function of the manager's posterior expected utilities $U_z^\dagger$ conditional on $a = a_h$ and having observed and reported truthfully z as follows.

First, $U_z^\dagger$, $z = g, b$ are uniquely determined by the binding participation and effort-incentive compatibility constraints (IR) and (ICT), respectively. Because these two constraints only involve the prior distribution of the manager's private information z, $\phi(z|a)$, the uniquely determined values of $U_z^\dagger$, $z = g, b$ only depend on $\phi(z|a)$ and are unaffected by accounting bias, $U_g^\dagger = \bar{U} + [(1 - \phi(g|a_l))/(\phi(g|a_h) - \phi(g|a_l)]v$ and $U_b^\dagger = \bar{U} - [\phi(g|a_l)/(\phi(g|a_h) - \phi(g|a_l)]v$, Şabac and Tian (2015, p. 1695).

Second, the principal minimizes the expected compensation cost $\mathrm{E}[c(z, y)|a_h]$ subject to the following binding constraints:

$$
\begin{aligned}
&\phi(H|g,a_h)U_{\hat{g}H} + \phi(L|g,a_h)U_{\hat{g}L} = U_g^{\dagger} \\
&\phi(H|b,a_h)U_{\hat{b}H} + \phi(L|b,a_h)U_{\hat{b}L} = U_b^{\dagger} \\
&\phi(b,H|a_h)(U_{\hat{b}H} - U_{\hat{g}H}) + \phi(b,L|a_h)(U_{\hat{b}L} - U_{\hat{g}L}) = 0 \\
&U_{\hat{b}H} = U_{\hat{b}L}\ ,
\end{aligned}
\tag{4}
$$

where the first two constraints maintain the manager's posterior expected utility that is separately determined above by incentive considerations alone; the third constraint is the reporting constraint (TG); and the last constraint follows from the ranking of payments in the sufficient statistic case, $I_{\hat{g}H} > I_{\hat{b}H} = I_{\hat{b}L} > I_{\hat{g}L}$. For details, see the characterization of the efficient contract in Proposition 1 of Şabac and Tian (2015, p. 1691).

The four equations in (4) above simplify to $U_{\hat{b}H} = U_{\hat{b}L} = U_b^{\dagger}$ and the following 2×2 system of linear equations for $U_{\hat{g}H}, U_{\hat{g}L}$:

$$
\begin{aligned}
q_{gh}U_{\hat{g}H} + (1-q_{gh})U_{\hat{g}L} = U_g^{\dagger} \\
q_{bh}U_{\hat{g}H} + (1-q_{bh})U_{\hat{g}L} = U_b^{\dagger}
\end{aligned}
\tag{5}
$$

The manager reports after a_h is taken, so we can focus on separating the two privately informed types, and the reporting problem is equivalent to the insurance problem in Rothschild and Stiglitz (1976) and in Stiglitz (1977). The problem is whether a separating equilibrium exists between the contracts $c_b = (U_{\hat{b}H}, U_{\hat{b}L})$ and $c_g = (U_{\hat{g}H}, U_{\hat{g}L})$, or equivalently between the 'bad type,' the manager who has received bad news $z = b$, and the 'good type,' the manager who has received good news $z = g$. A separable equilibrium means that the soft information is used ($c_b \neq c_g$) while a pooling equilibrium means that the soft information is not used ($c_b = c_g$).

We present the intuition in terms of the insurance problem in in Figure 6, where a separating equilibrium is shown. Most of the intuition carries over to the general case which is the focus of our study. The values $U_z^{\dagger}$ for $z = g, b$ are those determined above, which solve the moral hazard problem, and determine the two expected utility indifference lines, $U_z = U_z^\dagger$, for the two agent types. We draw this picture in the utility space, like Berg et al. (1990, Figures 1–7), but we keep the (utility corresponding to the) high outcome on the horizontal axis as in Rothschild and Stiglitz (1976, Figure III, p. 636) and in Stiglitz (1977, Figure 4 (b), p. 417). Thus, the indifference lines are straight. The bad type (corresponding to higher risk with respect to the high outcome) $y = H$ has a flatter expected utility indifference line (with slope $-q_{bh}/(1-q_{bh})$) than the good type (corresponding to a lower risk with respect to the high outcome $y = H$) who has a steeper indifference line (with slope $-q_{gh}/(1-q_{gh})$). The effort incentive problem is solved by setting

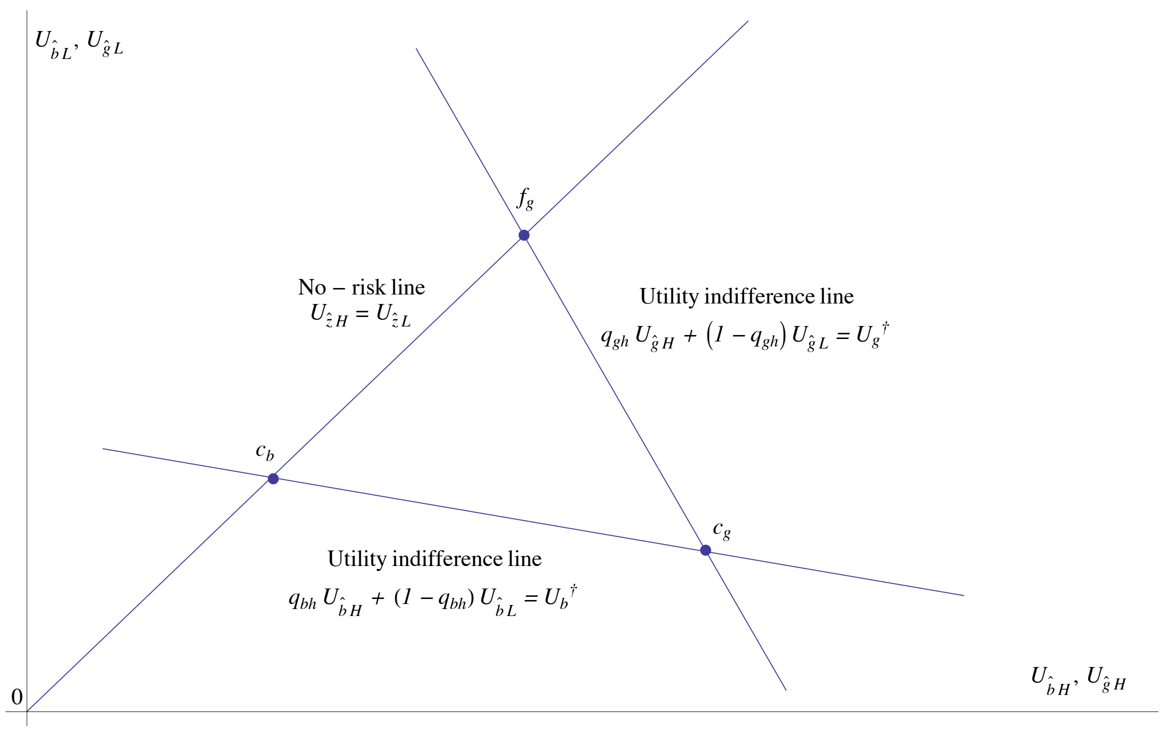


Figure 6: Contracts c_b and c_g in the sufficient statistic case.

the levels for the two indifference lines, $U_z = U_z^\dagger$ for $z = g, b$. The principal's remaining problem is to minimize the expected cost of compensation, while varying the contract c_b for the bad type on the line $U_b = U_b^\dagger$ (that is line $c_b c_g$ in Figure 2) and varying the contract c_g for the good type on the line $U_g = U_g^\dagger$ (that is line $f_g c_g$ in Figure 2).

The solution to this is the same as in the pure insurance problem: the bad type gets a no-risk contract and is made indifferent between the two contracts c_g and c_b. In other words, c_b is on the no-risk line $U_{\hat{b}H} = U_{\hat{b}L} = U_b^\dagger$ and c_g is at the intersection of the two indifference lines. The two indifference lines intersect away from the no-risk line, so that c_g and c_b can always be separated and the soft information is always valuable. This is exactly the contract derived by Gigler and Hemmer (2001, Lemma 2, p. 478).

Negative bias

In the sufficient statistic case we have $q_{gh} = q_{gl}$ and $q_{bh} = q_{bl}$. With negative bias on the accounting report, we have $\bar{q}_{ij} = (1-\alpha)q_{ij}$ for all $i = g, b$, $j = h, l$, as described in Table 5. Thus the sufficient statistic property is satisfied independently of $\alpha \in [0, 1]$ because $\bar{q}_{gh} = \bar{q}_{gl}$ and $\bar{q}_{bh} = \bar{q}_{bl}$.

We know from Şabac and Tian (2015) that the right-hand side of the disclosure condition is constant and equal to one as long as z is a sufficient statistic for y with respect to a. Thus, the right-hand side of the condition is equal to one independently of the accounting bias α. This side of the condition captures effort incentives and, in the sufficient statistic case, effort incentives are provided by z alone, which is unaffected by accounting bias.

The bad type contract $U_{\hat{b}H} = U_{\hat{b}L} = U_b^\dagger$ is independent of negative bias α because $U_z^\dagger$ is independent of such bias and $\bar{q}_h = q_h$. Indeed, to obtain the corresponding efficient contract for negative bias α, we only need to substitute the values of the corresponding probability parameters from Table 5.

Solving (5) for the good type contract in the sufficient statistic case yields

$$\begin{aligned} U_{\hat{g}L} &= \frac{q_{gh}U_b^\dagger - q_{bh}U_g^\dagger}{q_{gh} - q_{bh}} \\ U_{\hat{g}H} &= U_{\hat{g}L} + \frac{U_g^\dagger - U_b^\dagger}{q_{gh} - q_{bh}} \ . \end{aligned} \tag{6}$$

Because $\bar{q}_{zh} = (1 - \alpha)q_{zh}$ for $z = g, b$ and $\bar{q}_h = q_h$, it follows that $U_{\hat{g}L}$ is also independent of negative bias α and we have, after substituting $\bar{q}_{zh}$ into the expression for $U_{\hat{g}H}$,

$$U_{\hat{g}H}(\alpha) = U_{\hat{g}L} + \frac{U_g^\dagger - U_b^\dagger}{(q_{gh} - q_{bh})(1-\alpha)} = U_{\hat{g}L} + \frac{v}{(q_h - q_l)(q_{gh} - q_{bh})(1-\alpha)} \,. \tag{7}$$

To conclude the characterization of the efficient contract under negative accounting bias, we note that the bad type gets a risk-free contract independent of bias, whereas the good type gets a risky contract where the payment for low outcomes is unchanged but the payment for high outcomes increases with the bias α, see (7) above.

To understand why the efficient contract changes in this way with respect to the bias α it useful to turn to the left-hand side of the disclosure condition (LR), which captures the confirmatory role of the public signal y and is equal to $\phi(g|H, a_h)/\phi(g|L, a_h)$. Using the corresponding probability parameters from Table 5, it is easy to see that $\bar{\phi}(g|H, a_h)$ is independent of α, whereas $\bar{\phi}(g|L, a_h)$ is increasing in α. Thus, the ratio $\bar{\phi}(g|H, a_h)/\bar{\phi}(g|L, a_h)$, which characterizes the confirmatory power of y with respect to $z = g$, is decreasing in the negative accounting bias α. Finally, we note that negative bias generally reduces the confirmatory power of the hard accounting report because the above argument does not rely on the sufficient statistic condition.

To conclude, in the case of negative accounting bias, the left-hand side of the disclosure condition is decreasing in the bias α making the condition harder to satisfy, although in the sufficient statistic case the left-hand side remains strictly greater than one and the condition is always satisfied. The principal is worse off with increasing bias α not because the cost of effort incentives provided through z, that does not change, but because of the increasing cost of eliciting a truthful report of z from the manager (achieved in this case only by increasing payment to the good type for a high outcome as α increases).

To see that biasing the hard accounting report always makes the principal worse off, note that the expected compensation paid to the manager only depends on bias through the ex-post expected compensation paid to the manager that reports good news, $\mathrm{E}[c_g(y, \alpha)|a_h]$. The expected compensation paid to the agent has to increase to compensate for the riskier contract offered to the good type. Indeed, it is sufficient to prove that $\mathrm{E}[c_g(y,\alpha)|a_h] > \mathrm{E}[c_g(y,\alpha = 0)|a_h]$, or, equivalently $\alpha I_{\hat{g}L}+(1-\alpha)I_{\hat{g}H}(\alpha) > I_{\hat{g}H}$. But $u(\alpha I_{\hat{g}L}+(1-\alpha)I_{\hat{g}H}(\alpha)) > \alpha U_{\hat{g}L}+(1-\alpha)U_{\hat{g}H}(\alpha) = U_{\hat{g}H} = u(I_{\hat{g}H})$, where the first inequality is due to risk aversion, and the following equality follows directly from (7). Taking into account that the manager's utility is strictly increasing proves the desired inequality.

Positive bias

With positive bias, the analysis parallels that for negative bias. With positive bias on the accounting report, we have $\bar{q}_{ij} = \beta + (1-\beta)q_{ij}$ for all $i = g, b$, $j = h, l$, as described in Table 5. Thus the sufficient statistic property is satisfied independently of $\beta \in [0,1]$ because $\bar{q}_{gh} = \bar{q}_{gl}$ and $\bar{q}_{bh} = \bar{q}_{bl}$.

The characterization of the optimal contract in (4) and in (5) is the same. The contract offered to the bad type is independent of bias and we can write the contract offered to the good type, the solution to (5), as follows:

$$\begin{aligned} U_{\hat{g}H} &= \frac{(1-q_{bh})U_g^\dagger - (1-q_{gh})U_b^\dagger}{q_{gh}-q_{bh}} \\ U_{\hat{g}L} &= U_{\hat{g}H} - \frac{U_g^\dagger - U_b^\dagger}{q_{gh}-q_{bh}}\ . \end{aligned} \tag{8}$$

Because $1-\bar{q}_{zh} = (1-\beta)(1-q_{zh})$ for $z = g, b$ and $\bar{q}_h = q_h$, it follows that $U_{\hat{g}H}$ is also independent of positive bias β and we have, after substituting $\bar{q}_{zh}$ into the expression for $U_{\hat{g}L}$,

$$U_{\hat{g}L}(\beta) = U_{\hat{g}H} - \frac{U_g^\dagger - U_b^\dagger}{(q_{gh}-q_{bh})(1-\beta)} = U_{\hat{g}H} - \frac{v}{(q_h-q_l)(q_{gh}-q_{bh})(1-\beta)}\ . \tag{9}$$

To conclude the characterization of the efficient contract under positive accounting bias, we note that the bad type gets a risk-free contract independent of bias, whereas the good type gets a risky contract where the payment for high outcomes is unchanged but the payment for low outcomes decreases with the bias β, see (9) above.

To understand why the efficient contract changes in this way with respect to the bias β, it useful to turn to the left-hand side of the disclosure condition (LR), $\phi(g|H, a_h)/\phi(g|L, a_h)$, which captures the confirmatory role of the public signal y. Using the corresponding probability parameters from Table 5, it is easy to see that $\bar{\phi}(g|H, a_h)$ is decreasing in β, whereas $\bar{\phi}(g|L, a_h)$ is independent of β. Thus, the ratio $\bar{\phi}(g|H, a_h)/\bar{\phi}(g|L, a_h)$, which characterizes the confirmatory power of y with respect to $z = g$, is decreasing in the positive accounting bias β. Finally, we note that positive accounting bias reduces the confirmatory power of the hard accounting report in the general case because the above argument does not rely on the sufficient statistic condition.

To conclude, in the case of positive accounting bias, the left-hand side of the disclosure condition is decreasing in the bias β making the condition harder to satisfy, although in the sufficient statistic case the left-hand side remains strictly greater than one and the condition is always satisfied. The principal is worse off with increasing bias β not because the cost of effort incentives provided through z, that does not change, but because of the increasing cost of eliciting a truthful report of z from the manager (achieved in this case only by reducing the payment to the good type for a low outcome as β increases).

To see that biasing the hard accounting report always makes the principal worse off, note that the expected compensation paid to the manager only depends on bias through the ex-post expected compensation paid to the manager that reports good news, $\mathrm{E}[c_g(y, \beta)|a_h]$. The expected compensation paid to the agent has to increase to compensate for the riskier contract offered to the good type. Indeed, it is sufficient to prove that $\mathrm{E}[c_g(y, \beta)|a_h] > \mathrm{E}[c_g(y, \beta = 0)|a_h]$, or, equivalently $\beta I_{\hat{g}H} + (1 - \beta)I_{\hat{g}L}(\beta) > I_{\hat{g}L}$. But $u(\beta I_{\hat{g}H} + (1 - \beta)I_{\hat{g}L}(\beta)) > \beta U_{\hat{g}H} + (1 - \beta)U_{\hat{g}L}(\beta) = U_{\hat{g}L} = u(I_{\hat{g}L})$, where the first inequality is due to risk aversion, and the following equality follows directly from (9). The manager's utility being strictly increasing proves the desired inequality.

Negative versus positive bias

The sufficient statistic case is a good benchmark for understanding how bias affects the confirmatory role of the public signal because the effort incentives are provided exclusively by the soft managerial report, while the reporting incentives are provided by the hard accounting report. Because bias affects only the distribution of the hard signal (and does not affect the distribution of the soft signal), the only impact of bias will be on the reporting incentives provided by the hard signal.

Referring back to Figure 6, we note that introducing bias causes the two indifference lines for the good type, $f_g c_g$, and the bad type, $c_b c_g$, respectively, to rotate about the fixed points $f_g = (U_g^\dagger, U_g^\dagger)$ and $c_b = (U_b^\dagger, U_b^\dagger)$. With negative bias, both lines rotate in a counterclockwise direction because their slopes become flatter with increasing α, causing the contract for the good type to shift to the right, thus increasing $U_{\hat{g}H}$. Similarly, with positive bias, both lines rotate in a clockwise direction because their slopes become steeper with increasing β, causing the contract for the good type to shift down, thus decreasing $U_{\hat{g}L}$.

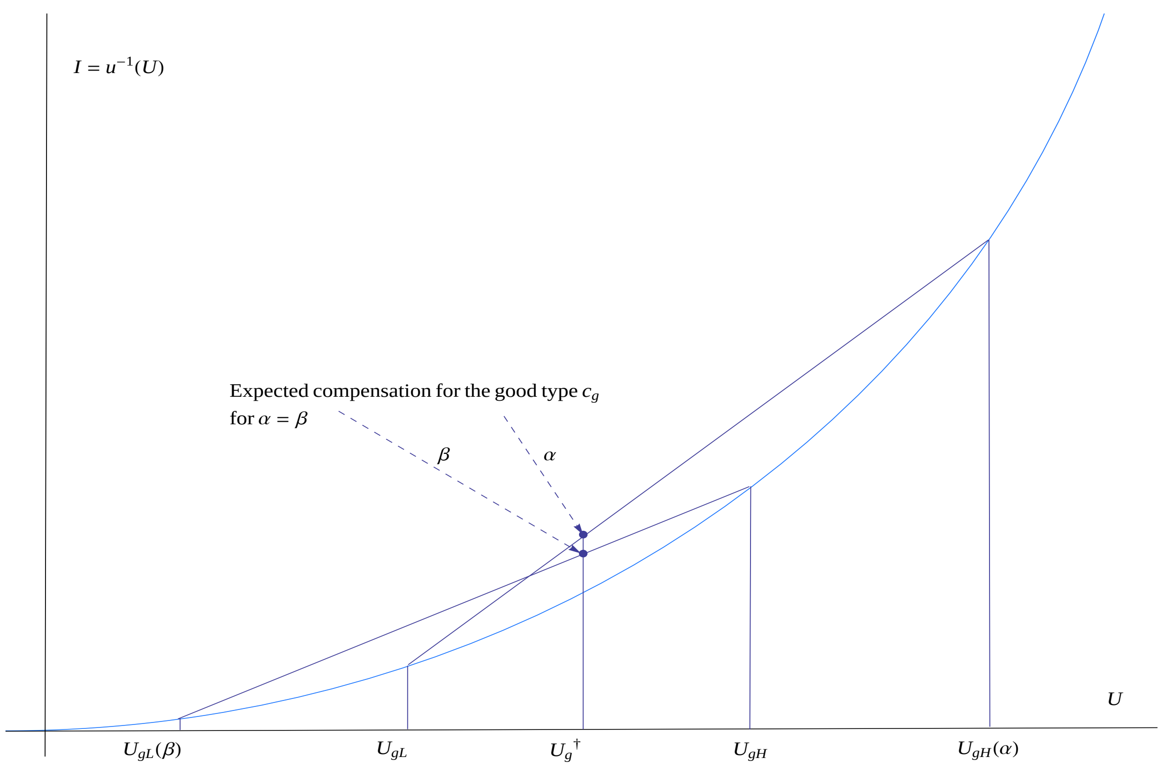


Figure 7: Increase in the risk premium: negative vs. positive bias in the sufficient statistic case.

For the same amount of negative and positive bias, $\delta = \alpha = \beta$ respectively, the principal increases the agent's utility of the high payment and reduces the agent's utility for the low payment by the same respective amounts $(U_g^\dagger - U_b^\dagger)/((q_{gh} - q_{bh})(1-\delta))$, see (7) and (9). But this implies the expected compensation cost for the good type will be higher with the negative bias than with the positive bias as illustrated in Figure 7. Shifting the utility for the high outcome $U_{\hat{g}H}$ by the same amount upwards as shifting the utility for the low outcome $U_{\hat{g}L}$ downwards leads to a higher expected compensation for the good type agent (a higher risk premium) due to the convexity of the inverse utility function $I = u^{-1}(U)$. Thus, the same amounts of negative bias being costlier than the corresponding positive bias, we can infer that negative bias is more damaging to the confirmatory power of the accounting report than the same amount of positive bias.

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