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Whistleblowing bounties and informational effects

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A B S T R A C T

We examine the impact of increasing whistleblowing bounties on whistleblowers' strategy and regulatory efficiency in detecting fraud. Our analysis shows the regulator extracts information about the incidence of fraud from whistleblowers' actions, and the quality of such information depends on the size of whistleblowing bounties. With a larger bounty, upon receiving a whistleblowing report, the quality of the regulator's information about fraud deteriorates, whereas upon observing no whistleblowing, the information quality about no fraud improves. Although the informational improvement upon no whistle-blowing has not been widely discussed, we demonstrate it is a key determinant of the optimal whistleblowing program. We show, considering the informational value of whistleblowing and no whistleblowing, the regulator should set the bounty to encourage more whistleblowing when the prior belief of fraud is stronger and the insider is better informed. Our analysis generates policy and empirical implications for designing and studying whistleblowing programs.

1. Introduction

In July 2010, the Securities and Exchange Commission (SEC) whistleblower program went into effect as part of the Dodd-Frank Act. Under the so-called “cash-for-information” program, the SEC is authorized to give monetary rewards (bounty) to whistleblowers who voluntarily provide useful information about corporate misconduct. The former Chairman of the SEC, Jay Clayton, claimed in a public statement that “the whistleblower program has contributed significantly to our ability to detect wrongdoing and better protect investors and the marketplace” (Clayton, 2018). However, recently, the SEC proposed a controversial amendment to restrict whistleblowing bounties. The amendment suggests that the SEC should have the discretion to reduce the award so that it would yield an award “that does not exceed an amount that is reasonably necessary to reward the whistleblower and to incentivize other similarly situated whistleblowers” (SEC, 2018).

The arguments for restricting the whistleblowing bounties are usually centered around the concern that an excessive bounty may attract tremendous frivolous and self-proclaimed whistleblowing, as some whistleblowers, even without reliable or precise information, will still submit a tip to the SEC in the hope of obtaining the bounty. As a consequence, the influx of

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low-quality whistleblowing tips will impair the regulator's efficiency in detecting fraud (Bowen et al., 2010; Dey, Heese, and Pé rez-Cavazos, 2019). On the other hand, the amendment also receives extensive criticisms from practitioners, who believe that the program's success is premised on the possibility of obtaining significant monetary awards. For example, in a comment letter by the National Whistleblower Center, the Center strongly criticizes setting a cap on the bounty and states that lowering the bounty "would disincentivize whistleblowers from coming forward" (National Whistleblower Center, 2018, 2019). While in September 2020, the SEC decided to withdraw this proposed amendment from the final rules for the present, the debate about whether the regulator should increase or restrict whistleblowing bounties is still ongoing. We believe it is important to examine the economic consequences of changing the whistleblowing bounty, as such analyses can inform the policy debate and provide regulatory implications.

In our paper, we examine the impact of increasing the whistleblowing bounty in a stylized model, in which a self-proclaimed good firm seeks investment from investors. The investment return is positive if the firm is truly good but is negative if the firm is fraudulent; i.e., if the firm is bad but misrepresents itself to be good by committing fraud. An insider of the firm observes a private signal indicating whether the firm has committed fraud, and a higher (lower) signal indicates that the firm is less (more) likely to be fraudulent. Upon observing the signal, the insider decides whether to "blow the whistle" (i.e., submit a tip to the regulator) or keep silent. Whistleblowing incurs a cost to the insider due to, for instance, potential retaliation from management, psychological stress, or reputation loss in the labor market, etc. Based on the observation of whistleblowing or no-whistleblowing, the regulator chooses her investigation effort level to maximize investment efficiency. The insider will receive the bounty reward if and only if the insider blows the whistle and the regulator's subsequent investigation detects fraud.

Our analysis shows that in equilibrium, the insider follows a threshold strategy and blows the whistle only when his signal is lower than a threshold (i.e., when his signal indicates a sufficiently high probability of fraud). We further demonstrate that the equilibrium threshold increases with the bounty, and therefore, by choosing an appropriate bounty amount, the regulator can induce the insider to adopt any whistleblowing threshold. Our analysis indicates that, as a larger bounty induces more whistleblowing, the information content of a whistleblowing tip deteriorates, but the information content of no-whistleblowing improves. This follows because the regulator rationally infers that the insider receives a signal above the threshold if there is no whistleblowing; however, she cannot distinguish whether the insider has received a very high signal indicating a very low probability of fraud or a less informative "marginal" signal barely above the threshold. As a larger bounty increases the whistleblowing threshold, the regulator understands that the silence is more likely to indicate that the insider receives a high signal suggesting a low probability of fraud, and thus she is more confident that there is no fraud. Therefore, the regulator's information upon no whistleblowing improves. In a similar vein, the regulator's information upon whistleblowing deteriorates since the regulator understands that such a whistleblowing tip is more likely from a marginal insider who would remain silent had the bounty not increased.

Moreover, we show that the regulator uses the information of whistleblowing and that of no whistleblowing to adjust her investigation decisions, which plays crucial roles in determining the optimal whistleblowing threshold (and thus the optimal bounty). The informational value of whistleblowing lies in that it warns the regulator about the incidence of fraud and prompts the regulator to exert more investigation efforts to detect fraud. Meanwhile, no whistleblowing also has an informational value as it implies a low risk of fraud, allowing the regulator to trim her investigation effort and thus make her detection strategy more cost-effective. In equilibrium, the regulator designs the whistleblowing program to induce a whistleblowing threshold in equilibrium that balances such informational values of whistleblowing and no whistleblowing. To derive additional empirical and policy implications, we analyze the comparative statics regarding both the optimal whistleblowing threshold and optimal bounty. For instance, our analysis shows that, considering the informational values of whistleblowing and no whistleblowing, the regulator should set a high threshold when the prior belief of fraud is strong and when the insider is better informed.

Our study highlights the importance of the informational effect when there is no whistleblowing. It is worth noting that most of the aforementioned debates regarding changing whistleblowing bounties focus exclusively on the informational efficiency when regulators receive whistleblowing tips, while little attention has been paid to the scenario where they do not. We demonstrate that the value of the information gleaned upon no whistleblowing plays a crucial role in affecting regulatory detection efficiency and shaping the optimal design of whistleblowing programs.

2. Related literature

Our paper is related to an emerging, mostly empirical literature on whistleblowing programs. Some early empirical studies focus on various characteristics of whistleblowing programs. For example, Bowen et al. (2010) investigate the characteristics of firms caught by employee whistleblowers, and find that the target firms tend to be the ones with relatively weak internal or external monitoring. Dyck et al. (2010) examine the characteristics of whistleblowers, and they document that the monetary reward is more effective in motivating whistleblowing relative to other incentives such as reputational incentives. More recently, some empirical studies examine the effect of insiders' whistleblowing on target firms' subsequent actions and regulatory enforcement. Call et al. (2018), Berger and Lee (2022), and Heese et al. (2021) document evidence that whistleblowing provides valuable information to regulators in the investigation process, facilitates enforcement actions against target firms, and deters accounting fraud. Wilde (2017) finds that firms subject to whistleblowing allegations exhibit significant decreases in financial misreporting and tax aggressiveness. However, in contrast to the fast-growing empirical research on whistleblowing, to the best of our knowledge, not much theoretical research has been done in this field, and our paper is among the first to analytically examine this issue. Our model delivers a framework to shed light on how regulators extract information from the whistleblowing program and use the information in regulatory enforcement against fraudulent firms.

Our paper also links to the literature on regulatory enforcement. For example, Schantl and Wagenhofer (2020) study firms' financial misreporting in the presence of both public and private enforcement. Nan and Wen (2019) analyze whether imposing a penalty based on an earlier positive signal and a bad realized outcome can be welfare-improving. Dye (2017) examines buyers' strategies when sellers are subject to penalties if they fail to disclose unfavorable information about their products. Our study relates to regulatory enforcement by focusing on the role of a specific yet hotly-debated policy regarding the whistleblowing program in regulatory enforcement efficiency.

Our paper shows that a larger whistleblowing bounty increases the chance of whistleblowing, which makes the whistleblowing report less informative but no-whistleblowing more informative to the regulator. These results share a similar feature with prior studies on accounting conservatism in that more conservative accounting induces more frequent alerts (or, alternatively, fewer good signals), but the alerts become less informative, and consequently, conservatism sometimes can impair efficiency.[1] For example, Kwon et al. (2001) show in a principal-agent setting that, when the principal is limited in penalties that can be imposed on agents, it is optimal for her to implement a conservative accounting system which detects an unfavorable outcome with a higher likelihood. However, when there is no restriction on penalties, conservatism may not be optimal. Nan and Wen (2014) show that a conservative system motivates good firms to improve their information quality, as it reduces the chance of a good signal and thus limits a free-riding benefit for bad firms, and hence increases good firms' marginal benefit from information-quality improvement. Laux and Ray (2020) study the effect of accounting conservatism on investment efficiency and innovation. They show that conservative reporting imposes stricter standards for favorable earnings signals and seems to impede innovations, but once considering endogenous optimal contracting, under some conditions conservative reporting may foster innovations. Kronenberger and Laux (2022) examine the effect of litigation exposure to auditors and corporations on the optimal degree of conservative reporting.

More broadly, our paper contributes to an extensive literature on corporate governance. Most extant studies in this literature focus on boards of directors (e.g., Drymiotes, 2007; Laux and Laux, 2009; Drymiotes and Sivaramakrishnan, 2010; Ramanan, 2014; Baldenius et al., 2019; Meng and Tian, 2020) and auditing (e.g., Deng et al., 2014; Patterson and Smith, 2007; Ewert and Wagenhofer, 2019; Gao and Zhang, 2019), while our study examines an important but under-explored component of corporate governance, whistleblowing programs. Whistleblowing programs share some similarities with auditing, as both aim to uncover financial fraud. However, the key issues under debate for auditing and whistleblowing are very different; accordingly, the main focus and the underlying economic forces modeled also differ. A central issue in auditing is that auditors lack adequate incentives to report financial misstatements, and therefore, the auditing literature mostly concentrates on how to mitigate these type II errors ("undue optimism") via measures such as litigation, legal enforcement, and auditor independence. In contrast, for the debate regarding whistleblowing bounties, the main issue is whether excessive bounties would trigger too much meritless whistleblowing that amplifies type I errors ("false alarms"), and our paper aims to shed some light on this issue.

3. Model setup

We consider whistleblowing in a setting in which a firm seeks an investment, I, from investors. The investment generates a positive cash flow, $X > I$, only if the firm is good; otherwise, if the firm is bad, the investment generates zero cash flow. The firm seeking the investment claims to be a good firm, yet there is a chance that the firm misrepresents itself to be good but is actually bad (that is, the firm commits fraud to misrepresent itself to be a good firm; we refer to it as a "fraud firm" for convenience). The prior belief is that, with probability p, the firm is good, and the chance of a fraud firm is $1-p$. We use $t=G$ to represent a truly good firm and $t=F$ to represent a fraud firm. In addition, for simplicity, we assume $pX > I$; that is, solely based on the prior belief, investors will invest in the firm by default. .[2]

The firm has a representative insider, who can be a potential "whistleblower." We refer to the insider as "he." The insider obtains a private signal, s, indicating whether the firm has committed fraud. Without loss of generality, we assume that the signal s has full support on the unit interval $[0,1]$. The signal s is generated from a distribution with density $\phi(s|t)$ and cumulative distribution $\Phi(s|t)$ conditional on the firm's type $t\in\{G,F\}$. The *ex ante* density of the signal s is then given by

$$\phi(s) = p\phi(s|G) + (1-p)\phi(s|F).$$

[1] It is noteworthy that, despite their connections, there are important differences in the underlying economic forces between our modeling of whistleblowing and accounting conservatism. In most studies on accounting conservatism, the accounting systems are usually exogenously specified; whereas in our study, the whistleblowing threshold is derived endogenously and, in particular, depends on the regulator's choice of whistleblowing bounty, which is optimally set in joint with her enforcement actions. Such an endogenous whistleblowing threshold then enables us to study both the equilibrium properties of insiders' whistleblowing strategies and the regulator's design of whistleblowing programs.

[2] In the baseline model, we assume the probability that the firm is fraudulent is exogenous. We consider an extension in the Online Appendix that endogenizes the firm's decision to commit fraud/manipulation. Our analysis shows that the informational effects of increasing whistleblowing bounties can feed into the firm's choice of manipulation. When increasing the bounty improves (deteriorates) the regulator's information, it translates into more (less) effective detection of fraud, which, in turn, deters (aggravates) the firm's manipulation. Hence, this extension implies that the informational effects of whistleblowing are further reinforced when considering firms' manipulation decisions.

We assume that the densities of the signal satisfy the monotone likelihood ratio property (MLRP), that is, $\phi(s|G)/\phi(s|F)$ is strictly increasing in s. Due to the MLRP, higher (lower) signals indicate that the firm is less (more) likely to be fraudulent. In addition, given the MLRP, the realization of the signal s uniquely determines the likelihood ratio $\phi(s|G)/\phi(s|F)$ and hence is isomorphic to the precision/quality of the insider's information about the firm's type. For instance, the insider's signal is of higher quality if the value of s is more extreme (i.e., closer to either 1 or 0) such that the likelihood ratio is further away from 1.

Upon observing his private signal s, the insider can choose to "blow the whistle," that is, to tip the regulator for potential fraud at the firm. We use r to denote his whistleblowing decision, where $r = 1$ means blowing the whistle and $r = 0$ represents that the insider keeps silent. Importantly, we assume that when the insider blows the whistle, he cannot credibly communicate his private signal s to the regulator. That is, the regulator can only observe the insider's whistleblowing action r but not the quality of his signal. This is to capture in a parsimonious way that, in reality, the quality of insiders' information may vary dramatically and it is difficult for the regulator to discern the quality of their tips.[3] The insider also incurs a private cost $C > 0$ from whistleblowing, which could be interpreted as the potential retaliation from management, psychological stress, or reputation loss in the labor market. If the insider blows the whistle and the regulator's investigation subsequently catches a fraud, the regulator compensates the insider with a whistleblowing bounty, M. In practice, paying a bounty can be costly to the regulator because, for example, the regulator faces pressure to maintain an adequate balance of the investor protection fund. To capture this feature in a parsimonious way, we assume paying bounty results in a cost of δM for the regulator, where the parameter $\delta > 0$ captures the extent to which the regulator cares about the bounty cost. We assume that δ is not too large to rule out the uninteresting case where the bounty cost is so high that the regulator always prefers to close the whistleblowing program.

There is a representative regulator, and we refer to the regulator as "she." The regulator makes her investigation decision based on her prior belief of fraud, $1 - p$, as well as whether there is a whistleblowing report, $r \in \{0, 1\}$. In particular, the regulator exerts an investigation effort $d \in [0, 1]$ at the cost of $\frac{1}{2}kd^2$. The parameter k can be interpreted as the resource constraint faced by the regulator, as a larger k means higher costs of investigation. We assume that k is not too small to avoid the extreme scenario where the regulator can always detect the fraud. With the investigation effort d, if the firm has committed fraud, the regulator can detect it with probability d; while with probability $1 - d$, she fails to detect the fraud. Notice that even if the regulator does not receive a whistleblowing report, she may still exert a positive investigation effort. We assume that the regulator only reveals the detection of fraud to the investors but not the occurrence of whistleblowing events. This assumption is consistent with the practice that "the SEC treats all tips, complaints and referrals as confidential and nonpublic, and does not disclose such information to third parties, except in limited circumstances authorized by statute, rule, or other provisions of law."[4] It is also consistent with empirical evidence that the regulator's enforcement actions, such as the SEC's Accounting and Auditing Enforcement Releases (AAERs), serve as an important source of information for investors about firms' financial misconduct (e.g., Karpoff et al., 2017).

Once the regulator detects fraud and reports it to investors, investors know that the firm is bad and do not provide any capital. Therefore, increasing the investigation effort can prevent investors from wasting resources on a fraudulent firm (recall that investors' default action is to invest). The regulator's goal is to maximize the expected return from the investment conditional on the whistleblowing event $r \in \{0, 1\}$, denoted by $E[V|r]$, where

$$E[V|r] = \Pr(t = G|r)(X - I) - (1 - d)\Pr(t = F|r)I, \tag{1}$$

while at the same time considering the costs of exerting investigation efforts and paying the bounty. Note that assuming the regulator maximizes $E[V|r]$ yields qualitatively similar results to assuming the regulator maximizes the probability of detecting fraud. This assumption is broadly consistent with the mission of the Office of Whistleblowers, which is to "help the Commission identify and stop securities laws violations.".[5]

Specifically, since the regulator's investigation effort decision is contingent on whether there is whistleblowing, we denote the regulator's effort decision upon receiving a whistleblowing report by d_1, and that upon no whistleblowing by d_0. When the insider is silent ($r = 0$), the regulator does not pay the bounty and thus bears only the investigation cost. Otherwise, if the insider blows the whistle ($r = 1$) and the regulator detects fraud, the regulator pays the bounty and incurs both the investigation and the bounty cost. The regulator's objective function, therefore, can be expressed as:

[3] In practice, the SEC may identify low-quality whistleblowing in some cases, as some tips submitted to the SEC are obviously groundless. However, there are many other cases in which the SEC cannot differentiate the quality of the tips; otherwise, we should not even have this debate regarding the SEC's proposal to restrict bounties in order to mitigate frivolous whistleblowing nor the concerns raised by academic studies regarding the influx of low-quality whistleblowing (e.g., Bowen et al., 2010; Dey et al., 2019).

[4] See https://www.sec.gov/complaint/awards-protections.

[5] See, for details, https://www.sec.gov/files/owb-2021-annual-report.pdf. In the Online Appendix, we formally derive that maximizing the *ex ante* investment return is equivalent to maximizing the probability of detecting a fraud firm.

$$\begin{cases} \max_{d_1} E[V|r=1] - \frac{1}{2}kd_1^2 - \delta M \Pr(F|r=1)d_1, & \text{if } r=1; \\ \max_{d_0} E[V|r=0] - \frac{1}{2}kd_0^2, & \text{if } r=0. \end{cases} \tag{2}$$

The insider's expected payoff depends on whether he blows the whistle. If he chooses to keep silent ($r=0$), his expected payoff is zero as he will neither receive the bounty nor incur the cost C. Instead, when the insider chooses to blow the whistle ($r=1$), he receives the bounty M only if the regulator's subsequent investigation does detect a fraud; however, if the regulator does not detect fraud (which could be because there is no fraud, or there is fraud but the regulator's investigation fails), the insider will not receive the bounty. The insider's expected payoff can be expressed as follows:

$$\begin{cases} \Pr(F|s)d_1M - C, & \text{if } r=1; \\ 0, & \text{if } r=0, \end{cases} \tag{3}$$

where $\Pr(F|s)$ denotes the insider's belief that the firm is fraudulent conditional on his signal s. The time line of our model is illustrated in Fig. 1.

4. The equilibrium

To shed light on how the whistleblowing bounty affects the insider's and the regulator's decisions, as well as the optimal bounty that maximizes the regulator's goal, we first analyze the equilibrium decisions of the insider and the regulator, taking the bounty as given.

By backward induction, at date 2, the regulator chooses the investigation effort, d, to maximize her objective function (2). With a higher investigation effort, the regulator is more likely to detect fraud, which helps to prevent inefficient investments. Meanwhile, exerting a higher effort not only leads to a higher investigation cost for the regulator but also increases the expected bounty cost, as the bounty is paid only when the regulator detects fraud with the insider's tip. Therefore, the regulator optimally chooses her investigation effort to balance these costs and benefits, based on her inference of the fraud probability, $\Pr(F|r)$, conditional on whether she receives whistleblowing $r \in \{0,1\}$. To form such an inference, the regulator needs to form a conjecture about the insider's reporting strategy $\hat{r}$, and rational expectations require that such a conjecture must coincide with the insider's equilibrium strategy. We first assume that the regulator conjectures a threshold strategy of the insider, i.e., the insider blows the whistle if and only if he observes a signal s below a threshold s_T. We will verify later that the insider indeed adopts such a threshold strategy in equilibrium. Given the conjecture, the regulator's investigation effort is as follows.

Lemma 1. *Given the insider's whistleblowing threshold s_T, the regulator's investigation decision is*

$$\begin{cases} d_1^*(s_T, M) = \Pr(F|s \le s_T)\frac{I - \delta M}{k}, & \text{if r} = 1; \\ d_0^*(s_T) = \Pr(F|s > s_T)\frac{I}{k}, & \text{if r} = 0. \end{cases} \tag{4}$$

Lemma 1 characterizes the regulator's equilibrium investigation decision as a function of her information (posterior belief) about the fraud probability, taking into account the insider's whistleblowing strategy. Upon receiving a whistleblowing tip, the regulator rationally infers that the insider's signal s lies below the threshold s_T, and upon receiving no tip, she infers that the signal s is above the threshold s_T. The regulator then updates her assessment of the probability of fraud based on her inference of the insider's signal. Obviously, the regulator exerts greater investigation efforts if she believes the firm is more likely to have committed fraud. In addition, Lemma 1 suggests that, upon receiving a whistleblowing tip, the regulator's

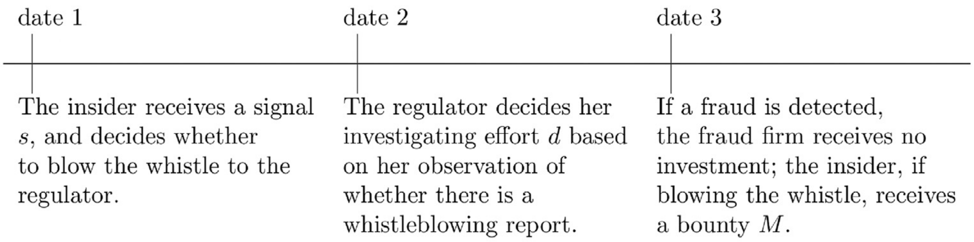

Fig. 1. Timeline.

investigating effort is decreasing in the bounty size M. To see the intuition, recall that the regulator pays the bounty only when she detects fraud based on a whistleblowing tip. A larger M increases the expected bounty cost for the regulator. All else equal, the regulator has an incentive to reduce the investigation effort upon whistleblowing in order to reduce the probability of paying the bounty and thus lower the expected bounty cost.

Back to date 1, the insider's payoff is zero if he remains silent. Nevertheless, if he blows the whistle, the expected payoff is $\Pr(F|s)\widehat{d}_1 M - C$, where $\widehat{d}_1$ is the insider's conjecture of the regulator's investigation effort following a whistleblowing report ($r = 1$). Rational expectations require that the conjectured investigation effort coincides with the regulator's equilibrium effort $d_1^*(s_T, M)$ characterized in Lemma 1. Therefore, conditional on his private signal s, the insider blows the whistle if and only if

$$\Pr(F|s)d_1^*(s_T, M)M - C \geq 0. \tag{5}$$

Note that the insider's payoff from whistleblowing (the LHS of (5)) is strictly decreasing in his private signal s. Intuitively, an insider who receives a higher signal infers that the firm is less likely to be fraudulent, and thus he anticipates a smaller chance that the regulator detects fraud and awards him the bounty if he blows the whistle. This property, in turn, implies that the insider's whistleblowing decision is described by a unique threshold, s_T, such that he blows the whistle if and only if $s \leq s_T$; otherwise, the insider remains silent. This verifies the regulator's conjecture of the insider's equilibrium whistleblowing strategy. We formally characterize the equilibrium of the insider's whistleblowing strategy in the following proposition.

Proposition 1. *There exists a unique threshold s_T such that the insider blows the whistle if and only if $s \leq s_T$, where s_T solves*

$$\Pr(F|s_T)d_1^*(s_T, M)M = C, \tag{6}$$

and is increasing in M. The equilibrium investigation effort $d_1^*(s_T, M)$ is given in Lemma 1.

Proposition 1 characterizes the insider's equilibrium whistleblowing threshold s_T as a function of the bounty M, trading off the benefit of receiving the bounty when the regulator detects fraud against the whistleblowing cost C. Fig. 2 provides a graphical illustration. When the bounty is very small ($M < M_1$), it does not cover the insider's whistleblowing cost, and the insider never blows the whistle in equilibrium, i.e., $s_T = 0$. By contrast, when the bounty is very large such that the whistleblowing cost becomes negligible relative to the bounty ($M > M_2$), it motivates the insider to always blow the whistle even when receiving a high signal, i.e., $s_T = 1$. This result implies that when the bounty size M is of extreme values, the regulator gleans no information from whistleblowing programs as the insider either always blows the whistle or never does. Therefore, in the subsequent analysis, we will focus on the case when the bounty size is in the range of $[M_1, M_2]$..[6]

When the bounty is in the range of $[M_1, M_2]$, the insider's signal s matters for his whistleblowing decision. The insider adopts a threshold strategy and tips the regulator if and only if s is below the threshold s_T, indicating that the probability of fraud is sufficiently high. The equilibrium threshold s_T is determined by the indifference condition (6). That is, at $s = s_T$, the insider is indifferent between blowing the whistle or not, as his expected benefit from receiving the bounty (the LHS of (6)) equals the whistleblowing cost (the RHS of (6)). Analyzing condition (6) shows that a larger bounty always leads to a higher threshold s_T and therefore induces more whistleblowing.

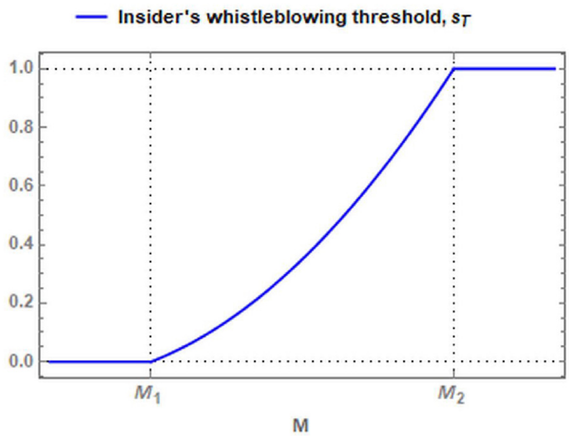

Fig. 2. The relationship between the insider's whistleblowing threshold s_T and bounty M.

[6] M_1 and M_2 are defined in the proof of Proposition 1 in appendix.

While this result is intuitive, examining the LHS of (6) more closely suggests that it arises from a trade-off between a direct effect and two indirect effects of increasing the bounty. The direct effect is that, holding the regulator's investigation effort d_1^* constant, a larger bounty M offers a greater expected benefit of whistleblowing, thereby providing stronger incentives for whistleblowing and leading to a higher threshold s_T. However, there are two indirect effects as the regulator's investigation effort $d_1^*(s_T, M)$ also responds to the adjustments in the bounty size M and the insider's whistleblowing threshold s_T. First, as the bounty increases, the regulator has a stronger incentive to reduce her investigation effort in order to lower the probability of paying the bounty and thus to lower her expected bounty cost. Second, the regulator understands that, as the bounty increases, it attracts whistleblowers with less precise information. Anticipating that the whistleblowing report is less informative about fraud (i.e., a lower $\Pr(F|s \le s_T)$), the regulator rationally cuts back her investigation effort d_1^* as M increases. By rational expectations, the insider also anticipates the regulator's decreased effort and thus infers a smaller chance of receiving the bounty because the regulator is less likely to detect fraud. This, in turn, weakens the insider's incentive for whistleblowing (i.e., s_T gets lower). The overall effect of the bounty on the whistleblowing threshold is ultimately determined by the trade-off between the direct and the indirect effects. We find that, in equilibrium, the direct effect always dominates such that a larger bounty raises the insider's whistleblowing threshold.

Proposition 1 shows that there is a one-to-one mapping between the regulator's choice of bounty, M, and the insider's whistleblowing threshold, s_T. Exploiting this relationship allows the regulator to induce the insider to adopt any whistleblowing threshold $s_T \in [0, 1]$ in equilibrium by offering the appropriate bounty. That is, the optimal whistleblowing threshold s_T^* that the regulator would like to induce can be implemented by choosing the corresponding bounty, M*. The optimal bounty M* corresponding to the optimal threshold s_T^* is derived directly from the equilibrium condition (6), which we summarize in the following corollary.

Corollary 1. *Suppose that the regulator's ex ante objective is maximized when the insider blows the whistle if and only if $s \le s_T^*$. The regulator implements the optimal whistleblowing threshold s_T^* in equilibrium by choosing*

$$M^* = \frac{1}{2\delta}\left[I - \sqrt{I^2 - \frac{4\delta Ck}{\Pr(F|s_T^*)\Pr(F|s \le s_T^*)}}\right]. \tag{7}$$

5. The informational effects of the bounty

The debate about whistleblowing bounties has been centered around whether increasing the bounty can improve the regulator's efficiency in detecting corporate misconduct. On the one hand, some believe that a larger bounty will motivate more whistleblowers to share information with the regulator. On the other hand, critics raise concerns that increasing the bounty will attract meritless allegations and therefore waste the regulator's resources. Notice that our results in Proposition 1 and Corollary 1 echo the conventional arguments on both sides of the debate. We show that increasing the bounty does elicit more whistleblowing tips to the regulator, while at the same time, it also attracts insiders with relatively weak information about the fraud. Nevertheless, in this debate, little attention has been paid to the regulator's information when there is *no* whistleblowing. A key finding in our analysis is that the bounty affects not only the regulator's information upon a whistleblowing report, but also the information she gleans from observing no whistleblowing; as it turns out, the latter effect plays a critical role in determining the whistleblowing bounty's overall effect on regulatory efficiency.

To study the informational effects of the bounty and to determine the optimal bounty, we proceed as follows. We first analyze the effects of the whistleblowing threshold s_T on the information content of whistleblowing and no-whistleblowing, and then derive the regulator's optimal choice of the threshold s_T^* that maximizes her *ex ante* objective. Lastly, we characterize the optimal bounty M^* that implements the optimal threshold s_T^*.

5.1. Information content of whistleblowing and No-whistleblowing

We first examine the effects of shifting the threshold on the information content of a whistleblowing report and that of observing no whistleblowing.

After receiving a whistleblowing report, the regulator updates her belief, and the posterior probability of fraud increases, i.e., $\Pr(F|r = 1) > \Pr(F) = 1 - p$. The information content of the whistleblowing report can be measured by

$$T_1 \equiv \Pr(F|r = 1) = \Pr(F|s \le s_T).$$

As T_1 increases, the regulator is more certain that the firm has committed fraud, suggesting that the whistleblowing report becomes more informative about fraud. Such information improvement upon a whistleblowing report, in turn, prompts the regulator to exert more efforts to detect fraud in order to prevent investments in fraudulent firms (i.e., $d_1^*(s_T, M)$ increases in T_1).

When there is no whistleblowing ($r = 0$), the regulator also updates her belief, and the posterior probability of a good firm increases, i.e., $\Pr(G|r = 0) > \Pr(G) = p$. The information content of no-whistleblowing can be represented by

$$T_0 \equiv \Pr(G|r=0) = \Pr(G|s > s_T).$$

When T_0 increases, the regulator is more certain that the firm did not commit fraud, and observing no whistleblowing thus becomes more informative about no fraud. In response to this information improvement, the regulator reduces her investigation effort to make her detection strategy more cost-effective and thus saves her investigation cost (i.e., $d_0^*(s_T)$ decreases in T_0).

The informational effect of the bounty, therefore, lies in how the bounty affects the information content of whistleblowing (measured by T_1) and that of observing no whistleblowing (measured by T_0). Note that T_1 and T_0 do not depend on the bounty M directly. Rather, the bounty M sways the insider's equilibrium whistleblowing strategy (i.e., the threshold s_T), which, in turn, affects the information content of whistleblowing and no-whistleblowing.

A key message from our analysis is that, when the threshold s_T increases, upon a whistleblowing report, the regulator's information deteriorates; however, upon no whistleblowing, the regulator's information *improves*. We formally state these results in the following proposition.

Proposition 2. *When the insider's whistleblowing threshold s_T increases (induced by a larger bounty M), the information content of whistleblowing deteriorates (i.e., $\frac{\partial T_1}{\partial s_T} \le 0$), while the information content of no whistleblowing improves ($\frac{\partial T_0}{\partial s_T} \ge 0$).*

The scenario in which the regulator receives a whistleblowing report ($r = 1$) is relatively straightforward. Upon a whistleblowing report, the regulator infers that the insider has a signal below the threshold, $s < s_T$, but she cannot distinguish whether the whistleblower has received a signal indicating a very high probability of fraud (i.e., a very low signal s close to 0) or a less informative signal that is just barely below s_T. As the threshold s_T increases, there is an increase in the likelihood of whistleblowing, but such an increase is precisely due to the "marginal" insider (that is, the insider whose signal was just above the previous threshold) switching from silence to whistleblowing. Therefore, as s_T increases, the regulator's information about fraud from the whistleblowing report deteriorates (i.e., $\frac{\partial T_1}{\partial s_T} \le 0$).

The more interesting scenario is when there is no whistleblowing. We find the regulator's information in the absence of whistleblowing improves as the threshold s_T increases. As discussed earlier, when the threshold s_T increases, the marginal insider now chooses to blow the whistle. Therefore, upon no whistleblowing, the regulator understands that the silence is more likely to indicate the insider has observed a high signal, and thus she is more confident that there is no fraud (i.e., $\frac{\partial T_0}{\partial s_T} \ge 0$). In the extreme case when s_T is close to 1 (e.g., when the regulator sets an extremely large bounty), the insider almost always blows the whistle except when he receives an extremely high signal that indicates an extremely low possibility of fraud (e.g., $s \to 1$). Therefore, upon no whistleblowing, the regulator rationally infers that the probability of fraud is extremely low, and the information the regulator gleans from no-whistleblowing reaches its maximum.

Notice that the results in Proposition 2 share similar features with some prior studies on accounting conservatism. For instance, Laux and Ray (2020) and Kronenberger and Laux (2021) model a more conservative accounting system as more stringent requirements to generate a favorable report; i.e., the threshold to recognize "good" news increases. As a result, more conservative accounting increases the information content of a high report but decreases the information content of a low report. In this light, more conservative accounting has similar informational effects as a higher whistleblowing threshold in our setting, to the extent that the decreased information content of the low report (whistleblowing) is accompanied by the increased information content of the high report (no-whistleblowing).

5.2. *The optimal whistleblowing threshold*

We are now ready to determine the *ex ante* optimal whistleblowing threshold. Writing out the regulator's *ex ante* objective (denoted by U) based on (2), we have

$$\begin{aligned} U(s_T, d_1^*, d_0^*) = & \int_{s_T}^{1} \left[\Pr(G|s)(X-I) - (1-d_0^*)\Pr(F|s)I - \frac{k}{2}(d_0^*)^2 \right] \phi(s) ds \\ & + \int_{0}^{s_T} \left[\Pr(G|s)(X-I) - (1-d_1^*)\Pr(F|s)I - \frac{k}{2}(d_1^*)^2 \right] \phi(s) ds - \delta \int_{0}^{s_T} \Pr(F|s) d_1^* M^*(s_T) \phi(s) ds. \end{aligned} \tag{8}$$

The last term represents the *ex ante* expected cost of paying the bounty, where $M^*(s_T)$ is the bounty level that induces the whistleblowing threshold s_T, as defined in equation (7). Taking the derivative of U with respect to the threshold s_T gives

$$\frac{dU(s_T, d_1^*, d_0^*)}{ds_T} = \frac{\partial U}{\partial s_T} + \frac{\partial U}{\partial d_1^*}\frac{\partial d_1^*}{\partial s_T} + \frac{\partial U}{\partial d_0^*}\frac{\partial d_0^*}{\partial s_T} = 0. \tag{9}$$

By the envelope theorem, we obtain $\frac{\partial U}{\partial d_1^*} = \frac{\partial U}{\partial d_0^*} = 0$. Intuitively, since the regulator chooses the investigation effort optimally, a marginal change in the effort at the optimal level will not affect her payoff. Consequently, the first-order condition (9) is reduced into $\frac{\partial U}{\partial s_T} = 0$ as follows[7]

$$\underbrace{\phi(s_T)\Pr(F|s_T)(d_1^* - d_0^*)I}_{\text{preventing inefficient investments}} - \underbrace{\phi(s_T)\left[\frac{1}{2}k(d_1^*)^2 - \frac{1}{2}k(d_0^*)^2\right]}_{\text{increasing investigation costs}} - \underbrace{\frac{\partial}{\partial s_T}\left[\delta\int_0^{s_T}\Pr(F|s)d_1^* M^*(s_T)\phi(s)ds\right]}_{\text{increasing expected costs of paying bounty}} = 0. \quad (10)$$

The first-order condition (10) shows that increasing the whistleblowing threshold s_T affects the regulator's payoff through two channels. First, as the regulator induces more whistleblowing, there will be an additional cost of paying the bounty, which is captured by the negative last term in (10). Second, more whistleblowing affects the information content of whistleblowing and no-whistleblowing, which, in turn, influences the regulator's use of such information in adjusting her investigation effort. This second "information-affecting-decision-making" channel is captured by the first two terms in (10). To illustrate, consider an increase in the threshold s_T so that the marginal insider with $s = s_T$ switches from no whistleblowing to whistleblowing. The switch in the insider's strategy has two effects on the regulator's use of information. On the one hand, when the insider switches to whistleblowing, it prompts the regulator to exert more investigation efforts (i.e., $d_1^* > d_0^*$), which helps to prevent inefficient investments in fraudulent firms and thus increases the regulator's payoff. This effect represents the informational value of the whistleblowing report and is captured by the first term of (10). On the other hand, when the insider switches, it also reduces the frequency of no whistleblowing. Recall that observing no whistleblowing also has an informational value that enables the regulator to lower her investigation effort and make her detection strategy more cost-effective, thus saving her investigation cost. When the insider starts to blow the whistle, the informational value of no whistleblowing disappears, leading to a loss in the regulator's payoff. This effect is captured by the second term of (10).

In sum, the regulator sets the optimal whistleblowing threshold by trading off the informational values of whistleblowing and no whistleblowing, and the additional bounty cost stemming from inducing more whistleblowing. Recall that proposition 2 suggests as the threshold s_T increases, the informational value of whistleblowing decreases but that of no whistleblowing increases. Accordingly, when s_T is sufficiently large, the informational value of whistleblowing decreases to a point that equals the sum of the informational value of no whistleblowing and the additional bounty cost stemming from more whistleblowing, which gives rise to the optimal threshold s_T^*. We characterize s_T^* in the following proposition.

Proposition 3. *There exists a unique optimal whistleblowing threshold* $s_T^* \in (0, 1)$ *that maximizes the regulator's objective, which satisfies equation* (10). *The optimal bounty M* that induces the optimal threshold* s_T^* *is given by equation* (7).

Proposition 3 characterizes the optimal whistleblowing threshold s_T^*. Substituting s_T^* into (7) then yields the optimal bounty M*. Our analysis shows that sometimes increasing the bounty M to a high level is optimal (especially in the region of M < M*), but the reason is different from conventional wisdom. Proponents of larger bounties usually argue that increasing the bounty helps to motivate more whistleblowing and thus improves the regulator's information. However, our result shows that, while it is true that the regulator's information may improve as the bounty increases, the improvement is not necessarily driven by more whistleblowing. Instead, the improvement in the regulator's information happens when she observes no whistleblowing.

5.3. Determinants of optimal whistleblowing threshold and optimal bounty

We next analyze some comparative statics of s_T^* to help us better understand the determinants of the optimal whistleblowing bounty, and to generate additional empirical and policy implications.

5.3.1. Comparative statics of s_T^* with respect to cost parameters

We first examine how the optimal whistleblowing threshold changes with some cost parameters, such as the cost of inefficient investment, investigation cost, bounty cost, and the insider's whistleblowing cost. We present our findings in the following proposition.

Proposition 4. *The optimal interior whistleblowing threshold* s_T^* *is increasing in the cost of inefficient investment, but decreasing in the investigation cost, the cost of bounty payment, and the insider's whistleblowing cost, i.e.,* $\frac{\partial s_T^*}{\partial I} > 0$, $\frac{\partial s_T^*}{\partial k} < 0$, $\frac{\partial s_T^*}{\partial \delta} < 0$, *and* $\frac{\partial s_T^*}{\partial C} < 0$.

Recall that the informational value of whistleblowing lies in that whistleblowing prompts the regulator to exert more investigation efforts to prevent inefficient investments, whereas the informational value of no whistleblowing is that it allows the regulator to trim down her investigation effort and save the investigation cost. Because the optimal threshold balances the two informational values, the regulator prefers more (less) whistleblowing when the informational value of whistleblowing (no whistleblowing) is greater. Intuitively, the informational value of whistleblowing is greater when the

[7] The detailed derivation of $\frac{\partial U}{\partial s_T} = 0$ is provided in the proof of Proposition 3.

cost of inefficient investment is higher (i.e., I increases), and the informational value of no whistleblowing is greater when the regulator's investigation cost is higher (i.e., k increases). This implies that the optimal whistleblowing threshold s_T^* increases in I and decreases in k.

Proposition 4 also points to a second consideration of the regulator in setting the optimal threshold, that is, the cost of paying the bounty. When the bounty cost δ increases, the regulator prefers to lower the whistleblowing threshold to reduce whistleblowing and save the bounty payment cost. In addition, since the regulator needs to compensate the insider for his whistleblowing cost C, a larger cost borne by the insider also causes the regulator to lower the whistleblowing threshold.

5.3.2. *Comparative statics of s_T^* with respect to informational parameters*

Another potentially interesting set of comparative statics is how the optimal whistleblowing threshold changes with the characteristics of the firm's information environment, in particular, the information quality of the insider and the prior probability of fraud. For instance, how should the regulator adjust the whistleblowing threshold if the insider's information improves? Should the regulator encourage more whistleblowing when, *ex ante*, she anticipates a greater likelihood of fraud? Unfortunately, deriving these comparative statics under a general distribution of the signal s is analytically intractable, and thus we hereafter consider a specific distribution of s. We assume that, with probability q, the insider is perfectly informed of whether the firm has committed fraud. However, with probability $1-q$, the insider is only imperfectly informed and receives a noisy signal s. Conditional on the type of the firm $t\in\{G,F\}$, the density functions of the signal s are given by $\phi(s|G)=s+\frac{1}{2}$ and $\phi(s|F)=\frac{3}{2}-s$. Note that the likelihood ratio, denoted by $LR(s)=\frac{\phi(s|G)}{\phi(s|F)}=\frac{s+\frac{1}{2}}{\frac{3}{2}-s}$, is strictly increasing in s, so that the MLRP is satisfied. .[8]

It is straightforward to verify that when the insider is perfectly informed, he blows the whistle if and only if the firm is fraudulent. When the insider is only imperfectly informed, the insider blows the whistle if and only if his signal is below a threshold s_T. Following the analysis in the general setting, we can characterize the optimal whistleblowing threshold s_T^* that maximizes the regulator's *ex ante* utility (2), where s_T^* is similarly determined as in equation (10). Our analysis demonstrates that the optimal whistleblowing threshold s_T^* crucially depends on the prior probability of fraud, $1-p$, and the probability that the insider is fully informed, q.

5.3.2.1. Case of low bounty cost. To illustrate, we first discuss the case in which the bounty cost δ is sufficiently low. We summarize our findings in the following proposition.

Proposition 5. *Assume that the density functions of the imperfectly informed insider's signal are $\phi(s|G)=s+\frac{1}{2}$ and $\phi(s|F)=\frac{3}{2}-s$, and the bounty cost δ is sufficiently low. The optimal whistleblowing threshold s_T^* is increasing in the prior probability of fraud, $1-p$. In addition, s_T^* is increasing in q when $1-p$ is high, but decreasing in q when $1-p$ is low.*

When the bounty cost δ is low, the regulator does not worry much about the bounty cost, and her main consideration is using the information from whistleblowing and no whistleblowing to adjust her investigation decision. Proposition 5 shows that when the prior belief of fraud increases, the regulator sets a higher whistleblowing threshold to motivate more whistleblowing. The intuition for this result lies in the aforementioned trade-off between the informational values of whistleblowing and no whistleblowing. Intuitively, anticipating a higher probability of fraud, the regulator places a greater emphasis on detecting fraudulent firms than saving the investigation cost; accordingly, the informational value of whistleblowing is more likely to dominate the informational value of no whistleblowing, inducing the regulator to set a higher threshold s_T.

In addition, Proposition 5 shows that the probability that the insider is fully informed, q, also plays a role in determining the optimal threshold. The effect of q, however, is subtle and depends on the prior probability of fraud as improving q increases both the informational values of whistleblowing and no whistleblowing. Intuitively, when the regulator knows that the insider is more likely to be perfectly informed (i.e., q is higher), a whistleblowing report becomes a stronger indicator of fraud (i.e., a higher $T_1\equiv \Pr(F|s\le s_T)$), and analogously, receiving no whistleblowing becomes a stronger sign of no fraud (i.e., a higher $T_0\equiv \Pr(G|s>s_T)$). This, in turn, implies that the informational values of whistleblowing and no whistleblowing are both magnified by a higher q. The overall effect of q on the whistleblowing threshold, therefore, depends on the relative magnitudes of the increases in the informational values of whistleblowing and no whistleblowing. When the prior belief of fraud is very strong (i.e., $1-p$ is high), recall that the informational value of whistleblowing is likely to dominate the informational value of no whistleblowing; therefore, a higher q causes a greater increase in the informational value of whistleblowing than in the informational value of no whistleblowing, which calls for a higher optimal threshold s_T^*.

In sum, Proposition 5 implies that, trading off the informational values of whistleblowing and no whistleblowing, the regulator should impose a high whistleblowing threshold s_T^* if the prior belief of fraud is strong and the insider is highly likely

[8] Notice that the insider is perfectly informed with probability q, so that he observes an extremely high (low) signal indicating that the firm is good (fraudulent). In this way, increasing the probability q makes it more likely that the insider observes very informative signals. Hence, the parameter q essentially captures how informed the insider is, and allows us to examine the related comparative statics. Furthermore, to ensure the MLRP, it is sufficient to impose that $\phi(s|G)$ is increasing in s and $\phi(s|F)$ is decreasing in s, i.e., conditional on the firm being good (fraudulent), the insider is more likely to observe a high (low) signal s. For simplicity, we have imposed the linear functional form on $\phi(s|G)$ and $\phi(s|F)$. Note that the values of the intercept terms in $\phi(s|G)$ and $\phi(s|F)$ are set to guarantee that the densities are integrated to 1, i.e., $\int_0^1\phi(s|G)ds=\int_0^1\phi(s|F)ds=1$.

to be fully informed. Conversely, when the prior belief of fraud is very weak (i.e., $1-p$ is low), the informational value of no whistleblowing associated with a higher q dominates, which requires the optimal threshold s_T^* to be lower.

5.3.2.2. Case of high bounty cost. Next, we turn to the case in which the bounty cost δ is high. Now the regulator trades off three forces in setting the optimal whistleblowing threshold: the informational value of whistleblowing and that of no whistleblowing, and the cost of the bounty payment. It turns out that introducing a high bounty cost considerably complicates the analysis, and it becomes intractable to derive closed-form conditions on effects of the prior of fraud, $1-p$, and the probability that the insider is informed, q; accordingly, we resort to numerical analysis..[9]

Fig. 3 provides a numerical illustration of how the optimal whistleblowing threshold s_T^* changes with the prior of fraud $1-p$, in the case of a high bounty cost. First, it shows that when the prior of fraud is weak (i.e., $1-p$ is small), the optimal threshold increases as the prior of fraud increases, which is the same as the low-bounty-cost case in Proposition 5. Intuitively, when the prior probability of fraud is low, the *ex ante* probability of paying whistleblowing bounty is low, and thus the regulator cares primarily about the informational value of whistleblowing instead of the bounty cost, similar to the case when δ is small. Therefore, the regulator increases the whistleblowing threshold s_T^* to encourage more whistleblowing as the prior of fraud increases.

In contrast, when the prior probability of fraud is already very strong (i.e., $1-p$ is large), Fig. 3 shows that the optimal threshold declines as the prior of fraud further increases. The intuition is as follows. With a high probability of fraud, the regulator anticipates a large chance of paying the whistleblowing bounty, suggesting that the expected bounty cost plays a dominating role in the regulator's choice of the whistleblowing threshold, especially when δ is high. In this case, as the prior probability of fraud further increases, the regulator prefers to lower the whistleblowing threshold to cut back the expected bounty cost.

We also resort to numerical analysis to examine how the optimal whistleblowing threshold s_T^* changes with the probability that the insider is informed, q. Panel A of Fig. 4 illustrates a case where the prior of fraud is relatively strong ($1-p$ is large), and it shows that s_T^* increases in q when q is small, but decreases in q when q is large. When the insider is unlikely to be informed (q is small), the probability of detecting fraud based on a whistleblowing report and thus paying the bounty is relatively moderate. Therefore, the regulator focuses mostly on the informational values of whistleblowing and no whistleblowing, and therefore the optimal whistleblowing threshold increases in q, similar to the low-bounty-cost case in Proposition 5. When the insider is very likely to be informed (q is large), a whistleblowing report indicates a substantial probability of fraud and a large chance of paying the bounty. Therefore, the expected bounty cost becomes a major concern. In response, the regulator optimally curbs whistleblowing by lowering the threshold s_T^* as q increases.

Panel B of Fig. 4 illustrates a case in which the prior probability of fraud is small ($1-p$ is small). In this case, since the chance of paying the bounty is small, the regulator is not too concerned about the expected bounty cost, and our numerical analysis shows the optimal whistleblowing threshold s_T^* decreases in q, which is the same as in the low-bounty-cost case in Proposition 5.[10].

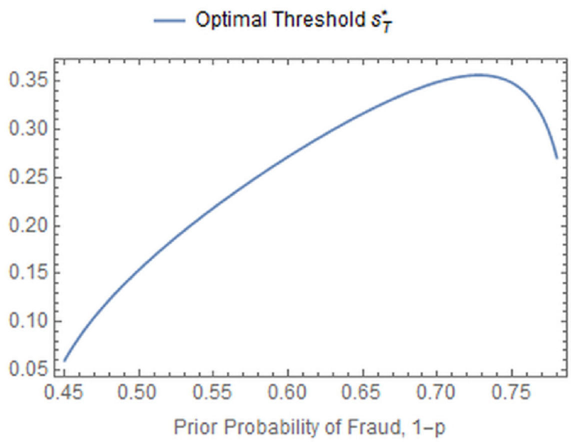

Fig. 3. The effect of the prior probability of fraud $1-p$ on the optimal whistleblowing threshold s_T^*, when δ is large. The following parameters are used: $I=1$, $k=1$, $C=0.1$, $q=0.4$, $\delta=0.2$.

[9] When the bounty cost δ is sufficiently low, the optimal threshold s_T^* is mainly driven by the trade-off between the informational value of whistleblowing and that of no whistleblowing. Proposition 5 characterizes how p and q change the two informational values, which, in turn, determine s_T^*. Nevertheless, when δ is high, s_T^* is determined by three forces as shown in (10)—the two informational values as well as the bounty payment cost. Trading off the three forces complicates the algebra considerably, making the analysis of the comparative statics intractable even in the limiting case (e.g., when p is close to 0).

[10] Panel B only plots the region where q is small because when q is sufficiently large, the optimal whistleblowing threshold decreases to the corner, i.e., $s_T^*=0$.

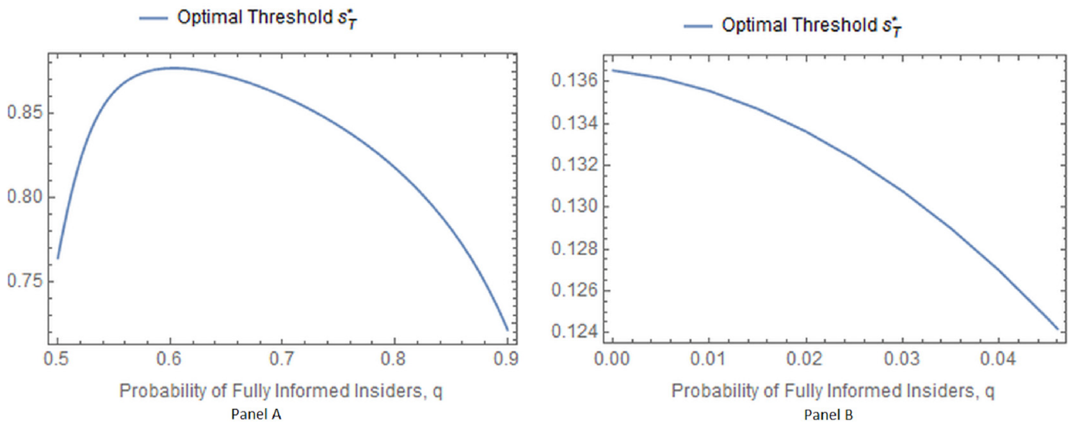

Fig. 4. The effect of the probability of fully informed insiders, q, on the optimal whistleblowing threshold s_T^*, when δ is large. The following parameters are used: $I = 1$, $k = 1$, $C = 0.1$, $\delta = 0.2$, $1 - p = 0.8$ in Panel A, and $1 - p = 0.4$ in Panel B.

5.3.3. Properties of the optimal bounty

Given the optimal whistleblowing threshold, we further examine the property of the optimal bounty. Using equation (7), the optimal bounty M^* can be expressed as a function of the optimal whistleblowing threshold s_T^*. We find that in general, the optimal bounty is non-monotonic in either p or q. To illustrate, consider first the effect of the prior probability of fraud, $1 - p$, on the optimal bounty M^*. Writing out the derivative of the optimal bounty M^* with respect to $1 - p$, we have

$$\frac{dM^*}{d(1-p)} = \underbrace{\frac{\partial M^*}{\partial(1-p)}}_{fraud\ prior\ effect<0} + \underbrace{\frac{\partial M^*}{\partial s_T^*}\frac{\partial s_T^*}{\partial(1-p)}}_{threshold\ effect}. \tag{11}$$

The first term of equation (11) represents a *fraud prior effect*, which is always negative. That is, *holding s_T^* constant,* the regulator reduces the bounty when the prior probability of fraud increases. Intuitively, a higher prior probability of fraud already motivates the insider to blow the whistle more often even if the bounty stays constant. Therefore, to keep the whistleblowing threshold s_T at the optimal level s_T^*, the regulator lowers the bounty to offset the increase in whistleblowing caused by the higher prior of fraud, i.e., $\frac{\partial M^*}{\partial(1-p)}<0$. Moreover, when the prior probability of fraud changes, the optimal whistleblowing threshold s_T^* also changes. Implementing a higher (lower) whistleblowing threshold, in turn, requires the regulator to raise (reduce) the bounty. This *threshold effect* is captured in the second term of equation (11). Recall from our earlier analysis that the effect of $1 - p$ on s_T^* can be ambiguous, and thus the threshold effect is also ambiguous. In sum, the overall effect of the prior probability of fraud on the optimal bounty depends on the trade-off between these potentially countervailing effects, and hence is non-monotonic.

Analogously, increasing the probability of a fully informed insider, q, has two effects on M^*, as illustrated below:

$$\frac{dM^*}{dq} = \underbrace{\frac{\partial M^*}{\partial q}}_{informed\ insider\ effect<0} + \underbrace{\frac{\partial M^*}{\partial s_T^*}\frac{\partial s_T^*}{\partial q}}_{threshold\ effect}. \tag{12}$$

The first term of equation (12) represents a negative *informed insider effect* when increasing q. It indicates that, *holding s_T^* constant,* the regulator should reduce the bounty when the insider is more likely fully informed, because the regulator then assesses a whistleblowing report to be a stronger indicator of fraud and thus exerts more efforts to detect fraud upon whistleblowing. This incentivizes the insider to blow the whistle as the chance of receiving the bounty increases. Therefore, to keep the whistleblowing threshold s_T at the optimal level s_T^*, the regulator should lower the bounty, i.e., $\frac{\partial M^*}{\partial q}<0$. The second term of equation (12) represents a *threshold effect* of increasing q; that is, a change in q also changes the optimal whistleblowing threshold s_T^*. Our earlier analysis shows that this threshold effect can be either positive or negative. Accordingly, the overall effect of increasing q on the optimal bounty depends on the trade-off between these potentially countervailing effects, and hence is non-monotonic.[11]

[11] Although we are unable to show analytically that in general, M^* is non-monotonic in q, we can analytically derive sufficient conditions under which M^* is increasing (decreasing) in q. Specifically, we show that when δ is sufficiently small, M^* is increasing in q when the prior probability of fraud is high but is decreasing in q when the prior probability of fraud is low. Detailed analysis is available upon request.

6. Conclusions and implications

We study the informational effects of changing the whistleblowing bounty to shed light on its economic consequences. We show that when the bounty increases, the information content of a whistleblowing report deteriorates, while the information content of no-whistleblowing improves. Such improvement in the information content of no-whistleblowing has not been on the radar of regulators and researchers, as the debate about whistleblowing bounties usually focuses on the argument that a larger bounty not only motivates more whistleblowing but also attracts meritless whistleblowing. Our study highlights the impact of the whistleblowing bounty on the regulator's information *in the case of no whistleblowing*, which serves as a key consideration in the design of optimal whistleblowing programs. In particular, our analysis characterizes the informational value of whistleblowing that prompts the regulator to exert effort to detect fraud, and the informational value of no whistleblowing that allows the regulator to cut her investigation effort and thus make her detection strategy more cost-effective. The trade-off between the informational values of whistleblowing and no whistleblowing is a key determinant of the optimal whistleblowing threshold that should prevail in equilibrium, which, in turn, provides implications for the optimal design of the whistleblowing program.

Our results may provide policy implications for regulators to design whistleblowing programs. We demonstrate that more whistleblowing can be beneficial when the chance of fraud is large and the insiders are informed; otherwise, it deteriorates the regulator's information and reduces efficiency. These results imply that it may be desirable for the regulator to set different whistleblowing bounties for different industries: in industries where potential fraud is a dominating concern compared with meritless whistleblowing, it may be desirable to strengthen whistleblowing incentives. Prior research suggests that fraud is more likely to occur in firms with poorer corporate governance (Beasley, 1996; Klein, 2002), higher use of stock-based compensation (Burns and Kedia, 2006; Call et al., 2016), and weaker external monitoring (Dechow et al., 2011). Moreover, it is documented that fraud is more likely to occur during economic booms than busts (Wang et al., 2010; Wang and Winton, 2021). Therefore, our results imply that regulators may consider adjusting the whistleblowing bounty to encourage more whistleblowing in firms that are more prone to fraud or during economic booms.

Our paper can also provide implications for empirical research. For example, our results predict that increasing whistleblowing rewards, such as the SEC's Dodd-Frank whistleblower program, reduces the regulator's information quality and investigation effort upon receiving a whistleblowing tip.[12] To test this prediction, researchers may consider using the probability of enforcement actions against firms subject to whistleblowing allegations as a measure of the regulator's effort (e.g., Blackburne et al., 2021; Holzman et al., 2022). In addition, we show that lowering the insider's whistleblowing cost leads to more whistleblowing, consistent with the finding in Heese and Perez-Cavazos (2021). Relatedly, our model also predicts a negative association between the probability of whistleblowing and the regulator's resource constraint, which can be measured by, for instance, the geographic distance between firms' headquarters to the SEC's regional offices (Kedia and Rajgopal, 2011) or the regional offices' case backlog (Bonsall et al., 2021).

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Appendix. Proofs

We first prove the following lemmas that will be used later in the proof. For ease of exposition, we denote the likelihood ratio of s by $LR(s) \equiv \frac{\phi(s|G)}{\phi(s|F)}$.

Lemma 2. *Investors will provide capital if and only if the regulator does not detect fraud.*

Proof of Lemma 2: If the regulator detects fraud (denoted by $\Delta = 1$), investors will not provide capital because the firm is certainly F. If the regulator does not detect fraud (denoted by $\Delta = 0$), there are two possible scenarios: (1) the firm is good, or (2) the firm is fraudulent but the regulator's investigation fails. Investors' posterior belief of the firm being good is thus:

$$\begin{aligned}\Pr(t = G|\Delta = 0) &= \frac{\Pr(t = G)\Pr(\Delta = 0|t = G)}{\Pr(t = G)\Pr(\Delta = 0|t = G) + \Pr(t = F)\Pr(\Delta = 0|t = F)} \\ &= \frac{p}{p + (1-p)\Pr(\Delta = 0|t = F)} \geq p,\end{aligned}$$

where the second line is due to $\Pr(\Delta = 0|t = G) = 1$. Therefore, the expected return of investing is $\Pr(t = G|\Delta = 0)X - I \geq pX - I > 0$, and investors will provide capital. □

[12] For example, to examine the deterrence effect of providing whistleblowing rewards, Berger and Lee (2022) contrast firms that were subject to the Dodd–Frank whistleblower provision (referred to as treated firms) with firms that were less affected by the provision (referred to as control firms). Therefore, this setting provides a potential venue to test our predictions.

Lemma 3. *Given the observation of whistleblowing $r = 1$ or no whistleblowing $r = 0$, if the regulator exerts effort d, the expected investment return is*

$$E[V|r] = \Pr(t = G|r)(X - I) - (1 - d)\Pr(t = F|r)I. \tag{13}$$

Proof of Lemma 3: By Lemma 2, $E[V|r]$ can be expressed as

$$\Pr(t = G|r)(X - I) + \Pr(t = F, \Delta = 0|r)(-I) + \Pr(t = F, \Delta = 1|r)\cdot 0. \tag{14}$$

Specifically, if the regulator detects fraud ($\Delta = 1$), the investment return is zero. If the regulator does not detect fraud, the return is $X - I$ for the good firm but $-I$ for the fraud firm. Given the effort d, the probability of the regulator missing a fraudulent firm is $\Pr(t = F, \Delta = 0|r) = (1 - d)\Pr(t = F|r)$. Substituting the above equation into (14) yields (13).

Lemma 4. *For any density functions $\phi(s|G)$ and $\phi(s|F)$ that satisfy the MLRP, the following properties hold:*

- $H(s_T) \equiv \frac{\Phi(s_T|G)}{\Phi(s_T|F)}$ *is strictly increasing in s_T.*
- $L(s_T) \equiv \frac{1-\Phi(s_T|G)}{1-\Phi(s_T|F)}$ *is strictly increasing in s_T.*

Proof of Lemma 4: Rewrite $H(s_T) = \frac{\int_0^{s_T}\phi(s|G)ds}{\int_0^{s_T}\phi(s|F)ds}$, and it is easy to show that

$$\frac{\partial H(s_T)}{\partial s_T} \propto \phi(s_T|G)\int_0^{s_T}\phi(s|F)ds - \phi(s_T|F)\int_0^{s_T}\phi(s|G)ds. \tag{15}$$

By the MLRP, $LR(s) = \frac{\phi(s|G)}{\phi(s|F)}$ is increasing in s. Therefore, for any $s \in [0, s_T)$, it must hold that $\frac{\phi(s|G)}{\phi(s|F)} < \frac{\phi(s_T|G)}{\phi(s_T|F)}$, i.e., $\phi(s_T|G)\phi(s|F) > \phi(s|G)\phi(s_T|F)$. Integrating the LHS and RHS over $s \in [0, s_T]$ yields

$$\int_0^{s_T}\phi(s_T|G)\phi(s|F)ds > \int_0^{s_T}\phi(s|G)\phi(s_T|F)ds \Rightarrow \frac{\partial H(s_T)}{\partial s_T} > 0.$$

Similarly, rewrite $L(s_T) = \frac{\int_{s_T}^1\phi(s|G)ds}{\int_{s_T}^1\phi(s|F)ds}$, and we have

$$\frac{\partial L(s_T)}{\partial s_T} \propto -\phi(s_T|G)\int_{s_T}^1\phi(s|F)ds + \phi(s_T|F)\int_{s_T}^1\phi(s|G)ds. \tag{16}$$

By the MLRP, for any $s \in (s_T, 1]$, it must hold that $\frac{\phi(s|G)}{\phi(s|F)} > \frac{\phi(s_T|G)}{\phi(s_T|F)}$, i.e., $\phi(s|G)\phi(s_T|F) > \phi(s_T|G)\phi(s|F)$. Integrating the LHS and RHS over $s \in [s_T, 1]$ yields

$$\int_{s_T}^1\phi(s|G)\phi(s_T|F)ds > \int_{s_T}^1\phi(s_T|G)\phi(s|F)ds \Rightarrow \frac{\partial L(s_T)}{\partial s_T} > 0.$$

Proof of Lemma 1 and Proposition 1: The proof proceeds as follows. In step 1, we show that the insider follows a threshold strategy. In step 2, we derive the regulator's decision rule (i.e., Lemma 1). In step 3, we solve the equilibrium threshold s_T using rational expectations. In step 4, we show that s_T is increasing in M. As will be shown in the proof of Proposition 3, the regulator never chooses $M > \frac{I}{2\delta}$; hence, we only consider the region of $M \in \left[0, \frac{I}{2\delta}\right]$ in the proof. We denote the insider's belief in the regulator's effort by $\widehat{d}_1$ and denote the regulator's belief in the insider's strategy by $\widehat{s}_T$.

Step 1) Given the signal s, the insider's expected payoff of blowing the whistle is $\Pr(F|s)\widehat{d}_1 M - C$. Because $\widehat{d}_1$ does not depend on s and $\Pr(F|s)$ is decreasing in s, the expected payoff is decreasing in s. Hence, the insider blows the whistle if and only if $\Pr(F|s)\widehat{d}_1 M - C \geq 0$, i.e., $s \leq s_T$.

Step 2) Taking the first-order condition in (2) leads to the following decision rules:

$$d_1^* = \Pr(F|r=1)\frac{I-\delta M}{k} = \Pr(F|s \le \widehat{s}_T)\frac{I-\delta M}{k} = \Pr(F|s \le s_T)\frac{I-\delta M}{k};$$
$$d_0^* = \Pr(F|r=0)\frac{I}{k} = \Pr(F|s > \widehat{s}_T)\frac{I}{k} = \Pr(F|s > s_T)\frac{I}{k},$$

where the last equality uses the rational expectations condition, i.e., $\widehat{s}_T = s_T$.

Step 3) To solve the equilibrium, we discuss the following three cases.

Case 1: The insider never blows the whistle, i.e., $s_T = 0$. Because $r = 1$ is off the equilibrium path, we consider the most reasonable off-equilibrium belief; that is, the regulator believes any whistleblowing tip comes from the insider who observes $s = 0$. In this case, the regulator's optimal effort is $d_1 = \Pr(F|s=0)\frac{I-\delta M}{k}$. Notice that

$$\Pr(F|s=0) = \frac{(1-p)\phi(s=0|F)}{(1-p)\phi(s=0|F) + p\phi(s=0|G)} = \frac{1-p}{1-p+pLR(0)}.$$

By rational expectations, the equilibrium is sustained if and only if $\Pr(F|s=0)d_1 M - C < 0$, i.e.,

$$\left[\frac{1-p}{1-p+pLR(0)}\right]^2 \frac{I-\delta M}{k} M - C < 0 \Leftrightarrow M < M_1 \equiv \frac{1}{2\delta}\left[I - \sqrt{I^2 - 4\delta kC\left[\frac{1-p+pLR(0)}{1-p}\right]^2}\right],$$

which is because $(I-\delta M)M$ strictly increases in $M \in [0, \frac{I}{2\delta}]$.

Case 2: The insider always blows the whistle, i.e., $s_T = 1$. In this case, the regulator's posterior belief remains at the prior, i.e., $\Pr(F|r=1) = 1-p$, and thus $d_1 = (1-p)\frac{I-\delta M}{k}$. Notice that

$$\Pr(F|s=1) = \frac{(1-p)\phi(s=1|F)}{(1-p)\phi(s=1|F) + p\phi(s=1|G)} = \frac{1-p}{1-p+pLR(1)}.$$

By rational expectations, the equilibrium is sustained if and only if $\Pr(F|s=1)d_1 M - C \ge 0$, which can be reduced to

$$\frac{(1-p)^2}{1-p+pLR(1)} \frac{I-\delta M}{k} M - C \ge 0 \Leftrightarrow M \ge M_2 \equiv \frac{1}{2\delta}\left[I - \sqrt{I^2 - 4\delta kC\frac{1-p+pLR(1)}{(1-p)^2}}\right].$$

Case 3: The insider blows the whistle if and only if $s \le s_T$, where $\widehat{s}_T \in (0,1)$. In this case, the regulator's effort is $d_1 = \Pr(F|s \le \widehat{s}_T)\frac{I-\delta M}{k}$, and the insider who observes $s = s_T$ is indifferent, i.e., $\Pr(F|s_T)\widehat{d}_1 M - C = 0$. By rational expectations, the indifference condition becomes

$$\Pr(F|s_T)\Pr(F|s \le s_T)\frac{(I-\delta M)}{k}M - C = 0. \tag{17}$$

We next show equation (17) has a unique solution in $M \in (M_1, M_2)$. To show the existence, notice that when $s_T \to 0$, we have

$$\Pr(F|s_T=0)\Pr(F|s \le 0)\frac{(I-\delta M)}{k}M - C = \left[\frac{1-p}{1-p+pLR(0)}\right]^2 \frac{(I-\delta M)}{k}M - C > 0,$$

which is because of $M > M_1$. When $s_T \to 1$, we have

$$\Pr(F|s_T=1)\Pr(F|s \le 1)\frac{(I-\delta M)}{k}M - C = \frac{(1-p)^2}{1-p+pLR(1)}\frac{(I-\delta M)}{k}M - C < 0,$$

which is because of $M < M_2$. By the intermediate value theorem, equation (17) has at least one solution $s_T \in (0,1)$. To show the uniqueness, by the MLRP, $\Pr(F|s_T)$ is positive and decreasing in s_T. Meanwhile, it is easy to see that

$$\Pr(F|s \le s_T) = \frac{(1-p)\Pr(s \le s_T|F)}{(1-p)\Pr(s \le s_T|F) + p\Pr(s \le s_T|G)} = \frac{1-p}{1-p+pH(s_T)},$$

which is positive and decreasing in s_T because $H(s_T)$ is increasing in s_T. Therefore, the LHS of (17) is decreasing in s_T, suggesting equation (17) has a unique solution. Taken together, if $M \in (M_1, M_2)$, there exists a unique interior threshold s_T such that the insider blows the whistle if $s \le s_T$.

Step 4) We lastly examine how s_T changes with M. The comparative statics are trivial when $M < M_1 (M > M_2)$, as the insider never (always) blows the whistle. When $M \in [M_1, M_2]$, s_T is the unique solution to the following equation

$$\underbrace{\Pr(F|x)\Pr(F|s \le x)\frac{(I-\delta M)}{k}M - C}_{\text{denote by } W_1(x)} = 0.$$

The implicit function theorem implies $\frac{\partial s_T}{\partial M} = -\left[\frac{\partial W_1(x)}{\partial M} / \frac{\partial W_1(x)}{\partial x}\right]|_{x=s_T}$. By the analysis in step 3, $\Pr(F|x)\Pr(F|s \le x)$ is decreasing in x, and thus $\frac{\partial W_1(x)}{\partial x} < 0$. Meanwhile, because $(I - \delta M)M$ is strictly increasing in $M \in [0, \frac{I}{2\delta}]$, it must hold that $\frac{\partial W_1(x)}{\partial M} > 0$. Therefore, we have shown that $\frac{\partial s_T}{\partial M} > 0$.

Proof of Corollary 1: By the proof of Proposition 1, there is a one-to-one mapping between M and s_T, as shown in equation (17). Therefore, if there is an optimal whistleblowing threshold s_T^*, the optimal bounty M^* that induces s_T^* should satisfy

$$\Pr(F|s_T^*)\Pr(F|s \le s_T^*)\frac{(I-\delta M^*)}{k}M^* - C = 0,$$

leading to a unique solution as follows:

$$M^* = \frac{1}{2\delta}\left[I - \sqrt{I^2 - \frac{4\delta C k}{\Pr(F|s_T^*)\Pr(F|s \le s_T^*)}}\right]. \tag{18}$$

Proof of Proposition 2: The information content of a whistleblowing report is

$$T_1 = \Pr(F|r=1) = \frac{1-p}{1-p+pH(s_T)}.$$

By the proof of Lemma 4, $H(s_T)$ is increasing in s_T, and thus T_1 is decreasing in s_T, i.e., $\frac{\partial T_1}{\partial s_T} < 0$. Similarly, the information content of no whistleblowing is $T_0 = \Pr(G|r=0)$. Notice that

$$1 - T_0 = \Pr(F|r=0) = \frac{1-p}{1-p+pL(s_T)}.$$

Because $\frac{\partial L(s_T)}{\partial s_T} > 0$, it must hold that $\frac{\partial(1-T_0)}{\partial s_T} < 0$, i.e., $\frac{\partial T_0}{\partial s_T} > 0$.

Proof of Proposition 3: The proof proceeds as follows. In step 1, we derive the regulator's *ex ante* objective function. We also verify that the regulator never chooses M greater than $\frac{I}{2\delta}$. In step 2, we apply the first-order approach to study the optimal threshold s_T^*. In step 3, we show s_T^* is interior and unique as long as δ is not too large.

Step 1) Denote the regulator's *ex ante* objective function by U. The prior density function of s is $\phi(s) = p\phi(s|G) + (1-p)\phi(s|F)$. When $s < s_T$, the insider blows the whistle in equilibrium, and the regulator's effort is d_1^*. By (2), the regulator's objective function becomes

$$\Pr(G|s)(X-I) - (1-d_1^*)\Pr(F|s)I - \frac{1}{2}k(d_1^*)^2 - \delta\Pr(F|s)d_1^* M^*(s_T).$$

When $s > s_T$, the insider does not blow the whistle, and the regulator's effort is d_0^*. In this case, the regulator's objective function becomes

$$\Pr(G|s)(X-I) - (1-d_0^*)\Pr(F|s)I - \frac{1}{2}k(d_0^*)^2.$$

Therefore, the regulator's *ex ante* objective is

$$\begin{aligned} U(s_T, d_1^*, d_0^*) &= \int_0^{s_T} \phi(s)\left[\Pr(G|s)(X-I) - (1-d_1^*)\Pr(F|s)I - \delta\Pr(F|s)d_1^* M^*(s_T) - \frac{1}{2}k(d_1^*)^2\right]ds \\ &+ \int_{s_T}^1 \phi(s)\left[\Pr(G|s)(X-I) - (1-d_0^*)\Pr(F|s)I - \frac{1}{2}k(d_0^*)^2\right]ds. \end{aligned} \tag{19}$$

We first show that any $M^h > \frac{I}{2\delta}$ is never optimal. To achieve this, we prove that choosing $M^l \equiv \frac{I}{\delta} - M^h$ strictly improves the regulator's payoff, i.e., $U\left(M^l\right) - U\left(M^h\right) > 0$. Recall that, given M, s_T is determined by equation (17). Because $\frac{(I-\delta M^h)}{k}M^h = \frac{(I-\delta M^l)}{k}M^l$, M^h and M^l lead to the same s_T, and thus $d_0^*\left(M^h\right) = d_0^*\left(M^l\right) = \Pr(F|s > s_T)\frac{I}{k}$. Therefore, we have

$$\begin{aligned} U\left(M^l\right) - U\left(M^h\right) = & \int_0^{s_T} \phi(s)\left[d_1^*\left(M^l\right)\Pr(F|s)\left(I - \delta M^l\right) - \frac{1}{2}k\left(d_1^*\left(M^l\right)\right)^2\right]ds \\ & - \int_0^{s_T} \phi(s)\left[d_1^*\left(M^h\right)\Pr(F|s)\left(I - \delta M^h\right) - \frac{1}{2}k\left(d_1^*\left(M^h\right)\right)^2\right]ds. \end{aligned} \tag{20}$$

Substituting $d_1^*\left(M^l\right) = \Pr(F|s \le s_T)\frac{I-\delta M^l}{k}$ into the first line of (20) yields

$$\begin{aligned} & \int_0^{s_T} \phi(s)\left[d_1^*\left(M^l\right)\Pr(F|s)\left(I - \delta M^l\right) - \frac{1}{2}k\left(d_1^*\left(M^l\right)\right)^2\right]ds \\ = & \frac{\left(I - \delta M^l\right)^2 \Pr(F|s \le s_T)}{k}\int_0^{s_T} \phi(s)\Pr(F|s)ds - \frac{\left(I - \delta M^l\right)^2 [\Pr(F|s \le s_T)]^2}{2k}\int_0^{s_T} \phi(s)ds \\ = & \frac{\left(I - \delta M^l\right)^2 \Pr(F|s \le s_T)}{k}\left[\int_0^{s_T} \phi(s)\Pr(F|s)ds - \frac{1}{2}\Pr(F|s \le s_T)\Pr(s \le s_T)\right] \\ = & \frac{\left(I - \delta M^h\right)^2 \Pr(F|s \le s_T)}{k}\frac{1}{2}\Pr(F|s \le s_T)\Pr(s \le s_T), \end{aligned}$$

where the last line is because

$$\Pr(F|s \le s_T) = \frac{\Pr(F)\Pr(s \le s_T|F)}{\Pr(s \le s_T)} = \frac{\int_0^{s_T}\Pr(F)\phi(s|F)ds}{\Pr(s \le s_T)} = \frac{\int_0^{s_T}\phi(s)\Pr(F|s)ds}{\Pr(s \le s_T)}.$$

Similarly, substituting $d_1^*\left(M^h\right)$ into the second line of (20) yields

$$\int_0^{s_T} \phi(s)\left[d_1^*\left(M^h\right)\Pr(F|s)\left(I - \delta M^h\right) - \frac{1}{2}k\left(d_1^*\left(M^h\right)\right)^2\right]ds = \frac{\left(I - \delta M^h\right)^2}{2k}[\Pr(F|s \le s_T)]^2\Pr(s \le s_T).$$

Therefore, it must hold that

$$U\left(M^l\right) - U\left(M^h\right) = [\Pr(F|s \le s_T)]^2\Pr(s \le s_T)\left[\frac{\left(I - \delta M^l\right)^2}{2k} - \frac{\left(I - \delta M^h\right)^2}{2k}\right] > 0.$$

Step 2) The first-order condition of (19) is:

$$\frac{dU(s_T, d_1^*, d_0^*)}{ds_T} = \frac{\partial U}{\partial s_T} + \frac{\partial U}{\partial d_1^*}\frac{\partial d_1^*}{\partial s_T} + \frac{\partial U}{\partial d_0^*}\frac{\partial d_0^*}{\partial s_T} = 0.$$

Applying the envelope theorem (i.e.,$\frac{\partial U}{\partial d_1^*} = \frac{\partial U}{\partial d_0^*} = 0$) leads to $\frac{dU}{ds_T} = \frac{\partial U}{\partial s_T}$. Therefore, we have

$$\begin{aligned}\frac{dU}{ds_T} &= \phi(s_T)\left[\Pr(G|s_T)(X-I)-(1-d_1^*)\Pr(F|s_T)I-\frac{1}{2}k(d_1^*)^2\right]\\&-\phi(s_T)\left[\Pr(G|s_T)(X-I)-(1-d_0^*)\Pr(F|s_T)I-\frac{1}{2}k(d_0^*)^2\right]-\frac{\partial}{\partial s_T}\left[\delta\int_0^{s_T}\Pr(F|s)d_1^*M^*(s_T)\phi(s)ds\right]\\&=\phi(s_T)\Pr(F|s_T)(d_1^*-d_0^*)I-\phi(s_T)\left[\frac{1}{2}k(d_1^*)^2-\frac{1}{2}k(d_0^*)^2\right]-\frac{\partial}{\partial s_T}\left[\delta\int_0^{s_T}\Pr(F|s)d_1^*M^*(s_T)\phi(s)ds\right].\end{aligned}$$

Substituting $d_1^*=\Pr(F|s\le s_T)\frac{I-\delta M^*(s_T)}{k}$ and $d_0^*=\Pr(F|s>s_T)\frac{I}{k}$ into $\frac{dU}{ds_T}$ and rearranging terms yields

$$\begin{aligned}\frac{dU}{ds_T} &= \phi(s_T)\left[\Pr(F|s_T)\Pr(F|s\le s_T)-\frac{1}{2}[\Pr(F|s\le s_T)]^2\right]\frac{(I-\delta M^*(s_T))^2}{k}\\&-\phi(s_T)\underbrace{\left[\Pr(F|s_T)\Pr(F|s>s_T)-\frac{1}{2}[\Pr(F|s>s_T)]^2\right]}_{+}\frac{I^2}{k}\\&\underbrace{-\Pr(F|s\le s_T)\frac{\delta[I-\delta M^*(s_T)]}{k}\frac{\partial M^*(s_T)}{\partial s_T}\int_0^{s_T}\phi(s)\Pr(F|s)ds}_{+}.\end{aligned}\tag{21}$$

Equation (21) suggests that for the optimal interior threshold s_T^* (i.e., $\frac{dU}{ds_T}=0$), it must hold that $\Pr(F|s_T^*)\Pr(F|s\le s_T^*)-\frac{1}{2}[\Pr(F|s\le s_T^*)]^2>0$. To further simplify equation (21), we collect terms about δ as follows:

$$\begin{aligned}\frac{dU}{ds_T} &= \frac{\phi(s_T)[\Pr(F|s\le s_T)-\Pr(F|s>s_T)]I^2}{2k}[2\Pr(F|s_T)-\Pr(F|s\le s_T)-\Pr(F|s>s_T)]\\&-\phi(s_T)\left[\Pr(F|s_T)\Pr(F|s\le s_T)-\frac{1}{2}[\Pr(F|s\le s_T)]^2\right]\frac{\left[2\delta M^*(s_T)I-(\delta M^*(s_T))^2\right]}{k}\\&-\frac{\Pr(F|s\le s_T)\delta[I-\delta M^*(s_T)]}{k}\frac{\partial M^*(s_T)}{\partial s_T}\int_0^{s_T}\phi(s)\Pr(F|s)ds.\end{aligned}$$

Therefore, the first-order condition $\frac{dU}{ds_T}=0$ can be expressed as

$$J\equiv 2\Pr(F|s_T^*)-\Pr(F|s\le s_T^*)-\Pr(F|s>s_T^*)-D(\delta,s_T^*)=0,\tag{22}$$

where $D(\delta,s_T^*)$ is defined as the following expression:

$$\begin{aligned}D(\delta,s_T^*) &\equiv \frac{2\left[\Pr(F|s_T^*)\Pr(F|s\le s_T^*)-\frac{1}{2}[\Pr(F|s\le s_T^*)]^2\right]}{[\Pr(F|s\le s_T^*)-\Pr(F|s>s_T^*)]I^2}\left[2\delta M^*(s_T^*)I-(\delta M^*(s_T^*))^2\right]\\&+\frac{2\Pr(F|s\le s_T^*)\delta[I-\delta M^*(s_T^*)]}{\phi(s_T^*)[\Pr(F|s\le s_T^*)-\Pr(F|s>s_T^*)]I^2}\frac{\partial M^*(s_T^*)}{\partial s_T^*}\int_0^{s_T^*}\phi(s)\Pr(F|s)ds\\&>0.\end{aligned}$$

Step 3) To show the existence, we verify the value of (22) at the two corners. First, when $s_T^*\to 1$, it is easy to verify that $\lim_{s_T^*\to 1}\Pr(F|s_T^*)=\lim_{s_T^*\to 1}\Pr(F|s>s_T^*)=\Pr(F|s=1)$ and $\lim_{s_T^*\to 1}\Pr(F|s\le s_T^*)=1-p>\Pr(F|s=1)$. Hence, it must hold that

$$\lim_{s_T^*\to 1}J=\underbrace{\Pr(F|s=1)-(1-p)}_{-}-D(\delta,s_T^*=1)<0.$$

When $s_T^*\to 0$, we have $\Pr(F|s_T^*)=\Pr(F|s\le s_T^*)=\Pr(F|s=0)$ and $\Pr(F|s>s_T^*)=1-p<\Pr(F|s=0)$. Hence, it must hold that

$$\lim_{s_T^*\to 0} J = \underbrace{\Pr(F|s=0)-(1-p)}_{+} - D(\delta, s_T^*=0),$$

which is positive if $D(\delta, s_T^*=0) < \Pr(F|s=0) - (1-p)$. After some tedious algebra, we find that $D(\delta, s_T^*=0)$ is increasing in δ and $\lim_{\delta\to 0} D(\delta, s_T^*=0) = 0$. Therefore, there exists a threshold $\overline{\delta}$ such that $D(\delta, s_T^*=0) < \Pr(F|s=0) - (1-p)$ if and only if $\delta < \overline{\delta}$. In this case, by the intermediate value theorem, there exists at least one interior solution to equation (22). To show the uniqueness, if there are multiple solutions to equation (22), we plug them into the regulator's objective function U, and the one leading to the largest U is the optimal threshold s_T^*. Taken together, we have shown that, as long as $\delta < \overline{\delta}$, there exists a unique optimal threshold s_T^* satisfying $J=0; \frac{\partial J}{\partial s_T^*}|_{s_T=s_T^*} < 0$.

Proof of Proposition 4: For any parameter y, applying the implicit function theorem leads to

$$\frac{\partial s_T^*}{\partial y} = -\frac{\frac{\partial J}{\partial y}}{\frac{\partial J}{\partial s_T}}|_{s_T=s_T^*} \propto \frac{\partial J}{\partial y}|_{s_T=s_T^*}.$$

Because $D(\delta, s_T^*)$ collect all terms about δ, k, C, and I, it can be further reduced to $\frac{\partial s_T^*}{\partial y} \propto = -\frac{\partial D(\delta, s_T^*)}{\partial y}|_{s_T=s_T^*}$.

First, to examine the effect of δ, notice that

$$\begin{aligned}\frac{\partial D(\delta, s_T)}{\partial \delta}|_{s_T=s_T^*} = & \frac{2\left[\Pr(F|s_T)\Pr(F|s\le s_T) - \frac{1}{2}[\Pr(F|s\le s_T)]^2\right]}{[\Pr(F|s\le s_T) - \Pr(F|s>s_T)]I^2} \frac{\partial\left[2\delta M^*(s_T)I - (\delta M^*(s_T))^2\right]}{\partial \delta}|_{s_T=s_T^*} \\ & + \frac{2\Pr(F|s\le s_T)\int_0^{s_T}\phi(s)\Pr(F|s)ds}{\phi(s_T)[\Pr(F|s\le s_T) - \Pr(F|s>s_T)]I^2} \frac{\partial\left\{\delta[I-\delta M^*(s_T)]\frac{\partial M^*(s_T)}{\partial s_T}\right\}}{\partial\delta}|_{s_T=s_T^*}.\end{aligned} \tag{23}$$

Substituting $M^*(s_T)$ from equation (18) into $2\delta M^*(s_T)I - (\delta M^*(s_T))^2$, we can show it is increasing in δ, i.e., the first line of (23) is positive. To examine the sign of the second line, we denote $\lambda_T \equiv \Pr(F|s_T)\Pr(F|s\le s_T)$, which is decreasing in s_T and independent of δ. Substituting λ_T into the second line of (23), we find after some tedious algebra that

$$\frac{\partial\left\{\delta[I-\delta M^*(s_T)]\frac{\partial M^*(s_T)}{\partial\lambda_T}\right\}}{\partial\delta} < 0 \Rightarrow \frac{\partial\left\{\delta[I-\delta M^*(s_T)]\frac{\partial M^*(s_T)}{\partial s_T}\right\}}{\partial\delta} > 0,$$

i.e., the second line of (23) is also positive. Taken together, we have shown that $\frac{\partial D(\delta, s_T)}{\partial\delta}|_{s_T=s_T^*} > 0$ and thus $\frac{\partial s_T^*}{\partial\delta} \propto -\frac{\partial D(\delta, s_T)}{\partial\delta}|_{s_T=s_T^*} < 0$.

Second, to examine the effect of k, we have

$$\begin{aligned}\frac{\partial D(\delta, s_T)}{\partial k}|_{s_T=s_T^*} = & \frac{2\left[\Pr(F|s_T)\Pr(F|s\le s_T) - \frac{1}{2}[\Pr(F|s\le s_T)]^2\right]}{[\Pr(F|s\le s_T) - \Pr(F|s>s_T)]I^2} \frac{\partial\left[2\delta M^*(s_T)I - (\delta M^*(s_T))^2\right]}{\partial k}|_{s_T=s_T^*} \\ & + \frac{2\delta\Pr(F|s\le s_T)\int_0^{s_T}\phi(s)\Pr(F|s)ds}{\phi(s_T)[\Pr(F|s\le s_T) - \Pr(F|s>s_T)]I^2} \frac{\partial\left\{[I-\delta M^*(s_T)]\frac{\partial M^*(s_T)}{\partial s_T}\right\}}{\partial k}|_{s_T=s_T^*}.\end{aligned} \tag{24}$$

Using the same technique above, we can show after some tedious algebra that the first and second lines of (24) are both positive. Therefore, it must hold that $\frac{\partial s_T^*}{\partial k} \propto -\frac{\partial D(\delta, s_T)}{\partial k}|_{s_T=s_T^*} < 0$.

Third, to examine the effect of C, we have

$$\begin{aligned}\frac{\partial D(\delta, s_T)}{\partial C}|_{s_T=s_T^*} = & \frac{2\left[\Pr(F|s_T)\Pr(F|s\le s_T) - \frac{1}{2}[\Pr(F|s\le s_T)]^2\right]}{[\Pr(F|s\le s_T) - \Pr(F|s>s_T)]I^2} \frac{\partial\left[2\delta M^*(s_T)I - (\delta M^*(s_T))^2\right]}{\partial C}|_{s_T=s_T^*} \\ & + \frac{2\Pr(F|s\le s_T)\int_0^{s_T}\phi(s)\Pr(F|s)ds}{\phi(s_T)[\Pr(F|s\le s_T) - \Pr(F|s>s_T)]I^2} \frac{\partial\left\{\delta[I-\delta M^*(s_T)]\frac{\partial M^*(s_T)}{\partial s_T}\right\}}{\partial C}|_{s_T=s_T^*}.\end{aligned} \tag{25}$$

We can show the first and second lines of (25) are both positive, and thus $\frac{\partial s_T^*}{\partial C} \propto -\frac{\partial D(\delta, s_T)}{\partial C}|_{s_T=s_T^*} < 0$.

Lastly, to examine the effect of I, we rearrange terms in $D(\delta, s_T)$ and it is easy to see that

$$\begin{aligned}\frac{\partial D(\delta, s_T)}{\partial I}\Big|_{s_T=s_T^*} &= \frac{2\left[\Pr(F|s_T)\Pr(F|s \le s_T) - \frac{1}{2}[\Pr(F|s \le s_T)]^2\right]}{[\Pr(F|s \le s_T) - \Pr(F|s > s_T)]} \frac{\partial\left[\frac{2\delta M^*(s_T)}{I} - \left(\frac{\delta M^*(s_T)}{I}\right)^2\right]}{\partial I}\Big|_{s_T=s_T^*} \\ &+ \frac{2\delta \Pr(F|s \le s_T)\int_0^{s_T}\phi(s)\Pr(F|s)ds}{\phi(s_T)[\Pr(F|s \le s_T) - \Pr(F|s > s_T)]} \frac{\partial\left\{\left[1 - \frac{\delta M^*(s_T)}{I}\right]\frac{\partial \frac{M^*(s_T)}{I}}{\partial s_T}\right\}}{\partial I}\Big|_{s_T=s_T^*}.\end{aligned} \tag{26}$$

After some tedious algebra, we can show that the first and second lines of (26) are both negative. Therefore, it must hold that $\frac{\partial s_T^*}{\partial I} \propto -\frac{\partial D(\delta, s_T)}{\partial I}\big|_{s_T=s_T^*} > 0$.

Proof of Proposition 5: First, it is easy to see that the insider never blows the whistle if he is perfectly informed that the firm is G. Additionally, as long as the bounty is not extremely low, he always blows the whistle if he is perfectly informed that the firm is F. This extreme case is trivial, as the regulator gleans no information. Therefore, we focus on the case where the imperfectly informed insider follows a threshold equilibrium, denoted by $s_T \in (0, 1)$. The regulator's posterior probabilities of fraud are:

$$\begin{aligned}\Pr(F|r=1) &= \frac{(1-p)\left[q + (1-q)\int_0^{s_T}\phi(s|F)ds\right]}{(1-p)\left[q + (1-q)\int_0^{s_T}\phi(s|F)ds\right] + p(1-q)\int_0^{s_T}\phi(s|G)ds}; \\ \Pr(F|r=0) &= \frac{(1-p)(1-q)\int_{s_T}^1\phi(s|F)ds}{(1-p)(1-q)\int_{s_T}^1\phi(s|F)ds + p\left[q + (1-q)\int_{s_T}^1\phi(s|G)ds\right]}; \\ \Pr(F|s=s_T) &= \frac{(1-p)\phi(s|F)}{(1-p)\phi(s|F) + p\phi(s|G)}.\end{aligned}$$

Applying the implicit function theorem yields $\frac{\partial s_T^*}{\partial p} \propto \frac{\partial J}{\partial p}\big|_{s_T=s_T^*}$ and $\frac{\partial s_T^*}{\partial q} \propto \frac{\partial J}{\partial q}\big|_{s_T=s_T^*}$. Next, we substitute the above probabilities into the first-order condition $J=0$, and after some tedious algebra, we can show that $\lim_{\delta\to 0} J = 0 \Leftrightarrow G(s_T) = 0$, where $G(s_T)$ is defined as the following function:

$$\begin{aligned}G(s_T) \equiv\ & 2(2p-1)(q-1)^2 s_T^4 + 8(p-1)(q-1)^2 s_T^3 + 3(2p-3)(q-1)^2 s_T^2 \\ & + \left[-2p(q-1)^2 + q^2 - 6q + 3\right]s_T - 2pq + 2q^2 + q - 2pq^2.\end{aligned}$$

It can be easily verified that

$$\begin{aligned}\frac{\partial^2 G(s_T)}{\partial p \partial q} &= 2q\left(s_T^2 - s_T + 1\right)\left(2s_T^2 - 2s_T - 1\right) - 4s_T^4 + 8s_T^3 - 6s_T^2 + 2s_T - 1 < 0; \\ \lim_{q\to 0}\frac{\partial G(s_T)}{\partial p} &= (s_T - 1)s_T\left(4s_T^2 - 4s_T + 2\right) < 0.\end{aligned}$$

In other words, because $\frac{\partial G(s_T)}{\partial p}$ is decreasing in q, it must hold that $\frac{\partial G(s_T)}{\partial p} \le \lim_{q\to 0}\frac{\partial G(s_T)}{\partial p} < 0$. Therefore, by continuity, because $\lim_{\delta\to 0}\frac{\partial J}{\partial p}\big|_{s_T=s_T^*} < 0$, when δ is sufficiently small, it must hold that $\frac{\partial s_T^*}{\partial p} < 0$.
Similarly, after some tedious algebra, it can be shown that

$$\begin{aligned}\lim_{p\to 0}\frac{\partial G(s_T)}{\partial q} &= 2q\left(-2s_T^4 + 8s_T^3 - 9s_T^2 + s_T + 2\right) + 4s_T^4 - 16s_T^3 + 18s_T^2 - 6s_T + 1 > 0; \\ \lim_{p\to 1}\frac{\partial G(s_T)}{\partial q} &= 4(q-1)s_T^4 - 6(q-1)s_T^2 - 2(q+1)s_T - 1 < 0.\end{aligned}$$

That is, if p is sufficiently small, it must hold that $\frac{\partial G(s_T)}{\partial q} > 0$; whereas if p is sufficiently large, it must hold that $\frac{\partial G(s_T)}{\partial q} < 0$. By continuity, for a sufficiently small δ, $\frac{\partial s_T^*}{\partial q} > 0$ if p is sufficiently small, and $\frac{\partial s_T^*}{\partial q} < 0$ if p is sufficiently large.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jacceco.2023.101616.

References

Baldenius, T., Meng, X., Qiu, L., 2019. Biased boards. Account. Rev. 94 (2), 1–27.
Berger, P.G., Lee, H., 2022. Did the dodd–frank whistleblower provision deter accounting fraud? J. Account. Res. 60 (4), 1337–1378.
Beasley, M.S., 1996. An empirical analysis of the relation between the board of director composition and financial statement fraud. Account. Rev. 443–465.
Blackburne, T., Kepler, J.D., Quinn, P.J., Taylor, D., 2021. Undisclosed SEC investigations. Manag. Sci. 67 (6), 3403–3418.
Bonsall, S.B., Holzman, E., Miller, B.P., 2021. Wearing Out the Watchdog: the Impact of SEC Case Backlog on the Formal Investigation Process. Available at: SSRN 3912645.
Bowen, R.M., Call, A.C., Rajgopal, S., 2010. Whistle-blowing: target firm characteristics and economic consequences. Account. Rev. 85 (4), 1239–1271.
Burns, N., Kedia, S., 2006. The impact of performance-based compensation on misreporting. J. Financ. Econ. 79 (1), 35–67.
Call, A.C., Martin, G.S., Sharp, N.Y., Wilde, J.H., 2018. Whistleblowers and outcomes of financial misrepresentation enforcement actions. J. Account. Res. 56 (1), 123–171.
Call, A.C., Kedia, S., Rajgopal, S., 2016. Rank and file employees and the discovery of misreporting: the role of stock options. J. Account. Econ. 62 (2–3), 277–300.
Clayton, J., 2018. Available at: https://www.sec.gov/news/public-statement/statement-open-meeting-amendments-commissions-whistleblower-program-rules.
Dechow, P.M., Ge, W., Larson, C.R., Sloan, R.G., 2011. Predicting material accounting misstatements. Contemp. Account. Res. 28 (1), 17–82.
Deng, M., Lu, T., Simunic, D.A., Ye, M., 2014. Do joint audits improve or impair audit quality? J. Account. Res. 52 (5), 1029–1060.
Dey, A., Heese, J., Pérez-Cavazos, G., 2019. Cash-for-information Whistleblower Programs: Cure or Curse? (Working paper).
Drymiotes, G., 2007. The monitoring role of insiders. J. Account. Econ. 44 (3), 359–377.
Drymiotes, G., Sivaramakrishnan, S., 2010. Board monitoring, consulting, and reward structures. Contemp. Account. Res. 29, 453–486.
Dyck, A., Morse, A., Zingales, L., 2010. Who blows the whistle on corporate fraud? J. Finance 65 (6), 2213–2253.
Dye, R., 2017. Optimal disclosure decisions when there are penalties for nondisclosure. Rand J. Econ. 48 (3), 704–732.
Ewert, R., Wagenhofer, A., 2019. Effects of increasing enforcement on financial reporting quality and audit quality. J. Account. Res. 57 (1), 121–168.
Gao, P., Zhang, G., 2019. Auditing standards, professional judgment, and audit quality. Account. Rev. 94 (6), 201–225.
Heese, J., Krishnan, R., Ramasubramanian, H., 2021. The Department of Justice as a gatekeeper in whistleblower-initiated corporate fraud enforcement: drivers and consequences. J. Account. Econ. 71 (1), 101357.
Heese, J., Perez-Cavazos, G., 2021. The effect of retaliation costs on employee whistleblowing. J. Account. Econ. 71 (2–3), 101385.
Holzman, E., Marshall, N.T., Schmidt, B., 2022. When are firms on the hot seat? An analysis of SEC investigation preferences.
Karpoff, J.M., Koester, A., Lee, D.S., Martin, G.S., 2017. Proxies and databases in financial misconduct research. Account. Rev. 92 (6), 129–163.
Kedia, S., Rajgopal, S., 2011. Do the SEC's enforcement preferences affect corporate misconduct? J. Account. Econ. 51 (3), 259–278.
Klein, A., 2002. Audit committee, board of director characteristics, and earnings management. J. Account. Econ. 33 (3), 375–400.
Kronenberger, S., Laux, V., 2022. Conservative accounting, audit quality, and litigation. Manag. Sci. 68 (3), 2349–2362.
Kwon, Y.K., Newman, D.P., Suh, Y.S., 2001. The demand for accounting conservatism for management control. Rev. Account. Stud. 6, 29–51.
Laux, C., Laux, V., 2009. Board committees, CEO compensation, and earnings management. Account. Rev. 84 (3), 869–891.
Laux, V., Ray, K., 2020. Effects of accounting conservatism on investment efficiency and innovation. J. Account. Econ. 70, 101319.
Meng, X., Tian, J.J., 2020. Board expertise and executive incentives. Manag. Sci. 66 (11), 5448–5464.
Nan, L., Wen, X., 2014. Financing and investment efficiency, information quality, and accounting biases. Manag. Sci. 60 (9), 2308–2323.
Nan, L., Wen, X., 2019. Penalties, manipulation, and investment efficiency. Manag. Sci. 65 (10), 4878–4900.
National Whistleblower Center, 2018. Available at: https://www.sec.gov/comments/s7-16-18/s71618-4780966-176887.pdf.
National Whistleblower Center, 2019. Available at: https://www.sec.gov/comments/s7-16-18/s71618-6247436-192751.pdf.
Patterson, E.R., Smith, J.R., 2007. The effects of Sarbanes-Oxley on auditing and internal control strength. Account. Rev. 427–455.
Ramanan, R.N.V., 2014. Corporate governance, auditing, and reporting distortions. J. Account. Audit Finance 29 (3), 306–339.
Schantl, S., Wagenhofer, A., 2020. Deterrence of financial misreporting when public and private enforcement strategically interact. J. Account. Econ. 70, 101311.
Security and Exchange Commision, 2018. Available at: https://www.sec.gov/news/press-release/2018-120.
Wang, T.Y., Winton, A., Yu, X., 2010. Corporate fraud and business conditions: evidence from IPOs. J. Finance 65 (6), 2255–2292.
Wang, T.Y., Winton, A., 2021. Industry informational interactions and corporate fraud. J. Corp. Finance 69, 102024.
Wilde, J.H., 2017. The deterrent effect of employee whistleblowing on firms' financial misreporting and tax aggressiveness. Account. Rev. 92 (5), 247–280.