

Increasing Internal Controls Incentives and Welfare Through Conservative Accounting

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Abstract

This paper examines whether accounting conservatism affects management's incentives to improve the effectiveness of internal controls and whether this is desirable from a welfare perspective. We employ an agency model in which an owner incentivizes the manager to take a productive action through optimal compensation that also creates incentives for earnings management and possibly for an improvement of internal controls. These efforts influence the contractual usefulness of accounting information and interact in subtle ways. We find that conservatism increases management's incentives to enhance internal controls, and this effect is crucial for conservatism to raise welfare in the presence of earnings management. We also find that conservatism has an ambiguous effect on earnings quality.

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1. Introduction

Internal controls over the accounting processes in firms aim to reduce misstatements and are an important mechanism to improve the quality of financial reporting. For example, the Sarbanes-Oxley Act (SOX) of 2002 introduced requirements for firms to maintain internal controls, which impose considerably costs to firms, and the PCAOB Standard AS 2201 requires the auditor to express an opinion on management's assessment of the effectiveness of internal control over financial reporting. Usually, mechanisms to improve internal controls are discussed in the corporate governance domain without considering their interaction with the accounting system. But, arguably, these characteristics can reinforce, or work against, the quality of internal controls. In this paper we show that conservatism, a fundamental characteristic of current accounting systems, increases incentives of management to improve internal controls, increases firm value, and can increase welfare through these the better controls.

Conservatism introduces a bias in the information, leading to understating equity and underreporting earnings in early periods. Whether conservative accounting is beneficial or harmful is highly controversial. Accounting standard setters, including the International Accounting Standards Board and the U.S. Financial Accounting Standards Board, reject conservatism in favor of neutrality (IASB 2010, FASB 2010), and in its deliberations of a new Conceptual Framework, the IASB is about to reintroduce conservatism, although in the form of caution in the face of uncertainty, thus trying to avoid bias (IASB 2015). The accounting literature has shown several instances in which conservatism is desirable. Some of the work addresses the decision usefulness objective the standard setters have in mind, whereas the majority finds benefits of conservatism in contracting settings.¹ This paper adds to the contracting literature by identifying a novel benefit of conservatism through its induced improvements of internal controls.

We develop an agency model in which the manager, besides providing productive effort, can enhance the quality of the accounting process through internal controls and engage in earnings

¹ For surveys of conservatism see, e.g., Watts (2003) and Ewert and Wagenhofer (2011). More specific references are discussed later in this Introduction.

management. Misstatements can result from errors in the underlying accounting process and from deliberate earnings management. The owner of the firm designs management compensation, based on reported earnings, to provide incentives for productive effort. This compensation also induces incentives for earnings management and may provide incentives to the manager to improve internal controls. Internal controls are important because they mitigate errors in the accounting process and improve the precision of earnings. Earnings management, on the other hand, is commonly viewed as detrimental to the usefulness of earnings. Conservatism biases reported earnings towards lower values, which affects management's incentives and, by anticipation of these effects, the owner's optimal compensation design. We examine the effect of conservatism on the following economic outcomes: firm value (the owner's expected utility), total welfare (sum of the owner's and the manager's expected utilities),² and earnings quality. The owner maximizes firm value, but can be interested in total welfare; regulators and standard setters are presumably interested in total welfare and earnings quality.

Our main findings are: More conservatism increases management's incentives to enhance internal controls; strictly increases firm value; can increase total welfare only if the manager enhances internal controls; and can increase or decrease earnings quality depending on whether earnings management is mainly corrective or misstating. These effects are consequences of the endogenous provision of incentives to the manager and the manager's resulting choices of improving internal controls and earnings management. They are gross of any direct costs of varying the accounting characteristics.

To highlight the role of internal controls for the benefit of conservatism, we start with the benchmark setting where the manager provides productive effort and engages in earnings management, but exclude internal controls effort. We show that a separate increase in either accounting error always decreases firm value and total welfare, which is intuitive. In contrast, increasing conservatism always increases firm value, but total welfare always declines.

² In our setting, the manager earns an expected rent, which is affected by the degree of conservatism. Hence, firm value and total welfare differ.

Conservatism reduces the probability of paying a bonus, which benefits the owner at the cost of the manager due to the increase in information precision, but at the same time increases the probability of low preliminary earnings, which induces more earnings management in expectation. We show that the reduction of the manager's rent is greater than the welfare increase of the owner, thus resulting in lower total welfare.

We then add internal controls and show that the manager enhances internal controls only if, *ex ante*, the accounting system is such that the likelihood of an understatement of actual earnings is higher than the likelihood of an overstatement. That is, the incentive depends on the characteristics of the accounting system and the production technology, both of which determine the probability distribution of earnings. As in the benchmark setting, one would expect that an increase of the probability of any error is harmful; perhaps surprisingly, our analysis reveals that increasing the probability of an understatement can actually be desirable to the firm. More understatement encourages the manager to exert more effort to enhance internal controls, and the resulting improvement of the accounting system overcompensates the decrease of precision caused by more understatement as long as the understatement error is not too small.

In this full setting, more conservatism strictly increases firm value as in the benchmark setting, but it can also increase total welfare, and this result rests on the beneficial effect of improved internal controls. Thus, our paper complements other papers that show benefits of conservative accounting, such as Chen, Hemmer, and Zhang (2007), Chen, Mittendorf, and Zhang (2010), and Gao (2013). Our results also highlight that the characteristics of the accounting system are important determinants for implementing high-quality internal controls by the manager. In the regulatory debate, it appears that this link is often disregarded. Many regulatory actions aim at enhancing internal controls in firms – we show that the trend to neutral accounting standards implicitly works against this regulatory objective.

We also consider the effect of accounting conservatism on earnings quality. We define earnings quality as the probability that, *ex ante*, the financial report coincides with the firm's true outcome. Our main finding is that varying conservatism can either increase or decrease earnings quality. We present conditions under which one or the other effect prevails. This result suggests

that earnings quality behaves quite independently from economic welfare, and it would be an unreliable metric if one is interested in whether implementing a particular measure enhances welfare. This result supports the view that the objectives of decision usefulness and stewardship are not fully congruent, contrary to what the FASB (2010) and the IASB (2010) assume in their Conceptual Frameworks. Our finding is similar in spirit to the general result in Gjesdal (1982) and subsequent papers, such as Feltham and Xie (1994) and Drymiotes and Hemmer (2013).³

Our paper speaks to empirical literature that has been motivated by the enactment of SOX and studies relations between internal controls and several accounting characteristics or earnings quality measures. For example, Goh and Li (2011) find a positive association between conditional conservatism and the quality of internal controls, which is consistent with our link between conservatism and internal control efforts. Ashbaugh-Skaife, Collins, Kinney, and LaFond (2008) find that internal control weaknesses are associated with lower accrual quality,⁴ measured by abnormal accruals and an accruals noise proxy. This finding is consistent with implications drawn from our paper that internal controls are inherently substitutes for earnings management efforts and come along with lower expected earnings management. Our paper provides a theoretical explanation for such predictions and empirical findings.

The model we employ is a specific multi-action agency model with a productive action and other actions that affect the performance measure. Prior literature includes Feltham and Xie (1994) who consider productive effort and earnings management (“window dressing”) in a LEN model in which earnings management is implicitly induced by providing incentives for productive effort. Our model structure extends Kwon, Newman, and Suh (2001) and Bertomeu, Darrrough, and Xue (2015) by adding an effort to improve internal controls. Kwon, Newman, and Suh (2001) consider an agency model in which the manager takes a productive action, but cannot perform other activities that influence the accounting report. Conservatism is beneficial because the manager’s compensation is bounded from below and too much precision on unfavorable signals is useless, so

³ See also Lambert (2001) and Christensen and Demski (2003).

⁴ See also Doyle, Ge, and McVay (2007) for a similar result.

more precision can be shifted to favorable signals. Bertomeu, Darrrough, and Xue (2015) introduce *ex ante* earnings management to this setting. They find that conservative accounting is optimal because the benefit of having more precise favorable signals is larger than the cost of increased earnings management incentives. This trade-off gives rise to a desirable interior level of conservatism. In an extension, they discuss *ex post* earnings management and find that (maximum) conservatism increases firm value, as we do in the present paper.⁵ Bertomeu et al. do not consider total welfare and earnings quality implications.

Drymiotis (2011) examines a setting in which the firm's owner can increase the precision of the accounting system (what is labeled as monitoring) and studies the effect on earnings management incentives. He finds that making the accounting system more precise can increase earnings management. Chan (2016) studies the effect of the SOX requirement to disclose internal control weaknesses on investment in internal controls and audit effort. He focuses on the interaction between internal controls and the compensation contract set by the owner, earnings management, and auditing. Chan finds that the disclosure of internal control weaknesses increases audit effort, but can increase or decrease investment in internal controls. Both papers assume the owner rather than the manager sets the internal control level and they do not consider conservatism.

Ewert and Wagenhofer (2016) develop an agency model with productive effort and earnings management and examine the interaction between auditing and enforcement activities and their resulting effects on managerial incentives. They show that increasing enforcement can have detrimental effects on firm value and on earnings quality because for highly effective enforcement, enforcement crowds out auditing and mitigates earnings management that may be "good" in the sense that it corrects understatement errors in the accounting system. Glover and Levine (2015) consider asymmetric information about measurement quality and also show that

⁵ In a related setting in which the manager receives a different piece of information, Gigler and Hemmer (2001) find that conservatism makes it more difficult to elicit truth-telling and is therefore undesirable.

earnings management can be “good” in that it reduces understatement. A similar effect surfaces for earnings quality in the present paper.

Providing incentives to enhance internal controls bears some resemblance to controlling managers’ activities to control risk in the production process. For example, Meth (1996) and Chen, Mittendorf, and Zhang (2010) study agency models in which the manager takes two actions, one to increase the average outcome and the other to influence its variance or spread. In these models, inducing less risky production choices improves the informativeness of the accounting system. In particular, Chen et al. find that conservatism is useful to motivate the mean-increasing action, but a liberal bias is necessary to induce the spread-reducing activity. Gao and Zhang (2016) consider peer pressure for earnings management and show that firms do not internalize this positive externality, thus, underinvest in internal controls.

Internal controls are also studied in the analytical auditing literature, such as, e.g., Nelson, Ronen, and White (1988), Smith, Tiras, and Vichitlekarn (2000), Pae and Yoo (2001), and Patterson and Smith (2007, 2016). These models consider strategic interactions between the manager’s or the owner’s implementation of internal controls and the auditor’s audit activities. These papers focus on different auditor liability regimes, changes in audit requirements and/or penalties for the manager and their impact on firm value. Compared to the present paper, they do not explicitly consider optimal contracting, but focus on auditors’ strategies.

The paper proceeds as follows: Section 2 develops the model and Section 3 derives the optimal contract, the manager’s choice of different activities and the economic effects of varying conservatism in the benchmark setting without internal controls effort. Section 4 presents our main results, which include the effects of varying conservatism on incentives for earnings management and improving internal controls, on firm value, total welfare, and earnings quality. Section 5 concludes.

2. Model

We consider a firm consisting of a representative owner and a manager in a one-period agency model. The manager exerts productive effort, can improve internal controls of the accounting system, and has the opportunity to manage earnings. Each of these actions is

personally costly to the manager. To provide incentives to the manager to work hard, the owner writes a compensation contract based on reported earnings (in a broad sense).

Production technology

The firm owns a production technology and installs an accounting system to track performance. Output is binary and measured by a monetary amount $x \in \{x_L, x_H\}$ with $0 < x_L < x_H$. Production of the firm's output depends on managerial effort $a \in \{a_L, a_H\}$ and other stochastic production factors. The manager incurs a private cost of productive effort of 0 for a_L and $V^a > 0$ for a_H . The effort determines the probability with which a low or a high output occurs: x_H occurs with probability p upon high effort a_H , and with probability q upon low effort, where $p > q$ and p and q are strictly within $(0, 1)$. The difference between p and q captures the incremental productivity of high effort.

The output accrues to the owner, who compensates the manager for the effort exerted. We assume the owner wants the manager to take higher productive action a_H , which requires that the net outcome for the owner, $(p - q)(x_H - x_L) - V^a$, is sufficiently large. Otherwise there is no incentive problem and a fixed compensation would implement a_L . The owner designs a compensation contract $s(\cdot)$ written on the financial report $m \in \{m_L, m_H\}$. The actual output x is unobservable and non-contractible, for example, because it is a long-term profit that cannot be captured fully by a one-period performance measure or it includes non-financial benefits. There are no other contractible signals available about the manager's actions.

The owner is risk neutral and maximizes the expected output less expected compensation,

$$E(U^o) = [(1 - p)x_L + px_H] - [\text{prob}(m_L)s(m_L) + \text{prob}(m_H)s(m_H)]. \quad (1)$$

Because we assume the owner induces a_H , the first term, expected output, is constant and the owner's problem reduces to minimizing the second term, the expected compensation subject to the manager agreeing to the contract and choosing a_H .

The manager is risk neutral and protected by limited liability. Specifically, we assume the manager has a zero reservation utility and compensation s cannot be negative. We explicitly state the manager's expected utility after introducing the accounting system.

Accounting system

The owner installs an accounting system that produces an accounting signal $y \in \{y_L, y_H\}$, where $y_L < y_H$. We also refer to the signal as preliminary earnings. It provides imperfect information about the output x , whose precision we capture by the two types of errors that can occur: α is the “ α -error”, i.e., the probability that it reports y_L , although the output is x_H ; and β is the “ β -error” with which it reports y_H , although the output is x_L . $\alpha, \beta \in [0, 0.5]$, where $\alpha = \beta = 0$ is the special case of a perfect information system and $\alpha = \beta = 0.5$ is a totally uninformative system. The errors in the accounting system arise from the book-keeping and other accounting processes, e.g., inventory sampling, misrecording book entries, double-booking, not booking transactions or events, individual mistakes and misjudgments, but also earnings management or fraud at lower levels of the firm.⁶ In a binary information setting, the error probabilities fully determine its information content and changing either of them affects the decisions taken by the owner and the manager and the resulting economic outcomes.

We assume that the accounting system is characterized by base errors $\alpha_0, \beta_0 \in [0, 0.5]$ and we distinguish two characteristics of the accounting system, precision and bias. Precision is measured by the sum of the conditional error probabilities, $\alpha_0 + \beta_0$. Thus, lowering either α_0 or β_0 , or both of them, increases precision. Bias is determined by the relation between α_0 and β_0 . Following prior literature (e.g., Gigler, Kanodia, Sapra, and Venugopalan 2009) we define the base accounting system as neutral if $\alpha_0 = \beta_0$, conservative if $\alpha_0 > \beta_0$, and aggressive if $\alpha_0 < \beta_0$. An accounting system is more conservative the greater the difference $\alpha_0 - \beta_0$ becomes. Conservatism makes it more likely that, given some production technology, the low signal y_L rather than the high signal y_H realizes. That is, conservative accounting tends to understate rather than overstate earnings in the period a transaction or event is recognized. At the same time, the signal y_L becomes less precise and the signal y_H more precise regarding the underlying actual output x .

Precision and bias are related. For example, if $\alpha_0 > \beta_0$, then lowering α_0 decreases conservatism; if $\alpha_0 < \beta_0$, then decreasing α_0 increases aggressiveness. Moreover, the lower α_0 and

⁶ We do not model such decisions explicitly but capture them within the α - and β -errors.

β_0 are, the less bias is possible. In the extreme, if an accounting system is fully precise ($\alpha_0 = \beta_0 = 0$) then there cannot be a bias.

To isolate the effects of conservatism, we hold the precision constant and parameterize both error probabilities by δ , which serves as our measure of conservatism: An accounting system $(\alpha'_0, \beta'_0) \equiv (\alpha_0 + \delta, \beta_0 - \delta)$ is more conservative the greater is δ , assuming $0 < \delta < \max\{0.5 - \alpha_0, \beta_0\}$. Intuitively, δ biases the original accounting system towards reporting bad news more likely than good news. In the subsequent analysis, we do not explicitly spell out δ in the equations, but use it only to derive comparative statics for a variation of conservatism.

The total precision of the accounting system depends on the base characteristics determined by $\alpha_0, \beta_0 \in [0, 0.5]$, the conservatism parameter δ and managerial effort that can increase the basic precision, which we refer to as internal controls (IC) effort. The IC effort is unobservable and determined before the accounting system reports signal y . For example, the manager can invest in or enhance the quality of the accounting processes to improve the precision of the accounting system. The manager incurs a private cost of IC effort, $V^e \varepsilon$, where $V^e > 0$. We symbolize the IC effort by $\varepsilon \geq 0$, which alters the α - and β -errors in the following way:

$$\alpha = \alpha_0 \exp(-\varepsilon) \quad \text{and} \quad \beta = \beta_0 \exp(-\varepsilon). \quad (2)$$

Greater ε reduces the errors by a percentage that is concave increasing in ε because $\exp(-\varepsilon) = 1$ if $\varepsilon = 0$, $\exp(-\varepsilon) \rightarrow 0$ if $\varepsilon \rightarrow \infty$, $\exp(-\varepsilon)' < 0$, and $\exp(-\varepsilon)'' > 0$. We assume that the manager cannot influence the precision of the α - and the β -error independently.

Earnings management

After exerting productive effort and IC effort, the accounting system reports a signal y representing, for example, the raw profit from the list of accounts of the period. The manager privately observes y and can then engage in earnings management to manipulate the signal and to realize a financial report (earnings) $m \in \{m_L, m_H\}$. For example, after fiscal year-end, there are many accounting procedures that require professional judgment, estimations, forecasts, and the like by the manager. The financial report m is publicly observable and contractible and is used as the performance measure in the manager's compensation contract.

The manager's earnings management (EM) effort $B_i \geq 0$ ($i = L, H$) determines the probability with which the report m deviates from y ,

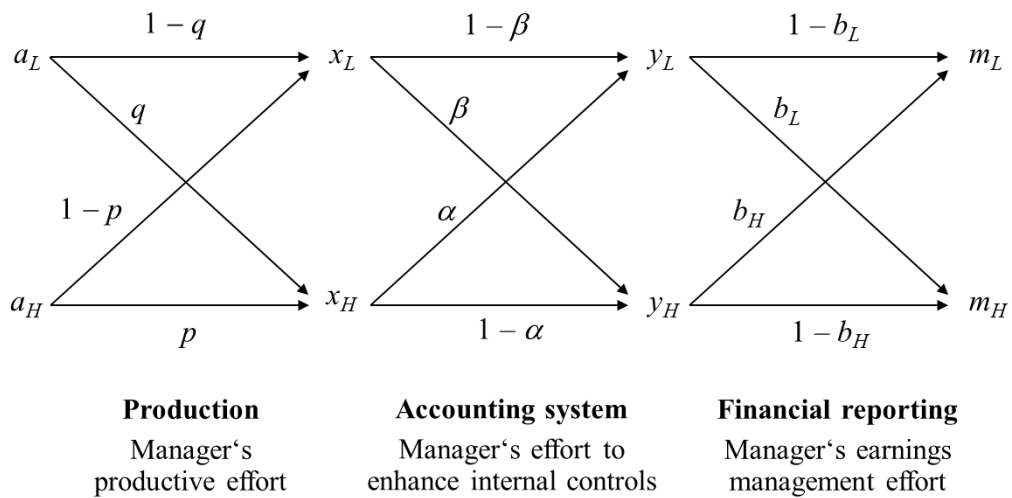
$$b_i = 1 - \exp(-B_i). \quad (3)$$

b_L is the probability that the financial report becomes m_H , although the accounting signal was y_L , and b_H is the probability that $m = m_L$ although $y = y_H$. The probability $b_i \in [0, 1)$ increases and is strictly concave in B_i .

The manager incurs a personal cost of EM effort of $V^m B_i$, where $V^m > 0$ is a constant scaling factor. V^m captures, e.g., the manager's energy or direct costs and opportunity costs of time of manipulating the results of the accounting system; it can also be a psychological cost of manipulation. A lower V^m indicates that the accounting system is easier to manipulate. We do not explicitly model the mechanisms that affect the level of V^m ; they can be a result of the accounting standards, which can provide more or less flexibility, but also of more effective controls, auditing, better enforcement, or more effective litigation.

Figure 1 depicts the stages of the production and the accounting system.

Figure 1: Production and accounting structure



The manager receives compensation from the owner for participating in the firm. Compensation $s(\cdot)$ is written on the financial report m , and both $s(m_L)$ and $s(m_H)$ are non-negative.

The manager's expected utility is

$$E[U^M | a_H, \varepsilon, B_L, B_H] = \text{prob}(m_L | \varepsilon, B_L, B_H) s(m_L) + \text{prob}(m_H | \varepsilon, B_L, B_H) s(m_H) - V^a - V^\varepsilon \varepsilon - V^m (\text{prob}(y_L | \varepsilon) B_L + \text{prob}(y_H | \varepsilon) B_H). \quad (4)$$

The time line is as follows:

1. Design of the base accounting system (α_0, β_0) and conservatism δ .
2. Owner offers compensation contract $s(m)$ to manager (and manager accepts).
3. Manager chooses productive effort a_H and IC effort ε .
4. Manager observes signal y_i from the accounting system and chooses earnings management (EM) effort B_i .
5. Manager issues financial report m_i .
6. Manager is paid according to the contract.

3. Benchmark without internal controls effort

3.1. Optimal contract

We begin the analysis with a benchmark setting in which there is no IC effort, i.e., $\varepsilon = 0$. This scenario arises endogenously in the full setting if the cost V^ε of IC effort is sufficiently high. All proofs are in the appendix.

To induce productive effort, the compensation must be greater for the high signal than for the low signal because the desirable productive effort a_H is more likely to produce x_H ; that is, $s(m_H) > s(m_L)$. Because compensation is non-negative and the reservation utility is zero, the owner optimally pays a bonus if m_H is realized and no bonus otherwise, i.e., $s \equiv s(m_H) > s(m_L) = 0$. The manager has an incentive to engage in earnings management only if $y = y_L$ to increase the probability that $m = m_H$. Underreporting earnings (i.e., reporting m_L although $y = y_H$) is never in the best interest of the manager. Therefore, $B \equiv B_L \geq 0$ and $B_H = 0$. Using these choices, the manager's expected utility becomes

$$E[U^M | a_H, B] = \text{prob}(m_H | B) s - V^a - \text{prob}(y_L) V^m B. \quad (5)$$

The subsequent analysis is by backward induction, starting with the last stage, the EM effort. The relevant components of the manager's expected utility, conditional on a_H and observing y_L , are the expected compensation and the cost of earnings management. The manager maximizes

$$\begin{aligned}\max_B E[U^M | a_H, y_L] &= \text{prob}(m_H | y_L) s - V^m B \\ &= (1 - \exp(-B)) s - V^m B.\end{aligned}$$

The first-order condition yields the optimal earnings management⁷

$$B = \begin{cases} \ln(s / V^m) > 0 & \text{if } s > V^m, \\ 0 & \text{otherwise.} \end{cases} \quad (6)$$

The probability that earnings management $B > 0$ is effective is $b_L = 1 - \exp(-B) = 1 - \frac{V^m}{s}$.

Given the optimal earnings management, the incentive compatibility constraint to induce the manager to choose a_H is

$$E[U^M | a_H] \geq E[U^M | a_L]$$

$$\text{or} \quad \text{prob}(m_H | B) s - V^a - \text{prob}(y_L) V^m B \geq \text{prob}(m_H | a_L, B) s - \text{prob}(y_L | a_L) V^m B. \quad (7)$$

Formally, if the manager were to choose a_L (out-of-equilibrium) he would possibly consider a different earnings management $B(a_L)$. But according to (6), B is independent of the productive action because the manager decides on earnings management only after observing low preliminary earnings y_L .

Finally, the owner maximizes her expected utility with respect to the bonus,

$$\max_s E[U^O] \hat{=} \min_s E[s] = \text{prob}(m_H) s, \quad (8)$$

subject to the incentive compatibility constraint and the participation constraint. Since the manager's reservation utility is zero and the manager is protected by limited liability, the participation constraint is redundant and the manager always earns a rent in expectation.

The following result characterizes the optimal solution.

⁷ The second-order condition is satisfied by virtue of the concavity of the decision problem.

Proposition 1: Assume $\varepsilon = 0$. The optimal contract promises a bonus s for high earnings as follows:

$$s = \begin{cases} \bar{V}^m & \text{if } \bar{V}^m \leq V^m, \\ \exp\left(\frac{\bar{V}^m}{V^m} - 1 + \ln(V^m)\right) & \text{if } \bar{V}^m > V^m. \end{cases}$$

where $\bar{V}^m \equiv \frac{V^a}{(p-q)(1-\alpha_0-\beta_0)}$.

The incentive compatibility constraint provides a lower bound on s to induce the high productive effort, and since the owner's expected utility strictly decreases in expected compensation, the incentive compatibility constraint determines the optimal bonus. The two cases in the proposition state the case that V^m is sufficiently high ($V^m \geq \bar{V}^m$) that it deters earnings management ($B = 0$), and the case of earnings management ($B > 0$).

3.2. Effects of varying conservatism

Firm value and total welfare

We consider two welfare measures: the value of the firm, which equals the expected utility of the owner, and total welfare, which we define as the sum of the expected utilities of the owner and the manager (other parties that might be affected by financial reporting are outside our model). These two measures do not coincide because the manager's expected utility is not constant, but he earns a rent from employment due to limited liability. Which of these two measures is relevant depends on who determines the level of conservatism in the accounting system. If it is the firm's owner, she is interested in maximizing her expected utility, which is firm value. If a regulator or standard setter is in charge of designing the accounting system, it would probably be more interested in total welfare, regardless of its distribution among the owner and the manager. More generally, maximizing total welfare seems economically more defensible due to Pareto optimality.⁸

⁸ We also believe that some results shown for firm value are a consequence of limited-liability agency models.

We define firm value FV as the owner's expected utility,

$$FV = E[U^O] = [(1-p)x_L + px_H] - \text{prob}(m_H)s(m_H). \quad (9)$$

As long as the optimal contract induces high productive effort, the expected outcome (the term in square brackets) is constant and changes in FV with a variation of the conservatism arise through its effect on the expected compensation.

Total welfare TW is the sum of firm value and the manager's expected utility,

$$TW = E[U^O] + E[U^M]. \quad (10)$$

$$TW = \begin{cases} E[x] - V^a & \text{if } B = 0, \\ E[x] - V^a - (p\alpha_0 + (1-p)(1-\beta_0) + \delta)V^m \ln\left(\frac{s}{V^m}\right) & \text{if } B > 0. \end{cases}$$

Expected compensation cancels out in total welfare, so TW eventually captures only the expected outcome for high productive effort less the agent's effort disutility and the expected cost of earnings management. The following proposition records comparative statics results for a variation of accounting characteristics.

Proposition 2: Assume $\varepsilon = 0$. (i) Firm value strictly decreases in α_0 and β_0 , but strictly increases in conservatism δ . (ii) Total welfare decreases in each parameter, α_0 , β_0 , and δ ; the decrease is strict if optimal earnings management is positive.

Both firm value and total welfare decrease in individual precision, i.e., with an increase in either α_0 or β_0 . This reflects the fact that reducing the precision of the accounting system due to larger individual accounting errors reduces the stewardship value of the accounting system.

Varying the precision of the accounting system directly affects both the required bonus to preserve incentive compatibility and the probability that the bonus is paid to the manager. In addition, there is an indirect effect: An increase in either error decreases the action-induced probability spread for the high accounting signal, thus requiring a larger bonus to motivate the manager to exert high productive effort. Specifically, a higher α_0 increases the bonus, but it also increases the instances that y_L occurs, so the probability that the manager earns the bonus declines. As shown in the proof, the latter effect is outweighed by the bonus effect, and therefore increasing

α_0 reduces firm value. Increasing the overstatement error β_0 , the lower precision again increases the bonus, but it also increases the probability of earning it. Both effects reduce firm value.

The effect of conservatism δ depends on which welfare measure is applied. Firm value strictly increases if the accounting system becomes more conservative, whereas total welfare decreases. The result that firm value increases for greater conservatism is a consequence of a trade-off between a decline in firm value due to higher α_0 and the simultaneous increase in firm value due to lower β_0 . In fact, we show in the proof that the bonus s is unaffected by a change of δ because the effects of varying both errors α_0 and β_0 in different directions cancel out. Thus, the effect of δ on firm value arises solely through the strict decline of the probability $\text{prob}(m_H)$ that a bonus is awarded and the owner strictly benefits from more conservatism. This result is in line with Kwon, Newman, and Suh (2001) and Bertomeu, Darrough, and Xue (2016), but in their models there is an interior optimal level of conservatism. A direct consequence of conservatism is that the higher $\text{prob}(y_L)$ increases the probability that the manager engages in earnings management. This implies a positive relationship between conservatism and instances of earnings management. Because the bonus is unchanged, the *ex ante* higher earnings management effort decreases the manager's expected utility in addition to the lower expected compensation. Indeed, this higher expected cost of induced earnings management reduces total welfare TW because the expected compensation washes out of TW. Hence, TW strictly declines in conservatism.

Earnings quality

We also examine earnings quality that results in our optimal contracting setting. Accounting standard setters, such as the IASB and the FASB, focus on decision usefulness rather than on stewardship (IASB 2010, FASB 2010). Earnings quality is more in line with a general decision usefulness objective because it suggests a “neutral” and unbiased view of information useful for decision making. Note, however, that the usefulness of accounting information depends on the specific decision problem and a neutral accounting system need not provide the best information to the decision maker, particularly if one is interested in stewardship uses of accounting. For example, the net cost of an understatement may be significantly different to that of an overstatement.

We define earnings quality EQ as the *ex ante* probability that the financial report m equals the actual output x , which is

$$\text{EQ} = p \text{prob}(m_H | x_H) + (1 - p) \text{prob}(m_L | x_L). \quad (11)$$

Proposition 3: The effect of α_0 , β_0 , and δ on earnings quality EQ is indeterminate and depends on the parameters. Either one of the conditions $p\alpha - (1 - p)(1 - \beta) \leq 0$ and $B = 0$ is sufficient that EQ declines in α_0 and β_0 . EQ increases in δ if $p < 0.5$ and decreases if $p > 0.5$.

The proof in the appendix derives the explicit conditions for an increase and decrease. The reason for the ambiguity in the results is that EQ depends on the expected sum of the α - and β -errors in equilibrium. Obviously, increasing either α_0 or β_0 has a direct negative effect on EQ. But there is also an indirect effect that arises from the necessary increase of the bonus s to preserve incentive compatibility. A larger bonus increases earnings management, i.e., reporting m_H despite y_L occurs. Earnings management increases misreporting and reduces EQ if the accounting signal may be correct, i.e., y_L realizes and x_L is the actual outcome, which occurs with probability $(1 - p)(1 - \beta)$. Conversely, it improves EQ if it corrects a mistake in the accounting signal, i.e., the accounting system reports y_L although x_H is the actual outcome. This case occurs with probability $p\alpha$. If the sign of the difference

$$p\alpha - (1 - p)(1 - \beta) \quad (12)$$

is positive (negative), then higher earnings management has a positive (negative) impact on EQ. The total effect of increasing α_0 or β_0 on EQ depends on relative strength of the direct and indirect effect.

The proposition records two sufficient conditions for a strict decrease of EQ in α_0 and β_0 : One is $p\alpha - (1 - p)(1 - \beta) \leq 0$, and the other is that the solution does not induce earnings management ($B = 0$). The proof also reveals that the effect of α_0 and β_0 need not be in the same direction; i.e., it is possible that EQ increases in one error, but decreases in the other error; this predominantly depends on p .

The effect of an increase of conservatism δ is also ambiguous, but the direction depends only on the probability p that the outcome is x_H , i.e., the project is successful. EQ increases in δ if

$p < 0.5$ and decreases if $p > 0.5$. The reason for this rather simple condition is that a change of δ does not change the optimal bonus and the level of earnings management. Conservatism solely shifts probability mass from the high to the low accounting signal. If p is less than 0.5, the expected increase in the understatement error (affecting EQ unfavorably) is smaller than the expected decrease in the overstatement error (affecting EQ favorably), inducing an increase in earnings quality, and vice versa.

4. Main results

We now turn to the full setting, including internal controls effort by the manager. The key issues are, first, to identify conditions under which the manager has an incentive to improve internal controls and, second, how internal controls effort changes the prior results. The analysis focuses on the more interesting case that the manager engages in earnings management ($B > 0$); we briefly discuss results for $B = 0$ later.

4.1. Optimal contract

Equilibrium internal controls effort

In the previous analysis we show that optimal earnings management is $B = \ln(s/V^m)$ if $B > 0$. This B is structurally unaffected by the introduction of IC effort ε , although the introduction of the IC effort changes the value of the bonus s . The manager's expected utility is

$$E[U^M | a_H, \varepsilon, B] = \text{prob}(m_H | \varepsilon, B)s - V^a - V^\varepsilon \varepsilon - \text{prob}(y_L | \varepsilon)V^m \ln(s/V^m).$$

Proposition 4: The manager improves internal controls ($\varepsilon > 0$) if and only if V^ε is sufficiently small and

$$T \equiv p\alpha_0 - (1-p)\beta_0 > 0. \quad (13)$$

If $\varepsilon > 0$ then it is equal to

$$\varepsilon = \ln \left(\frac{T [1 + \ln(s/V^m)] V^m}{V^\varepsilon} \right).$$

The proposition states two conditions such that $\varepsilon > 0$. The first is that the cost of EM effort is sufficiently small (the proof in the appendix states the explicit condition). The second condition,

$T > 0$, relates to the *ex ante* probability of two errors: $p\alpha_0$ is the expected error that the accounting system understates the output and $(1-p)\beta_0$ is the expected error that the accounting system overstates the output given productive effort a_H . Note that ε reduces both types of errors. If understating is more likely than overstating, then increasing costly IC effort increases the probability that y_H realizes, which is beneficial for the manager because it increases the probability of receiving the bonus s . Conversely, if overstating is more likely than understating, the manager has no incentive to improve the accounting system. Therefore, if $p\alpha_0 > (1-p)\beta_0$, then the advantage outweighs the disadvantage and the manager exerts IC effort $\varepsilon > 0$ if it is not too costly. Note that this condition $T > 0$ implies that $p\alpha > (1-p)\beta$ because ε reduces the original errors by the same percentage.

The proposition states the optimal ε if $\varepsilon > 0$. Holding s constant, ε increases in T and decreases in V^ε . Furthermore, it increases in V^m because a higher cost of earnings management reduces the manager's EM effort, which is partially substituted by an increase in IC effort. That is, from the manager's perspective enhancing internal controls has an effect that is reminiscent of *ex ante* earnings management.

Equilibrium productive effort and compensation

The owner solves for the optimal bonus,

$$\min_s E[\tilde{s}] = \text{prob}(m_H)s \quad (14)$$

subject to the incentive compatibility constraint to induce the manager to choose a_H ,

$$\begin{aligned} E[U^M | a_H] &\geq E[U^M | a_L] \\ &= \text{prob}(m_H | a_L, \varepsilon(a_L), B(a_L))s - V^\varepsilon \varepsilon(a_L) - \text{prob}(y_L | a_L, \varepsilon(a_L))V^m B(a_L). \end{aligned} \quad (15)$$

$B(a_L)$ denotes the earnings management if the manager were to choose a_L out-of-equilibrium.

The observation in the benchmark setting that B is independent of a still holds as B only depends on the realization of y_L , but now the IC effort varies for different a . Therefore, we need to distinguish three cases that imply structurally different incentive compatibility constraints:

Case 1: The manager engages in IC effort and would also engage in IC effort if he chose the out-of-equilibrium productive effort a_L . This is the case if $q\alpha_0 - (1-q)\beta_0 > 0$ (which implies $p\alpha_0 - (1-p)\beta_0 > 0$).

Case 2: The manager engages in IC effort but would not engage in IC effort if he chose the out-of-equilibrium productive effort a_L . The condition for this situation is $q\alpha_0 - (1-q)\beta_0 < 0$ and $p\alpha_0 - (1-p)\beta_0 > 0$.

Case 3: The manager never engages in positive IC effort. The condition $p\alpha_0 - (1-p)\beta_0 < 0$ is sufficient. This case is the benchmark setting in Section 3.

The next result characterizes the optimal contract.

Proposition 5: Assume $B > 0$. The optimal bonus s to induce high productive effort is defined in

$$\ln(s) = \frac{V^a}{(p-q)V^m} + \frac{V^\varepsilon}{(p-q)V^m} \ln\left(\frac{p\alpha_0 - (1-p)\beta_0}{q\alpha_0 - (1-q)\beta_0}\right) - 1 + \ln(V^m) \text{ in case 1,} \quad (16)$$

$$V^m(1 + \ln(s/V^m)) [p - q(1 - \alpha_0 - \beta_0) - \beta_0] - V^\varepsilon \left[1 + \ln\left(\frac{V^m [1 + \ln(s/V^m)] (p\alpha_0 - (1-p)\beta_0)}{V^\varepsilon}\right) \right] - V^a = 0 \text{ in case 2,} \quad (17)$$

$$\ln(s) = \frac{V^a}{(p-q)(1 - \alpha_0 - \beta_0)V^m} - 1 + \ln(V^m) \text{ in case 3.}$$

Our subsequent analysis focuses on case 1 that involves all three activities by the manager. This case provides the most insights into the interactions between the action choices and their joint effects. For completeness, the proofs also contain an explicit analysis of case 2.

4.2. Effects of varying conservatism

Incentives to improve internal controls

We first state the effect of conservatism on the incentives to enhance internal controls.

Proposition 6: If the optimal IC effort $\varepsilon > 0$, then it strictly increases in conservatism δ .

The proposition states that a more conservative accounting system induces a higher IC effort. This result holds regardless of whether or not the manager engages in earnings management.

According to Proposition 4 and explicitly including δ , the optimal $\varepsilon > 0$ with $B > 0$ is defined as

$$\varepsilon = \ln \left(\frac{(p(\alpha_0 + \delta) - (1-p)(\beta_0 - \delta))V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right).$$

A change of δ has two effects: First, higher δ increases the probability difference term,

$$p(\alpha_0 + \delta) - (1-p)(\beta_0 - \delta) = p\alpha_0 - (1-p)\beta_0 + \delta,$$

which has a positive impact on the IC effort; and second, an increase of δ reduces the bonus s , which mitigates the IC effort. The proof establishes that the probability effect outweighs the compensation effect, so that ε unambiguously increases in conservatism.

As a result, conservatism has a strictly positive effect on the manager's incentive to engage in activities to enhance internal controls and to improve the precision of the accounting system.

Firm value and welfare

The next result shows that conservatism always increases the owner's expected utility, but has ambiguous effects on total welfare. The latter effect differs from the benchmark setting, where we show that total welfare strictly decreases in conservatism.

Proposition 7: Assume $B > 0$. Increasing accounting conservatism δ has the following effects:

- (i) Firm value strictly increases.
- (ii) Total welfare can increase or decrease, depending on the parameters.

Part (i) of the proposition states that firm value, which is the owner's expected utility, strictly increases in conservatism δ . Two effects drive this result: First, increasing δ reduces the probability that a bonus is paid,

$$\begin{aligned} \text{prob}(m_H) &= p(1 - (\alpha + \delta)(1 - b_L)) + (1-p)(b_L + (\beta - \delta)(1 - b_L)) \\ &= p(1 - \alpha(1 - b_L)) + (1-p)(b_L + \beta(1 - b_L)) - \delta(1 - b_L) \end{aligned}$$

Second, greater δ strictly lowers the bonus s required to motivate the manager to pick the desirable productive effort. Note that in the benchmark setting, the bonus was independent of δ . Because of its impact on IC effort, the bonus can be reduced in the full setting.

Proposition 7 (ii) states that the impact of conservatism on total welfare TW is ambiguous. Recall that TW is the sum of the owner's and the manager's expected utility, both of which are affected by δ because the manager earns an expected rent. Expected compensation cancels out in the sum of the owner's and the manager's expected utilities because it is a direct wealth transfer between the owner and the manager. The other components include the costs of productive effort, IC effort, and earnings management, where the latter two depend on the degree of conservatism. Since IC effort is strictly positive in the optimal contract, the optimal bonus decreases in δ , which mitigates earnings management. The proof shows that the lower earnings management overcompensates the effect of the larger probability that y_L occurs, implying that expected earnings management and its associated cost declines with more conservatism. However, there is another effect: More conservatism increases the IC effort and the expected cost of this effort. The net effect on welfare is indeterminate and depends on the specific parameters (the proof of the proposition shows the explicit expressions). As in the benchmark setting, the manager's expected utility always declines.

The following corollary that immediately follows from the proposition underscores the importance of internal controls for our results.

Corollary 1: Assume $B > 0$. Strictly positive IC effort is a necessary condition that total welfare increases in conservatism.

Another effect of the IC effort arises if one examines an individual variation of α_0 and β_0 . Proposition 2 states that an increase in either error reduces firm value. Adding IC effort, this result does not hold for α_0 anymore. Consider case 1 in which the manager chooses $\varepsilon > 0$ and $B > 0$, holding s constant. The optimal B is conditional on the realization of $y = y_L$; therefore, the variation of α_0 and β_0 does not directly affect the optimal B . A variation of α_0 and β_0 affects the probability that the manager earns a bonus, $\text{prob}(m_H)$, and this influences his IC effort choice. According to Proposition 4, the optimal IC effort is

$$\underbrace{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)] \exp(-\varepsilon)}_{\equiv L} = V^\varepsilon.$$

Holding s constant, an individual increase in α_0 increases the IC effort because

$$\frac{d\varepsilon}{d\alpha_0} = -\left(\frac{\partial L}{\partial \alpha_0}\right)\left(\frac{\partial L}{\partial \varepsilon}\right)^{-1} = \frac{p}{p\alpha_0 - (1-p)\beta_0} > 0.$$

The greater IC effort ε even overcompensates the loss in base precision through the increase in α_0 .

In fact, given s , we can show that $d\alpha/d\alpha_0 < 0$.

In contrast, an individual increase in β_0 always increases the error because higher β_0 decreases IC effort,

$$\frac{d\varepsilon}{d\beta_0} = -\frac{1-p}{p\alpha_0 - (1-p)\beta_0} < 0.$$

Adding the induced adjustment of the bonus s , there is another indirect effect on the IC and the EM effort. The owner faces a trade-off between these different effects. The next proposition states the results.

Corollary 2: Assume $B > 0$.

- (i) An increase in α_0 decreases firm value if $\alpha_0 < \hat{\alpha}$ and increases it if $\alpha_0 > \hat{\alpha}$.
- (ii) An increase in β_0 always decreases firm value.

An increase in α_0 has positive and negative effects, and the proposition states that if α_0 is sufficiently high the net effect is positive. The threshold value $\hat{\alpha}$ is the α_0 that separates cases 1 and 2 from Proposition 1. The proposition shows that an increase in α_0 is strictly positive in case 1, but strictly negative in case 2. Generally, $\hat{\alpha}$ depends on the parameters of the setting, and there are settings in which $\hat{\alpha}$ is outside of the domain of α_0 , in which increasing α_0 can never have a positive effect on the manager's expected utility.

Contingent on the existing level of α_0 , an increase of precision can have either a positive or a negative effect. Assume $\hat{\alpha} < 0.5$, then starting with the "worst" precision $\alpha_0 = 0.5$, an increase in precision (decrease in α_0) *reduces* the owner's expected utility until the threshold $\hat{\alpha}$ is reached. A further increase in precision for $\alpha_0 < \hat{\alpha}$ raises the owner's expected utility again. Therefore, the owner prefers a boundary solution with either an $\alpha_0 = 0$ or $\alpha_0 = 0.5$.

Corollary 2 also confirms that an increase of β_0 is always harmful. The reason here is that increasing β_0 never increases the manager's IC effort, so the precision of the accounting system always declines. Furthermore, it increases the probability $\text{prob}(m_H)$ that the manager receives a bonus. The probability $\text{prob}(y_L)$ that the manager engages in earnings management declines, which leads to a reduction of the required bonus. While this *per se* is advantageous to the owner, it further reduces internal controls. Consequently, the lower precision of the base accounting system unambiguously requires a higher expected compensation to induce the manager to pick the high productive effort a_H .

Finally, to complete the analysis, we show that the possibility of earnings management is also crucial for the results. Our main results were stated for $B > 0$. $B = 0$ if V^m is sufficiently high, i.e., $V^m > (p - q)(1 - \alpha_0 - \beta_0) / V^a$.

Proposition 8: Assume $B = 0$. Increasing accounting conservatism δ has the following effects, and both effects are strict if $(p\alpha_0 - (1 - p)\beta_0 + \delta) > 0$:

- (i) Firm value increases.
- (ii) Total welfare decreases.

The proposition shows that the effects in Proposition 7 carry over to the case of no earnings management with one exception:⁹ Total welfare always weakly decreases in conservatism, whereas the effect is ambiguous with earnings management. The ambiguity arises from a tradeoff between increasing the probability of paying the bonus and mitigating earnings management. The latter effect is absent if there is no earnings management.

Earnings quality

Earnings quality equals

$$\begin{aligned} \text{EQ} &= p(1 + \alpha(b_L - 1)) + (1 - p)(1 - \beta)(1 - b_L) \\ &= p - \frac{V^m}{s}(p\alpha - (1 - p)(1 - \beta)). \end{aligned}$$

⁹ Another effect of δ is that it shifts the domain of the three different cases to the left, which means there is a broader range of situations in which strictly positive IC effort is provided.

Conservatism δ has a direct effect on the probability term in this equation because

$$p\alpha - (1-p)(1-\beta) = p\alpha_0 - (1-p)(1-\beta_0) + (1-2p)\delta.$$

Indirect effects arise from an adjustment of the IC effort ε and the optimal bonus s . The next result shows that the effect of conservatism on earnings quality is ambiguous, which echoes Proposition 3, but the effect on the IC effort is an additional source for this ambiguity.

Proposition 9: The effect of δ on EQ is indeterminate and depends on the parameters.

In the proof we show that the impact of conservatism on EQ is jointly determined by the following three components:

$$\frac{dEQ}{d\delta} = \underbrace{\frac{V^m}{s}(1-2p)\exp(-\varepsilon)}_{\text{Direct effect } (E_1)} + \underbrace{\frac{V^m}{s^2} \frac{ds}{d\delta} (p\alpha - (1-p)(1-\beta))}_{\text{Indirect effect from EM } (E_2)} + \underbrace{\frac{V^m}{s} (p\alpha + (1-p)\beta) \frac{d\varepsilon}{d\delta}}_{\text{Indirect effect from IC } (E_3)}. \quad (18)$$

The first component, E_1 , results from the direct impact of δ on the accounting errors given the IC effort ε . The crucial variable that determines its sign is whether p is greater or less 0.5. The second component, E_2 , captures the effect caused by the change in earnings management, which materializes through the adjustment of s . The third component, E_3 , results directly from the adjustment of ε . The first component is also present in the benchmark setting, whereas the latter two components are a consequence of the internal controls effort.

We show that

$$E_2 \begin{cases} = 0 & \text{if } \varepsilon = 0; \\ > 0 & \text{if } \varepsilon > 0 \text{ and } p\alpha < (1-p)(1-\beta); \\ < 0 & \text{if } \varepsilon > 0 \text{ and } p\alpha > (1-p)(1-\beta). \end{cases}$$

If there is no earnings management ($B = 0$) or if $\varepsilon = 0$, then E_2 vanishes. If the manager exerts positive IC and EM efforts, the optimal bonus decreases in δ , which reduces earnings management in equilibrium. The sign of E_2 is determined by whether earnings management affects the expected deviation between reported earnings and the true outcome x positively or negatively. If $p\alpha < (1-p)(1-\beta)$ holds, then a decrease in earnings management increases EQ because the bias-induced correction of the α -error is less *ex ante* than the decrease in precision that the bias causes by misrepresenting a correct accounting signal.

Proposition 4 establishes that $p\alpha_0 - (1-p)\beta_0 > 0$ (implying $p\alpha - (1-p)\beta > 0$) is a necessary and sufficient condition to induce IC effort ($\varepsilon > 0$). Note that because $\beta < (1-\beta)$ the sign of $(p\alpha - (1-p)(1-\beta))$ is indeterminate and is not implied by the other condition, but depends on the specific parameter values.

The sign of the third effect in (18), E_3 , is that of the sign of $\frac{d\varepsilon}{d\delta}$. As we record in Proposition 6, $\frac{d\varepsilon}{d\delta} \geq 0$, which is intuitive because the IC effort improves the overall accounting precision through reducing the expected accounting errors, thus enhancing earnings quality EQ. Consequently,

$$E_3 \begin{cases} = 0 & \text{if } \varepsilon = 0; \\ > 0 & \text{if } \varepsilon > 0. \end{cases}$$

Collecting the three terms, the effect of conservatism on earnings quality is ambiguous. Whether more conservatism increases or decreases EQ, depends not only on the sign of the components, but also on their respective strength. However, the next result presents a useful comparative statics result.

Corollary 3: If p is „small,“ then more conservatism increases EQ.

The reason is that if p is „small,“ all three errors are non-negative. Thus, for firms with projects that have a relatively low probability of success, more conservatism is associated with an increase in earnings quality. Presumably, these are highly innovative firms. Put alternatively, p must be sufficiently “large” in order to reverse this result. p is typically large for more traditional industries. Compared to the benchmark setting, the presence of IC efforts provides an additional path by which conservatism positively affects earnings quality.

Recall that firm value strictly increases in accounting conservatism. That suggests that firms, if they can choose the degree of conservatism, would prefer a conservative accounting system and accept a potentially negative effect of this choice on earnings quality. Conversely, if firms believe that earnings quality reduces their cost of capital or has other benefits, they need to trade off these benefits against the contracting value of the accounting system. While p is a significant factor that determines EQ, q is not because it only affects the out-of-equilibrium strategy of low productive

effort and indirectly determines compensation s . Consequently, the marginal productivity of effort, measured by $p - q$, does not have a direct effect on EQ, whereas firm value is affected by it through the incentive compatibility constraint on productive effort.

5. Discussion and conclusions

This paper analyzes the effects of accounting conservatism on management incentives to enhance internal controls and on welfare and earnings quality. We develop an agency model with an owner who hires a manager to provide productive effort through incentive compensation based on accounting earnings. These incentives also induce incentives to engage in earnings management and to enhance internal controls.

First, we establish that the manager has an incentive to enhance internal controls if, and only if, the *ex ante* likelihood of an understatement of actual earnings is higher than that of an overstatement. Although the errors are a result of an imprecise accounting process, the production technology co-determines the prior probabilities of high or low actual earnings. Greater conservatism, i.e., increasing understatement and reducing overstatement of earnings, induces more internal controls effort. The benefit of conservatism arises precisely through its impact on management's incentives to enhance internal controls. Our analysis establishes an interdependence between accounting standards and corporate governance via internal controls. The result suggests that a trend away from conservative towards neutral accounting implicitly works against other regulatory actions that aim at enhancing internal controls in firms.

Second, we examine how conservatism affects economic outcomes because enhancing internal controls need not be efficient *per se*. We show that conservatism increases firm value, so the firm's owner clearly desires more conservatism. In contrast, the manager prefers less conservatism because his expected utility (economic rent) declines. We also consider total welfare as a Pareto efficiency measure, defined as the sum of the owner's and the manager's expected utilities. Total welfare can increase or decrease for greater conservatism depending on the trade-off between (i) an increase of internal controls, which reduces incentive compensation, which again mitigates earnings management, and the change in the cost of the efforts, and (ii) the increase in the probability of paying a bonus.

Besides welfare, we also study earnings quality. Arguably, the objective of accounting standard setters is to increase earnings quality. We show that conservatism has an ambiguous effect on earnings quality because it has a direct effect on the probability of the α - and β -errors and indirect effects on internal controls and on earnings management through the adjustment of the optimal compensation. This ambiguous result is in contrast to the strictly positive effect of conservatism on firm value, but in line with the (although distinct) ambiguous effect on total welfare. Specifically, we show that earnings quality of firms with a low probability of a successful project is more likely to increase with greater conservatism.

Table 1 summarizes the main findings of this paper.

Table 1: Effects of increasing conservatism on various outcomes

	No internal controls effort		Internal controls effort	
	No EM	EM	No EM	EM
Internal controls	–	–	↑ P6	↑ P6
Firm value	↑ P2	↑ P2	↑ P8	↑ P7
Total welfare	↔ P2	↓ P2	↓ P8	↑↓ P7
Earnings quality	↑↓ P3	↑↓ P3	↑↓ P9	↑↓ P9

EM ... Earnings management, P ... Proposition with this result.

– ... not applicable, ↔ ... no effect, ↑ ... increases in conservatism, ↓ ... decreases in conservatism, ↑↓ ... ambiguous effect.

As with any economic model, our results are derived based on a number of assumptions about the economic setting and the accounting system. We briefly discuss key assumptions in the following. Both our production technology and the accounting system are binary. Moving to a continuous production technology could offer direct insights into the adjustments of the managerial effort that the owner finds most desirable. In the binary case, this adjustment is implicit in the three cases we study. A binary accounting system is determined by the probabilities of understatement and overstatement only, and both precision and bias are driven by this specification. We capture conservative accounting through the increase in the probability of

understatement and an equal decrease in the probability of overstatement. We also assume that each of these variations is costless; introducing costs dampens some effects, but may enhance others by virtue of the existence of such exogenous costs.¹⁰ If precision were costlessly achievable, the owner would simply choose error probabilities of zero, which precludes any benefit from enhancing the quality of the accounting system in the first place.

The manager observes the realized accounting signal before engaging in earnings management. An alternative assumption is that the manager biases the probabilities with which the report m_i deviates from y , $i = L, H$, before observing y . Our modeling of the internal controls effort is akin to *ex ante* earnings management. *Ex ante* earnings management could be incorporated in our model by assuming that the effort to improve the accounting system can become negative, thus lowering the precision of the base accounting system. In that case, the cost of IC effort should be such that biasing the accounting system in either direction is costly to the manager. It might also be interesting to consider a setting in which better internal controls make it more difficult for the manager to engage in earnings management.

We also assume that the cost of earnings management is fixed. Some accounting standards and internal controls are explicitly designed to reduce discretion for earnings management. Our analysis can be extended to capture this aspect. Increasing the cost of earnings management would increase firm value, decrease the manager's expected utility, but increase total welfare; earnings quality would increase if expected understatement is high because then earnings management is more likely to correct false understatements than misreporting high earnings.

We assume reported earnings are the only signal used for contracting. Of course, if there is other contractible information available the value of the accounting information can decline, and it may also be more useful to confirm other sources of information. Given one binary contractible signal, a simple bonus contract emerges. Alternatively, consider for example a setting in which the owner requests that the manager reports the accounting signal y directly and uses this report in

¹⁰ Note that the manager's effort to improve the accounting system bears an endogenous private cost that we study in this paper.

addition to the earnings report m for compensating the manager, that is, compensation $s_{ij} \equiv s(\hat{y}_i, m_j)$. In this case, the revelation principle applies and the manager can be deterred from earnings management by paying no bonus if he misreports the actual y_L as \hat{y}_H and earnings management is unsuccessful, so that $m = m_L$.¹¹ While such a contract eliminates earnings management in equilibrium, the opportunity for earnings management still determines the compensation and the expected utilities of the manager and the owner. Therefore, the main insights of the paper continue to hold for such a more sophisticated contract.

Our model captures one period. Conservatism has multi-period effects if one imposes a clean-surplus condition that the sum of the cash flows from a project equals the sum of its earnings, so that an understatement of earnings reverses in future periods. It would be interesting to extend our setting to a multi-period model and explicitly model the inter-period accounting process.

Finally, we consider a two-player agency setting with an owner and a manager. More realistic settings involve several players. For example, fruitful extensions might be to introduce a board of directors or a second manager that is responsible for the effectiveness of internal controls; or an auditor that examines the effectiveness of internal controls in place.

¹¹ Bertomeu et al. (2015) consider a similar extension.

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Appendix: Proofs

Proof of Proposition 1

The manager's expected utility given the choice of productive effort a_H is (assuming $B > 0$ and $\varepsilon = 0$)

$$E[U^M | a_H] = \text{prob}(m_H | B)s - V^a - \text{prob}(y_L)V^m B,$$

where

$$\begin{aligned} \text{prob}(m_H | B) &= 1 - \text{prob}(y_L)(1 - b_L) = 1 - \text{prob}(y_L)\exp(-B) \\ &= 1 - (p\alpha_0 + (1-p)(1-\beta_0))\frac{V^m}{s}. \end{aligned}$$

These probabilities change for $a = a_L$ by substituting q for p .

The manager's expected utility becomes

$$\begin{aligned} E[U^M | a_H] &= \text{prob}(m_H | B)s - V^a - \text{prob}(y_L)V^m B \\ &= s \left(1 - (p\alpha_0 + (1-p)(1-\beta_0))\frac{V^m}{s} \right) - V^a - V^m (p\alpha_0 + (1-p)(1-\beta_0)) \ln(s/V^m) \\ &= s - (p\alpha_0 + (1-p)(1-\beta_0))(1 + \ln(s/V^m))V^m - V^a \end{aligned}$$

and the incentive compatibility constraint becomes

$$\begin{aligned} s - (p\alpha_0 + (1-p)(1-\beta_0))(1 + \ln(s/V^m))V^m - V^a \\ \geq s - (q\alpha_0 + (1-q)(1-\beta_0))(1 + \ln(s/V^m))V^m \\ \left[(q\alpha_0 + (1-q)(1-\beta_0)) - (p\alpha_0 + (1-p)(1-\beta_0)) \right] (1 + \ln(s/V^m))V^m \geq V^a \\ \ln(s) \geq \frac{V^a}{\left[(q\alpha_0 + (1-q)(1-\beta_0)) - (p\alpha_0 + (1-p)(1-\beta_0)) \right] V^m} - 1 + \ln(V^m) \\ = \frac{V^a}{\left[(p-q)(1-\alpha_0 - \beta_0) \right] V^m} - 1 + \ln(V^m). \end{aligned}$$

If $B = 0$ then $\text{prob}(m_H | B) = 1 - \text{prob}(y_L)$, and the incentive compatibility constraint is

$$s(1 - (p\alpha_0 + (1-p)(1-\beta_0))) - V^a \geq s(1 - (q\alpha_0 + (1-q)(1-\beta_0)))$$

resulting in

$$s \geq \frac{V^a}{(p-q)(1-\alpha_0-\beta_0)}.$$

Since the owner minimizes expected compensation, $\text{prob}(m_H)s$, the incentive compatibility constraints determine the minimum s , resulting in the optimal s stated in the proposition. \square

Proof of Proposition 2

(i) Assuming $a = a_H$, firm value is

$$\text{FV} = [(1-p)x_L + px_H] - \text{prob}(m_H)s.$$

Changes in the characteristics of the accounting system only affect the expected compensation

$$\begin{aligned} \text{prob}(m_H)s(m_H) &= [1 - \text{prob}(m_L)]s = [1 - \text{prob}(y_L)(1-b_L)]s \\ &= \left[1 - (p\alpha + (1-p)(1-\beta)) \frac{V^m}{s} \right] s \\ &= s - (p\alpha + (1-p)(1-\beta))V^m \\ &= s - (p\alpha_0 + (1-p)(1-\beta_0) + \delta)V^m. \end{aligned}$$

Consider $B > 0$. Then $\ln(s) = \frac{V^a}{(p-q)(1-\alpha_0-\beta_0)V^m} - 1 + \ln(V^m)$ and we have

$$\frac{1}{s} \frac{ds}{d\alpha_0} = \frac{1}{s} \frac{ds}{d\beta_0} = \frac{V^a}{(p-q)V^m} \frac{1}{(1-\alpha_0-\beta_0)^2},$$

which implies $\frac{ds}{d\alpha_0} = \frac{ds}{d\beta_0} = s \frac{V^a}{(p-q)V^m} \frac{1}{(1-\alpha_0-\beta_0)^2} > 0$.

Differentiating expected compensation with respect to α_0 yields

$$\begin{aligned} \frac{d \text{prob}(m_H|B)s}{d\alpha_0} &= \frac{ds}{d\alpha_0} - V^m p \\ &= s \frac{V^a}{(p-q)V^m} \frac{1}{(1-\alpha_0-\beta_0)^2} - V^m p. \end{aligned}$$

Substituting $V^m = \frac{V^a}{(p-q)(1-\alpha_0-\beta_0)(1+\ln(s/V^m))}$, the derivative becomes

$$\begin{aligned}\frac{d \text{prob}(m_H|B)s}{d\alpha_0} &= s \frac{V^a}{(p-q)V^m} \frac{1}{(1-\alpha_0-\beta_0)^2} - V^m p \\ &= s \frac{(1+\ln(s/V^m))}{(1-\alpha_0-\beta_0)} - V^m p > 0,\end{aligned}$$

where the last inequality follows from

$$s > V^m \Rightarrow 0 < p < 1 + \ln(s/V^m) < \frac{1 + \ln(s/V^m)}{(1-\alpha_0-\beta_0)}.$$

$$\frac{d \text{prob}(m_H|B)s}{d\beta_0} > 0 \text{ follows immediately from } \frac{ds}{d\beta_0} > 0 \text{ and } \frac{d \text{prob}(m_H|B)}{d\beta_0} > 0.$$

To prove $\frac{d \text{prob}(m_H|B)s}{d\delta} < 0$, recall that the expected cost

$$\text{prob}(m_H)s(m_H) = s - (p\alpha_0 + (1-p)(1-\beta_0) + \delta)V^m.$$

$\ln(s)$ does not depend on δ , so $\frac{ds}{d\delta} = 0$. Therefore,

$$\frac{d \text{prob}(m_H|B)s}{d\delta} = \frac{ds}{d\delta} - V^m = -V^m < 0.$$

Now consider $B = 0$. The optimal bonus is

$$s = \bar{V}^m \equiv \frac{V^a}{(p-q)(1-\alpha_0-\beta_0)}$$

which is independent of δ . Therefore, the expected compensation strictly decreases in δ because $\text{prob}(m_H)$ decreases in δ .

(ii) Total welfare is

$$\text{TW} = \begin{cases} E[x] - V^a & \text{if } B = 0, \\ E[x] - V^a - (p\alpha_0 + (1-p)(1-\beta_0) + \delta)V^m \ln\left(\frac{s}{V^m}\right) & \text{if } B > 0. \end{cases}$$

If $B = 0$, TW depends on neither α_0 , β_0 , and δ .

If $B > 0$ then

$$\text{TW} = E[x] - V^a - (p\alpha_0 + (1-p)(1-\beta_0) + \delta)V^m \ln\left(\frac{s}{V^m}\right).$$

Derivation of TW with respect to α_0 yields

$$\frac{dTW}{d\alpha_0} = -pV^m \ln\left(\frac{s}{V^m}\right) - \text{prob}(y_L)V^m \frac{1}{s} \frac{ds}{d\alpha_0} < 0.$$

>0

Derivation of TW with respect to β_0 results in

$$\begin{aligned} \frac{dTW}{d\beta_0} &= (1-p)V^m \ln\left(\frac{s}{V^m}\right) - \text{prob}(y_L)V^m \frac{1}{s} \frac{ds}{d\beta_0} \\ &= (1-p)V^m \ln\left(\frac{s}{V^m}\right) - \text{prob}(y_L)V^m \frac{V^a}{V^m(p-q)(1-\alpha_0-\beta_0)^2} \\ &= (1-p)V^m \ln\left(\frac{s}{V^m}\right) - \text{prob}(y_L) \frac{V^m \left(1 + \ln\left(\frac{s}{V^m}\right)\right)}{(1-\alpha_0-\beta_0)} \\ &= V^m \ln\left(\frac{s}{V^m}\right) \left[(1-p) - \frac{\text{prob}(y_L)}{(1-\alpha_0-\beta_0)} \right] - \frac{\text{prob}(y_L)V^m}{(1-\alpha_0-\beta_0)} \\ &= V^m \ln\left(\frac{s}{V^m}\right) \left[\frac{(1-p)(1-\alpha_0-\beta_0) - (p\alpha_0 + (1-p)(1-\beta_0) + \delta)}{(1-\alpha_0-\beta_0)} \right] - \frac{\text{prob}(y_L)V^m}{(1-\alpha_0-\beta_0)} \\ &= V^m \ln\left(\frac{s}{V^m}\right) \left[\frac{-\alpha_0 - \delta}{(1-\alpha_0-\beta_0)} \right] - \frac{\text{prob}(y_L)V^m}{(1-\alpha_0-\beta_0)} < 0. \end{aligned}$$

Finally, differentiating TW with respect to δ yields $\frac{dTW}{d\delta} = -V^m \ln\left(\frac{s}{V^m}\right) < 0$ because

$$\frac{ds}{d\delta} = 0. \quad \square$$

Proof of Proposition 3

Consider $B > 0$. Using $b_L = 1 - \frac{V^m}{s}$, EQ is

$$\begin{aligned} \text{EQ} &= p(1 + \alpha(b_L - 1)) + (1-p)(1-\beta)(1-b_L) \\ &= p\left(1 - \alpha \frac{V^m}{s}\right) + (1-p)(1-\beta) \frac{V^m}{s} \\ &= p + \frac{V^m}{s}((1-p)(1-\beta) - p\alpha) \\ &= p + \frac{V^m}{s}((1-p)(1-\beta_0) - p\alpha_0 + (1-2p)\delta). \end{aligned}$$

The total derivatives are

$$\begin{aligned}\frac{dEQ}{d\alpha_0} &= \frac{V^m}{s^2} \frac{ds}{d\alpha_0} (p\alpha - (1-p)(1-\beta)) - \frac{V^m}{s} p \\ &\quad >0 \\ \frac{dEQ}{d\beta_0} &= \frac{V^m}{s^2} \frac{ds}{d\beta_0} (p\alpha - (1-p)(1-\beta)) - \frac{V^m}{s} (1-p). \\ &\quad >0\end{aligned}$$

We show in the proof of Proposition 2 that $\frac{ds}{d\alpha_0} = \frac{ds}{d\beta_0} > 0$. The sign of the two derivatives is

indeterminate and depends on the sign of $p\alpha - (1-p)(1-\beta)$ and the relative value of the first and second term.

The total derivative with respect to δ is

$$\frac{dEQ}{d\delta} = \frac{V^m}{s} (1-2p)$$

because $\frac{ds}{d\delta} = 0$. Therefore, the sign of $\frac{dEQ}{d\delta}$ is positive if $p < 0.5$ and negative if $p > 0.5$.

For $B = 0$, EQ is equal to

$$\begin{aligned}EQ &= p(1-\alpha) + (1-p)(1-\beta) \\ &= 1 - p\alpha_0 - (1-p)\beta_0 + (1-2p)\delta,\end{aligned}$$

and $\frac{dEQ}{d\alpha_0} < 0$, $\frac{dEQ}{d\beta_0} < 0$, and $\frac{dEQ}{d\delta} > 0$ if $(1-2p) > 0$ follows immediately. \square

Proof of Proposition 4

$$\begin{aligned}\text{prob}(m_H | \varepsilon, B) &= 1 - \text{prob}(y_L | \varepsilon)(1-b_L) \\ &= 1 - (1-p)\exp(-B) - (p\alpha_0 - (1-p)\beta_0)\exp(-\varepsilon)\exp(-B) \\ &= 1 - (1-p)\frac{V^m}{s} - (p\alpha_0 - (1-p)\beta_0)\exp(-\varepsilon)\frac{V^m}{s}\end{aligned}$$

and $\text{prob}(y_L | \varepsilon) = (1-p) + (p\alpha_0 - (1-p)\beta_0)\exp(-\varepsilon)$.

The manager's expected utility under the optimal B is

$$\begin{aligned}E[U^M | a_H, \varepsilon, B] &= \left(1 - (1-p)\frac{V^m}{s} - (p\alpha_0 - (1-p)\beta_0)\exp(-\varepsilon)\frac{V^m}{s} \right) s - V^a - V^\varepsilon \varepsilon \\ &\quad - \left((1-p) + (p\alpha_0 - (1-p)\beta_0)\exp(-\varepsilon) \right) V^m \ln(s/V^m).\end{aligned}$$

$$\begin{aligned}\frac{\partial}{\partial \varepsilon} E[U^M | a_H, \varepsilon, B] &= (p\alpha_0 - (1-p)\beta_0) \exp(-\varepsilon)V^m + (p\alpha_0 - (1-p)\beta_0) \exp(-\varepsilon)V^m \ln(s/V^m) - V^\varepsilon = 0 \\ & (p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)] \exp(-\varepsilon) = V^\varepsilon.\end{aligned}$$

This expression has a solution with $\varepsilon > 0$ if $p\alpha_0 - (1-p)\beta_0 > 0$ and if

$$(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)] > V^\varepsilon,$$

which is the above expression substituting for $\varepsilon = 0$ because $\exp(-\varepsilon) \leq 1$. Otherwise, $\varepsilon = 0$.

The optimal ε is

$$\begin{aligned}\exp(-\varepsilon) &= \frac{V^\varepsilon}{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]} \\ \varepsilon &= \ln \left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right).\end{aligned}$$

It is easy to see that ε increases in $p\alpha_0 - (1-p)\beta_0$, decreases in V^ε , and it increases in V^m for constant s because for $s > V^m$,

$$\frac{\partial (V^m [1 + \ln(s/V^m)])}{\partial V^m} = [1 + \ln(s/V^m)] - V^m \frac{V^m}{s} \frac{s}{(V^m)^2} = \ln \left(\frac{s}{V^m} \right) > 0. \quad \square$$

Proof of Proposition 5

The incentive compatibility constraint implies that in order to induce the manager to exert effort a_H , the contract must promise an expected utility strictly greater than that for effort a_L . As in the benchmark setting, the expected utility for a_L is always nonnegative because the manager can choose a_L , $\varepsilon = 0$, and $B = 0$, so he bears no effort cost and receives positive expected compensation. Since earnings management is chosen if it is advantageous, the manager's expected utility for a_L is clearly nonnegative and fulfills the participation constraint with reservation utility zero. It follows that if the contract satisfies incentive compatibility, it also satisfies the participation constraint.

Case 1: Using

$$\text{prob}(m_H | \varepsilon, B) = 1 - \frac{(1-p)V^m}{s} - \frac{V^\varepsilon}{s(1 + \ln(s/V^m))}$$

$$\text{prob}(y_L | \varepsilon) = (1-p) + \frac{V^\varepsilon}{V^m [1 + \ln(s/V^m)]},$$

the manager's expected utility is

$$\begin{aligned} E[U^M | a_H] &= \text{prob}(m_H | \varepsilon, B) s - V^a - V^\varepsilon \varepsilon - \text{prob}(y_L | \varepsilon) V^m B \\ &= s - (1-p)V^m - \frac{V^\varepsilon}{1 + \ln(s/V^m)} - V^a - V^\varepsilon \varepsilon - V^m \left((1-p) + \frac{V^\varepsilon}{V^m [1 + \ln(s/V^m)]} \right) \ln(s/V^m) \\ &= s - (1-p)V^m (1 + \ln(s/V^m)) - V^a - V^\varepsilon (1 + \varepsilon) \\ &= s - (1-p)V^m (1 + \ln(s/V^m)) - V^a - V^\varepsilon \left(1 + \ln \left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) \right). \end{aligned}$$

If $q\alpha_0 - (1-q)\beta_0 > 0$ then the manager would choose $\varepsilon > 0$ if he deviates to a_L (out-of-equilibrium strategy). Therefore, $E[U^M | a_L]$ is structurally similar to $E[U^M | a_H]$, replacing q for p ,

$$E[U^M | a_L] = s - (1-q)V^m (1 + \ln(s/V^m)) - V^\varepsilon \left(1 + \ln \left(\frac{(q\alpha_0 - (1-q)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) \right).$$

The incentive compatibility constraint $E[U^M | a_H] \geq E[U^M | a_L]$ is

$$\begin{aligned} &(p-q)V^m (1 + \ln(s/V^m)) - \\ &V^\varepsilon \left[\ln \left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) - \ln \left(\frac{(q\alpha_0 - (1-q)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) \right] \geq V^a \\ &(p-q)V^m (1 + \ln(s/V^m)) - V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0}{q\alpha_0 - (1-q)\beta_0} \right) \geq V^a \end{aligned}$$

and

$$\ln(s) \geq \frac{V^a}{(p-q)V^m} + \frac{V^\varepsilon}{(p-q)V^m} \ln \left(\frac{p\alpha_0 - (1-p)\beta_0}{q\alpha_0 - (1-q)\beta_0} \right) - 1 + \ln(V^m).$$

The owner's program is

$$\min_s \text{prob}(m_H) s = s - (1-p)V^m - \frac{V^\varepsilon}{1 + \ln(s/V^m)}$$

subject to $\ln(s) \geq \frac{V^a}{(p-q)V^m} + \frac{V^\varepsilon}{(p-q)V^m} \ln \left(\frac{p\alpha_0 - (1-p)\beta_0}{q\alpha_0 - (1-q)\beta_0} \right) - 1 + \ln(V^m).$

The objective function increases in s because

$$\frac{\partial}{\partial s} \left(\frac{V^\varepsilon}{1 + \ln(s/V^m)} \right) = - \left(\frac{V^\varepsilon}{(1 + \ln(s/V^m))^2} \right) \frac{1}{s} < 0.$$

Hence, the optimal s is determined by the incentive constraint, assuming that ε and B are interior solutions.

Case 2: If $\varepsilon > 0$ and $q\alpha_0 - (1-q)\beta_0 < 0$ then the out-of-equilibrium IC effort in case the manager chose a_L is $\varepsilon(a_L) = 0$. The incentive compatibility constraint becomes

$$\begin{aligned} E[U^M | a_H] &= s - (1-p)V^m (1 + \ln(s/V^m)) - V^a - V^\varepsilon \left(1 + \ln \left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) \right) \\ &\geq E[U^M | a_L, \varepsilon = 0] = s - (q\alpha_0 + (1-q)(1-\beta_0))(1 + \ln(s/V^m))V^m. \end{aligned}$$

Equating this condition determines the minimal s , which implicitly defines the optimal s ,

$$V^m (1 + \ln(s/V^m)) (p - q + q\alpha_0 - (1-q)\beta_0) - V^\varepsilon \ln \left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) = V^a + V^\varepsilon.$$

Using

$$\begin{aligned} p - q + q\alpha_0 - (1-q)\beta_0 &= p - q + (q + p - p)\alpha_0 - (1-q + p - p)\beta_0 \\ &= (p - q)(1 - \alpha_0 - \beta_0) + p\alpha_0 - (1-p)\beta_0 \end{aligned}$$

and rearranging leads to

$$\begin{aligned} &V^m (1 + \ln(s/V^m)) [(p - q)(1 - \alpha_0 - \beta_0) + p\alpha_0 - (1-p)\beta_0] \\ &\quad - V^\varepsilon \ln \left(\frac{V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) = V^a + V^\varepsilon + V^\varepsilon \ln(p\alpha_0 - (1-p)\beta_0) \end{aligned}$$

or

$$\begin{aligned} M(s) &\equiv V^m (1 + \ln(s/V^m)) [p - q(1 - \alpha_0 - \beta_0) - \beta_0] \\ &\quad - V^\varepsilon \left[1 + \ln \left(\frac{V^m [1 + \ln(s/V^m)] (p\alpha_0 - (1-p)\beta_0)}{V^\varepsilon} \right) \right] - V^a = 0. \end{aligned}$$

There is no explicit solution to this equation for s .

Case 3 has been shown in Proposition 1. □

Proof of Proposition 6

Assume $B > 0$ first.

Case 1: The optimal bonus is defined by

$$V^m \left(1 + \ln(s/V^m)\right) = \frac{V^a}{(p-q)} + \frac{V^\varepsilon}{(p-q)} \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right).$$

Inserting this into the first-order condition for ε ,

$$(p\alpha_0 - (1-p)\beta_0 + \delta)V^m \left[1 + \ln(s/V^m)\right] \exp(-\varepsilon) = V^\varepsilon,$$

yields

$$\begin{aligned} (p\alpha_0 - (1-p)\beta_0 + \delta) \left[\frac{V^a}{(p-q)} + \frac{V^\varepsilon}{(p-q)} \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] \exp(-\varepsilon) &= V^\varepsilon \\ \underbrace{(p\alpha_0 - (1-p)\beta_0 + \delta) \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right]}_{\equiv L} &= \exp(\varepsilon)(p-q)V^\varepsilon. \end{aligned}$$

Then $\text{sign}\left(\frac{d\varepsilon}{d\delta}\right) = \text{sign}\left(\frac{\partial L}{\partial \delta}\right)$. We have

$$\begin{aligned} \frac{\partial L}{\partial \delta} &= \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] \\ &\quad - (p\alpha_0 - (1-p)\beta_0 + \delta)V^\varepsilon \frac{(p-q)(\alpha_0 + \beta_0)}{(p\alpha_0 - (1-p)\beta_0 + \delta)(q\alpha_0 - (1-q)\beta_0 + \delta)} \\ &= \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] - (\alpha_0 + \beta_0) \frac{(p-q)V^\varepsilon}{(q\alpha_0 - (1-q)\beta_0 + \delta)}. \end{aligned}$$

The first-order condition for $\varepsilon(a_L)$ implies

$$\begin{aligned} (q\alpha_0 - (1-q)\beta_0 + \delta) \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] &= \exp(\varepsilon(a_L))(p-q)V^\varepsilon \\ \Rightarrow \frac{(p-q)V^\varepsilon}{(q\alpha_0 - (1-q)\beta_0 + \delta)} &= \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] \exp(-\varepsilon(a_L)). \end{aligned}$$

Inserting this expression into the derivative yields

$$\begin{aligned}\frac{\partial L}{\partial \delta} &= \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] - (\alpha_0 + \beta_0) \frac{(p-q)V^\varepsilon}{(q\alpha_0 - (1-q)\beta_0 + \delta)} \\ &= \left[V^a + V^\varepsilon \ln \left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta} \right) \right] \underbrace{\left[1 - (\alpha_0 + \beta_0) \exp(-\varepsilon(a_L)) \right]}_{>0} > 0.\end{aligned}$$

The inequality follows from $\alpha_0 + \beta_0 \leq 1$ and $\exp(-\varepsilon(a_L)) < 1$ for $\varepsilon(a_L) > 0$, and therefore

$$\frac{d\varepsilon}{d\delta} > 0.$$

Case 2: The first-order condition for ε is the same as in case 1, but there is no explicit expression for ε because the IC constraint yields an implicit equation for s . Consider the first-order condition for ε in the form

$$\underbrace{(p\alpha_0 - (1-p)\beta_0 + \delta)V^m \left[1 + \ln(s/V^m) \right]}_{=L} = \exp(\varepsilon)V^\varepsilon.$$

Differentiating L with respect to δ gives

$$\begin{aligned}\frac{dL}{d\delta} &= V^m \left[1 + \ln(s/V^m) \right] + (p\alpha_0 - (1-p)\beta_0 + \delta) \frac{V^m}{s} \frac{ds}{d\delta} \\ &= V^m \left[1 + \ln(s/V^m) \right] + (p\alpha_0 - (1-p)\beta_0 + \delta) \frac{V^m}{s} \left(- \left(\frac{\partial M(s, \delta)}{\partial \delta} \right) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1} \right).\end{aligned}$$

Using $\frac{\partial M(s, \delta)}{\partial \delta} = V^m \left(1 + \ln(s/V^m) \right) - \frac{V^\varepsilon}{p\alpha_0 - (1-p)\beta_0 + \delta}$, the derivative of L becomes

$$\begin{aligned}\frac{dL}{d\delta} &= V^m \left[1 + \ln(s/V^m) \right] + \frac{V^m}{s} \left(V^\varepsilon - (p\alpha_0 - (1-p)\beta_0 + \delta) V^m \left[1 + \ln(s/V^m) \right] \right) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1} \\ &= V^m \left[1 + \ln(s/V^m) \right] + \frac{V^m}{s} V^\varepsilon (1 - \exp(\varepsilon)) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1}.\end{aligned}$$

Note that

$$\begin{aligned}
\frac{\partial M(s, \delta)}{\partial s} &= \frac{V^m}{s} \left((p-q)(1-\alpha_0-\beta_0) + p\alpha_0 - (1-p)\beta_0 + \delta \right) - \frac{V^\varepsilon}{(1+\ln(s/V^m))} \frac{1}{s} \\
&= \frac{1}{(1+\ln(s/V^m))s} \left(V^m (1+\ln(s/V^m)) \left((p-q)(1-\alpha_0-\beta_0) + p\alpha_0 - (1-p)\beta_0 + \delta \right) - V^\varepsilon \right) \\
&= \frac{1}{(1+\ln(s/V^m))s} \left(V^a + V^\varepsilon \ln \left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1+\ln(s/V^m)]}{V^\varepsilon} \right) \right) \\
&= \frac{1}{(1+\ln(s/V^m))s} (V^a + V^\varepsilon \varepsilon) > 0.
\end{aligned}$$

Inserting this expression into the derivative yields

$$\frac{dL}{d\delta} = \frac{V^m [1+\ln(s/V^m)]}{(V^a + V^\varepsilon \varepsilon)} \left[V^a + V^\varepsilon \varepsilon + V^\varepsilon (1 - \exp(\varepsilon)) \right].$$

The first-order condition for ε implies

$$(p\alpha_0 - (1-p)\beta_0 + \delta)V^m [1+\ln(s/V^m)] = \exp(\varepsilon)V^\varepsilon,$$

and the IC constraint becomes

$$V^m (1+\ln(s/V^m)) \left((p-q)(1-\alpha_0-\beta_0) + p\alpha_0 - (1-p)\beta_0 + \delta \right) - V^\varepsilon = V^a + V^\varepsilon \varepsilon.$$

Inserting in $dL/d\delta$ yields

$$\frac{dL}{d\delta} = \frac{V^m [1+\ln(s/V^m)]}{(V^a + V^\varepsilon \varepsilon)} \left[V^m (1+\ln(s/V^m)) (p-q)(1-\alpha_0-\beta_0) \right] > 0,$$

which implies $\frac{d\varepsilon}{d\delta} > 0$.

Next, we prove the same result for the case of no earnings management ($B = 0$). The manager's expected utility reduces to

$$\begin{aligned}
E[U^M | a_H, \varepsilon] &= \text{prob}(m_H | \varepsilon) s - V^a - V^\varepsilon \varepsilon - \underbrace{\text{prob}(y_L | \varepsilon) V^m B}_{=0} \\
&= \left(p - (p\alpha_0 - (1-p)\beta_0 + \delta) \exp(-\varepsilon) \right) s - V^a - V^\varepsilon \varepsilon.
\end{aligned}$$

The first-order condition for the optimal ε is

$$(p\alpha_0 - (1-p)\beta_0 + \delta) \exp(-\varepsilon) s = V^\varepsilon.$$

Inserting this expression into the manager's utility, we obtain

$$E[U^M | a_H, \varepsilon] = ps - V^a - V^\varepsilon (1 + \varepsilon),$$

so the optimal $\varepsilon = \ln\left(\frac{(p\alpha_0 - (1-p)\beta_0 + \delta)s}{V^\varepsilon}\right)$.

Case 1: $\varepsilon > 0$ for both a_H and a_L : Rewriting

$$E[U^M | a_H, \varepsilon] = ps - V^a - V^\varepsilon (1 + \varepsilon) \geq E[U^M | a_L, \varepsilon(a_L)] = qs - V^\varepsilon (1 + \varepsilon(a_L))$$

yields

$$s = \frac{V^a}{(p-q)} + \frac{V^\varepsilon}{(p-q)} (\varepsilon - \varepsilon(a_L)) = \frac{V^a}{(p-q)} + \frac{V^\varepsilon}{(p-q)} \ln\left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta}\right).$$

Inserting this s into the first-order condition for ε results in

$$(p\alpha_0 - (1-p)\beta_0 + \delta) \left[\frac{V^a}{(p-q)} + \frac{V^\varepsilon}{(p-q)} \ln\left(\frac{p\alpha_0 - (1-p)\beta_0 + \delta}{q\alpha_0 - (1-q)\beta_0 + \delta}\right) \right] \exp(-\varepsilon) = V^\varepsilon,$$

which is the same expression as with positive earnings management. Therefore, $\frac{d\varepsilon}{d\delta} > 0$.

Case 2: $\varepsilon > 0$ for a_H but $\varepsilon = 0$ for a_L . The incentive compatibility constraint is

$$E[U^M | a_H, \varepsilon] = ps - V^a - V^\varepsilon (1 + \varepsilon) \geq E[U^M | a_L] = (q - (q\alpha_0 - (1-q)\beta_0 + \delta))s,$$

which reduces to

$$M(s, \delta) \equiv s[p - q(1 - \alpha_0 - \beta_0) - \beta_0 + \delta] - V^\varepsilon (1 + \varepsilon) - V^a = 0.$$

The first-order condition for ε yields

$$\underbrace{(p\alpha_0 - (1-p)\beta_0 + \delta)}_{=L} s = \exp(\varepsilon) V^\varepsilon.$$

$$\begin{aligned} \frac{dL}{d\delta} &= s + (p\alpha_0 - (1-p)\beta_0 + \delta) \frac{ds}{d\delta} \\ &= s + (p\alpha_0 - (1-p)\beta_0 + \delta) \left(- \left(\frac{\partial M(s, \delta)}{\partial \delta} \right) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1} \right). \end{aligned}$$

Using $\frac{\partial M(s, \delta)}{\partial \delta} = s - \frac{V^\varepsilon}{p\alpha_0 - (1-p)\beta_0 + \delta} > 0$ leads to

$$\frac{dL}{d\delta} = s + (V^\varepsilon - s(p\alpha_0 - (1-p)\beta_0 + \delta)) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1} = s + V^\varepsilon (1 - \exp(\varepsilon)) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1}.$$

Inserting

$$\begin{aligned} \frac{\partial M(s, \delta)}{\partial s} &= [p - q(1 - \alpha_0 - \beta_0) - \beta_0 + \delta] - V^\varepsilon \frac{1}{s} = \frac{1}{s} (V^a + V^\varepsilon (1 + \varepsilon)) - V^\varepsilon \frac{1}{s} \\ &= \frac{1}{s} (V^a + V^\varepsilon \varepsilon). \end{aligned}$$

into the derivative yields

$$\begin{aligned} \frac{dL}{d\delta} &= s + V^\varepsilon (1 - \exp(\varepsilon)) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1} = s + \frac{s}{(V^a + V^\varepsilon \varepsilon)} V^\varepsilon (1 - \exp(\varepsilon)) \\ &= \frac{s}{(V^a + V^\varepsilon \varepsilon)} [V^a + V^\varepsilon (1 + \varepsilon) - V^\varepsilon \exp(\varepsilon)]. \end{aligned}$$

Substituting $M(s, \delta)$ for $V^a + V^\varepsilon (1 + \varepsilon)$ and L for $V^\varepsilon \exp(\varepsilon)$ results in

$$\begin{aligned} \frac{dL}{d\delta} &= \frac{s}{(V^a + V^\varepsilon \varepsilon)} [s(p - q(1 - \alpha_0 - \beta_0) - \beta_0 + \delta) - (p\alpha_0 - (1-p)\beta_0 + \delta)s] \\ &= \frac{s^2}{(V^a + V^\varepsilon \varepsilon)} [(p - q)(1 - \alpha_0 - \beta_0)] > 0, \end{aligned}$$

implying $\frac{d\varepsilon}{d\delta} > 0$. □

Proof of Proposition 7

(i) Case 1: The optimal s is

$$\ln(s) = \frac{V^a}{(p-q)V^m} + \frac{V^\varepsilon}{(p-q)V^m} [\ln(p\alpha_0 - (1-p)\beta_0 + \delta) - \ln(q\alpha_0 - (1-q)\beta_0 + \delta)] - 1 + \ln(V^m).$$

Totally differentiating this expression with respect to δ yields

$$\begin{aligned} \frac{ds}{d\delta} &= s \frac{V^\varepsilon}{(p-q)V^m} \left[\frac{(q-p)(\alpha_0 + \beta_0)}{(p\alpha_0 - (1-p)\beta_0 + \delta)(q\alpha_0 - (1-q)\beta_0 + \delta)} \right] \\ &= -s \frac{V^\varepsilon}{V^m} \left[\frac{(\alpha_0 + \beta_0)}{(p\alpha_0 - (1-p)\beta_0 + \delta)(q\alpha_0 - (1-q)\beta_0 + \delta)} \right] < 0, \end{aligned}$$

which implies that the optimal bonus decreases in greater conservatism δ . The effect on firm value FV is determined by the change of the expected compensation,

$$\text{prob}(m_H)s = s - (1-p)V^m - \frac{V^\varepsilon}{1 + \ln(s/V^m)}.$$

The first-order derivative with respect to δ is

$$\frac{d \text{prob}(m_H)s}{d\delta} = \frac{ds}{d\delta} \underbrace{\left(1 + \frac{V^\varepsilon}{s(1 + \ln(s/V^m))^2} \right)}_{\substack{<0 \\ >1}} < 0.$$

Case 2: The change of s by increasing δ is given by

$$\frac{ds}{d\delta} = - \left(\frac{\partial M(s, \delta)}{\partial \delta} \right) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1},$$

where the incentive compatibility constraint for productive effort $M(s, \delta)$ is

$$\begin{aligned} M(s, \delta) &= V^m (1 + \ln(s/V^m)) ((p-q)(1-\alpha_0 - \beta_0) + p\alpha_0 - (1-p)\beta_0 + \delta) \\ &\quad - V^\varepsilon \ln \left(\frac{(p\alpha_0 - (1-p)\beta_0 + \delta)V^m [1 + \ln(s/V^m)]}{V^\varepsilon} \right) - V^a - V^\varepsilon = 0. \end{aligned}$$

$$\frac{\partial M(s, \delta)}{\partial \delta} = V^m (1 + \ln(s/V^m)) - \frac{V^\varepsilon}{p\alpha_0 - (1-p)\beta_0 + \delta} > 0.$$

The inequality follows from the manager's first order condition for the AQ effort which is

$$(p\alpha_0 - (1-p)\beta_0 + \delta)V^m (1 + \ln(s/V^m)) \exp(-\varepsilon) = V^\varepsilon,$$

noting that $\exp(-\varepsilon) < 1$ for $\varepsilon > 0$. Therefore,

$$\frac{ds}{d\delta} = - \left(\frac{\partial M(s, \delta)}{\partial \delta} \right) \left(\frac{\partial M(s, \delta)}{\partial s} \right)^{-1} < 0$$

because $\frac{\partial M(s, \delta)}{\partial s} > 0$ (see proof of Proposition 6).

Expected compensation is

$$\text{prob}(m_H)s = s - (1-p)V^m - \frac{V^\varepsilon}{1 + \ln(s/V^m)}$$

which decreases in δ since s decreases in δ .

(ii) With positive IC effort, total welfare is

$$\begin{aligned}
\text{TW} &= \text{E}[U^O | a_H] + \text{E}[U^M | a_H] \\
&= \text{E}[x] - \text{prob}(m_H) s + \text{prob}(m_H) s - V^a - V^\varepsilon \varepsilon - V^m \text{prob}(y_L | a_H, \delta, \varepsilon) \ln(s/V^m) \\
&= \text{E}[x] - V^a - V^\varepsilon \varepsilon - V^m \text{prob}(y_L | a_H, \delta, \varepsilon) \ln(s/V^m)
\end{aligned}$$

In cases 1 and 2,

$$\begin{aligned}
\text{prob}(y_L | a_H, \delta, \varepsilon) &= (1-p) + (p\alpha_0 - (1-p)\beta_0 + \delta) \exp(-\varepsilon) \\
&= (1-p) + \frac{V^\varepsilon}{V^m (1 + \ln(s/V^m))},
\end{aligned}$$

which increases in δ because s decreases in δ . Expected earnings management,

$$\text{prob}(y_L | a_H, \delta, \varepsilon) \ln(s/V^m) = (1-p) \ln(s/V^m) + \frac{V^\varepsilon}{V^m} \left[\frac{\ln(s/V^m)}{1 + \ln(s/V^m)} \right],$$

decreases in δ because

$$\begin{aligned}
\frac{d(\text{prob}(y_L | a_H, \delta, \varepsilon) \ln(s/V^m))}{d\delta} &= (1-p) \frac{1}{s} \frac{ds}{d\delta} + \frac{V^\varepsilon}{V^m} \left(\frac{\frac{1}{s} \frac{ds}{d\delta} (1 + \ln(s/V^m)) - \ln(s/V^m) \frac{1}{s} \frac{ds}{d\delta}}{(1 + \ln(s/V^m))^2} \right) \\
&= \frac{1}{s} \frac{ds}{d\delta} \left((1-p) + \frac{1}{(1 + \ln(s/V^m))^2} \right) < 0.
\end{aligned}$$

Thus, the reduction of the bias overcompensates the greater probability of y_L . However, ε strictly increases in δ , which reduces welfare due to larger cost of exerting ε . The net effect of increasing δ on welfare is indeterminate and depends on parameters. \square

Proof of Corollary 2

A variation of α_0 and β_0 has different effects in the three cases in Proposition 5. All else equal, increasing α_0 from 0 moves the setting from case 3 to 2 and 1, whereas increasing β_0 moves the setting from case 1 to 2 and 3.

Case 1: The optimal s is

$$\begin{aligned}\ln(s) &= \frac{V^a}{(p-q)V^m} + \frac{V^\varepsilon}{(p-q)V^m} \ln\left(\frac{p\alpha_0 - (1-p)\beta_0}{q\alpha_0 - (1-q)\beta_0}\right) - 1 + \ln(V^m) \\ &= \frac{V^a}{(p-q)V^m} + \frac{V^\varepsilon}{(p-q)V^m} \left[\ln(p\alpha_0 - (1-p)\beta_0) - \ln(q\alpha_0 - (1-q)\beta_0) \right] - 1 + \ln(V^m).\end{aligned}$$

Totally differentiating this expression with respect to α_0 yields

$$\begin{aligned}\frac{1}{s} \frac{ds}{d\alpha_0} &= \frac{V^\varepsilon}{(p-q)V^m} \left[\frac{p}{p\alpha_0 - (1-p)\beta_0} - \frac{q}{q\alpha_0 - (1-q)\beta_0} \right] \\ &= \frac{V^\varepsilon}{(p-q)V^m} \left[\frac{\beta_0(q-p)}{(p\alpha_0 - (1-p)\beta_0)(q\alpha_0 - (1-q)\beta_0)} \right] < 0\end{aligned}$$

and

$$\frac{ds}{d\alpha_0} = -s \frac{V^\varepsilon}{V^m} \left[\frac{\beta_0}{(p\alpha_0 - (1-p)\beta_0)(q\alpha_0 - (1-q)\beta_0)} \right] < 0.$$

The owner's expected compensation is

$$\text{prob}(m_H)s = s - (1-p)V^m - \frac{V^\varepsilon}{1 + \ln(s/V^m)}.$$

The first derivative with respect to α_0 is

$$\frac{d \text{prob}(m_H)s}{d\alpha_0} = \underbrace{\frac{ds}{d\alpha_0}}_{<0} + \underbrace{\frac{V^\varepsilon}{s(1 + \ln(s/V^m))^2}}_{>0} \underbrace{\frac{ds}{d\alpha_0}}_{<0} < 0.$$

Therefore, the owner's expected utility increases in α_0 .

A similar calculation yields the signs of the change of s for an increase in β_0 ,

$$\frac{ds}{d\beta_0} > 0 \quad \text{and} \quad \frac{d \text{prob}(m_H)s}{d\beta_0} > 0.$$

In case 2 the optimal s is implicitly defined by the incentive compatibility constraint,

$$\begin{aligned}M(s, \alpha_0) &\equiv V^m (1 + \ln(s/V^m)) ((p-q)(1-\alpha_0 - \beta_0) + p\alpha_0 - (1-p)\beta_0) \\ &\quad - V^\varepsilon \ln\left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m [1 + \ln(s/V^m)]}{V^\varepsilon}\right) - V^a - V^\varepsilon = 0.\end{aligned}$$

Let $\bar{\alpha}$ denote the boundary value for α_0 such that $\varepsilon = 0$ is the manager's optimal choice of IC effort, i.e.,

$$(p\bar{\alpha} - (1-p)\beta_0)V^m(1 + \ln(s(\bar{\alpha})/V^m))\exp(0) = V^\varepsilon.$$

The incentive compatibility constraint at $\bar{\alpha}$ becomes $M(s = s(\bar{\alpha}), \bar{\alpha}) = 0$, which is

$$V^m(1 + \ln(s(\bar{\alpha})/V^m))((p-q)(1-\alpha_0-\beta_0)) + V^\varepsilon - V^\varepsilon \ln\left(\frac{V^\varepsilon}{V^\varepsilon}\right) - V^a - V^\varepsilon = 0$$

or

$$V^m(1 + \ln(s(\bar{\alpha})/V^m)) = \frac{V^a}{(p-q)(1-\alpha_0-\beta_0)}.$$

This equation is equivalent to the definition of s in case 3. Hence $s(\bar{\alpha})$ satisfies the incentive compatibility constraint at $\bar{\alpha}$ if $\varepsilon > 0$ for a_H only, implying that $s(\alpha_0)$ is continuous at $\bar{\alpha}$. To determine the sign of

$$\frac{ds}{d\alpha_0} = -\left(\frac{\partial M(s, \alpha_0)}{\partial \alpha_0}\right)\left(\frac{\partial M(s, \alpha_0)}{\partial s}\right)^{-1},$$

recall that using $M(s, \alpha_0) = 0$

$$\frac{\partial M(s, \alpha_0)}{\partial s} = \frac{1}{(1 + \ln(s/V^m))s} \left(V^a + V^\varepsilon \ln\left(\frac{(p\alpha_0 - (1-p)\beta_0)V^m[1 + \ln(s/V^m)]}{V^\varepsilon}\right) \right) > 0.$$

Furthermore,

$$\frac{\partial M(s, \alpha_0)}{\partial \alpha_0} = -qV^m(1 + \ln(s/V^m)) - V^\varepsilon \frac{p}{p\alpha_0 - (1-p)\beta_0} < 0.$$

Therefore, $\frac{ds}{d\alpha_0} > 0$ for $\bar{\alpha} < \alpha < \hat{\alpha}$, where $\hat{\alpha}$ is the threshold α value when case 1 applies.

$\hat{\alpha}$ is implicitly defined by

$$(q\hat{\alpha} - (1-q)\beta_0)V^m[1 + \ln(s(\hat{\alpha})/V^m)] = V^\varepsilon,$$

which is the IC effort choice condition at $\exp(-\varepsilon)|_{\varepsilon=0} = 1$. Because $M(s, \alpha_0)$ only provides an implicit solution for $s(\hat{\alpha})$, the above threshold cannot be solved explicitly.

To complete the proof note that for α_0 in the range of $\bar{\alpha} < \alpha < \hat{\alpha}$, the owner's expected compensation cost is

$$\text{prob}(m_H | a_H) s = s - (1-p)V^m - \frac{V^\varepsilon}{1 + \ln(s/V^m)},$$

which strictly increases in s and therefore in α_0 .

A similar approach provides the results for an increase in β_0 ,

$$\frac{ds}{d\beta_0} > 0 \text{ and } \frac{d \text{prob}(m_H)s}{d\beta_0} > 0. \quad \square$$

Proof of Proposition 8

If there is no earnings management then $B = 0$ and $b_L = 0$. There are the same three cases as with earnings management, depending on the signs of $(p\alpha_0 - (1-p)\beta_0 + \delta)$ and $(q\alpha_0 - (1-q)\beta_0 + \delta)$. The proof is similar to that of Proposition 4 with the only difference that we substitute s for $V^m [1 + \ln(s/V^m)]$.

First, from Proposition 3 we know for $B = 0$ that in cases 1 and 2, $\frac{d\varepsilon}{d\delta} > 0$, and in case 3, $\frac{d\varepsilon}{d\delta} = 0$.

(i) Substituting ε from above, the owner's expected utility is

$$\begin{aligned} E[x] - \text{prob}(m_H | \varepsilon)s &= E[x] - (p - (p\alpha_0 - (1-p)\beta_0 + \delta)\exp(-\varepsilon))s \\ &= E[x] + V^\varepsilon - ps. \end{aligned}$$

This expression strictly decreases in s . We show in Proposition 4 that $\frac{ds}{d\delta} \leq 0$, thus more conservatism increases the owner's expected utility. This effect is strict for cases 1 and 2.

(ii) Total welfare is given by

$$\begin{aligned} E[U^O | a_H] + E[U^M | a_H] &= E[x] - \text{prob}(m_H)s + \text{prob}(m_H)s - V^a - V^\varepsilon \varepsilon \\ &= E[x] - V^a - V^\varepsilon \varepsilon. \end{aligned}$$

From $\frac{d\varepsilon}{d\delta} \geq 0$, welfare decreases in δ . □

Proof of Proposition 9

Using $b_L = 1 - \frac{V^m}{s}$, earnings quality can be written as

$$\begin{aligned}
\text{EQ} &= p(1 + \alpha(b_L - 1)) + (1 - p)(1 - \beta)(1 - b_L) \\
&= p\left(1 - \alpha \frac{V^m}{s}\right) + (1 - p)(1 - \beta) \frac{V^m}{s} \\
&= p + \frac{V^m}{s}((1 - p)(1 - \beta) - p\alpha).
\end{aligned}$$

Note that $\alpha = (\alpha_0 + \delta)\exp(-\varepsilon)$ and $\beta = (\beta_0 - \delta)\exp(-\varepsilon)$. Therefore, the change of EQ by increasing δ is

$$\begin{aligned}
\frac{d\text{EQ}}{d\delta} &= -\frac{V^m}{s^2} \frac{ds}{d\delta} ((1 - p)(1 - \beta) - p\alpha) - \frac{V^m}{s} \left((1 - p) \frac{d\beta}{d\delta} + p \frac{d\alpha}{d\delta} \right) \\
&= -\frac{V^m}{s^2} \frac{ds}{d\delta} ((1 - p)(1 - \beta) - p\alpha) - \frac{V^m}{s} \left((2p - 1)\exp(-\varepsilon) - (p\alpha + (1 - p)\beta) \frac{d\varepsilon}{d\delta} \right) \\
&= \underbrace{\frac{V^m}{s} (1 - 2p)\exp(-\varepsilon)}_{=E_1} + \underbrace{\frac{V^m}{s^2} \frac{ds}{d\delta} (p\alpha - (1 - p)(1 - \beta))}_{=E_2} + \underbrace{\frac{V^m}{s} (p\alpha + (1 - p)\beta) \frac{d\varepsilon}{d\delta}}_{=E_3}.
\end{aligned}$$

The sign of E_1 is independent of δ and depends only on p . If $p < 0.5$ the $E_1 > 0$ and if $p > 0.5$ then $E_1 < 0$.

We show earlier that $\frac{ds}{d\delta} < 0$ for $\varepsilon > 0$, which implies

$$E_2 \begin{cases} = 0 & \text{if } \varepsilon = 0 \\ > 0 & \text{if } \varepsilon > 0 \text{ and } p\alpha < (1 - p)(1 - \beta) \\ < 0 & \text{if } \varepsilon > 0 \text{ and } p\alpha > (1 - p)(1 - \beta). \end{cases}$$

$E_3 > 0$ if $\varepsilon > 0$ because $\frac{d\varepsilon}{d\delta} > 0$. □