The Effects of Critical Audit Matter Disclosure on Audit Effort, Investor Scrutiny, and Investment Efficiency

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ABSTRACT: We study the effects of the disclosure of critical audit matters (CAMs) on an auditor's audit effort and an investor's scrutiny effort decisions, as well as on investment efficiency. Both the auditor and the investor can prevent a bad investment by respectively auditing and scrutinizing the firm's financial reports to detect misstatements about the investment value. Investment efficiency is determined by the investor's total mix of information. The disclosure of CAMs helps the investor assess investment risk and infer the auditor's effort, and thus enables the investor to fine-tune scrutiny effort, which can in turn adversely influence the auditor's effort decision. We show when and why the disclosure of CAMs increases or decreases *ex ante* audit effort, *ex ante* investor scrutiny, and investment efficiency. Our analyses have both testable empirical implications and policy implications.

Keywords: Auditing; critical audit matters; investment efficiency

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I. INTRODUCTION

Since 2019, the Public Company Accounting Oversight Board (PCAOB) has required auditors to disclose critical audit matters (CAMs) beyond the binary pass/fail opinion.[1] CAMs are likely to be identified in areas where investors have a particular interest, such as significant management estimates and judgments, areas of high financial statement and audit risk, and significant unusual transactions. Proponents argue that CAM disclosure will add to investors' total mix of information—providing insights relevant to analyzing risks in capital valuation and allocation—and will focus investors' attention on key financial reporting areas that deserve more attention, thus contributing to investors' ability to make investment decisions (PCAOB Release No. 2017-001). However, although CAM disclosure helps investors assess investment risk and fine-tune effort in scrutinizing the project they intend to fund, its impact on audit effort cannot be overlooked. To the extent that CAM disclosure improves investment decisions, the associated decrease in investment loss might disincentivize audit effort by decreasing auditors' expected legal liability. Therefore, whether CAM disclosure can increase investors' total mix of information is unclear and requires comprehensive economic analysis. This paper presents a theoretical model to study how CAM disclosure would influence the strategic interactions between the auditor's and investor's effort decisions in detecting financial misstatements, and examine when and why the disclosure increases or decreases the investor's total mix of information.

In our model, a firm offers an investment opportunity to its investor and hires an auditor to detect possible misstatements in its financial reports. The firm's investment can be either risky or risk-free. While a risk-free investment always succeeds, a risky investment can fail and incur a loss for the investor. The CAM acts as a signal about the riskiness of the investment. Both the auditor and the investor can prevent a bad investment by respectively auditing and scrutinizing the firm's financial reports to detect misstatements about the investment value. The auditor privately observes an imperfect signal about the existence of CAMs before choosing audit effort. We investigate two regimes, the disclosure and non-disclosure regimes. The difference between the two regimes is that the auditor

[1] Auditing Standard (AS) 3101 "The Auditor's Report on an Audit of Financial Statements When the Auditor Expresses an Unqualified Opinion" went into effect for large-accelerated filers for fiscal years ending on or after June 30, 2019, and for all other companies for fiscal years ending on or after December 15, 2020. The PCAOB defines CAMs as "matters communicated or required to be communicated to the audit committee and that: (1) relate to accounts or disclosures that are material to the financial statements; and (2) involved especially challenging, subjective, or complex auditor judgment."

discloses the signal of CAMs only in the disclosure regime. After observing the auditor's disclosure of CAMs (only in the disclosure regime) and audit opinion, the investor chooses scrutiny effort and then decides whether to invest.

There are two salient features about the disclosure of CAMs in our model. First, the presence of a CAM does not affect the auditor's opinion on the truthfulness of financial statements, but its presence provides information about the firm's investment risk. The investor bears a loss in the event of an investment failure and thus will rationally choose higher scrutiny effort when she perceives higher investment risk. As such, the disclosure of CAMs helps the investor assess investment risk, resulting in a more efficient scrutiny effort decision *ex post*. This "fine-tuning" opportunity is absent if the auditor does not disclose the CAM signal. Second, the auditor privately observes the CAM signal and chooses effort contingent on this signal. Accordingly, although the auditor's effort is not observable to the investor, CAM disclosure assists the investor in inferring the auditor's effort choice, which further influences the investor's scrutiny effort decision.

Against this backdrop, in our model, auditor effort and investor scrutiny are "strategic substitutes" in the sense of Bulow, Geanakoplos, and Klemperer (1985). First, the investor suffers an investment loss when the investment fails. Because audit effort decreases the investor's perceived investment risk, the investor's best response is a decreasing function of audit effort. Second, the auditor is motivated to exert audit effort by potential legal liability in the event of an investment failure, which happens only if the investor invests. As such, the investor's scrutiny effort improves her investment decision, which in turn renders the auditor's best response function decreasing in investor scrutiny. Accordingly, we find that CAM disclosure always oppositely affects audit effort and investor scrutiny. Specifically, CAM disclosure results in larger investor scrutiny and smaller audit effort in expectation (i.e., the expected effort levels before the auditor observes the CAM signal) if and only if the auditor's legal liability is small or the CAM signal is precise. The rationale is as follows. A CAM acts as a signal about the prior investment risk (before the auditor and the investor exert effort). If the CAM signal is precise, the prior investment risk is far higher when the CAM signal indicates the presence than the absence of CAMs. Although audit effort choice is also affected by the CAM signal, which in turn affects the investor's perceived investment risk when the signal is disclosed, this effect is weak if the auditor has small legal liability and hence is not quite sensitive to a change in investment risk. As such, CAM disclosure, which reveals the presence of CAMs, raises the chance for the investor to perceive high investment risk and hence induces higher investor scrutiny in expectation. Due to the "strategic substitutes" relation between audit effort and investor scrutiny, CAM disclosure decreases the expected audit effort. The opposite is true if the auditor's legal liability is large and the CAM signal is imprecise.

In the disclosure regime, the investor has three sources of information about investment value: CAM disclosure, the information generated by the auditor's audit effort, and the information generated by the investor's own scrutiny effort. In the non-disclosure regime, only the latter two sources are available. The "strategic substitutes" relation between audit effort and investor scrutiny suggests that, despite adding one source of information, the disclosure of CAM may adversely affect the net information from the latter two sources. To sharpen our insight, we further use investment efficiency as a comprehensive measure of the effects of CAM disclosure. We define investment efficiency as the probability that a bad investment is saved times the investment amount. Investment efficiency is determined by all information available to the investor.

We show that although CAM disclosure can improve investment efficiency by enabling the investor to fine-tune her scrutiny effort conditional on the CAM signal, its ultimate effect on investment efficiency also depends on how it affects investor scrutiny and audit effort. Because CAM disclosure can improve one party's effort at the expense of the other party's effort, the disclosure's impact on investment efficiency depends on whether it is more desirable to induce higher audit effort or higher investor scrutiny. We show that in the non-disclosure regime (i.e., when the investor does not have the fine-tuning opportunity), owing to the auditor's "first-mover" advantage, investment efficiency *ex ante* always increases in expected audit effort, but decreases in expected investor scrutiny if the level of investor scrutiny is low. Accordingly, when the auditor's legal liability is large and the CAM signal is imprecise, CAM disclosure improves investment efficiency by both increasing expected audit effort and allowing fine-tuning by the investor. In contrast, given that investor scrutiny is low prior to the CAM disclosure requirement, CAM disclosure induces higher expected investor scrutiny and thereby impairs investment efficiency when the auditor's legal liability is small or the CAM signal is precise. Proponents of CAM disclosure argue that the disclosure will contribute to investors' ability to make investment decisions by adding to investors' total mix of information and identifying areas that deserve more attention (PCAOB Release No. 2007-001), particularly when investor scrutiny is considered inadequate and the informational value of CAM disclosure is high.

Our result contends against this view by showing that CAM disclosure decreases investment efficiency exactly when investor scrutiny is low, CAM disclosure increases investor scrutiny in expectation, and the auditor's CAM signal is of high quality.

Our paper contributes to the debate on the impact of CAM disclosure by exploring both sides: the notion that CAM disclosure will improve investment decisions by providing more information to investors and the counterargument that it will disincentivize audit effort. Our paper is among the first to theoretically analyze the economic consequences of disclosing audit risk, specifically, the investment risk identified by the auditor. Our results highlight the impact of the disclosure on the strategic interactions between the auditor's and investor's effort decisions. Although CAM disclosure by itself adds to the investor's information about investment risk, it can reduce the investor's total mix of information through influencing these interactions.

Our paper also adds to the literature about increasing audit transparency. Our paper is closely related to Chen, Jiang, and Zhang (2019) in that we both examine how audit-related disclosures affect the strategic interactions between auditors and investors. Yet, the papers differ in two ways. First, we focus on CAM disclosure, which helps the investor to assess investment risk as well as infer audit effort, whereas Chen et al. (2019) focus on the disclosure of audit quality. Second, we analyze how CAM disclosure affects both the auditor's and investor's effort choices, whereas Chen et al. (2019) study how the disclosure of audit quality affects the auditor's effort (which stochastically affects audit quality).

Prior studies in the literature have discussed how audit regulations affect audit effort and welfare (e.g., Dye 1993; Ye and Simunic 2013, 2015; Liu and Zhang 2021; Chan and Liu 2022). Our paper complements this literature in two aspects. First, while many prior studies focus on the effects of auditor liability rules, we show how the economic consequences of audit disclosure requirements depend on the auditor liability rules. Second, prior studies focus mainly on the strategic interactions between the reporting firm and its external auditor (e.g., Caplan 1999; Hillegeist 1999; Pae and Yoo 2001; Patterson and Smith 2007; Chan 2018), whereas we emphasize the strategic interactions between auditors and investors.

Our analyses generate testable empirical implications. While some recent experimental studies examine the potential effect of CAM disclosure on auditor liability (e.g., Brown, Majors, Peecher 2015; Brasel, Doxey, Grenier, and Reffett 2016; Gimbar, Hansen, and Ozlanski 2016; Kachelmeier, Rimkus, Schmidt, and Valentine 2019), we focus on the information value of CAM disclosure and identify conditions under which CAM disclosure increases or decreases audit effort, investment efficiency, and audit fees. Our empirical implications can help explain early empirical findings of no systematic relationship between initial CAM implementation and audit fees/audit hours (PCAOB 2020; Burke, Hoitash, Hoitash, and Xiao 2021), as well as guide future empirical research.

The rest of the paper is organized as follows. Section II lays out the model. Section III solves for the equilibrium under the non-disclosure regime and that under the disclosure regime. In Section IV, we compare the equilibrium outcomes across different regimes. Section V provides empirical implications. The last section concludes. All proofs are provided in the Appendices.

II. MODEL SETUP

This section presents a parsimonious model in which CAM disclosure provides investors with information to assess the riskiness of a firm and evaluate the quality of the firm's audit. We consider a one-period (with four dates: 0, 1, 2, and 3), risk-neutral, zero discount setup. There is a firm with a (representative) investor and an auditor. For convenience, we refer to the investor as "she" and the auditor as "he." The firm has a project that requires a fixed amount of investment I. If undertaken, the project will generate a random payoff $x \in \{0,\ v\}$ at date 3, where $v > I$. It is common knowledge that the project is either risk-free or risky with equal probability. If the project is risk-free, $x = v$ with probability 1. In contrast, if the project is risky, $x = 0$ with probability $\phi \in (0, 1)$ and $x = v$ with probability $1 - \phi$. A CAM acts as a signal about the project type (i.e., which distribution x follows) and exists if and only if the project is risky, i.e., $\Pr(CAM|\text{risky project}) = 1$ and $\Pr(NoCAM|\text{risk-free project}) = 1$. Accordingly, $\Pr(CAM) = \Pr(NoCAM) = \frac{1}{2}$.

Date 0—Project type: At date 0, nature determines the project type. The firm always reports its project value as $x = v$.[2] As such, the firm's financial report is not credible without attestation by an auditor. To ensure that there is *ex ante* social value

[2]We implicitly assume that the firm has a manager who holds a private interest in the investment and thus always reports the project value as $x = v$. As will be clear later, the auditor and the investor are the only strategic players in the model.

for the auditor's service, we assume that the net present value (NPV) of the investment is zero; that is,

$$\left(1-\frac{\phi}{2}\right)v=I, \tag{1}$$

and the investor's default decision in the absence of any new information is not to invest.[3] New information contained in the audit report as well as generated by the investor herself can improve the investor's investment decision.

Date 1—Audit report: At date 1, an auditor is hired from a competitive audit market at a fixed fee F to attest to the truth of the firm's financial report. After being hired, the auditor privately receives an imperfect signal $A \in \{C, N\}$ about the existence of CAMs, where C and N respectively mean that the auditor finds and does not find a CAM. As mentioned, a CAM is a signal about the project type; therefore, C and N imperfectly signal that the project is risky and risk-free, respectively.[4] The signal A never mistakes a non-CAM as a CAM, but correctly reveals the CAM only with probability $p \in (0,\ 1)$ if a CAM exists.[5] That is,

$$\Pr\left(N|NoCAM\right)=1 \text{ and } \Pr\left(C|CAM\right)=p\in(0,\ 1). \tag{2}$$

p is common knowledge and represents the informational quality of the auditor's signal about CAMs. p may depend not only on auditor characteristics such as the engagement auditor's prior training, knowledge, and experience, but also on client firm characteristics such as its industry, organizational structure and complexity, income sources, and asset composition. For example, p would be high for subjective and complex accounts such as goodwill and intangible assets reported on its financial statements (Murphy 2019).

Upon observing the CAM signal $A \in \{C, N\}$, the auditor's belief about investment

[3]This assumption can be justified if the firm is operating in a highly risky industry where in the absence of favorable information the investor abstains from undertaking the investment opportunity.

[4]To put things into context, we can think of v as the carrying amount of an asset the firm holds and x as the future value of this asset. We assume that in the absence of a CAM the audit of x requires only past transaction data and all the data are available. Specifically, we assume that $x = v$ in the absence of a CAM. In contrast, in the presence of a CAM, other factors can affect the future value of this asset, such as uncertainty over significant asset impairment, or worse, write-off of the asset, and the measurement of a CAM is pending the outcome of future events, or the relevant data concerning events that have already occurred cannot be accumulated on a timely, cost-effective basis.

[5]The assumption of an imperfect signal about the existence of CAMs emphasizes the challenging, subjective, or complex nature of the information about CAMs, as well as provides a role for investor scrutiny. We assume that the signal about CAMs admits only the type II error, just as the audit technology described in a subsequent paragraph.

risk $\Pr(x=0|C)$ and $\Pr(x=0|N)$ satisfies

$$\Pr(x=0|C)=\phi>\Pr(x=0)=\frac{\phi}{2}>\Pr(x=0|N)=\frac{1-p}{2-p}\phi. \tag{3}$$

Owing to the assumed asymmetric information technology, the firm's investment is risky for sure if $A=C$ and, thus, $\Pr(x=0|C)$ is independent of the quality of the CAM signal p. In contrast, the investment risk conditional on N is lower when p is larger (i.e., $\frac{\partial \Pr(x=0|N)}{\partial p}=-\frac{\phi}{(2-p)^2}<0$) because, given $A=N$, a larger p implies that the firm's project is less likely to be risky.

For simplicity, we assume that the CAM signal is exogenous and does not cause extra cost.[6] We also assume that the auditor receives the CAM signal before he completes the audit process; therefore, audit effort is a function of the identification of CAMs. This assumption is consistent with the fact that an auditor discovers CAMs often in the audit planning stage, and sometimes in the audit implementation stage.[7]

After observing the CAM signal, the auditor strategically decides an effort level $e\in[0,1]$, which allows him to detect the misstatement (if any) in the financial report about x with probability e. The auditor detects no misstatement if there is none.[8] As will be shown in Section III, the auditor's effort decision is conditional on his signal about CAMs as well as whether he discloses this signal. Audit effort incurs a private cost of $\frac{1}{2}ke^2$ to the auditor. We assume that $k>>0$ to ensure an interior solution for the optimal audit effort.

At the end of the audit, the auditor publicly issues an audit opinion $a\in\{0,v\}$. Consistent with the PCAOB's view, we assume that the presence of a CAM does not alter the audit opinion on the financial statements (PCAOB Release No. 2016-003). Accordingly, the auditor gives a qualified opinion $a=0$ if he detects a misstatement

[6] In May/June 2020, the PCAOB surveyed 902 engagement partners at the eight audit firms regarding their experiences in implementing the CAM requirements. The PCAOB calculated that among the Big 4, each firm spent about \$6.5 million on new procedures and training to implement CAMs. Considering that the firms generated anywhere from \$29 billion to \$46 billion in revenue in 2019, the PCAOB concluded that the costs related to auditor implementation of the CAM requirements were largely inconsequential.

[7] Auditors need to respond to the CAMs, as they are required to describe their relevant responses. See, e.g., the PCAOB's staff guidance on AS 3103 "Implementation of Critical Audit Matters: A Deeper Dive on the Communication of CAMs" (May 22, 2019).

[8] This is a common assumption in the literature (e.g., Dye 1995; Chan and Wong 2002; Laux and Newman 2010; Gao and Zhang 2019) and is consistent with the notion of discovery sampling (Arens and Loebbecke 1981).

regarding the reported value of x and an unqualified opinion $a = v$ otherwise. That is,

$$\Pr(a = v|x = v) = 1 \text{ and } \Pr(a = 0|x = 0) = e. \tag{4}$$

To investigate the effects of CAM disclosure, we consider two regimes $R \in \{D, X\}$, where D and X respectively mean the disclosure and non-disclosure regimes. The auditor truthfully discloses his CAM signal $A \in \{C, N\}$ together with his opinion a in the disclosure regime D.[9] He does not disclose A in the non-disclosure regime X.[10]

Date 2—Investor scrutiny and investment: If the auditor issues a qualified opinion $a = 0$, then given (4) the investor will not fund the investment, and the game ends. In contrast, if the auditor's opinion is unqualified $a = v$, then at date 2 the investor decides on a scrutiny effort $\gamma \in [0, 1]$ to investigate the value of x and will receive an imperfect signal $s \in \{0, v\}$, where $s = v$ and $s = 0$ respectively indicate that $x = v$ and $x = 0$. The investor never mistakes $x = v$ but correctly identifies $x = 0$ with only probability γ. That is,

$$Pr(s = v|x = v) = 1 \text{ and } \Pr(s = 0|x = 0) = \gamma. \tag{5}$$

Investor scrutiny γ incurs a private cost of $\frac{1}{2}m\gamma^2$ to the investor. We assume that $m >> 0$

[9] This assumption allows us to focus on the auditor's effort decision. First, according to AS 3101, for each critical audit matter communicated in the auditor's report, the auditor should describe the principal considerations that led the auditor to determine that the matter is critical, describe how the CAM was addressed in the audit, and refer to the relevant financial statement accounts or disclosures that relate to the CAM. Thus, it is unlikely that the auditor can report a CAM by fabricating such negative evidence without the rectification from his client. Second, CAMs include any matter arising from the audit of the financial statements that was communicated or required to be communicated to the audit committee. Specifically, AS 1301 requires auditors to communicate to the audit committee an overview of the overall audit strategy, including significant risks identified during the auditor's risk assessment procedures, and significant changes to the planned audit strategy or the significant risks initially identified and the reasons for such changes during the course of the audit. AS 1301 also requires the auditor to communicate to the audit committee the information of people who are not employed by the auditor, such as specialists, but perform audit procedures in the current period audit. Therefore, it is unlikely that the auditor will report that there is no CAM when he finds one.

[10] The auditor might have incentives to deviate from the "norm" to disclose his CAM signal. The reason is that the CAM signal allows the investor to fine-tune her scrutiny effort and thus can lower the probability of a bad investment, thereby decreasing the auditor's expected legal liability *ex post*. However, if such disclosure is not favorable to and is well anticipated by the investor, she will do something to prevent the auditor from deviating from the "norm." Indeed, before CAM disclosure is mandated, auditors have maintained essentially the same reporting model over many years, simply providing a binary "pass/fail" opinion on a company's financial statements. That is, auditors express the view that a client's financial statements are presented either fairly (pass) or not (fail) in accordance with generally accepted accounting principles. Audit reports strictly take this standard format, and the information about CAMs is largely prohibited from being disclosed.

to ensure an interior solution for the optimal investor scrutiny. As will be discussed in detail in Section III, the investor's scrutiny decision is contingent on whether the CAM signal is disclosed. The investor undertakes the investment if and only if her signal is $s = v$.[11]

Date 3—Project outcome and auditor liability: At date 3, the outcome of the investment is realized and an investment failure will accordingly reveal any undetected misstatement. In both disclosure and non-disclosure regimes, an *audit failure* occurs when the auditor issues an unqualified opinion and the investor chooses to invest, but the investment is revealed to be bad, namely, when $a = v$, $s = v$, and $x = 0$. The auditor will be held liable and pay the damage amount αI in the audit failure, where $\alpha \in (0,\ 1)$ measures the severity of the auditor's liability. Since $\alpha < 1$, the auditor's legal exposure is lower than the investor's financial loss I; thus, the investor has incentives to exert scrutiny effort to minimize her "uninsured" financial loss in an audit failure, i.e., $(1 - \alpha)I$.

Audit effort e and investor scrutiny γ jointly determine investment efficiency, which is measured by the probability that a bad investment is saved times the investment amount I. Our focus is on how the disclosure requirement affects the strategic interactions between audit effort and investor scrutiny and the consequential effect on investment efficiency.

The sequence of events in the model and its information structures under different disclosure regimes are also summarized as follows:

Date 0: Nature chooses firm value and, accordingly, the existence of CAMs. The firm claims that its project value is $x = v$.

Date 1: The auditor first observes an imperfect signal about the existence of CAMs $A \in \{C, N\}$, then exerts effort e to examine the firm's report, and finally issues an audit opinion $a \in \{0, v\}$. The auditor discloses the CAM signal A only in the disclosure regime. If $a = 0$, the game ends.

Date 2: If $a = v$, the investor exerts scrutiny effort γ to find out the value of x. She invests I in the firm's project if and only if her signal is $s = v$.

Date 3: If the investment is made, it generates a payoff of $x \in \{0, v\}$. If $x = 0$, the auditor pays damage αI to the investor.

[11] Since in our model the investor will not further examine the investment upon observing the auditor's qualified opinion, CAM disclosure is relevant only if the auditor issues an unqualified opinion. This model feature is consistent with the PCAOB's new requirement that auditors should provide CAM disclosure in conjunction with unqualified opinions (AS 3101).

III. EQUILIBRIUM DERIVATION

The equilibrium solution concept for the model is Bayesian Nash equilibrium, which requires that each player's choice be optimized given his/her subjective belief about the strategy of the opposing player at each decision point. The model is solved by backward induction. Since the analyses in both the disclosure and non-disclosure regimes share many common steps, in this section we analyze the equilibrium in each of these two settings synchronously to avoid repetition. The difference between these two settings is that the auditor discloses his signal about the existence of CAMs $A \in \{C, N\}$ only in the disclosure regime. Notice that both the investor's scrutiny decision and the auditor's effort decision can be conditional on the auditor's CAM signal as well as on whether the signal is disclosed. For the investor, we use subscripts DN, DC, and X to denote the case in which she sees $A = N$ in the disclosure regime, sees $A = C$ in the disclosure regime, and sees nothing in the non-disclosure regime, respectively. For the auditor, we use subscripts RN and RC to denote the respective cases in which his signal is N and C, where $R \in \{D, X\}$. Accordingly, we have $e \in \{e_{DC}, e_{DN}, e_{XC}, e_{XN}\}$ and $\gamma \in \{\gamma_{DC}, \gamma_{DN}, \gamma_X\}$. Our analysis will highlight how the probability of investment failure $\Pr(x = 0|\text{information set}; R)$ evolves as the auditor's and investor's signals arrive sequentially and how this probability affects the auditor's and investor's decisions. To ease our discussion, we refer to $\Pr(x = 0|A)$ as the prior investment risk perceived by the investor in the disclosure regime and that perceived by the auditor in both regimes; we refer to $\Pr(x = 0)$ as the prior investment risk perceived by the investor in the non-disclosure regime.[12] In contrast, we refer to $\Pr(x = 0|a = v; X)$ and $\Pr(x = 0|a = v, A; D)$ as the investor's pre-posterior belief of investment risk in the non-disclosure and disclosure regimes, respectively.

Investor's Scrutiny Effort and Investment Decisions

Because the game ends whenever the auditor issues a qualified opinion $a = 0$, we derive the investor's optimal scrutiny effort and investment decision rules only when the auditor issues an unqualified opinion $a = v$. The investor cannot observe audit effort and thus will form conjectures, denoted by the pairs $\{\hat{e}_{XN}, \hat{e}_{XC}\}$ and $\{\hat{e}_{DN}, \hat{e}_{DC}\}$ in the non-disclosure and disclosure regimes, respectively. We use the hat $\hat{}$ to denote a conjecture.

[12] The auditor's audit opinion and disclosure of CAMs become available to the investor at the same time. The label prior investment risk $\Pr(x = 0|A)$ implicitly means that the investor reads the CAM disclosure first and the audit opinion second.

Given (1), upon observing $a = v$, the investor's default investment decision without her own scrutiny effort will change from not to invest to invest in the non-disclosure regime as well as in the disclosure regime with $A = N$. In contrast, the investor's posterior belief might be quite pessimistic in the disclosure regime with $A = C$. To ensure that the investor's scrutiny effort is useful for decision making in equilibrium, we assume that

$$\Pr(x = v|a = v, s = v, C; D)v - I = \frac{(1-\phi)v}{1 - \phi + \phi(1 - \hat{e}_{DC})(1 - \gamma_{DC})} - I > 0, \tag{6}$$

which holds if v is sufficiently large.[13]

Depending on what she knows about CAMs, the investor's expected profit before exerting scrutiny effort is

$$\begin{aligned}
\Pi_X^I &= \Pr(x = v|a = v; X)(v - I) - \Pr(s = v, x = 0|a = v; X)(1 - \alpha) I - \frac{1}{2}m\gamma^2, \\
\Pi_{DA}^I &= \Pr(x = v|a = v, A; D)(v - I) - \Pr(s = v, x = 0|a = v, A; D)(1 - \alpha) I - \frac{1}{2}m\gamma^2,
\end{aligned}$$

where $A \in \{N, C\}$ is known to the investor only in the disclosure regime. The first term of Π^I describes the situation in which the investment is good and has a net present value of $v - I > 0$ as a result. The second term relates to the situation in which the investment is bad: the investor will incur a loss I if she fails to uncover the firm's misstatement, and she will then recoup αI through suing the auditor. The third term of Π^I is the investor's scrutiny effort cost.

The investor's scrutiny helps herself identify and thus avoid a bad investment. Accordingly, investor scrutiny γ does not affect the first term of Π^I but decreases $\Pr(s = v, x = 0|a = v; X)$ and $\Pr(s = v, x = 0|a = v, A; D)$ in the second term, which can be rewritten as

$$\begin{aligned}
\Pr(s = v, x = 0|a = v; X) &= (1 - \gamma_X)\Pr(x = v|a = v; X), \\
\Pr(s = v, x = 0|a = v, A; D) &= (1 - \gamma_{DA})\Pr(x = 0|a = v, A; D).
\end{aligned}$$

The investor's scrutiny decision is then characterized by the first-order condition of her

[13] In Appendix A, we show that inequality (6) holds if $v > \frac{k}{2\alpha\phi(1-\phi)}$.

maximization problem:

$$\begin{aligned}\gamma_X^* &= \Pr(x=0|a=v;X)\frac{(1-\alpha)I}{m}, \\ \gamma_{DA}^* &= \Pr(x=0|a=v,A;D)\frac{(1-\alpha)I}{m},\end{aligned} \tag{7}$$

where

$$\Pr(x=0|a=v;X) = \frac{1-\hat{\bar{e}}_X|_{CAM}}{\frac{1}{\Pr(x=0)}-\hat{\bar{e}}_X|_{CAM}}, \tag{8}$$

$$\Pr(x=0|a=v,A;D) = \frac{1-\hat{e}_{DA}}{\frac{1}{\Pr(x=0|A)}-\hat{e}_{DA}} \tag{9}$$

are the investor's pre-posterior belief of investment risk (i.e., after observing the unqualified audit opinion but before exerting scrutiny effort) in the non-disclosure and disclosure regimes, respectively. In the non-disclosure regime, the investor does not know the CAM signal and thus can only update her belief using the expected audit effort $\bar{e}_X|_{CAM} \equiv E_X[e|CAM] = (1-p)e_{XN} + pe_{XC}$ as shown in equation (8). The investor exerts higher scrutiny when her pre-posterior belief of investment risk is higher, i.e., $\frac{\partial \gamma_X^*}{\partial \Pr(x=0|a=v;X)} > 0$ and $\frac{\partial \gamma_{DA}^*}{\partial \Pr(x=0|a=v,A;D)} > 0$, because she suffers from a net loss of $(1-\alpha)I$ when the investment fails. Investor scrutiny increases when her irrecoverable investment loss $(1-\alpha)I$ or effort efficiency $1/m$ increases, which is intuitive. The investor's pre-posterior belief of investment risk is determined by the prior investment risk and audit effort. Lemma 1 below shows the corresponding properties of $\gamma_X^*(\hat{\bar{e}}_X|_{CAM})$, $\gamma_{DN}^*(\hat{e}_{DN})$ and $\gamma_{DC}^*(\hat{e}_{DC})$.

Lemma 1 The investor's optimal scrutiny effort under the non-disclosure regime, $\gamma_X^*(\hat{\bar{e}}_X|_{CAM})$, and that under the disclosure regime, $\gamma_{DC}^*(\hat{e}_{DC})$ and $\gamma_{DN}^*(\hat{e}_{DN})$, have the following properties:

1. they decrease with their respective arguments; that is, $\frac{\partial \gamma_X^*(\hat{\bar{e}}_X|_{CAM})}{\partial \hat{\bar{e}}_X|_{CAM}} < 0$, $\frac{\partial \gamma_{DN}^*(\hat{e}_{DN})}{\partial \hat{e}_{DN}} < 0$, and $\frac{\partial \gamma_{DC}^*(\hat{e}_{DC})}{\partial \hat{e}_{DC}} < 0$;

2. holding $\hat{e}$ fixed across different regimes and different CAM signals (i.e., $\hat{e} = \hat{\bar{e}}_X|_{CAM} = \hat{e}_{DN} = \hat{e}_{DC}$), the disclosure of signal C (N) increases (decreases) investor scrutiny; that is, $\gamma_{DN}^*(\hat{e}) < \gamma_X^*(\hat{e}) < \gamma_{DC}^*(\hat{e})$.

Lemma 1.1 states that the investor's scrutiny effort is decreasing in her conjectured audit effort in both the non-disclosure and disclosure regimes. This is because a higher audit effort means that the investment with an unqualified audit opinion is less likely to be bad (i.e., $\frac{\partial \Pr(x=0|a=v;X)}{\partial \hat{e}_X|_{CAM}} < 0$ and $\frac{\partial \Pr(x=0|a=v,A;D)}{\partial \hat{e}_{DA}} < 0$) and, consequently, the marginal benefit of the investor scrutiny is smaller.

Holding the conjectured audit effort $\hat{e}$ constant, CAM disclosure helps the investor assess the investment risk and therefore fine-tune her scrutiny effort according to the auditor's disclosure, leading to $\gamma^*_{DC}(\hat{e}) > \gamma^*_X(\hat{e}) > \gamma^*_{DN}(\hat{e})$, as shown in Lemma 1.2. However, as the optimal audit effort would vary across different regimes and CAM signals, the ultimate effect of CAM disclosure on investor scrutiny remains unclear and will be analyzed in Section IV.

Using (3), (8), and (9), we explicitly rewrite the investor's scrutiny decision as

$$\gamma^*_X = \frac{(1-\alpha)\,\phi I}{m}\frac{1-\hat{\bar{e}}_X|_{CAM}}{2-\phi\hat{\bar{e}}_X|_{CAM}}, \tag{10}$$

$$\gamma^*_{DA} = \begin{cases} \frac{(1-\alpha)\phi I}{m}\frac{(1-p)(1-\hat{e}_{DN})}{2-p-\phi(1-p)\hat{e}_{DN}} & \text{if } A = N, \\ \frac{(1-\alpha)\phi I}{m}\frac{1-\hat{e}_{DC}}{1-\phi\hat{e}_{DC}} & \text{if } A = C. \end{cases} \tag{11}$$

We assume that $m > (1-\alpha)\,\phi I$ to ensure an interior solution for the investor's optimal scrutiny effort.

Auditor's Effort Decision

The auditor is motivated to exert audit effort because of potential legal liabilities in the event of an audit failure, which occurs when the auditor issues an unqualified opinion and the investor chooses to invest but the project is revealed to be bad. Accordingly, the probability of audit failure is given by

$$\Pr(s=v, a=v, x=0|A;R) = \Pr(s=v, a=v|x=0, A;R)\Pr(x=0|A),$$

where

$$\begin{aligned} \Pr(s &= v, a=v|x=0, A;X) = (1-e_{XA})(1-\hat{\gamma}_X), \\ \Pr(s &= v, a=v|x=0, A;D) = (1-e_{DA})(1-\hat{\gamma}_{DA}). \end{aligned}$$

At date 1 after the audit fee F is fixed and the CAM signal is observed, the auditor chooses audit effort e to minimize the sum of his expected legal liability and effort cost:

$$\min_{e} \ \Pr(s = v, a = v, x = 0|A; R)\alpha I + \frac{1}{2}ke^2.$$

The auditor's effort decision is characterized by the first-order condition of his cost minimization problem:

$$\begin{aligned} e^*_{XA} &= (1-\hat{\gamma}_X)\frac{\alpha I}{k}\Pr(x=0|A) \\ &= \begin{cases} (1-\hat{\gamma}_X)\frac{\alpha\phi I}{k}\frac{1-p}{2-p} & \text{if } A = N, \\ (1-\hat{\gamma}_X)\frac{\alpha\phi I}{k} & \text{if } A = C, \end{cases} \end{aligned} \tag{12}$$

$$\begin{aligned} e^*_{DA} &= (1-\hat{\gamma}_{DA})\frac{\alpha I}{k}\Pr(x=0|A) \\ &= \begin{cases} (1-\hat{\gamma}_{DN})\frac{\alpha\phi I}{k}\frac{1-p}{2-p} & \text{if } A = N, \\ (1-\hat{\gamma}_{DC})\frac{\alpha\phi I}{k} & \text{if } A = C. \end{cases} \end{aligned} \tag{13}$$

We require $k > \alpha\phi I$ to ensure that the auditor's optimal audit effort is interior.

It is easy to see that $e^*_{XN}(\hat{\gamma}_X) < e^*_{XC}(\hat{\gamma}_X)$ due to the different prior investment risk, i.e., $\Pr(x = 0|C) > \Pr(x = 0|N)$. Also observe that $e^*_{XA}(\hat{\gamma}_X)$ and $e^*_{DA}(\hat{\gamma}_{DA})$ increase when the auditor's legal liability α increases, which is intuitive. Lemma 2 below provides more properties of $e^*_{XA}(\hat{\gamma}_X)$ and $e^*_{DA}(\hat{\gamma}_{DA})$ for $A \in \{C, N\}$.

Lemma 2 The auditor's optimal efforts under the non-disclosure regime, i.e., $e^*_{XC}(\hat{\gamma}_X)$ and $e^*_{XN}(\hat{\gamma}_X)$, and under the disclosure regime, i.e., $e^*_{DC}(\hat{\gamma}_{DC})$ and $e^*_{DN}(\hat{\gamma}_{DN})$, have the following properties:

1. they decrease with their respective arguments; that is, $\frac{\partial e^*_{XC}(\hat{\gamma}_X)}{\partial \hat{\gamma}_X} < 0$, $\frac{\partial e^*_{XN}(\hat{\gamma}_X)}{\partial \hat{\gamma}_X} < 0$, $\frac{\partial e^*_{DC}(\hat{\gamma}_{DC})}{\partial \hat{\gamma}_{DC}} < 0$, and $\frac{\partial e^*_{DN}(\hat{\gamma}_{DN})}{\partial \hat{\gamma}_{DN}} < 0$;
2. holding $\hat{\gamma}$ fixed across different regimes and different CAM signals (i.e., $\hat{\gamma} = \hat{\gamma}_X = \hat{\gamma}_{DN} = \hat{\gamma}_{DC}$), audit effort is higher given C than N, and CAM disclosure does not affect audit quality; that is, $e^*_{DN}(\hat{\gamma}) = e^*_{XN}(\hat{\gamma}) < e^*_{XC}(\hat{\gamma}) = e^*_{DC}(\hat{\gamma})$.

The investor's own investigation reduces the chance that she will undertake a bad investment and thereby decreases the auditor's expected legal liability under both the non-disclosure and disclosure regimes. Thus, the auditor optimally reduces audit effort when his conjectured investor scrutiny increases, as shown in Lemma 2.1.

Holding the conjectured investor scrutiny $\hat{\gamma}$ constant, the auditor's CAM signal facilitates his assessment of litigation risk and hence allows him to fine-tune his audit effort, leading to $e^*_{DN}(\hat{\gamma}) = e^*_{XN}(\hat{\gamma}) < e^*_{XC}(\hat{\gamma}) = e^*_{DC}(\hat{\gamma})$, as shown in Lemma 2.2. Again, since the investor's scrutiny effort would vary across different regimes and CAM signals, the ultimate effect of CAM disclosure on the equilibrium audit efforts remains unclear and will be analyzed in Section IV.

Equilibrium

Rational expectations among agents imply that their conjectures about others' unobservable actions must be correct in equilibrium. A Bayesian Nash equilibrium is characterized by the set of audit effort and investor scrutiny, which solves the best response function of the auditor and that of the investor simultaneously. The following proposition characterizes the unique Bayesian Nash equilibrium in the non-disclosure regime and that in the disclosure regime.

Proposition 1 The unique Bayesian Nash equilibrium in the non-disclosure regime and that in the disclosure regime are characterized by a triple, $(\gamma^*_X, e^*_{XN}, e^*_{XC})$, and a quadruple, $(\gamma^*_{DN}, \gamma^*_{DC}, e^*_{DN}, e^*_{DC})$, respectively. Specifically, let $\Psi \equiv \frac{(1-\alpha)\phi I}{m} < 1$ and $\Omega \equiv \frac{\alpha \phi I}{k} < 1$; then in the *non-disclosure* regime

$$e^*_{XA} = \begin{cases} (1-\gamma^*_X)\Omega\frac{1-p}{2-p} & \text{if } A = N, \\ (1-\gamma^*_X)\Omega & \text{if } A = C, \end{cases} \tag{14}$$

and γ^*_X is the unique positive real root of the following quadratic equation:

$$\phi\Omega\gamma^{*2}_X + [2(2-p) - (\phi+\Psi)\Omega]\gamma^*_X - \Psi(2-p-\Omega) = 0; \tag{15}$$

in the *disclosure* regime

$$e^*_{DA} = \begin{cases} (1-\gamma^*_{DN})\Omega\frac{1-p}{2-p} & \text{if } A = N, \\ (1-\gamma^*_{DC})\Omega & \text{if } A = C, \end{cases} \tag{16}$$

and γ^*_{DN} and γ^*_{DC} are the respective unique positive real roots of each of the following quadratic equations:

$$\phi\Omega\gamma^{*2}_{DN} + \left[\left(\frac{2-p}{1-p}\right)^2 - (\phi+\Psi)\Omega\right]\gamma^*_{DN} - \Psi\left(\frac{2-p}{1-p} - \Omega\right) = 0, \tag{17}$$

$$\phi\Omega\gamma^{*2}_{DC} + [1-(\phi+\Psi)\Omega]\gamma^*_{DC} - \Psi(1-\Omega) = 0. \tag{18}$$

IV. ECONOMIC CONSEQUENCES OF CAM DISCLOSURE

As shown in Lemmas 1.1 and 2.1, auditor effort and investor scrutiny are “strategic substitutes,” in the sense that the auditor and the investor will rationally decrease effort if the other player increases effort. Therefore, we expect that CAM disclosure will oppositely influence the level of audit effort and that of investor scrutiny. A key question is then how CAM disclosure would affect investment efficiency, which captures the investor’s total mix of information. In this section, we identify conditions under which CAM disclosure increases/decreases investor scrutiny (and accordingly decreases/increases audit effort). Upon this understanding, we discuss whether it is more desirable to induce audit effort or investor scrutiny and further answer when and why CAM disclosure increases/decreases investment efficiency.

Effects of CAM Disclosure on Audit Effort and Investor Scrutiny

We start with the comparison of the equilibrium audit effort and investor scrutiny across different disclosure regimes. Recall from Lemmas 1.2 and 2.2 that when audit effort is held constant, CAM disclosure increases (decreases) investor scrutiny given C (N), whereas when investor scrutiny is held constant, CAM disclosure has no effect on audit effort. The next proposition highlights the importance of endogenizing both audit effort and investor scrutiny to evaluate the consequences of CAM disclosure.

Proposition 2 CAM disclosure increases (decreases) investor scrutiny and decreases (increases) audit effort conditional on signal C (N) if and only if the auditor's legal liability is small or the CAM signal is precise. That is, there exist thresholds $\bar{\alpha}$ and $\bar{p}$ such that

$$\begin{cases} \text{if } \alpha < \bar{\alpha} \text{ or } p > \bar{p}, \text{ then } \gamma^*_{DN} < \gamma^*_X < \gamma^*_{DC},\ e^*_{DC} < e^*_{XC} \text{ and } e^*_{XN} < e^*_{DN}; \\ \text{if } \alpha > \bar{\alpha} \text{ and } p < \bar{p}, \text{ then } \gamma^*_{DN} > \gamma^*_X > \gamma^*_{DC} \text{ and } e^*_{DN} < e^*_{XN} < e^*_{XC} < e^*_{DC}. \end{cases}$$

On the premise that the presence of CAMs indicates a higher level of investment risk, the investor should respond to the disclosed CAM by increasing her scrutiny effort, namely, $\gamma^*_{DN} < \gamma^*_X < \gamma^*_{DC}$, because she is more likely to incur an irrecoverable investment loss. It follows that CAM disclosure induces lower audit effort given signal C, i.e., $e^*_{DC} < e^*_{XC}$, because investor scrutiny helps avoid bad investment and therefore leads to lower audit failure risk. The opposite is true given signal N, i.e., $e^*_{DN} > e^*_{XN}$.

However, the revelation of CAMs does not necessarily induce the investor to perceive higher investment risk. The key is how strong the investor's prior belief $\Pr(x = 0|A)$ is, and how significantly the auditor's strategic effort affects the investor's pre-posterior belief of investment risk in the disclosure regime, which is given by

$$\Pr(x = 0|a = v, A; D) = \frac{1 - e^*_{DA}}{\frac{1}{\Pr(x=0|A)} - e^*_{DA}},$$

as shown in (9). Hold the auditor's effort e^*_{DA} fixed for now. Then $\Pr(x = 0|a = v, A; D)$ is monotonically increasing in $\Pr(x = 0|A)$. Because $\Pr(x = 0|C) = \phi > \frac{1-p}{2-p}\phi = \Pr(x = 0|N)$, we have $\Pr(x = 0|a = v, C; D) > \Pr(x = 0|a = v, N; D)$. In this situation, the investor perceives a higher level of investment risk upon learning the existence of CAMs, consistent with the result shown in Lemma 1.2.

However, when the auditor strategically responds to the prior investment risk $\Pr(x = 0|A)$, the investor's pre-posterior belief $\Pr(x = 0|a = v, A; D)$ may change with the prior $\Pr(x = 0|A)$ non-monotonically such that the inequality $\Pr(x = 0|a = v, C; D) > \Pr(x = 0|a = v, N; D)$ no longer holds. To see this, using $e^*_{DA} = (1 - \gamma^*_{DA}) \Pr(x = 0|A) \frac{\alpha I}{k}$ as shown in (13), we rewrite (9) as

$$\Pr\left(x=0|a=v,A;D\right)=\frac{1-\left(1-\gamma_{DA}^{*}\right)\Pr\left(x=0|A\right)\frac{\alpha I}{k}}{\frac{1}{\Pr(x=0|A)}-\left(1-\gamma_{DA}^{*}\right)\Pr\left(x=0|A\right)\frac{\alpha I}{k}}. \tag{19}$$

Mute the investor's strategic behavior for now (i.e., hold γ_{DA}^{*} fixed). If the auditor's legal liability α is small, the auditor is not quite responsive to a change in the prior investment risk $\Pr\left(x=0|A\right)$, so his strategic effort effect is insignificant such that the inequality $\Pr\left(x=0|a=v,C;D\right) > \Pr\left(x=0|a=v,N;D\right)$ continues to hold. For example, in the limit when $\alpha \rightarrow 0$, we have $\Pr\left(x=0|a=v,A;D\right) = \Pr\left(x=0|A\right)$. As the auditor's legal liability α gets larger, his strategic effort effect becomes more significant, and the relation between $\Pr\left(x=0|a=v,A;D\right)$ and $\Pr\left(x=0|A\right)$ becomes non-monotonic: the right-hand side of (19) increases in $\Pr\left(x=0|A\right)$ when $A=N$ but decreases in $\Pr\left(x=0|A\right)$ when $A=C$ if $\Pr\left(x=0|C\right)$ is sufficiently large.[14] Taken together, (1) a sufficiently small p guarantees that the prior investment risk given N, i.e., $\Pr\left(x=0|N\right)$, is large and, thus, the pre-posterior belief of investment risk given N, i.e., $\Pr\left(x=0|a=v,N;D\right)$, is large, and (2) a sufficiently large α guarantees that the auditor strongly responds to the prior investment risk and thus exerts sufficiently high audit effort given C, leading to a small pre-posterior belief of investment risk given C, i.e., a small $\Pr\left(x=0|a=v,C;D\right)$. Therefore, a sufficiently small p together with a sufficiently large α ensures that $\Pr\left(x=0|a=v,C;D\right) < \Pr\left(x=0|a=v,N;D\right)$.

The investor's strategic scrutiny decision can adversely influence the auditor's effort decision, but this effect is weak if the auditor's legal liability α is large. The reason is that, as shown in equation (7), when α is large, the investor can recoup a large proportion of investment loss and is consequently not very responsive to the CAM signal.

Therefore, if the auditor's legal liability is large and the CAM signal is imprecise, the investor perceives a lower rather than higher level of investment risk upon learning about the presence of CAMs, resulting in $\gamma_{DC}^{*} < \gamma_{X}^{*} < \gamma_{DN}^{*}$ and $e_{DN}^{*} < e_{XN}^{*} < e_{XC}^{*} < e_{DC}^{*}$.

It is now clear how CAM disclosure affects audit effort and investor scrutiny. Notice that the auditor's and investor's efforts can save investment losses only when CAMs are present. Thus, we now examine how CAM disclosure influences *ex ante* (before the auditor receives the CAM signal) auditor effort and investor scrutiny in the presence of CAMs;

[14]See Appendix A for details.

that is,[15]

$$\begin{aligned}
\bar{e}^*_D|_{CAM} &\equiv E_D[e^*|CAM] = (1-p)e^*_{DN} + pe^*_{DC} \\
\text{versus } \bar{e}^*_X|_{CAM} &\equiv E_X[e^*|CAM] = (1-p)e^*_{XN} + pe^*_{XC}, \\
\bar{\gamma}^*_D|_{CAM} &\equiv E_D[\gamma^*|CAM] = (1-p)\gamma^*_{DN} + p\gamma^*_{DC} \\
\text{versus } \bar{\gamma}^*_X|_{CAM} &\equiv E_X[\gamma^*|CAM] = (1-p)p\gamma^*_X + p\gamma^*_X = \gamma^*_X.
\end{aligned}$$

Proposition 3 When CAMs are present, CAM disclosure increases expected investor scrutiny and decreases expected audit effort if and only if the auditor's legal liability is small or the CAM signal is precise. That is,

$$\begin{cases}
\text{if } \alpha < \bar{\alpha} \text{ or } p > \bar{p}, \text{ then } \bar{\gamma}^*_D|_{CAM} > \gamma^*_X \text{ and } \bar{e}^*_D|_{CAM} < \bar{e}^*_X|_{CAM}; \\
\text{if } \alpha > \bar{\alpha} \text{ and } p < \bar{p}, \text{ then } \bar{\gamma}^*_D|_{CAM} < \gamma^*_X \text{ and } \bar{e}^*_D|_{CAM} > \bar{e}^*_X|_{CAM}.
\end{cases}$$

The intuition behind Proposition 3 is as follows. In the non-disclosure regime, the investor can only guess the auditor's CAM signal based on her prior belief, i.e., $\Pr(C) = \frac{p}{2}$ and $\Pr(N) = 1 - \frac{p}{2}$. In contrast, in the disclosure regime, the investor can observe the CAM signal, and when CAMs are present, $\Pr(C|CAM) = p$ and $\Pr(N|CAM) = 1 - p$. As a result, CAM disclosure increases the chance for the investor to perceive (by either guessing or observing) signal C and correspondingly decreases that for signal N. CAM disclosure, therefore, increases the investor's expected scrutiny effort (i.e., $\bar{\gamma}^*_D|_{CAM} > \gamma^*_X$) if and only if her pre-posterior belief of investment risk $\Pr(x = 0|a = v, A; D)$ is higher given C than given N. As we discussed for the intuition behind Proposition 2, this is true if and only if $\alpha < \bar{\alpha}$ or $p > \bar{p}$.

Regarding audit effort, because the auditor always observes the CAM signal, the impact of CAM disclosure on audit effort is determined by how CAM disclosure affects the investor's scrutiny decision and how the auditor interacts with the investor. Our analysis thus far has demonstrated that audit effort and investor scrutiny are strategic substitutes. Specifically, investor scrutiny decreases the chance for the investor to undertake a bad investment and thus decreases the auditor's expected legal liability. CAM disclosure, therefore, decreases audit effort if it increases investor scrutiny, and *vice versa*.

[15] In Appendix B, we also compare the unconditional ones, i.e., $E_D[e^*]$ versus $E_X[e^*]$ as well as $E_D[\gamma^*]$ versus $E_X[\gamma^*]$, and obtain similar results.

Propositions 2 and 3 have policy implications. Proponents argue that CAM disclosure will focus investors' attention on key financial reporting areas that deserve more attention. Consistent with this view, if audit effort is held constant, CAM disclosure increases the investor's effort to scrutinize a risky project, not only *ex post* conditional on signal C but also *ex ante* before the CAM signal is observed. Propositions 2 and 3, however, highlight the importance of endogenizing audit effort: due to the auditor's strategic decision, CAM disclosure indeed decreases rather than increases the investor's effort to scrutinize a risky project both *ex post* and *ex ante* if the auditor's legal liability is large and the CAM signal is imprecise.

Figure 1 shows how *ex ante* audit effort, investor scrutiny, and overall informativeness change with the precision of the CAM signal p when the auditor's legal liability α is moderately high and when α is moderately low.

[Insert Figure 1 about here]

Effect of CAM Disclosure on Investment Efficiency

Having examined CAM disclosure's effects on audit effort and investor scrutiny, we now turn to our main research question of how CAM disclosure affects the investor's total mix of information. Specifically, in the disclosure regime, the investor has three sources of information about investment value: CAM disclosure, the information generated by auditor effort, and the information generated by investor scrutiny. In the non-disclosure regime, only the latter two sources are available. We have shown in the previous subsections that, because of the "strategic substitutes" relation between audit effort and investor scrutiny, CAM disclosure improves one party's effort at the expense of the other party's effort. As such, despite adding one source of information, CAM disclosure can adversely affect the net information from the latter two sources. To sharpen our insight, we examine investment efficiency, defined as the investment amount times the probability that a bad investment is saved. Investment efficiency is a comprehensive measure of the effects of CAM disclosure and is determined by all information available to the investor. In the context of our model, the saving of investment loss stems from the detection of a bad investment (i.e., $x = 0$), which is made possible by both audit effort and investor scrutiny. Let IE denote investment efficiency. It can be written as:

$$IE_R = [\Pr(x=0) - \Pr(s=v, a=v, x=0, N; R) - \Pr(s=v, a=v, x=0, C; R)]\, I,$$

for $R \in \{D, X\}$. Specifically,

$$IE_X = \frac{\phi I}{2} - \frac{\phi I}{2}[(1-p)(1-e_{XN}) + p(1-e_{XC})](1-\gamma_X), \tag{20}$$

$$IE_D = \frac{\phi I}{2} - \frac{\phi I}{2}[(1-p)(1-e_{DN})(1-\gamma_{DN}) + p(1-e_{DC})(1-\gamma_{DC})]. \tag{21}$$

On the right-hand side of equations (20) and (21), the first term measures the expected investment loss if neither the auditor nor the investor exerts effort to investigate the investment value x. This term also represents the maximum investment loss that can be saved by the auditor and the investor. The second term captures the investment loss when both the auditor and the investor fail to detect the bad investment. Both audit effort and investor scrutiny *ex post* increase investment efficiency, with the difference that the auditor is the "first mover," and the investor exerts scrutiny effort only when the auditor issues $a = v$.

CAM disclosure's direct impact is to enable the investor to fine-tune her scrutiny effort contingent on the CAM signal. Thus, we first discuss how fine-tuning by the investor affects investment efficiency, holding audit effort fixed. Holding e_{RC} and e_{RN} fixed across the disclosure and non-disclosure regimes, the investment loss saved by investor scrutiny changes from $\frac{\phi I}{2}[(1-p)(1-e_{RN}) + p(1-e_{RC})]\gamma_X^*(\bar{e}_R|_{CAM})$ in the non-disclosure regime to $\frac{\phi I}{2}[(1-p)(1-e_{RN})\gamma_{DN}^*(e_{RN}) + p(1-e_{RC})\gamma_{DC}^*(e_{RC})]$ in the disclosure regime. As shown in Lemma 3, this change is always positive.

Lemma 3 Holding e_{RC} and e_{RN} fixed across the disclosure and non-disclosure regimes, CAM disclosure increases the investment loss saved by investor scrutiny. That is, $\frac{\phi I}{2}[(1-p)(1-e_{RN}) + p(1-e_{RC})]\gamma_X^*(\bar{e}_R|_{CAM}) < \frac{\phi I}{2}[(1-p)(1-e_{RN})\gamma_{DN}^*(e_{RN}) + p(1-e_{RC})\gamma_{DC}^*(e_{RC})]$.

Lemma 3 shows that consistent with regulators' belief, CAM disclosure can improve investment efficiency by allowing the investor to fine-tune her scrutiny effort conditional on the CAM signal. Nevertheless, the ultimate effect of CAM disclosure on investment efficiency also depends on how the disclosure affects investor scrutiny and audit effort in expectation. Since CAM disclosure imposes opposite impacts on audit effort and investor scrutiny, its effect on investment efficiency is about whether it is more desirable to induce audit effort or investor scrutiny. To answer this question, we now try to understand, without fine-tuning by the investor, how an exogenous increase in audit effort or investor scrutiny affects investment efficiency. Using (10) and (11), we rewrite equation (20) as[16]

$$IE_X = \frac{\phi I}{2}\left[\frac{\Psi}{2-\phi \bar{e}_X|_{CAM}}(1-\bar{e}_X|_{CAM})^2 + \bar{e}_X|_{CAM}\right], \tag{22}$$

$$IE_X = \frac{\phi I}{2}\left[\frac{\Omega}{2-p}\gamma_X^2 + \left(1-\frac{2\Omega}{2-p}\right)\gamma_X + \frac{\Omega}{2-p}\right]. \tag{23}$$

Differentiating equations (22) and (23) with respect to $\bar{e}_X|_{CAM}$ and γ_X, respectively, we obtain Lemma 4.

Lemma 4 In the non-disclosure regime:

(i) *ex ante* (before the auditor receives the CAM signal) investment efficiency increases in the expected audit effort; that is, $dIE_X\left(\bar{e}_X|_{CAM}, \gamma_X^*(\bar{e}_X|_{CAM})\right)/d\bar{e}_X|_{CAM} > 0$;

(ii) *ex ante* investment efficiency decreases in investor scrutiny if and only if investor scrutiny is small; that is, $dIE_X\left(\gamma_X, \bar{e}_X^*|_{CAM}(\gamma_X)\right)/d\gamma_X < 0$ if and only if $\gamma_X < \bar{\gamma}$ (or, equivalently, $\bar{e}_X^*|_{CAM}(\gamma_X) > 1/2$), where $\bar{\gamma}$ is given in the proof.

Lemma 4 examines how *ex ante* investment efficiency in the non-disclosure regime IE_X changes with $\bar{e}_X|_{CAM}$ and γ_X if we take one of them as given and allow the other to respond strategically. Lemma 4 reveals a surprising relation. Even though both investor scrutiny and audit effort can detect bad investment and hence improve investment efficiency *ex post* (as shown in equation 20), the interaction between the investor and the auditor can fundamentally change how investor scrutiny and auditor effort affect investment efficiency *ex ante*. Notice that equation (20) can be rewritten as

$$IE_X = \frac{\phi I}{2} - \frac{\phi I}{2}(1-\bar{e}_X|_{CAM})(1-\gamma_X), \tag{24}$$

which shows that investor scrutiny and audit effort crowd out each other's effect in improving investment efficiency (*crowd-out effect*). It is because a higher audit effort leaves

[16] See Appendix A for the derivation of equations (22) and (23).

less room for investor scrutiny to improve investment efficiency, and vice versa.[17] In other words, holding $\bar{e}_X|_{CAM}$ and γ_X exogenous, the marginal effect of $\bar{e}_X|_{CAM}$ in saving investment loss decreases in γ_X, and the marginal effect of γ_X in saving investment loss decreases in $\bar{e}_X|_{CAM}$. When the auditor's strategic response is taken into consideration, an exogenous increase in γ_X both directly increases IE_X and indirectly decreases IE_X by decreasing $\bar{e}^*_X|_{CAM}(\gamma_X)$. Due to the crowd-out effect, the larger γ_X, the smaller the negative indirect impact (i.e., the less significantly a decrease in $\bar{e}^*_X|_{CAM}(\gamma_X)$ can affect IE_X); thus, investment efficiency is a convex function of γ_X *ex ante*. To see this, differentiating equation (24) with respective to γ_X yields,

$$\frac{dIE_X}{d\gamma_X} = \frac{\phi I}{2}\left[1 - \bar{e}^*_X|_{CAM}(\gamma_X) + (1-\gamma_X)\frac{d\bar{e}^*_X|_{CAM}(\gamma_X)}{d\gamma_X}\right],$$

where $\frac{d\bar{e}^*_X|_{CAM}(\gamma_X)}{d\gamma_X} < 0$. Crowd-out effect means that the larger γ_X, the smaller the coefficient of $\frac{d\bar{e}^*_X|_{CAM}(\gamma_X)}{d\gamma_X}$. The "strategic substitutes" relation between audit effort and investor scrutiny can further strengthen the convexity of $IE_X\left(\gamma_X, \bar{e}^*_X|_{CAM}(\gamma_X)\right)$: the first term $1 - \bar{e}^*_X|_{CAM}(\gamma_X)$ is increasing in γ_X. Accordingly, *ex ante* IE_X increases in γ_X if and only if γ_X is large.

Similarly, *ex ante* investment efficiency is also a convex function of $\bar{e}_X|_{CAM}$ due to the crowd-out effect. However, we show that *ex ante* investment efficiency is monotonically increasing in $\bar{e}_X|_{CAM}$. This difference between how audit effort and investor scrutiny affect investment efficiency *ex ante* stems from the moving sequences of the auditor and the investor, which determine how the auditor and the investor differently respond to each other's strategy. Specifically, partially differentiating $\gamma^*_X\left(\bar{e}_X|_{CAM}\right)$ and $\bar{e}^*_X|_{CAM}\left(\gamma_X\right)$ with respect to their respective arguments yields[18]

$$\begin{aligned}
\frac{\partial\gamma^*_X(\bar{e}_X|_{CAM})}{\partial\bar{e}_X|_{CAM}} &= -\frac{\left(2-\bar{e}_X|_{CAM}\right)\Psi}{(2-\phi\bar{e}_X|_{CAM})^2} = -\frac{\gamma^*_X}{1-\bar{e}_X|_{CAM}}\frac{2-\bar{e}_X|_{CAM}}{2-\phi\bar{e}_X|_{CAM}}, \\
\frac{\partial\bar{e}^*_X|_{CAM}\left(\gamma_X\right)}{\partial\gamma_X} &= -\frac{\Omega}{2-p} = -\frac{\bar{e}^*_X|_{CAM}}{1-\gamma_X}.
\end{aligned}$$

[17] This *crowd-out effect* is different from the "strategic substitutes" relation between audit effort and investor scrutiny discussed earlier. *Crowd-out effect* means that higher effort of one party decreases the effect of the effort of the other party in improving investment efficiency. "Strategic substitutes" means that higher effort of one party lowers the other party's marginal profit and hence effort.

[18] The second equalities of the two equations come from $\gamma^*_X(\bar{e}_X|_{CAM}) = \frac{(1-\bar{e}_X|_{CAM})\Psi}{2-\bar{e}_X|_{CAM}\phi}$ and $\bar{e}^*_X|_{CAM}\left(\gamma_X\right) = \frac{\Omega(1-\gamma_X)}{2-p}$, respectively.

One can see that the two expressions are largely comparable with the exception that $\frac{2-\bar{e}_X|_{CAM}}{2-\phi\bar{e}_X|_{CAM}} \in (0,1)$. Accordingly, investor scrutiny decreases in audit effort less dramatically than audit effort decreases in investor scrutiny. The rationale is that due to the auditor's "first-mover" advantage, investor scrutiny is conditional on the audit result (i.e., the investor scrutinizes the firm only when the auditor gives an unqualified opinion), but audit effort is not conditional on the investor scrutiny result.

We have thus far discussed (i) holding audit effort fixed, how fine-tuning by the investor affects investment efficiency, (ii) how fine-tuning by the investor affects the expected audit effort, and (iii) without the investor's fine-tuning opportunity, how an exogenous increase in the expected audit effort affects investment efficiency. To view how CAM disclosure affects investment efficiency via these effects integratedly, we use equation (11) to rewrite equation (21) as[19]

$$\begin{aligned} IE_D &= \frac{\phi I}{2}\left[\bar{e}_D|_{CAM} + \frac{\Psi}{2-\phi\bar{e}_D|_{CAM}}\left(1-\bar{e}_D|_{CAM}\right)^2\right] \\ &+ \frac{\phi I}{2}\frac{p\left(1-\phi e_{DC}\right)\left[2-p-\phi(1-p)e_{DN}\right]}{\left(2-\phi\bar{e}_D|_{CAM}\right)\Psi}\left[\gamma^*_{DC}\left(e_{DC}\right)-\gamma^*_{DN}\left(e_{DN}\right)\right]^2. \quad (25) \end{aligned}$$

In equation (25), we take audit effort as exogenously given and allow the investor to strategically respond to the given audit effort. Equation (25) helps us decompose the effects of CAM disclosure into two parts. Each part captures one of the following two steps that together cause the same changes in equilibrium as CAM disclosure does: (i) exogenously changing audit effort from e^*_{XA} to e^*_{DA}, and then (ii) providing the investor the CAM signal and allowing the investor to react rationally. Notice that the first term of equation (25) has the same form as equation (22). Accordingly, the effect of step (i) on investment efficiency is captured by the change in the first term of equation (25) if the expected audit effort changes from $\bar{e}^*_X|_{CAM}$ to $\bar{e}^*_D|_{CAM}$. Lemma 4 shows that this effect is positive if and only if $\bar{e}^*_D|_{CAM} > \bar{e}^*_X|_{CAM}$, which is equivalent to $\alpha > \bar{\alpha}$ and $p < \bar{p}$ as shown in Proposition 3. The effect of step (ii) on investment efficiency is captured by the second term of equation (25), which is always positive. Because audit effort has been set at the equilibrium level, the investor's feedback effect on audit effort is muted; thus, the effect of step (ii) is always positive as discussed in Lemma 3. Taken together, CAM disclosure increases investment efficiency when it increases audit effort in expectation, which is true if and only if $\alpha > \bar{\alpha}$ and $p < \bar{p}$.

[19]See Appendix A for the derivation of equation (25).

In contrast, if $\alpha < \bar{\alpha}$ or $p > \bar{p}$, CAM disclosure, on one hand, improves investment efficiency by enabling the investor to fine-tune her scrutiny effort and, on the other hand, decreases investment efficiency by decreasing the expected audit effort. Thus, the overall impact of CAM disclosure on investment efficiency is ambiguous. To gain more insights on this situation when $\alpha < \bar{\alpha}$ or $p > \bar{p}$, we use (16) to alternatively rewrite equation (21) as

$$\begin{aligned} IE_D &= \frac{\phi I}{2}\left[\frac{\Omega}{2-p}\bar{\gamma}_D^2|_{CAM} + \left(1 - \frac{2\Omega}{2-p}\right)\bar{\gamma}_D|_{CAM} + \frac{\Omega}{2-p}\right] \\ &\quad - \frac{\phi I p\,(1-p)\,\Omega\,(1-\gamma_{DC})\,(\gamma_{DC}-\gamma_{DN})}{2-p}. \end{aligned} \tag{26}$$

In expression (26), investor scrutiny is taken as exogenously given, and the auditor is allowed to strategically respond to the given investor scrutiny. Equation (26) decomposes the impact of CAM disclosure on investment efficiency according to the following two steps: (i) exogenously increasing investor scrutiny from γ_X^* to $\bar{\gamma}_D^*|_{CAM}$ (without dispersion) and allowing the auditor to react rationally, and then (ii) exogenously changing investor scrutiny from $\bar{\gamma}_D^*|_{CAM}$ to $\{\gamma_{DC}^*, \gamma_{DN}^*\}$ (adding dispersion) and allowing the auditor to respond rationally. To see how the auditor reacts, we rewrite $\bar{e}_X^*|_{CAM}$ and $\bar{e}_D^*|_{CAM}$ as

$$\begin{aligned} \bar{e}_X^*|_{CAM} &= \frac{\Omega\,(1-\gamma_X^*)}{2-p}, \\ \bar{e}_D^*|_{CAM} &= \frac{\Omega\,(1-\bar{\gamma}_D^*|_{CAM})}{2-p} - \frac{\Omega p\,(1-p)\,(\gamma_{DC}^*-\gamma_{DN}^*)}{2-p}. \end{aligned}$$

When $\alpha < \bar{\alpha}$ or $p > \bar{p}$, we have $\gamma_{DC}^* > \gamma_{DN}^*$ and $\bar{\gamma}_D^*|_{CAM} > \gamma_X^*$. Accordingly, both the exogenous increase in investor scrutiny (step i) and the fine-tuning by the investor (step ii) decrease expected audit effort and thus can negatively affect investment efficiency. The effect of step (i) is manifesting in the first term of expression (26). Given that $\gamma_X < \bar{\gamma}$, the decrease in expected audit effort dominates the increase in investor scrutiny in influencing investment efficiency as shown in Lemma 4, so the effect of step (i) is to decrease investment efficiency. The negative effect of step (ii) on investment efficiency through decreasing expected audit effort is shown by the negative sign of the second term in expression (26). Hence, given that $\gamma_X < \bar{\gamma}$, CAM disclosure decreases investment efficiency when $\alpha < \bar{\alpha}$ or $p > \bar{p}$. Proposition 4 below summarizes the impact of CAM disclosure on investment efficiency.

Proposition 4 (i) CAM disclosure leads to higher investment efficiency if the auditor's legal liability is large and the CAM signal is imprecise; that is, $IE_D^* > IE_X^*$ if $\alpha > \bar{\alpha}$ and $p < \bar{p}$.

(ii) Suppose that $\bar{\gamma}_D^*|_{CAM} < \bar{\gamma}$. CAM disclosure leads to lower investment efficiency if the auditor's legal liability is small or the CAM signal is precise; that is, $IE_D^* < IE_X^*$ if $\alpha < \bar{\alpha}$ or $p > \bar{p}$.

Proposition 4 has important policy implications. Proponents of CAM disclosure argue that the disclosure will contribute to investors' ability to make investment decisions by adding to investors' total mix of information and identifying areas that deserve more attention (PCAOB Release No. 2007-001), particularly when the investor scrutiny is considered inadequate and the informational value of CAM disclosure is high. However, Proposition 4 shows that CAM disclosure decreases investment efficiency exactly when investor scrutiny is low, CAM disclosure increases investor scrutiny on average, and the auditor's CAM signal is of high quality.

Notice that $\bar{\gamma}_D^*|_{CAM} < \bar{\gamma}$ is a sufficient but unnecessary condition, which means that the result stated in part (ii) of Proposition 4 may still hold even if the condition $\bar{\gamma}_D^*|_{CAM} < \bar{\gamma}$ is violated, as shown in Figure 1. If $\bar{\gamma}_D^*|_{CAM} > \bar{\gamma}$, the effect of exogenously increasing investor scrutiny from γ_X^* to $\bar{\gamma}_D^*|_{CAM}$ (without dispersion) can be to increase investment efficiency as discussed in Lemma 4. However, the effect of exogenously changing investor scrutiny from $\bar{\gamma}_D^*|_{CAM}$ to $\{\gamma_{DC}^*, \gamma_{DN}^*\}$ (adding dispersion) is to decrease investment efficiency if $\alpha < \bar{\alpha}$ or $p > \bar{p}$. Therefore, when the condition $\bar{\gamma}_D^*|_{CAM} < \bar{\gamma}$ does not hold, the impact of CAM disclosure is ambiguous if $\alpha < \bar{\alpha}$ or $p > \bar{p}$.

Also notice that $\bar{\gamma}_D^*|_{CAM} < \bar{\gamma}$ is equivalent to $\bar{e}_D^*|_{CAM} > 1/2$, which seems realistic. Martin Baumann, the PCAOB's chief auditor back then was quoted in the Wall Street Journal (Chasan 2014) as saying, "When we look at an audit, the rate of failure has been in a range of around 35 to 40%." People suspect that this PCAOB's alleged audit failure rate is inflated due to, e.g., the PCAOB's selective screening and hindsight bias (Peecher and Solomon 2014). In a different dimension, Berglund (2020) shows that the type II going concern opinion errors (i.e., bankruptcies preceded by clean audit opinions) varied from 18.6 to 45.7 percent during 2005 to 2014, with an average rate of 30 percent.

Effect of CAM Disclosure on Audit Fee

We now examine the effect of CAM disclosure on the audit fee F. Under the assumption of a competitive audit market, the audit fee consists of two components: the auditor's expected effort cost and legal liability evaluated at the equilibrium audit effort and investor scrutiny. In particular, for $R \in \{D,\ X\}$, we have

$$F_R^* = \underbrace{\frac{1}{2} k e_{RN}^{*2} \Pr(N) + \frac{1}{2} k e_{RC}^{*2} \Pr(C)}_{\text{expected audit effort cost}} + EL_R^*,$$

and the auditor's expected liability EL_R^* is

$$\begin{aligned} EL_R^* &= \alpha I \left[\Pr(s = v, a = v, x = 0, C; R) + \Pr(s = v, a = v, x = 0, N; R) \right] \\ &= \begin{cases} \frac{\phi \alpha I}{2} [(1-p)(1-e_{XN}^*) + p(1-e_{XC}^*)](1-\gamma_X^*) & \text{if } R = X, \\ \frac{\phi \alpha I}{2} [(1-p)(1-e_{DN}^*)(1-\gamma_{DN}^*) + p(1-e_{DC}^*)(1-\gamma_{DC}^*)] & \text{if } R = D. \end{cases} \end{aligned} \quad (27)$$

The audit fails when the bad investment is undertaken (i.e., $a = v$, $s = v$, and $x = 0$). As such, the effect of CAM disclosure on the auditor's expected liability is opposite to that on investment efficiency: $EL_R^* = \alpha(\frac{\phi I}{2} - IE_R^*)$. Accordingly, CAM disclosure often has opposite effects on the expected audit effort cost and auditor liability. For example, *ceteris paribus*, the auditor will charge less for the lower expected audit effort in the disclosure regime when the CAM signal is precise. However, the lower audit effort also increases the expected auditor liability, so the auditor would charge a higher fee to break even. The net effect on the audit fee then depends on which force dominates. Proposition 5 shows that when the CAM signal is sufficiently precise, CAM disclosure's negative impact on the audit fee through decreasing the expected audit effort dominates its positive impact through increasing the auditor's expected liability.

Proposition 5 CAM disclosure decreases the audit fee if the CAM signal is sufficiently precise; that is, $F_D^* < F_X^*$ if p is sufficiently large.

V. POLICY AND EMPIRICAL IMPLICATIONS

Proponents of CAM disclosure argue that the disclosure will focus investors' attention on key financial reporting areas that deserve more attention, add to investors' total mix of information, and thus contribute to investors' ability to make investment decisions (PCAOB Release No. 2017-001). We show that this is true if we assume CAM disclosure does not affect audit effort. However, when its effect on auditors' effort is considered, CAM disclosure is likely to improve investment efficiency mainly when auditors' legal liability is large and the quality of the auditor's CAM signal is low.

Our analyses generate novel predictions on the economic consequences of CAM disclosure. In particular, we show that its impacts on audit effort, investor scrutiny, investment efficiency, and the audit fee can vary by the auditor's legal liability (α) and the precision of the CAM signal (p), which in reality may vary across different auditor and client firm characteristics. For example, larger auditors are more prone to litigation because they have deeper pockets (Dye 1993). The quality of the CAM signal is likely to be engagement-specific, depending on both auditor and client firm characteristics such as the engagement auditor's prior training, knowledge, and experience, and the client firm's industry, organizational structure and complexity, income sources, and asset composition.

Table 1 below summarizes our main results. To save space, we highlight only a few empirical implications from these results here. First, CAM disclosure is more likely to decrease audit effort on average and decrease investment efficiency if the auditor's legal liability is small or the CAM signal is precise. Second, if the CAM signal is very precise, CAM disclosure also decreases audit fees.

[Insert Table 1 about here]

In terms of empirical findings on the initial implementation of the CAM requirements, a recent study by the PCAOB, as well as some emerging academic research on CAMs, finds no systematic relationship between initial CAM implementation and audit fees/audit hours (PCAOB 2020; Burke et al. 2021). This finding seems somewhat surprising given that CAM disclosure requirements would lead to incremental audit work prior and subsequent to the auditor's discovery of CAMs. Our model can help explain this seemingly surprising empirical finding. Note that as the CAM requirement took effect for large accelerated filers with audit reports issued on or after June 30, 2019 (PCAOB 2017), the early empirical research on CAMs is likely to document the effects of CAM disclosure on larger firms that are mostly audited by Big N auditors. Our model predicts that in an audit environment with large auditors who are more prone to litigation, CAM disclosure can either increase or decrease expected audit effort. In particular, CAM disclosure decreases the average level of audit effort and the audit fee when the CAM signal is sufficiently precise. Thus, our model suggests that controlling the auditor and client firm characteristics relevant to the quality of the CAM signal is important in conducting empirical tests.

VI. CONCLUSION

We examine the effects of disclosing CAMs on audit effort, investor scrutiny, and investment efficiency. Both audit effort and investor scrutiny help the investor identify and reject bad investment *ex post*. CAM disclosure assists the investor in assessing investment risk as well as inferring audit effort, thereby allowing her to fine-tune scrutiny effort. We show, however, that CAM disclosure can reduce investment efficiency, namely, the total mix of information to the investor, through adversely affecting audit effort. We show that the auditor's legal liability and the quality of the auditor's CAM signal are important determinants of the economic consequences of CAM disclosure. CAM disclosure is likely to achieve the regulator's goal of providing more accurate audit reports and improving investment efficiency mainly when the auditor's legal liability is large and the quality of the auditor's CAM signal is low.

REFERENCES

Arens, A., and J. Loebbecke. 1981. *Applications of Statistical Sampling to Auditing.* Englewood Cliffs, NJ: Prentice Hall.

Berglund, N. R. 2020. Do Client Bankruptcies Preceded by Clean Audit Opinions Damage Auditor Reputation? *Contemporary Accounting Research* 37(3): 1914-1951.

Boone, J. P., I. Khurana, and K. K. Raman. 2010. Do the Big 4 and Second-Tier Firms Provide Audits of Similar Quality? *Journal of Accounting and Public Policy* 29(4): 330-352.

Brasel, K. R., M. M. Doxey, J. H. Grenier, and A. Reffett. 2016. Risk Disclosure Preceding Negative Outcomes: The Effects of Reporting Critical Audit Matters on Judgments of Auditor Liability. *The Accounting Review* 91(5): 1345–1362.

Brown, K., T. Majors, and M. Peecher. 2015. The Influence of Evaluator Expertise, a Judgement Rule, and Critical Audit Matters on Assessment of Auditor Legal Liability. Working Paper, University of Illinois at Urbana-Champaign.

Bulow, J.I., J.D. Geanakoplos, and P.D. Klemperer. 1985. Multimarket Oligopoly: Strategic Substitutes and Complements. *Journal of Political Economy* 93: 488—511.

Burke, J., R. Hoitash, U. Hoitash, and X. Xiao. 2021. The Determinants, Textual Properties, and Consequences of U.S. Critical Audit Matter Disclosures. Working Paper, University of Colorado Denver, Bentley University, Northeastern University, Northeastern University.

Caplan, D. 1999. Internal Control and Detection of Management Fraud. *Journal of Accounting Research* 37(1): 101-117.

Chan, D. 2018. The Effects of Internal Control Reporting Regulation on Control Quality, Compensation and Audit Effort. Working Paper, The University of Hong Kong.

Chan, D., and N. Liu. 2022. Financial Reporting, Auditing, Analyst Scrutiny, and Investment Efficiency. *The Accounting Review* (forthcoming).

Chan, D., and K. Wong. 2002. Scope of Auditors' Liability, Audit Quality, and Capital Investment. *Review of Accounting Studies* 7: 97–122.

Chasan, E. 2014. One in Three Audits Fails, PCAOB Chief Auditor Says. *Wall Street Journal*, 4.

Chen, Q., X. Jiang, and Y. Zhang. 2019. The Effects of Audit Quality Disclosure on Audit Effort and Investment Efficiency. *The Accounting Review* 94(4): 189–214.

DeAngelo, L. E. 1981. Auditor Size and Audit Quality. *Journal of Accounting and Economics* 3(3): 183–100.

Dye, R. 1993. Auditing Standards, Legal liability, and Auditor Wealth. *Journal of Political Economy* 101: 887–914.

Dye, R. 1995. Incorporation and the Audit Market. *Journal of Accounting and Economics* 19: 75–114.

Gao, P., and G. Zhang. 2019. Auditing Standards, Professional Judgement, and Audit Quality. *The Accounting Review* 94(6): 201–225.

Gimbar, C., B. Hansen, and M. Ozlanski. 2016. The Effect of Critical Audit Matter Paragraphs and Accounting Standard Precision on Auditor Liability. *The Accounting Review* 91(6): 1629–1646.

Hillegeist, S.A. 1999, Financial Reporting and Auditing Under Alternative Damage Apportionment Rules. *The Accounting Review* 74 (July): 347–369.

Kachelmeier, S., D. Rimkus, J. Schmidt, and K. Valentine. 2019. The Forewarning Effect of Critical Audit Disclosures Involving Measurement Uncertainty. *Contemporary Accounting Research* 37(4): 2186–2212.

Laux, V., and P. Newman. 2010. Auditor Liability and Client Acceptance Decisions. *The Accounting Review* 85: 261–285.

Liu, N., and X. Zhang. 2021. Leader versus Lagger: How the Timing of Financial Reports Affects Information Quality and Investment Efficiency. Working paper, Southern University of Science and Technology, University of California, Berkeley.

Murphy, L. 2019. Critical Audit Matters: What Firms are Reporting. *Journal of Accountancy.* Available at: https://www.journalofaccountancy.com/news/2019/oct/cpa-firm-reporting-critical-audit-matters-201921907.html (last accessed May 29, 2022).

Pae, S., and S. Yoo. 2001. Strategic Interaction in Auditing: An Analysis of Auditors' Legal Liability, Internal Control System Quality, and Audit Effort. *The Accounting Review* 76(3): 333-356.

Patterson, E., and R. Smith. 2007. The Effects of Sarbanes-Oxley on Auditing and

Internal Control Strength. *The Accounting Review* 82(2): 427–455.

Peecher, M., and I. Solomon. 2014. PCAOB's 'Audit Failure' Rate is Highly Suspect. *CFO.com*.

Public Company Accounting Oversight Board (PCAOB). 2007. Observations On Auditors' Implementation Of PCAOB Standards Relating to Auditors' Responsibilities with Respect to Fraud. Washington, DC: PCAOB (Release No. 2007-001, January 22, 2007).

Public Company Accounting Oversight Board (PCAOB). 2012. Auditing Standard 1301. Communications with Audit Committees. Washington, DC: PCAOB.

Public Company Accounting Oversight Board (PCAOB). 2016. Proposed Auditing Standard: The Auditor's Report on an Audit of Financial Statements when the Auditor Expresses an Unqualified Opinion and Related Amendments to PCAOB. Washington, DC: PCAOB (Release No. 2016-003, May 11, 2016).

Public Company Accounting Oversight Board (PCAOB). 2017. Auditing Standard 3101. The Auditor's Report on an Audit of Financial Statements when the Auditor Expresses an Unqualified Opinion. Washington, DC: PCAOB.

Public Company Accounting Oversight Board (PCAOB). 2019. Implementation of Critical Audit Matters: A Deeper Dive on the Communication of CAMs. PCAOB Staff Guidance. Washington, DC: PCAOB (May 22, 2019).

Public Company Accounting Oversight Board (PCAOB). 2020. Staff White Paper: Econometric Analysis on the Initial Implementation of CAM Requirements. Washington, DC: PCAOB (October 2020).

Ye, M., and D. Simunic. 2013. The Economics of Setting Auditing Standards. *Contemporary Accounting Research* 30: 1191–1215.

Ye, M., and Simunic, D. A. 2022. The Impact of PCAOB-Type Regulations on Auditors Under Different Legal Systems. Journal of Accounting, Auditing & Finance (forthcoming).

Table 1: Consequences of CAM Disclosure

	Auditor's liability is small or CAM signal is precise	Auditor's liability is large and CAM signal is imprecise
Audit effort given C	$\downarrow$	$\uparrow$
Audit effort given N	$\uparrow$	$\downarrow$
Investor scrutiny given C	$\uparrow$	$\downarrow$
Investor scrutiny given N	$\downarrow$	$\uparrow$
Ex ante audit effort	$\downarrow$	$\uparrow$
Ex ante investor scrutiny	$\uparrow$	$\downarrow$
Investment efficiency	$\downarrow^{\dagger}$	$\uparrow$
Audit fee	$\downarrow^{\ddagger}$	I/D

† if $\bar{e}^*_D|_{CAM} > 1/2$

‡ if CAM signal is very precise

I/D means indeterminable.

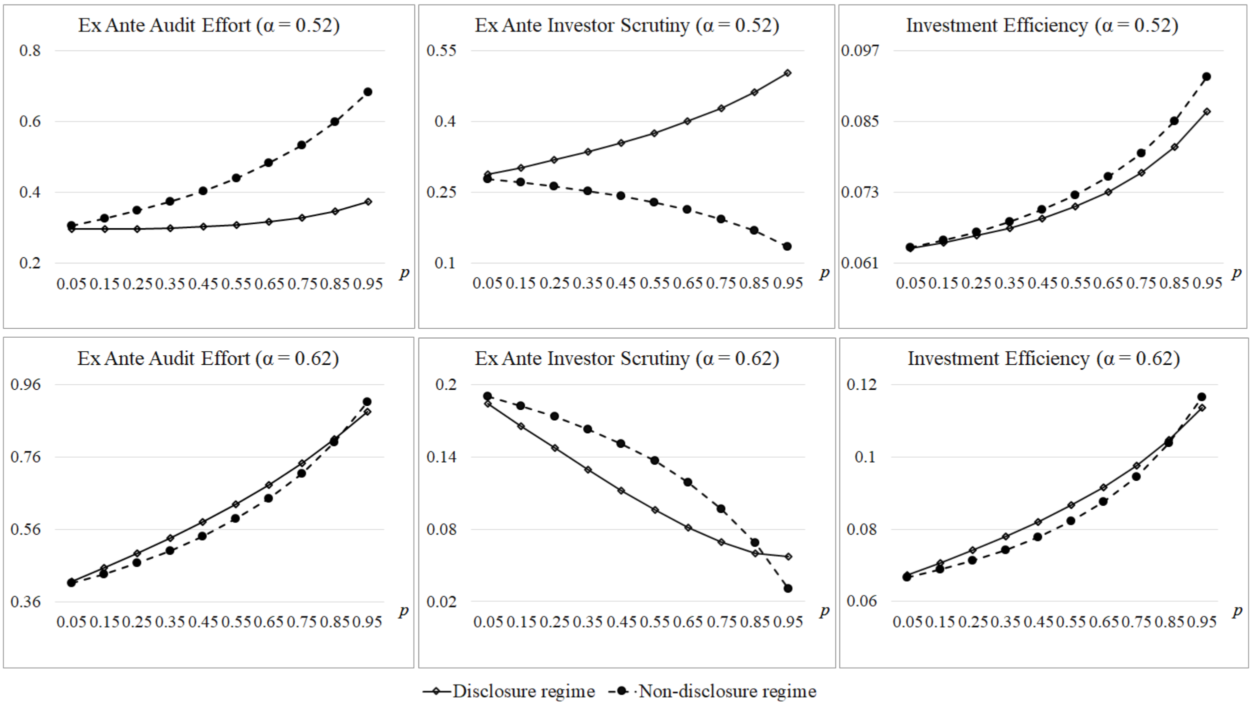

Figure 1: How *ex ante* audit effort ($\bar{e}_D^*|_{CAM}$ and $\bar{e}_X^*|_{CAM}$), investor scrutiny ($\bar{\gamma}_D^*|_{CAM}$ and γ_X^*), and investment efficiency (IE_D^* and IE_X^*) change with the precision of the CAM signal p. Other parameters are: $\phi = 0.3$; $i = 0.85$; $v = 1$; $m = 0.16$; $k = 0.16$.

APPENDIX A: DERIVATION OF EXPRESSIONS AND CONDITIONS

Derivation of parameter restriction that satisfies condition (6):

Using equation (1), inequality (6) holds if and only if

$$(1-\hat{e}_{DC})(1-\gamma_{DC}) < \frac{1-\phi}{2-\phi}. \tag{A.1}$$

In equilibrium, substituting $e^*_{DC} = (1-\gamma^*_{DC})\Omega$ into condition (A.1) yields

$$[1-(1-\gamma^*_{DC})\Omega](1-\gamma^*_{DC}) < \frac{1-\phi}{2-\phi}.$$

Note that the left-hand side of the above inequality is a concave function of $(1-\gamma^*_{DC})$ and attains its (global) maximum at $\frac{1}{4\Omega}$ when $1-\gamma^*_{DC} = \frac{1}{2\Omega}$. Hence, the above inequality is satisfied if $\frac{1}{4\Omega} < \frac{1-\phi}{2-\phi}$, which is equivalent to $\frac{\alpha\phi I}{k} > \frac{2-\phi}{4(1-\phi)}$. Using equation (1) again, the last inequality is equivalent to $v > \frac{k}{2\alpha\phi(1-\phi)}$. $\square$

Derivation of IE_X and IE_D:

To save space, we provide only the derivation of IE_D. The derivation of IE_X can be done analogously. Using equation (11), we have

$$\begin{aligned}
& (1-p)(1-e_{DN})(1-\gamma^*_{DN}(e_{DN})) + p(1-e_{DC})(1-\gamma^*_{DC}(e_{DC})) \\
= \; & [(1-p)(1-e_{DN}) + p(1-e_{DC})] - [(1-p)(1-e_{DN})\gamma^*_{DN}(e_{DN}) + p(1-e_{DC})\gamma^*_{DC}(e_{DC})] \\
= \; & 1-\bar{e}_D|_{CAM} - \left[\frac{(1-p)^2(1-e_{DN})^2}{2-p-\phi(1-p)e_{DN}} + \frac{p(1-e_{DC})^2}{1-\phi e_{DC}}\right]\Psi \\
= \; & 1-\bar{e}_D|_{CAM} - \frac{\Psi}{2-\phi\bar{e}_D|_{CAM}}(1-\bar{e}_D|_{CAM})^2 \\
& -p\left(1-\phi e_{DC}\right)\frac{2-p-\phi(1-p)e_{DN}}{2-\phi\bar{e}_D|_{CAM}}\left[\frac{1-e_{DC}}{1-\phi e_{DC}} - \frac{(1-p)(1-e_{DN})}{2-p-\phi(1-p)e_{DN}}\right]^2\Psi \\
= \; & 1-\bar{e}_D|_{CAM} - \frac{\Psi}{2-\phi\bar{e}_D|_{CAM}}(1-\bar{e}_D|_{CAM})^2 \\
& -\frac{p\left(1-\phi e_{DC}\right)[2-p-\phi(1-p)e_{DN}]}{(2-\phi\bar{e}_D|_{CAM})\Psi}\left(\gamma^*_{DC}(e_{DC}) - \gamma^*_{DN}(e_{DN})\right)^2.
\end{aligned}$$

Substituting the above result to equation (21) yields equation (25).

Similarly, using equation (13), we have

$$
\begin{aligned}
& (1-p)(1-e^*_{DN}(\gamma_{DN}))(1-\gamma_{DN}) + p(1-e^*_{DC}(\gamma_{DC}))(1-\gamma_{DC}) \\
= \; & (1-\bar{e}^*_D|_{CAM})\,(1-\bar{\gamma}_D|_{CAM}) + \left[e^*_{DC}(\gamma_{DC}) - e^*_{DN}(\gamma_{DN})\right](1-p)\,p\,(\gamma_{DC}-\gamma_{DN}) \\
= \; & \left[1-\Omega\,(1-\bar{\gamma}_D|_{CAM})\,\frac{1}{2-p}\right](1-\bar{\gamma}_D|_{CAM}) + \frac{\Omega p\,(1-p)\,(\gamma_{DC}-\gamma_{DN})}{2-p}\,(1-\bar{\gamma}_D|_{CAM}) \\
& + \left[e^*_{DC}(\gamma_{DC}) - e^*_{DN}(\gamma_{DN})\right](1-p)\,p\,(\gamma_{DC}-\gamma_{DN}) \\
= \; & \left[1-\Omega\,(1-\bar{\gamma}_D|_{CAM})\,\frac{1}{2-p}\right](1-\bar{\gamma}_D|_{CAM}) + \frac{\Omega p\,(1-p)\,(\gamma_{DC}-\gamma_{DN})}{2-p}\,(1-\bar{\gamma}_D|_{CAM}) \\
& + \left[(1-\gamma_{DC}) - (1-\gamma_{DN})\frac{1-p}{2-p}\right]\Omega\,(1-p)\,p\,(\gamma_{DC}-\gamma_{DN}) \\
= \; & \left[1-\Omega\,(1-\bar{\gamma}_D|_{CAM})\,\frac{1}{2-p}\right](1-\bar{\gamma}_D|_{CAM}) + \frac{2\Omega p\,(1-p)\,(1-\gamma_{DC})\,(\gamma_{DC}-\gamma_{DN})}{2-p}.
\end{aligned}
$$

Substituting the above result to equation (21) yields equation (26). $\square$

How $\Pr(x=0|a=v,A;D)$ **changes with** $\Pr(x=0|A)$**:**

Partially differentiating expression (19) with respect to $\Pr(x=0|A)$ yields

$$
\frac{\partial \Pr(x=0|a=v,A;D)}{\partial \Pr(x=0|A)} \propto -2\,(1-\gamma_{DA})\,\frac{\alpha I}{k}\Pr(x=0|A) + \left[\Pr(x=0|A)\right]^2(1-\gamma_{DA})\,\frac{\alpha I}{k} + 1.
$$

It remains to determine the sign of $-2\,(1-\gamma_{DA})\,\frac{\alpha I}{k}\Pr(x=0|A) + \left[\Pr(x=0|A)\right]^2(1-\gamma_{DA})\,\frac{\alpha I}{k} + 1$ when $A=C$ and $A=N$. Observe that when $A=N$, we have $\Pr(x=0|N) = \frac{1-p}{2-p}\phi$ and, therefore,

$$
\begin{aligned}
& -2\,(1-\gamma_{DN})\,\frac{\alpha I}{k}\Pr(x=0|N) + \left[\Pr(x=0|N)\right]^2(1-\gamma_{DN})\,\frac{\alpha I}{k} + 1 \\
= \; & -2\,(1-\gamma_{DN})\,\frac{\alpha I}{k}\frac{1-p}{2-p}\phi + \left[\frac{(1-p)\,\phi}{2-p}\right]^2(1-\gamma_{DN})\,\frac{\alpha I}{k} + 1 \\
> \; & 1-(1-\gamma_{DN})\,\frac{\phi\alpha I}{k} + \left[\frac{(1-p)\,\phi}{2-p}\right]^2(1-\gamma_{DN})\,\frac{\alpha I}{k} > 0,
\end{aligned}
$$

where the first inequality follows from $\frac{2(1-p)}{2-p} < 1$ and the second inequality follows from $\frac{\alpha\phi I}{k} < 1$.

Next, observe that when $A = C$, we have $\Pr(x = 0|C) = \phi$ and, therefore,

$$\begin{aligned}
&\lim_{\phi \to \frac{k}{\alpha I}} \left\{ -2\left(1-\gamma_{DC}\right)\frac{\alpha I}{k}\Pr\left(x=0|C\right) + \left[\Pr\left(x=0|C\right)\right]^2\left(1-\gamma_{DC}\right)\frac{\alpha I}{k}+1 \right\} \\
= \;& -\left(2-\frac{k}{\alpha I}\right)\left(1-\gamma_{DC}\right)+1,
\end{aligned}$$

where the upper limit of ϕ comes from the condition that $\frac{\alpha\phi I}{k} < 1$. Notice that a relatively big α will ensure that $-\left(2-\frac{k}{\alpha I}\right)\left(1-\gamma_{DC}\right)+1 < 0$.

Also observe that

$$\begin{aligned}
&\frac{\partial\left\{-2\left(1-\gamma_{DA}\right)\frac{\alpha I}{k}\Pr\left(x=0|A\right)+\left[\Pr\left(x=0|A\right)\right]^2\left(1-\gamma_{DA}\right)\frac{\alpha I}{k}+1\right\}}{\partial\Pr\left(x=0|A\right)} \\
= \;& -2\left(1-\gamma_{DA}\right)\frac{\alpha I}{k}\left[1-\Pr\left(x=0|A\right)\right] < 0.
\end{aligned}$$

Hence, we can conclude that when α is large, $\frac{\partial\Pr(x=0|a=v,A;D)}{\partial\Pr(x=0|A)} < 0$ if $\Pr(x=0|C)$ is sufficiently large. $\square$

APPENDIX B: EFFECTS OF CAM DISCLOSURE ON UNCONDITIONAL EXPECTED AUDIT EFFORT AND INVESTOR SCRUTINY

We now examine how CAM disclosure influences the unconditional expected audit effort and investor scrutiny before the auditor receives the CAM signal, i.e.,

$$\begin{aligned}
\bar{e}_D^* &\equiv E_D[e^*] = \Pr(N)e_{DN}^* + \Pr(C)e_{DC}^* \\
\text{versus } \bar{e}_X^* &\equiv E_X[e^*] = \Pr(N)e_{XN}^* + \Pr(C)e_{XC}^*, \\
\bar{\gamma}_D^* &\equiv E_D[\gamma^*] = \Pr(N|a=v)\gamma_{DN}^* + \Pr(C|a=v)\gamma_{DC}^* \\
\text{versus } \bar{\gamma}_X^* &\equiv E_X[\gamma^*] = \gamma_X^*,
\end{aligned}$$

where $\Pr(N) = 1 - \frac{p}{2}$, $\Pr(C) = \frac{p}{2}$, $\Pr(N|a=v) = \frac{2-p-\phi(1-p)e_{DN}^*}{2-\phi\left[(1-p)e_{DN}^*+pe_{DC}^*\right]}$, and $\Pr(C|a=v) = \frac{p\left(1-\phi e_{DC}^*\right)}{2-\phi\left[(1-p)e_{DN}^*+pe_{DC}^*\right]}$. Note that the investor will exert effort only if the auditor issues an unqualified opinion. As such, the investor will exert efforts γ_{DN}^* and γ_{DC}^* with probabilities $\Pr(N|a=v)$ and $\Pr(C|a=v)$, respectively.

In our model, there are strategic interactions between the auditor's effort decision and the investor's scrutiny effort decision only in the presence of a CAM. Using (10), (11), (14), and (16), we can express $\bar{e}_R^*$ and $\bar{\gamma}_R^*$ as the following functions of $\bar{\gamma}_R^*|_{CAM}$ and $\bar{e}_R^*|_{CAM}$, respectively, for $R \in \{D,\ X\}$:

$$\begin{aligned}
\bar{e}_D^* &= \frac{\alpha\phi I}{2k}\left(1-\bar{\gamma}_D^*|_{CAM}\right),\ \ \bar{\gamma}_D^* = \frac{(1-\alpha)\phi I}{m}\frac{1-\bar{e}_D^*|_{CAM}}{2-\phi\bar{e}_D^*|_{CAM}}, \\
\bar{e}_X^* &= \frac{\alpha\phi I}{2k}\left(1-\gamma_X^*\right),\ \ \bar{\gamma}_X^* = \frac{(1-\alpha)\phi I}{m}\frac{1-\bar{e}_X^*|_{CAM}}{2-\phi\bar{e}_X^*|_{CAM}}.
\end{aligned}$$

We state the impacts of CAM disclosure on the expected audit effort and investor scrutiny in the following corollary.

Corollary 1 CAM disclosure increases the expected investor scrutiny and decreases the expected audit effort if and only if the auditor's legal liability is small or the CAM signal is precise; that is, $\bar{\gamma}_D^* > \gamma_X^*$ and $\bar{e}_D^* < \bar{e}_X^*$ if and only if $\alpha < \bar{\alpha}$ or $p > \bar{p}$.

APPENDIX C: PROOFS

Proof of Lemma 1. For part 1, taking the first derivative of $\gamma_X^*(\hat{\hat{e}}_X|_{CAM})$ with respect to $\hat{\hat{e}}_X|_{CAM}$ yields

$$\frac{\partial\gamma_X^*(\hat{\hat{e}}_X|_{CAM})}{\partial\hat{\hat{e}}_X|_{CAM}} = -\frac{(1-\alpha)\phi I}{m}\frac{2-\phi}{(2-\phi\hat{\hat{e}}_X|_{CAM})^2} < 0.$$

The proofs of the counterparts in the disclosure regime are similar and thus omitted for brevity.

For part 2, we have

$$\begin{aligned}
\gamma_{DC}^*(\hat{e}) - \gamma_X^*(\hat{e}) &= \frac{(1-\alpha)\,\phi I}{m}\frac{(1-\hat{e})}{(1-\phi\hat{e})\,(2-\phi\hat{e})} > 0, \\
\gamma_{DN}^*(\hat{e}) - \gamma_X^*(\hat{e}) &= -\frac{(1-\alpha)\,\phi I}{m}\frac{p\,(1-\hat{e})}{[2-p-\phi\,(1-p)\,\hat{e}]\,(2-\phi\hat{e})} < 0.
\end{aligned}$$

This completes the proof. $\square$

Proof of Lemma 2. The proof is straightforward and therefore omitted for brevity. $\square$

Proof of Proposition 1. In a rational expectations equilibrium, $\hat{\gamma}_X = \gamma_X^*$, $\hat{e}_{XN} = e_{XN}^*$ and $\hat{e}_{XC} = e_{XC}^*$ in the non-disclosure regime. Substituting e_{XD}^* in (12) into γ_X^* in (10) and simplifying terms yield the quadratic equation (15). Notice that the discriminant of equation (15) is given by

$$[2(2-p)-(\phi+\Psi)\Omega]^2 + 4\phi\Psi\Omega(2-p-\Omega) > 0.$$

Hence, equation (15) has two real roots and only one of them is positive.

The proof of the equilibrium under the disclosure regime is analogous to that under the non-disclosure regime and thus omitted for brevity. $\square$

Proof of Proposition 2. We first compare γ_X^* with γ_{DN}^* and γ_{DC}^*, respectively. Let

$$\Theta_N(\gamma) \equiv \phi\Omega\gamma^2 + \left[\left(\frac{2-p}{1-p}\right)^2 - (\phi+\Psi)\Omega\right]\gamma - \Psi\left(\frac{2-p}{1-p} - \Omega\right).$$

$\Theta_N(\gamma)$ is an increasing function of γ and satisfies the condition that $\Theta_N(\gamma_{DN}^*) = 0$. Using $\Theta_N(\gamma)$, equation (15) can be rewritten as

$$\Theta_N(\gamma_X^*) = \frac{p(2-p)}{(1-p)^2}\left[(3-2p)\gamma_X^* - (1-p)\Psi\right].$$

Thus, $\gamma_{DN}^* < \gamma_X^*$ is equivalent to $(3-2p)\gamma_X^* > (1-p)\Psi$.

Similarly, let

$$\Theta_C(\gamma) \equiv \phi\Omega\gamma^2 + [1-(\phi+\Psi)\Omega]\gamma - \Psi(1-\Omega).$$

$\Theta_C(\gamma)$ is an increasing function of γ for a stable equilibrium. It satisfies the condition that $\Theta_C(\gamma_{DC}^*) = 0$. Using $\Theta_C(\gamma)$, equation (15) can alternatively be rewritten as

$$\Theta_C(\gamma_X^*) = -\left[(3-2p)\gamma_X^* - (1-p)\Psi\right].$$

Thus, $\gamma_X^* < \gamma_{DC}^*$ is equivalent to $(3-2p)\gamma_X^* > (1-p)\Psi$.

Therefore, $\gamma_{DN}^* < \gamma_X^*$ is equivalent to $\gamma_X^* < \gamma_{DC}^*$. Now we determine the condition for $\gamma_X^* < \gamma_{DC}^*$. Let

$$\Theta_X(\gamma) \equiv \phi\Omega\gamma^2 + \left[2\left(2-p\right) - \left(\phi+\Psi\right)\Omega\right]\gamma - \Psi\left(2-p-\Omega\right).$$

$\Theta_X(\gamma)$ is an increasing function of γ and satisfies the condition that $\Theta_X(\gamma_X^*) = 0$. Using $\Theta_X(\gamma)$, equation (18) can be rewritten as:

$$\Theta_X(\gamma_{DC}^*) = \left[(3-2p)\gamma_{DC}^* - (1-p)\Psi\right],$$

and $\gamma_X^* < \gamma_{DC}^*$ if and only if $[(3-2p)\gamma_{DC}^* - (1-p)\Psi] > 0$.

Taking the limit, we obtain

$$\begin{aligned}\lim_{p\to 1}\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right] &= \gamma_{DC}^{*}>0,\\ \lim_{p\to 0}\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right] &= 3\gamma_{DC}^{*}-\Psi.\end{aligned}$$

Totally differentiating $[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi]$ with respect to p yields

$$\frac{d\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right]}{dp}=\Psi-2\gamma_{DC}^{*}.$$

Therefore, if $\gamma_{DC}^{*}\geq\Psi/2$, then $\frac{d\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right]}{dp}<0$ and, thus, $[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi]>0$ for all p. In contrast, if $\gamma_{DC}^{*}<\Psi/2$, we need to check the sign of

$$\lim_{p\to 0}\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right].$$

Note that when $\gamma_{DC}^{*}>\Psi/3$, we have

$$\lim_{p\to 0}\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right]>0,$$

and, thus, $[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi]>0$ for all p. In contrast, when $\gamma_{DC}^{*}<\Psi/3$, we have

$$\lim_{p\to 0}\left[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi\right]<0,$$

and thus there exists a threshold $\bar{p}$ such that $[(3-2p)\gamma_{DC}^{*}-(1-p)\Psi]<0$ if and only if $p<\bar{p}$. In sum, $\gamma_{X}^{*}>\gamma_{DC}^{*}$ if and only if $\gamma_{DC}^{*}<\Psi/3$ and $p<\bar{p}$; or equivalently, $\gamma_{X}^{*}<\gamma_{DC}^{*}$ if and only if $\gamma_{DC}^{*}>\Psi/3$ or $p>\bar{p}$.

We then examine the condition $\gamma_{DC}^{*}>\Psi/3$. Solving equation (18) yields the explicit expression of γ_{DC}^{*} as follows:

$$\gamma_{DC}^{*}=\frac{-[1-(\phi+\Psi)\Omega]+\sqrt{[1-(\phi+\Psi)\Omega]^{2}+4\phi\Psi\Omega(1-\Omega)}}{2\phi\Omega},$$

which enables us to rewrite $\gamma_{DC}^{*}>\Psi/3$ as

$$(3-\phi)\,(3-\Psi)\,\Omega-6<0. \tag{A.2}$$

Recall that $\Psi \equiv \frac{(1-\alpha)\phi I}{m}$ and $\Omega \equiv \frac{\alpha\phi I}{k}$. Note that the left-hand side of (A.2) is increasing in α. When α is big such that $\Psi \to 0$ and $\Omega \to 1$, $(3-\phi)(3-\Psi)\Omega - 6 = 3(3-\phi) - 6 > 0$. When α is small such that $\Omega \to 0$, $(3-\phi)(3-\Psi)\Omega - 6 = -6 < 0$. Thus, there exists a threshold $\bar{\alpha}$ such that $\gamma_{DC}^* > \Psi/3$ iff $\alpha < \bar{\alpha}$; or equivalently, $\gamma_{DC}^* < \Psi/3$ iff $\alpha > \bar{\alpha}$.

Therefore, $\begin{cases} \gamma_{DN}^* < \gamma_X^* < \gamma_{DC}^* \text{ if and only if } \alpha < \bar{\alpha} \text{ or } p > \bar{p}; \\ \gamma_{DN}^* > \gamma_X^* > \gamma_{DC}^* \text{ if and only if } \alpha > \bar{\alpha} \text{ and } p < \bar{p}. \end{cases}$

Next, we compare the equilibrium audit efforts. Comparing (14) with (16), we obtain that $e_{DN}^* > e_{XN}^*$ and $e_{XC}^* > e_{DC}^*$ if and only if $\gamma_N^* < \gamma_X^* < \gamma_C^*$. It is also easy to see from (14) that $e_{XN}^* < e_{XC}^*$. Taken together, we obtain that

$$\begin{cases} e_{XN}^* < e_{DN}^* \text{ and } e_{DC}^* < e_{XC}^* \text{ if } \gamma_{DN}^* < \gamma_X^* < \gamma_D^*; \\ e_{DN}^* < e_{XN}^* < e_{XC}^* < e_{DC}^* \text{ if } \gamma_{DN}^* > \gamma_X^* > \gamma_{DC}^*. \end{cases}$$

This completes the proof. $\square$

Proof of Proposition 3. We first compare $\bar{\gamma}_D^*|_{CAM}$ with γ_X^*. Recall that

$$\Theta_X(\gamma) \equiv \phi\Omega\gamma^2 + [2(2-p) - (\phi+\Psi)\Omega]\gamma - \Psi(2-p-\Omega),$$

which satisfies that $\Theta_X(\gamma_X^*) = 0$. Multiplying both sides of equations (17) and (18) by $(1-p)$ and p, respectively, adding the two new equations, making use of the function $\Theta_X(\gamma)$, and then simplifying terms yield

$$\Theta_X(\bar{\gamma}_D^*|_{CAM}) = p(\gamma_{DC}^* - \gamma_{DN}^*)[(1-p)(\Psi+\phi)\Omega + 2 - p - 2(1-p)\phi\Omega\gamma_{DC}^*].$$

Observe that the right-hand side of the above equation is positive for all $p \in (0,\ 1)$ if and only if $\gamma_{DC}^* > \gamma_{DN}^*$. Therefore, since $\Theta_X(\gamma)$ is increasing in γ, we obtain that $\bar{\gamma}_D^*|_{CAM} > \gamma_X^*$ if and only if $\gamma_{DC}^* > \gamma_{DN}^*$.

We now compare $\bar{e}_D^*|_{CAM}$ with $\bar{e}_X^*|_{CAM}$. It is straightforward to see that

$$\bar{e}_D^*|_{CAM} = \frac{\Omega}{2-p}\left[1 - (1-p)\bar{\gamma}_D^*|_{CAM} - p\gamma_{DC}^*\right].$$

Hence, if $\gamma^*_{DC} > \gamma^*_{DN}$ and, therefore, $\bar{\gamma}^*_D|_{CAM} < \gamma^*_{DC}$ and $\bar{\gamma}^*_D|_{CAM} > \gamma^*_X$, we have

$$\begin{aligned}
\bar{e}^*_D|_{CAM} &< \frac{\Omega}{2-p}\left(1-\bar{\gamma}^*_D|_{CAM}\right) \\
&< \frac{\Omega}{2-p}(1-\gamma^*_X) \\
&= \bar{e}^*_X|_{CAM}.
\end{aligned}$$

Similarly, if $\gamma^*_{DC} < \gamma^*_{DN}$ and, therefore, $\bar{\gamma}^*_D|_{CAM} > \gamma^*_{DC}$ and $\bar{\gamma}^*_D|_{CAM} < \gamma^*_X$, we have

$$\begin{aligned}
\bar{e}^*_D|_{CAM} &> \frac{\Omega}{2-p}\left(1-\bar{\gamma}^*_D|_{CAM}\right) \\
&> \frac{\Omega}{2-p}(1-\gamma^*_X) \\
&= \bar{e}^*_X|_{CAM}.
\end{aligned}$$

Finally, from Proposition 2, we learn that $\gamma^*_{DC} > \gamma^*_{DN}$ if and only if $\alpha < \bar{\alpha}$ or $p > \bar{p}$. This completes the proof. $\square$

Proof of Lemma 3. Similar to the derivation of IE_D in Appendix A, $[(1-p)(1-e_{RN})+p(1-e_{RC})]\gamma^*_X\left(\bar{e}_R|_{CAM}\right)$ can be rewritten as

$$\begin{aligned}
&\left[(1-p)(1-e_{RN})\gamma^*_{DN}\left(e_{RN}\right)+p(1-e_{RC})\gamma^*_{DC}\left(e_{RC}\right)\right] \\
= \;& \frac{\Psi(1-\bar{e}_R|_{CAM})^2}{2-\phi\bar{e}_R|_{CAM}} + \frac{p\left(1-\phi e_{RC}\right)\left[2-p-\phi(1-p)e_{RN}\right]}{(2-\phi\bar{e}_R|_{CAM})\Psi}\left(\gamma^*_{DC}\left(e_{RC}\right)-\gamma^*_{DN}\left(e_{RN}\right)\right)^2.
\end{aligned}$$

Similarly, $[(1-p)(1-e_{RN})+p(1-e_{RC})]\gamma^*_X\left(\bar{e}_R|_{CAM}\right)$ can be rewritten as

$$[(1-p)(1-e_{RN})+p(1-e_{RC})]\gamma^*_X\left(\bar{e}_R|_{CAM}\right) = \frac{\Psi(1-\bar{e}_R|_{CAM})^2}{2-\phi\bar{e}_R|_{CAM}}.$$

Therefore, holding e_{RC} and e_{RN} fixed across the disclosure and non-disclosure regimes, $\frac{\phi I}{2}[(1-p)(1-e_{RN})+p(1-e_{RC})]\gamma^*_X\left(\bar{e}_R|_{CAM}\right) < \frac{\phi I}{2}[(1-p)(1-e_{RN})\gamma^*_{DN}\left(e_{RN}\right)+p(1-e_{RC})\gamma^*_{DC}\left(e_{RC}\right)]$. This completes the proof. $\square$

Proof of Lemma 4. For part 1, partially differentiating $IE_X\left(\bar{e}_X|_{CAM}, \gamma^*_X\left(\bar{e}_X|_{CAM}\right)\right)$

as shown in equation (22) with respect to $\bar{e}_X|_{CAM}$ yields

$$\frac{\partial IE_X\left(\bar{e}_X|_{CAM}, \gamma_X^*\left(\bar{e}_X|_{CAM}\right)\right)}{\partial \bar{e}_X|_{CAM}} \propto 1 - \frac{2(1-\bar{e}_X|_{CAM})}{2-\phi\bar{e}_X|_{CAM}}\Psi + \left(\frac{1-\bar{e}_X|_{CAM}}{2-\phi\bar{e}_X|_{CAM}}\right)^2 \phi\Psi > 0,$$

where the inequality follows from $\frac{2(1-e)}{2-\phi e} < 1$ for any $e \in (0,1)$ and $\Psi \equiv \frac{(1-\alpha)\phi I}{m} < 1$.

For part 2, partially differentiating $IE_X\left(\gamma_X, \bar{e}_X^*|_{CAM}\left(\gamma_X\right)\right)$ as shown in equation (23) with respect to γ_X^* yields

$$\frac{\partial IE_X\left(\gamma_X, \bar{e}_X^*|_{CAM}\left(\gamma_X\right)\right)}{\partial \gamma_X} \propto \gamma_X + \frac{2-p}{2\Omega} - 1.$$

Thus, $\frac{\partial IE_X\left(\gamma_X, \bar{e}_X^*|_{CAM}(\gamma_X)\right)}{\partial \gamma_X} < 0$ if and only if $\gamma_X < \bar{\gamma}$, where $\bar{\gamma} = 1 - \frac{2-p}{2\Omega}$. Evaluating γ_X at the equilibrium value and using the earlier result that $\bar{e}_X^*|_{CAM} = \frac{\Omega}{2-p}(1-\gamma_X^*)$, we obtain that $\gamma_X^* < 1 - \frac{2-p}{2\Omega}$ is equivalent to $\bar{e}_X^*|_{CAM} > \frac{1}{2}$. This completes the proof. $\square$

Proof of Proposition 4. We learn from equations (22) and (25) and Lemma 4 that if $\bar{e}_D^*|_{CAM} > \bar{e}_X^*|_{CAM}$, then $IE_D^* > IE_X^*$. Proposition 3 shows that $\bar{e}_D^*|_{CAM} > \bar{e}_X^*|_{CAM}$ if and only if $\alpha > \bar{\alpha}$ and $p < \bar{p}$. Thus, $IE_D^* > IE_X^*$ if $\alpha > \bar{\alpha}$ and $p < \bar{p}$.

We learn from equations (23) and (26) and Lemma 4 that, given $\bar{\gamma}_D^*|_{CAM} < \bar{\gamma}$, if $\bar{\gamma}_D^*|_{CAM} > \gamma_X^*$ and $\gamma_{DC}^* > \gamma_{DN}^*$, then $IE_D^* < IE_X^*$. Propositions 2 and 3 show that $\bar{\gamma}_D^*|_{CAM} > \gamma_X^*$ and $\gamma_{DC}^* > \gamma_{DN}^*$ if and only if $\alpha < \bar{\alpha}$ or $p > \bar{p}$. Thus, $IE_D^* < IE_X^*$ if $\alpha < \bar{\alpha}$ or $p > \bar{p}$. This completes the proof. $\square$

Proof of Proposition 5. In equilibrium, the audit fee in the non-disclosure regime is given by

$$\begin{aligned}
F_X^* &= \frac{1}{2}ke_{XN}^{*2}\Pr(N) + \frac{1}{2}ke_{XC}^{*2}\Pr(C) + EL_X^* \\
&= \frac{k}{4}[(2-p)e_{XN}^{*2} + pe_{XC}^{*2}] + \frac{\alpha\phi I}{2}\left[(1-p)\left(1-e_{XN}^*\right) + p\left(1-e_{XC}^*\right)\right]\left(1-\gamma_X^*\right) \\
&= \frac{\alpha\phi I}{4}\{[(1-p)\left(1-e_{XN}^*\right) + p\left(1-e_{XC}^*\right)]\left(1-\gamma_X^*\right) + 1 - \gamma_X^*\},
\end{aligned}$$

where the derivation of the last equality uses $\Pr(N) = 1 - \frac{p}{2}$, $\Pr(C) = \frac{p}{2}$, $\Omega = \frac{\alpha\phi I}{k}$ and

(12). The counterpart in the disclosure regime is given by

$$F_D^* = \frac{\alpha\phi I}{4}\{[(1-p)(1-e_{DN}^*)(1-\gamma_{DN}^*) + p(1-e_{DC}^*)(1-\gamma_{DC}^*)] + 1 - \bar{\gamma}_D^*|_{CAM}\}.$$

When p approaches 1, we have

$$\begin{aligned}
\lim_{p\to 1}(F_D^* - F_X^*) &= \frac{\alpha\phi I}{4}\lim_{p\to 1}\{(1-e_{DC}^*)(1-\gamma_{DC}^*) - (1-e_{XC}^*)(1-\gamma_X^*) + [(1-\gamma_{DC}^*) - (1-\gamma_X^*)]\} \\
&= \frac{\alpha\phi I}{4\Omega}\lim_{p\to 1}[(1-e_{DC}^*)e_{DC}^* - (1-e_{XC}^*)e_{XC}^* + (e_{DC}^* - e_{XC}^*)] \\
&= \frac{\alpha\phi I}{4\Omega}\lim_{p\to 1}(e_{DC}^* - e_{XC}^*)[2 - (e_{DC}^* + e_{XC}^*)] \\
&< 0,
\end{aligned}$$

where we have made use of (14) and (16) and the inequality follows from Proposition 2 that $e_{DC}^* < e_{XC}^*$ if $p > \bar{p}$. Hence, by continuity, there exists a unique p, say $\bar{p}_1 \in (\bar{p},\ 1)$, such that $F_D^* < F_X^*$ if $p > \bar{p}_1$. This completes the proof. □

Proof of Corollary 1. As shown in Appendix B,

$$\begin{aligned}
\bar{e}_D^* &= \frac{\alpha\phi I}{2k}(1 - \bar{\gamma}_D^*|_{CAM}),\ \ \bar{\gamma}_D^* = \frac{(1-\alpha)\phi I}{m}\frac{1-\bar{e}_D^*|_{CAM}}{2-\phi\bar{e}_D^*|_{CAM}}, \\
\bar{e}_X^* &= \frac{\alpha\phi I}{2k}(1 - \gamma_X^*),\ \ \bar{\gamma}_X^* = \frac{(1-\alpha)\phi I}{m}\frac{1-\bar{e}_X^*|_{CAM}}{2-\phi\bar{e}_X^*|_{CAM}}.
\end{aligned}$$

Thus, $\bar{e}_D^* > \bar{e}_X^*$ if and only if $\bar{\gamma}_D^*|_{CAM} < \gamma_X^*$, which is equivalent to $\alpha > \bar{\alpha}$ and $p < \bar{p}$.

Partially differentiating $\frac{1-e}{2-\phi e}$ with respective to e, yields,

$$\partial\frac{1-e}{2-\phi e}/\partial e = -\frac{2-\phi}{(2-\phi e)^2} < 0.$$

Accordingly, $\bar{\gamma}_D^* > \bar{\gamma}_X^*$ if and only if $\bar{e}_D^*|_{CAM} < \bar{e}_X^*|_{CAM}$, which is equivalent to $\alpha < \bar{\alpha}$ or $p > \bar{p}$. This completes the proof. □