Auditing Complex Estimates: Does Emphasizing Management Bias Decrease Sensitivity to Measurement Imprecision?

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ABSTRACT: Both management bias and measurement imprecision threaten the accurate reporting of complex accounting estimates. However, factors present in the current audit environment tend to emphasize the former. Although bias is important, it is also necessary to consider how regulators’ and practitioners’ efforts to increase audit quality by emphasizing risks arising from bias might impact auditors’ sensitivity to risks stemming from measurement imprecision. In an experimental economics setting that holds measurement imprecision constant, auditor-participants generally exert a high level of effort when the risk of management bias is high. When the risk of bias is relatively low, however, emphasizing risks related to bias leads auditors to “lower their guard” to a greater extent than when both bias and imprecision are emphasized, causing a suboptimal allocation of audit effort. Accordingly, this study suggests that directing auditors’ attention towards management bias can come at the expense of auditor sensitivity to other important sources of risk.

KEYWORDS: complex accounting estimates; management bias; measurement imprecision; audit quality; risk; heuristic processing; experimental economics
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I. INTRODUCTION

Auditors face significant challenges when evaluating complex accounting estimates (Griffith, Hammersley, and Kadous 2015a; Glover, Taylor, and Wu 2016a). Such difficulties can be roughly categorized as related to either the potential for management bias or the presence of measurement imprecision. In recent years, new developments in professional standards, regulatory inspections, and practitioner methodologies have emphasized bias more than imprecision. Although mitigating management bias is critical for effective audits, this study examines the possibility that an imbalanced emphasis on risks related to bias could decrease auditors’ sensitivity to risks arising from measurement imprecision. If so, factors in the current audit environment that direct auditors’ attention towards management bias could lead auditors to respond inadequately to the difficulties associated with measurement imprecision when the risk of bias is low.

While accurate financial reporting of estimates is undoubtedly vulnerable to the influence of bias, measurement imprecision poses an additional challenge that is significant in its own right. Christensen, Glover, and Wood (2012) and Cannon and Bedard (2016) provide evidence that the degree of uncertainty surrounding complex estimates frequently exceeds several multiples of audit materiality. Given the difficulties associated with estimating uncertain amounts (e.g., Bratten, Jennings, and Schwab 2016), audit failures related to complex estimates can arise even in the absence of intentional bias. For example, Santander Consumer USA recently restated three years of financial statements due to the misreporting of certain accounting estimates, with no apparent management intent to distort the misstated amounts (Santander 2016). In fact, the restatement increased Santander’s total equity and net income.
Several factors present in the current audit environment place more emphasis on management bias than on measurement imprecision. A prime example is mandatory fraud brainstorming (AICPA 2002), which directs auditors to consider engagement-specific risks from intentional bias, without providing a similar platform to consider other sources of risk. Similarly, Auditing Standard 2810, “Evaluating Audit Results,” (formally classified as Auditing Standard 14, PCAOB 2010) requires auditors to consider the impact of bias on complex estimates, but does not specify an equally explicit mandate for considering the effects of measurement imprecision. Because auditors encounter clients for which the risk of bias can be relatively more or less pronounced (e.g., due to strong internal controls or high management integrity), it is important to consider whether emphasizing management bias can lead auditors to be insufficiently sensitive to measurement imprecision when the risk of bias is low. If so, overall audit quality could suffer.

For theoretical support, I draw on the dual process approach to judgment and decision making (e.g., Evans and Stanovich 2013; Griffith, Kadous, and Young 2016) to develop an interactive prediction. Dual process models differentiate between individuals’ use of more intuitive, automatic decision processes versus deliberate, systematic processes. Individuals tend to make decisions characterized by intuitive processes when heuristic cues are available, accessible, and applicable (Chen and Chaiken 1999; Chen, Duckworth, and Chaiken 1999). Therefore, emphasizing the probable impact of management bias on complex estimates likely increases auditors’ propensity to attune heuristically to relative levels of the risk of bias when deciding upon the extent of necessary audit procedures. Given an emphasis on bias, auditors are likely to be responsive to the risk of bias, but are unlikely to fully consider other relevant sources of risk (i.e., measurement imprecision). Accordingly, when the risk of bias is low, auditors
responding heuristically to an emphasis on bias are likely to reduce their effort by more than what would be warranted given continued risks from measurement imprecision. In contrast, emphasizing the risk of bias and measurement imprecision is likely to promote a systematic decision-making approach whereby auditors more fully consider overall risk when auditing complex estimates.

In a contextually stark experiment with undergraduate participants, I capture financial incentives and choices analogous to those present in strategic interactions between reporters who have discretion over a complex accounting estimate, and auditors who respond by exerting costly audit effort. I manipulate (within-participants) the relative risk of management bias by varying whether or not reporters benefit economically from intentionally inflating an accounting estimate. I also manipulate (between-participants) whether auditors view reminders in the experimental materials that emphasize (1) risk related to management bias, or (2) risks arising from bias and measurement imprecision. Importantly, the experimental parameters hold the magnitude of measurement imprecision constant across conditions, and the experimental instructions ensure that participants in all conditions are aware of the implications that both management bias and measurement imprecision have for auditors’ and reporters’ payoff functions. Thus, the experiment manipulates emphasis, not total information. Auditors in my setting mitigate their exposure to the negative consequences of an audit failure – whether driven by bias or imprecision – by exerting costly audit effort.

Results show an interactive effect of the two manipulated factors on auditors’ decisions regarding costly effort. When the estimate is likely to be biased, auditors exert a high level of effort regardless of whether the experimental materials emphasize management bias alone or

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1 Throughout this paper, I use the terms manager and reporter interchangeably when referring to audit clients. Although auditors are typically thought of as interacting with client management, the term reporter connotes a more specific characterization of the client’s role in the context of a strategic interaction with auditors.
both bias and imprecision. However, when the risk of bias is relatively low, auditors in the condition emphasizing only management bias reduce effort to a greater extent than auditors exposed to an emphasis on bias and imprecision. Lower effort in the bias-emphasis condition, when the risk of bias is low, results in a significantly suboptimal allocation of audit resources. This effect appears to be subconscious, as auditors assess risk at similar levels across conditions, yet they make different effort decisions. Supplemental analysis supports the notion that an imbalanced emphasis on bias leads auditors to rely heuristically on the presence or absence of bias when choosing a level of costly audit effort, in contrast to a more systematic decision process that occurs under a dual emphasis on both bias and imprecision.

Beyond auditors’ decisions, the results from my experiment also provide insight into reporter behavior surrounding complex accounting estimates. Predictably, reporters incentivized to be biased exhibit substantial bias. However, I find that even reporters with financial incentives to provide an unbiased estimate exhibit some degree of upward reporting bias consistent with their preference for more favorable realizations of the estimated amount. Akin to Hales’ (2007) study involving investors’ propensity to engage in “motivated reasoning,” I find that reporters’ preferences have a modest influence on their estimates, despite financial incentives to be impartial. From an internal control perspective, this result speaks to difficulties associated with preventing managers’ unintentional biases from impacting the reporting of subjective amounts.

The overall implication of my findings is that efforts to increase auditor sensitivity to management bias can come at the expense of inadequately addressing risks arising from measurement imprecision. Beyond the institutional factors resulting in increased emphasis on management bias within the audit profession, there is a growing academic literature documenting ways in which auditors can enhance the detection of, and response to, bias in complex estimates.
(e.g., Griffith, Hammersley, Kadous, and Young 2015b; Rasso 2015). Notwithstanding the insights afforded by these studies, their emphasis on bias leaves a potentially incomplete picture of the challenges auditors face in situations where the risk of bias may be low but measurement imprecision nevertheless impacts financial reporting accuracy.

Auditors are responsible for addressing risk, regardless of its source. My study indicates that efforts by auditing standard setters, inspectors, practitioners, and others to emphasize risks stemming from management bias are unlikely to always improve audit quality. Efforts to give other significant sources of risk (in the context of complex estimates, measurement imprecision) “equal billing” mitigates auditors’ tendency to disproportionately lower their guard when the risk of management bias is relatively low. That is, this study suggests that auditing standards, the focus of inspections, and prescribed audit methodologies could benefit from a more balanced emphasis on both bias and imprecision as sources of risk stemming from complex accounting estimates. As a practical example, supplementing fraud brainstorming sessions with discussions regarding the risks posed by measurement imprecision would likely reduce auditors’ tendency to under-audit when the risk of bias is low.

II. BACKGROUND, THEORY, AND HYPOTHESIS

Institutional Emphasis on Management Bias

The current audit environment emphasizes auditors’ responsibility to consider and respond to risks arising from management bias and fraud. In this subsection, I outline prominent factors contributing to this institutional emphasis that directly impact audits of complex accounting estimates.
Professional Auditing Standards

Professional auditing standards have a fundamental impact on the manner in which audits are conducted. Following several high-profile accounting scandals in the early 2000s, detecting fraud became a high priority for standard setters and the audit profession. As a result, Statement on Auditing Standards No. 99 codified several changes to auditors’ responsibility for fraud detection (AICPA 2002). SAS 99 contains specific directives for auditors to be sensitive to management bias in accounting estimates. One of the most notable aspects of SAS 99 is the requirement that, during the planning phase of every audit, the entire audit team meet to identify and prominently communicate engagement-specific factors that impact the likelihood of management bias and fraud. Brazel, Carpenter, and Jenkins (2010) document a link between high-quality instances of these fraud brainstorming sessions and auditor response to fraud risks. Thus, mandatory fraud brainstorming, when well-conducted, increases auditors’ sensitivity to the presence or absence of risks stemming from management bias. In the context of auditing complex estimates, risk factors distinct from bias (such as measurement imprecision) are not afforded with similar platforms to attract auditor attention.

Presently, auditors of U.S. publicly traded companies rely on PCAOB Auditing Standards 2501 and 2502 (formerly classified as Interim Standards AU 342 and 328) as the primary guidance specifically related to accounting estimates (PCAOB 2003a, b). While AS 2501 and 2502 focus more on prescribing procedural aspects of audits, rather than providing guidance on relevant risks, Auditing Standard 2810 “Evaluating Audit Results” (formally classified as Auditing Standard 14) contains a paragraph titled “Evaluating Bias in Accounting Estimates,”

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2 PCAOB Interim Standards AU 342 and 328 were adopted from existing AICPA standards upon formation of the PCAOB under the Sarbanes-Oxley Act of 2002. Effective December 31, 2016, PCAOB standards were reorganized with AU 342 and 328 becoming AS 2501 and 2502, respectively. The reorganization did not substantively alter the contents of the standards. As mentioned below, the PCAOB and IAASB are both in the process of developing new comprehensive standards related to auditing complex estimates.
but does not highlight the impact of measurement imprecision on misstatement risk other than to stipulate that estimates should be supported by sufficient, appropriate audit evidence (PCAOB 2010).

Further, the evolution of current standards suggests regulators are *increasing* the emphasis placed on auditors’ responsibility to consider the potential impact of management bias on accounting estimates and subjective amounts. The AICPA’s AU-C 540 took effect for audits of financial statements for periods ending on or after December 15, 2012 (AICPA 2012). For auditors of private companies, AU-C 540 replaced AU 342 and 328 (AICPA 1989; 2003). A comparison of the more current language used in AU-C 540 to language in the superseded standards provides evidence of standards setters placing increased emphasis on management bias. As a coarse indicator, AU 342 and 328 use the word “bias” a combined three times, while AU-C 540 mentions “bias” 29 times. The newer standard alerts auditors to management bias in its first paragraph (AU 342 first mentions bias in paragraph 4, AU 328 in paragraph 33) and contains several developed subsections and paragraphs (not present in the superseded standards) discussing risks arising from management bias.

The PCAOB and the IAASB are currently in the process of considering extensive revisions to existing standards related to complex accounting estimates (PCAOB 2014; IAASB 2016). The IAASB has stated that revising ISA 540 (which is essentially identical to AU-C 540) is an opportunity to implement even “more robust requirements” related to “consideration of indicators of management bias” (IAASB 2016, 7). Although AU-C 540 and ISA 540 both acknowledge the presence of uncertainty surrounding estimates, risks posed by management bias is a primary focus that is increasing in prominence.

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3 Although AU-C 540 ostensibly “does not change or expand [the] superseded AU sections in any significant respect,” new language was adopted for the standard (AICPA 2014, 9). ISA 540, which mirrors AU-C 540 almost verbatim, provides guidance for auditors under purview of international standards (IFAC 2008).
Regulatory Inspections and Audit Practitioner Methodology

PCAOB inspections of audit firms routinely focus on procedures performed around accounting estimates (Griffith et al. 2015a). While inspections evaluate multiple components of audits, the PCAOB’s 2016 Staff Inspection Brief specifically identifies procedures performed in response to “the potential for management bias” in “fair value measurements and other accounting estimates” as a point of emphasis for inspectors (PCAOB 2016, 5). This focus echoes past pronouncements by the PCAOB specifically linking auditors’ professional skepticism with review of accounting estimates for management bias (e.g., PCAOB 2012).

SAS 99 calls for audit training to specifically incorporate fraud detection and prevention (AICPA 2002). While the impact of this call on audit firms’ training curricula is difficult to assess, firms strongly advocate methodology that reflects vigilance for management bias, especially when approaching accounts that require significant judgment (e.g., Bell, Peecher, and Solomon 2005; Glover and Prawitt 2013). In interviews conducted by Griffith et al. (2015a), when auditors describe the process of evaluating whether estimates are reasonable in light of the audit evidence, “[a]uditors’ descriptions focus mainly on detecting bias in management’s estimates” (849). Although auditors might not always effectively detect management bias or fraud (e.g., Hammersley, Bamber, and Carpenter 2010; Boritz, Kochetova-Kozloski, and Robinson 2015), the above suggests that regulators and practitioners strongly emphasize the importance of auditors’ sensitivity to risks arising from management bias.

Improving Auditors’ Approach to Complex Estimates

Because complex accounting estimates are particularly susceptible to management bias, recent studies have focused on improving auditors’ ability to address bias.4 Griffith et al. (2015b)

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4 See Bratten, Gaynor, McDaniel, Montague, and Sierra 2013 for a broad review of prior research that speaks to how auditors approach complex estimates.
and Rasso (2015) demonstrate that auditors’ mindsets can play an important role in identifying likely indicators of management bias, making appropriate assessments of the reasonableness of financial reporting, and taking actions necessary to correct biased reporting. Austin, Hammersley, and Ricci (2016) show how audit documentation instructions impact auditors’ interpretation and evaluation of evidence related to a biased estimate. Emett, Libby, and Nelson (2016) and Backof, Martin, and Thayer (2016) speak to how the distribution of misstatements across a portfolio of estimated amounts and review of prior-period estimation accuracy, respectively, can shape auditors’ assessments of management bias. Although not always focused specifically on complex estimates, a vast literature on auditors’ response to fraud risks similarly illuminates factors that inhibit or improve auditors’ ability to effectively deal with risks arising from biased financial reporting (e.g., Hoffman and Zimbelman 2009; Bowlin 2011; Hammersley 2011; Hammersley, Johnstone, and Kadous 2011; Kachelmeier, Majors, and Williamson 2014).

An emphasis on bias – whether in the institutional environment or academic literature – leaves a potentially incomplete picture of the challenges auditors face. While prior studies provide insight into how auditors can better respond to management bias and fraud, auditors face risks from multiple sources. Moreover, risks vary across clients, such that auditors routinely encounter different magnitudes of risk in different settings (e.g., Bhattacharjee, Maletta, and Moreno 2007; Hallman 2016). Auditors are likely to readily perceive different levels of risks related to bias due to observable differences (e.g., management integrity, internal controls) between clients, underscoring the importance of considering the implications of emphasizing bias for settings where the risk of bias is relatively low.

My study contributes to the literature on improving auditors’ approach to complex estimates by examining how emphasizing risks related to bias might impact auditor sensitivity to
another important source of risk: measurement imprecision. Theory elaborated below suggests that when auditors are focused on management bias, they are likely to be less sensitive to other important risk factors. Better understanding the implications of this premise, especially in the context of complex accounting estimates where the extent of measurement imprecision routinely exceeds several multiples of audit materiality thresholds (Christensen et al. 2012; Cannon and Bedard 2016), provides a more complete picture of how efforts intended to improve auditors’ response to management bias are likely to impact overall audit quality.

Implications of Dual Process Theory for Auditors’ Consideration of Risk

Psychology theory related to attention suggests that, when attending to stimuli, individuals allocate cognitive resources from a fixed pool of processing capacity, such that effectively dividing one’s attention in the presence of multiple stimuli is difficult (e.g., Kahneman 1973). In multidimensional settings, different stimuli often compete for a decision maker’s attention. Theory and experimental results from a wide range of contexts demonstrate how specific motivational factors and characteristics of stimuli influence individuals’ perceptions of cue relevance and, in turn, the ability to thoroughly and objectively consider all relevant information (e.g., Einhorn and Hogarth 1981; Petty and Cacioppo 1986; Maheswaran, Mackie, and Chaiken 1992).

Placing emphasis on a particular stimulus increases the salience and perceived importance of that factor, and can impact subsequent choices and behaviors. For example, emphasizing the link between seat belt use and susceptibility to personal risk increases individuals’ use of seat belts (Weinstein, Grubb, and Vautier 1986). In this example, however, it is unclear what impact (if any) emphasizing seat belt use would have on other behaviors that impact personal safety when driving an automobile (such as using a turn signal). To provide
insight on how these dynamics likely map into the context of auditing complex estimates, I draw on theory related to dual process models of human thought (e.g., Stanovich and West 2002; Evans and Stanovich 2013; Griffith et al. 2016).

Dual process models differentiate between intuitive cognitive processes that rely on heuristic decision rules versus more analytic, systematic processes. Because heuristic processing requires less effort, it is often characterized as the primary operating process unless the individual determines that more systematic processing is needed (Kahneman and Frederick 2005). Put differently, individuals are more likely to base judgments on intuitive processes when heuristic cues are available, accessible, and applicable (Chen and Chaiken 1999; Chen et al. 1999). Given the cognitive difficulty of attending to multiple cues, placing emphasis on one cue in particular not only elevates the prominence of that cue, but encourages individuals to engage in heuristic processing on the basis of information conveyed by that cue.

In the setting of complex accounting estimates, risks arise due to the potential for management bias and the presence of measurement imprecision. The reality that institutional features of the current audit environment place a strong emphasis on management bias likely encourages auditors to rely heuristically on the relative risk of management bias (i.e., high versus low risk) when approaching complex estimates. Thus, when the risk of bias is high, auditors will respond with a high level of audit effort. When the risk of bias is low, however, auditors using management bias as a heuristic cue are likely to “lower their guard” more than what would be warranted given a more systematic consideration that also takes measurement imprecision into account.

If environmental factors emphasize both management bias and measurement imprecision, the relative risk of management bias is less likely to serve as a heuristic cue and, as a result,
auditors are likely to engage in relatively more systematic processing. In sum, the implications of emphasizing management bias – versus bias and imprecision – for auditors’ effort choices depends on the relative level of risk posed by management bias. I predict an interactive pattern where, regardless of emphasis, auditors will respond to a high risk of management bias with a high level of effort. However, when the risk of bias is low, a more systematic approach will allow auditors to better appreciate, and more appropriately respond to, risks arising from measurement imprecision. Formally stated, I test the following hypothesis.

**Hypothesis:** Relative to emphasizing risks related to both management bias and measurement imprecision, emphasizing the risk of bias will cause auditors to choose a suboptimal level of costly audit effort when the risk of management bias is low.

### III. METHOD AND DESIGN

**Task**

A research design utilizing the tenets of experimental economics affords the benefit of capturing relevant real world dynamics while providing a clean test of theory. Specifically, I construct an incentivized game that represents a strategic interaction between two players: a reporter and an auditor. My setting operationalizes a high level of risk arising from measurement imprecision, warranting a diligent response from auditors (Christenson et al. 2012; Cannon and Bedard 2016), but holds that risk constant across conditions to test for the joint impact of management bias risk (manipulated within-participants) and environmental factors emphasizing source(s) of risk (manipulated between-participants) on audit effort. Abstract terminology and student participants help prevent contextual factors common in real audits from confounding the behavioral phenomenon I seek to test (Haynes and Kachelmeier 1998).

The experimental instructions and task are administered through linked computers operating the z-Tree interface for economic experiments (Fischbacher 2007). To ensure
participants understand the task, the instructions (which are identical for both participant types) explain all parameters of the game and include several embedded comprehension checks and a quiz reviewing the most important elements of the game. Incorrect answers prompt remedial instructions. Participants must respond correctly to all compression checks and quiz questions before beginning the task.

The reporter, referred to in the experimental materials as “Player A,” is the first mover. The reporter’s job is to estimate the value of an asset based on a private signal that is noisy, but unbiased. Specifically, the signal is equal to the true value of the asset plus some unknown amount of noise randomly drawn from a discrete uniform distribution over the interval from -15 to 15. Because the signal is within the asset’s true value plus or minus 15, the reporter’s estimate is constrained to be within plus or minus 15 of the signal. To aid in comprehension, the task is presented to participants as guessing the number of marbles in a sealed container. The number of marbles is representative of true asset value and the reporter’s guess corresponds to a complex accounting estimate. Participants are told that because the container of marbles is sealed shut, the reporter cannot count the marbles and must make a guess after viewing a measurement of the container’s weight provided by an imprecise scale.

For making the guess, the reporter receives a fixed payment of $5. My first manipulation, described in detail below, involves the determination of an additional payment to the reporter that ranges from $0 to $15. The determination of this additional payment, manipulated within-participants, creates incentives for the reporter to exhibit accuracy (to the extent possible given the inherent imprecision of the signal) or bias in his/her estimate. Because the private signal is unbiased in expectation, reporters incentivized to be accurate are best served by simply making their estimate equal to the private signal.
Participants in the auditor role, “Player B,” are matched with a reporter and view the estimate, but not the imprecise signal. Thus, while the auditor is always aware of whether s/he is paired with a reporter incentivized to be biased or unbiased, the auditor does not know the extent to which the reporter’s estimate deviates from the imprecise signal, and neither player knows the asset’s true value. The auditor is endowed with $20, but faces exposure to a penalty analogous to the negative consequences of an audit failure including exposure to litigation, loss of reputation, or regulatory inspections that would cite lack of diligence (e.g., Palmrose 2000; Chaney and Philipich 2002; Glover et al. 2016b).

The amount of the penalty is based on the absolute value of the difference between the reporter’s estimate and the true asset value. Specifically, if the reporter’s guess is off by more than 5 marbles, but less than 15 marbles, the number of marbles by which the guess is off equates to the amount of the auditor’s penalty in U.S. Dollars. Capturing the notion of materiality, the auditor does not face any penalty if the reporter’s guess is within 5 marbles of the actual number in the container. For guesses that are off by 15 marbles or more, the auditor’s exposure is capped at $15.

To mitigate the likelihood of incurring the penalty, the auditor chooses a level of costly audit effort (labeled in the experimental materials as a “Protection Level”) that ranges from 1 to 10. The auditor must pay $0.50 for the lowest level of audit effort, and an additional $0.50 for each incremental level. This costly action represents my primary dependent variable. As shown in Table 1, Panel A, the probability that the auditor incurs a penalty decreases as audit effort increases. Although my game does not incorporate a specific realization of audit evidence or an

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5 I assume auditors face equal exposure for overstated and understated reports. GAAS requires auditors to obtain reasonable assurance that financial statements are free from material misstatements whether due to fraud or error (AICPA 2011). In my setting, bias (i.e., fraud) presents a risk of overstatement only, but imprecision (i.e., error) can result in overstatement or understatement. This dynamic maps into the context of complex accounting estimates given the extreme magnitude of estimation uncertainty documented by prior research (e.g., Christensen et al. 2012; Cannon and Bedard 2016).
explicit adjustment to the estimate generated by the reporter (c.f., Kachelmeier and Van Landuyt 2016), costly effort in my setting nevertheless protects auditors from a penalty much in the same way that high levels of audit effort in the real world increase auditors’ ability to detect material misstatements or avoid punitive actions from inspectors citing lack of diligence.

Another effect of the auditor’s effort choice is to increase the probability that the reporter incurs a separate, independent penalty that ranges from $0 to $5. This penalty captures costs imposed on reporters when auditors increase scrutiny on reported amounts or take corrective actions for detected errors (e.g., Gibbons, Salterio, and Webb 2001). Specifically, the amount of the reporter’s penalty is equal to $1 for each marble by which the reporter’s guess is off in excess of 5 marbles. For guesses that are off by 10 marbles or more, the penalty is capped at $5. Table 1, Panel B shows the relationship between audit effort and the probability that the reporter incurs this penalty. Whether or not the reporter incurs a penalty is determined independently of the auditor’s penalty to mitigate the impact of considerations related to retribution or fairness (e.g., Fehr and Gächter 2000) that are extraneous to the theory my experiment is designed to test.

The auditor’s and reporter’s payoff functions are summarized below:

   Reporter’s payoff = $5 + Additional compensation ranging from $0 to $15 – Reporter’s Penalty ranging from $0 to $5 (if incurred)

   Auditor’s payoff = $20 – Cost of Audit Effort – Auditor’s Penalty ranging from $0 to $15 (if incurred)

[INSERT TABLE 1 ABOUT HERE]

6 Although companies that issue misstated financial statements also face exposure to other potential costs that are reduced through high audit effort (e.g., litigation and subsequent restatements), I abstract from these considerations to simplify the experimental setting. These elements could easily be incorporated into the reporter’s payoff function without altering equilibrium behaviors, but would significantly increase the complexity of the game.
Participants and Procedure

Participants consist of 90 undergraduate students enrolled in introductory accounting classes at a large public university who are randomly assigned a role analogous to either an auditor (n = 68) or reporter (n = 22). Each experimental session has exactly two reporters, with the rest of the participants assigned to the role of auditor. Although the experimental task takes place between auditors and reporters interacting in pairs, participants are aware that multiple auditors may be matched with a single reporter and that the decisions made by one randomly selected matched auditor are used for determining each reporter’s final payment. Although all reporters view the same imprecise signals (held constant across experimental sessions), matching multiple auditors with a single reporter helps to control for the influence that idiosyncratic differences in reporters’ estimates might have on auditors’ effort choices.\(^7\)

The experimental task is repeated by anonymous auditor/reporter pairings for two sets of five rounds (10 rounds total). Monetary balances do not carry over from round to round, and outcomes (such as the selected level of audit effort and true asset value) are not revealed until the end of the session.\(^8\) As a result, each round represents an independent one-shot game. True asset value and the reporter’s noisy signal changes in each period, but realizations of these random amounts are determined in advance and held constant across experimental sessions. After the first set of five rounds, auditor/reporter pairings rotate and participants complete the second set of five rounds. Prior to the start of each set of five rounds, participants are reminded of the method used to determine reporters’ additional compensation for that particular set of five rounds.

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\(^7\) Specifically, the decision to have exactly two reporters per session results in the minimum possible variance in the estimates actually viewed by auditors within a given bias risk condition, while still allowing auditors to be matched with a different reporter in the alternative within-participants bias risk conditions, as explained below.\(^8\) Although auditor reputation building is an important component of audit effectiveness (Mayhew 2001), incorporating multi-period considerations would unnecessarily complicate my setting and potentially confound the effect of bias risk on audit effort. That is, immediately revealing outcomes could provide feedback that might impact auditors’ perception of risk and influence subsequent effort choices.
rounds which is manipulated within-participants as described in the next subsection. Also, before the start of each set of five rounds, auditors provide an assessment of the overall risk they face in the upcoming set of five rounds.

At the end of the second set of five rounds, participants complete a post-experimental questionnaire. Following the questionnaire, the outcomes from one randomly selected round from the first set of five rounds and one randomly selected round from the second set of five are used to determine participants’ payoffs, which are displayed on the computer screen. Participants are then paid and dismissed. On average, participants earn $29.94, including a $5 “show up” payment, for an approximately 60-minute experimental session.

**Manipulations**

*Risk of Management Bias*

I use the additional compensation included in the reporter’s payoff function to manipulate, within-participants, the risk of management bias. The way the additional compensation is determined changes between the first and second set of five rounds. Importantly, the instructions fully describe both compensation schemes prior to start of the first round. The ordering of the two compensation schemes is counter-balanced between experimental sessions to control for order effects.

When a reporter is incentivized to exhibit bias, his/her additional compensation increases as the number of marbles s/he guesses increases. Recall that the reporter can guess any amount between the signal *minus* 15 and the signal *plus* 15. If a reporter in the “high risk of bias” condition guesses the signal *minus* 15 (the lowest possible guess), his/her additional compensation is $0. The reporter receives an additional $0.50 for each marble s/he guesses in excess of this minimum guess, up to a maximum of $15 for guessing the signal *plus* 15. Figure 1,
Panel A graphically depicts this compensation scheme. Given the reporter’s payoff function, a reporter in the high risk of bias condition maximizes expected wealth by issuing the highest possible estimate.

When a reporter is incentivized to be unbiased, his/her additional compensation increases as the *actual* number of marbles in the container increases, as opposed to the number of marbles guessed. Recall that the signal can be any amount between true asset value (i.e., the actual number of marbles in the container) minus 15 and true asset value plus 15. If the actual number of marbles in the container is equal to the signal minus 15 (the lowest possible realization of asset value), the reporter’s additional compensation is $0. The reporter receives an additional $0.50 for each marble in the container beyond this minimum possible amount, up to $15 if the actual number of marbles in the container is equal to the signal plus 15. Figure 1, Panel B graphically depicts this compensation scheme. Because the reporter’s estimate does *not* influence his/her additional compensation in the “low risk of bias” condition, but can contribute to the amount of the reporter’s penalty, a reporter in this condition maximizes expected wealth by making a guess that is equal to the private signal (which is a noisy, but unbiased estimate of truth).

[INSERT FIGURE 1 ABOUT HERE]

The reporter’s incentives in the low risk of bias condition harken to Hales (2007), but in a context analogous to financial reporting, rather than investing. Hales (2007) provides evidence on how directional preferences bias investors’ valuation judgments even when investors are incentivized to make accurate judgments. In my setting, even when a reporter’s estimate does not increase their payment, the reporter’s payment increases as the *actual* number of marbles in the container increase. Motivated reasoning (Kunda 1990), which forms the theoretical
underpinnings for Hales (2007), suggests that due to preferences for a higher number of marbles in the container, even reporters in the low risk of bias condition are likely to exhibit some degree of upward bias in their estimates. Thus, beyond implications for auditing, reporter behavior in my setting has potential to offer insights into unintentional biases surrounding the financial reporting of uncertain amounts.  

*Emphasizing Bias versus Bias and Imprecision*

I operationalize my between-participants manipulation of an environmental emphasis on bias (“bias-emphasis”) versus bias and imprecision (“dual-emphasis”) through wording that appears only to auditors immediately prior to the instructions and prior to the start of each set of five rounds. Across conditions, the instructions provide all participants with extensive training on how incentives (manipulated within-participants) and measurement imprecision (held constant across conditions) could impact reporters’ estimates. However, the additional wording that places emphasis on bias versus bias and imprecision differs. Figure 2 shows a timeline of the experimental session and the additional wording used to convey the between-participants emphasis conditions. With the exception of what is depicted in Figure 2, Panels B and C, I hold all other wording constant across conditions.

[INSERT FIGURE 2 ABOUT HERE]

While the bias-emphasis condition is intended to capture general implications of the institutional emphasis on bias described previously, the most direct real-world analog to the wording used in the experimental instrument is the outcome of a high-quality fraud

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9 While I do not formalize the preceding argument as a hypothesis, allowing for the possibility that reporter-participants might not exhibit optimal behavior not only offers an opportunity for insights into the financial reporting of complex estimates, but also speaks to the broader importance of utilizing human participants, rather than programmed algorithms, for the role of reporter. Auditors plan audit procedures in response to risks, not known reporting outcomes. Thus, operationalizing the risk of management bias through financial reporting incentives, and not more directly through imposed reporter behavior, facilitates a more externally valid experimental setting and, by extension, a more externally valid normative evaluation of auditor behavior.
brainstorming session where the audit team has effectively assessed and communicated risks related to management bias (Brazel et al. 2010). Although participants in my setting do not actually engage in brainstorming, just as fraud brainstorming meetings are intended to ensure that all members of the audit team are aware of engagement-specific risks stemming from intentional bias, wording in the bias-emphasis condition reminds auditor-participants how reporters’ incentives are likely to shape reporter behavior. Regardless, the abstract nature of the task and manipulation is intended to capture the effects, and speak to behavioral consequences, of the broad set of environmental factors that contribute to an institutional emphasis on bias.

In the dual-emphasis condition, I provide auditors with the same reminders concerning the risk of bias, as well as a reminder that the imprecision of the reporter’s private signal also contributes to the potential that the estimate diverges from true value. Thus, the dual-emphasis condition speaks to the possibility of regulators and practitioners engaging in deliberate efforts to give all significant risks “equal billing.” For example, fraud brainstorming sessions could be augmented to include discussions of other relevant, significant sources of risk.

Optimal Strategies

Irrespective of the level of audit effort, reporters in the high risk of bias condition maximize expected payoff by making the highest estimate possible (the signal plus 15). Reporters in the low risk of bias condition maximize wealth by simply making an estimate that is equal to the signal because this minimizes the expected amount of their penalty.10 Given rational behavior on the part of the reporter, auditors’ best response in the high risk of bias condition is to exert maximum audit effort (10 on the scale from 1 to 10), while auditors’ best response in the

10 Although, in reality, strategic interactions between auditors and reporters typically take the form of a mixed-strategy game (e.g., Bowlin, Hales, and Kachelmeier 2009; Bowlin, Hobson, and Piercey 2015), making reporters’ optimal strategy impervious to the chosen level of audit effort simplifies the setting without compromising the most important tensions faced by auditors and reporters. Further, this pure-strategy approach helps convey to auditors an unambiguous difference between a high and low risk of bias.
low risk of bias condition is an effort level of 8. Appendix A provides a complete description of the parameters and a discussion of equilibrium behavior.

In my setting, risk arising from imprecision, *alone*, is large enough to warrant a relatively high level of audit effort. Management bias further increases the magnitude of risk that auditors face, such that the optimal level of audit effort increases from 8 to 10. This corresponds a real-world setting in which an estimate’s reasonable range can be many times larger than audit materiality (Christensen et al. 2012; Cannon and Bedard 2016), and regulators and practitioners recognize the need for auditors to devote a high level of effort to these accounts (e.g., Griffith et al. 2015a).

IV. RESULTS

**Manipulation Checks**

To confirm auditors are attuned to the within-participants manipulation driving the risk of management bias, the post-experimental questionnaire asks auditors to recall the order in which they were paired with a reporter compensated based on the actual realization of the asset’s value (i.e., the number of marbles in the container) versus the reporter’s estimate. Only one participant answered this question incorrectly and excluding that participant from my analyses does not alter the statistical conclusions reported below. 11 Additionally, auditors expect reporters compensated based on true asset value (the estimate) to guess an average of 1.1 (13.4) more marbles than the number indicated by the reporters’ private signal. A repeated measures ANOVA (untabulated) confirms that auditors expect significantly more upward bias from reporters incentivized to be biased (two-tailed *p* < 0.01), with no between-participants differences driven by emphasis

11 Additionally, one auditor-participant failed to complete the post-experimental questionnaire. Excluding this participant, individually, or both this participant and the participant that incorrectly recalled the order of Player A’s compensation does not alter inferences from my analyses.
Thus, the manipulation of reporters’ incentives results in meaningful differences in the risk of management bias anticipated by auditors.

With regard to the between-participants manipulation of emphasis, the post-experimental questionnaire asks auditors to rate how much emphasis the experimental materials place on the fact that “Player A’s guess” and “the imprecision of the scale” each contribute to the amount of auditors’ potential loss. As shown in Table 2, responses to the question measuring perceived emphasis on bias (i.e., Player A’s guess) do not differ between the condition emphasizing bias only and the condition emphasizing bias and imprecision ($t_{65} = 0.94$, two-tailed $p = 0.35$). However, responses to the question measuring perceived emphasis on imprecision are significantly higher for auditors in the dual-emphasis, relative to bias-emphasis, condition ($t_{65} = 2.16$, two-tailed $p = 0.03$). Thus, as intended, an emphasis on the risk of bias is salient in both conditions, but auditors perceive a higher emphasis on risks arising from imprecision in the dual-emphasis condition, relative to auditors in the bias-emphasis condition.

[INSERT TABLE 2 ABOUT HERE]

Additionally, it is important to verify that participants in the bias-emphasis condition were aware of the implications of measurement imprecision. The detailed instructions and multiple comprehension checks described previously help to ensure that the manipulation of emphasis did not alter participants’ understanding of the parameters of the game. Accordingly, all auditors correctly answered a post-experimental question asking them to recall the amount of imprecision present in the measurement of the asset. As shown in Table 2, Panel B, even auditors in the bias-emphasis condition were aware of some emphasis being placed on measurement imprecision. Thus, it seems clear that the between-participants manipulation was successful in

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12 Further, a one-sample $t$-test indicates that the amount of expected bias from reporters compensated based on true asset value (i.e., 1.1 marbles) is not significantly greater than zero (two-tailed $p = 0.27$).
manipulating emphasis, while ensuring that all participants understood the implications of imprecision for the experimental task.

**Primary Findings**

*Audit Effort*

To test my hypothesized interaction, I examine auditors’ average levels of costly audit effort over the five experimental rounds comprising the high risk of bias condition and the five rounds comprising the low risk of bias condition. Results are depicted in Figure 3. Table 3 reports descriptive statistics and a repeated measures ANOVA that analyzes the risk of management bias as a within-participants factor and emphasis as a between-participants factor.\(^{13}\) Unsurprisingly, I find a strong main effect of the risk bias \((F_{1,66} = 41.02, \text{two-tailed } p < 0.01)\), indicating that auditors exert more effort when the risk of bias is high. More importantly, I also find a significant interaction between the risk of bias and emphasis \((F_{1,66} = 4.15, \text{two-tailed } p = 0.05)\). Confirming my hypothesis, simple effects show that, relative to auditors in the dual-emphasis condition, auditors in the bias-emphasis condition exert less costly effort than auditors in the dual-emphasis condition when the risk of bias is low \((F_{1,66} = 2.65, \text{one-tailed } p = 0.05)\), but not when the risk of bias is high \((F_{1,66} = 0.24, \text{two-tailed } p > 0.50)\).\(^{14}\)

\(^{13}\) Given observed reporter behavior, optimal audit effort is 8 in both the high and low risk of bias conditions (rather than 10 and 8, respectively). Average effort in each of the four experimental cells is below the optimal level, suggesting that participants in all conditionals appear willing to assume more risk than expected given predictions based solely on the intuition of economic wealth-maximization.

\(^{14}\) To control for the impact of reporters’ specific estimates on chosen levels of audit effort, I also recast the data in a panel in which each auditor provides ten observations – one for each experimental round. Results from a baseline OLS regression that includes auditor fixed effects (untabulated) are inferentially consistent with the repeated measures ANOVA. Including the reporters’ estimates as a control variable in the model strengthens my primary results and also indicates a significant main effect of reporters’ estimates \((p < 0.01)\). Controlling for the counter-balanced order in which reporters’ incentives vary does not alter the impact of the other variables in the model, and the effect of order is not significant \((p > 0.50)\).
The key insight from my analysis of auditors’ costly effort choices is that, as predicted, placing an imbalanced emphasis on risks arising from management bias, versus emphasizing both bias an imprecision, leads to under-auditing when the risk of bias is low. That is, environmental factors intended to increase auditors’ sensitivity to the risk of management bias appear to have the effect of decreasing auditors’ responsiveness to risks arising from imprecision in complex estimates. When the risk of bias is low, emphasizing bias causes auditors to “lower their guard” to a greater extent than when environmental factors place a more balanced emphasis on both bias and imprecision, resulting in a significantly less optimal allocation of audit effort.

Notably, solely emphasizing bias appears to confer no significant benefit when the risk of management bias is high, as auditors exert a relatively high level of effort regardless of emphasis condition. Though auditors in the bias-emphasis, versus dual-emphasis, condition do exert slightly more effort when the risk of bias is high, the difference is not statistically significant ($F_{1,66} = 0.24$, two-tailed $p > 0.50$). Therefore, emphasizing the importance of risks related to bias and imprecision appears to mitigate under-auditing when management bias poses less of a threat, without diluting auditors’ response to bias.

**Risk Assessment**

*Ex-ante*, I expected auditors’ assessment of overall risk, measured prior to the start of the two sets of five experimental rounds, to follow the hypothesized pattern exhibited by audit effort. Table 4 suggests that, while the relative risk of bias has a strong main effect on auditors’ risk assessments ($F_{1,66} = 46.3$, two-tailed $p < 0.01$), the two manipulated variables do not interact ($F_{1,66} = 1.49$, two-tailed $p = 0.23$). That is, auditors’ risk assessments do not appear to be sensitive to whether the experimental materials emphasize bias versus bias and imprecision.

[INSERT TABLE 4 ABOUT HERE]
On one hand, this finding is comforting as it suggests that auditors’ judgments of risk are not impaired in the same way that audit effort choices appear to be. On the other hand, this equivalence suggests that an imbalanced emphasis on bias has a subconscious impact on audit effort decisions, which exhibit the hypothesized interactive pattern. Put differently, when the risk of bias is low, there is no meaningful difference between auditors’ assessments of overall risk, and yet auditors in the bias-emphasis condition exert significantly less audit effort, resulting in a less optimal allocation of resources compared to auditors in the dual-emphasis condition. The supplemental analysis reported next is intended to provide additional insight for interpreting this finding.

**Supplemental Analysis: The Perceived Impact of Imprecision on Audit Effort**

To provide evidence on the process underlying my primary findings, I examine auditors’ response to a post-experimental question eliciting the extent to which auditors perceive that measurement imprecision influences their chosen level of audit effort. On average, auditors in both the bias-emphasis and dual-emphasis conditions acknowledge that risks related to measurement imprecision have a meaningful impact on their audit effort decisions. However, if my primary findings regarding audit effort are driven by a subconscious impact of environmental factors emphasizing bias, then auditors’ perceptions regarding the extent to which imprecision drives audit effort are unlikely to be predictive of actual effort choices. Conversely, if auditors exposed to a balanced emphasis on bias and imprecision more systematically consider relevant risks, these auditors’ perceptions regarding the impact of imprecision on audit effort should be associated with the level of audit effort actually selected.

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15 On a seven-point scale anchored at 1 = “Strongly disagree” and 7 = “Strongly agree,” auditor participants respond to the following statement: “The fact that the scale Player A used to estimate the number of marbles in the container was not very precise had a big impact on the Protection Level I chose.” On average, auditors’ responses to this question are 4.94 and 5.10 in the bias and dual-emphasis conditions, respectively. These amounts are not statistically different (t\(_6\) = 0.45, two-tailed \(p > 0.50\), untabulated), and both are significantly greater than the scale’s midpoint (both two-tailed \(p\)-values < 0.01, untabulated).
Correlations shown in Table 5 are consistent with this pattern. Although, on average, auditors in the bias-emphasis condition claim that imprecision has a large impact on their effort choices, these perceptions are uncorrelated with actual costly audit effort choices (two-tailed $p$-values > 0.50). Only in the dual-emphasis condition do auditors exhibit a significant positive correlation between their perceptions of the impact of imprecision on effort choices and their actual effort choices (two-tailed $p$-values < 0.01).\(^\text{16}\)

[INSERT TABLE 5 ABOUT HERE]

These supplemental results provide evidence that, despite what auditors might consciously think, when choosing a level of audit effort, measurement imprecision has a different impact on effort decisions made by auditors in the dual-emphasis, versus bias-emphasis, condition. The correlations shown in Table 5 are consistent with the theoretical premise that auditors in the bias-emphasis condition rely heuristically on the relative risks of management bias, and therefore do not fully incorporate the implications of imprecision when making effort decisions. Likewise, consistent with auditors in the dual-emphasis condition engaging in more systematic processing, these auditors’ perceptions regarding the impact of imprecision on effort reflect auditors’ actual effort choices. These supplemental findings also bolster the notion that, although an emphasis on bias (versus bias and imprecision) does not affect auditors’ risk assessments, the alternative emphasis conditions impact effort choices on a subconscious level.

**Reporter Behavior**

Beyond results related to auditors, my study also offers insight into managers’ financial reporting decisions under incentives to exhibit accuracy or upward bias in complex accounting estimates. Figure 4 shows the imprecise signal provided to the reporter (i.e., the weight of the

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\(^{16}\) Untabulated $z$-tests confirm the correlation coefficients in Panel C are statistically different between emphasis conditions (both two-tailed $p$-values < 0.08)
marbles according to the scale) for each of the 10 experimental rounds and reporters’ average guesses based on whether or not they are incentivized to exhibit bias. Recall that the order in which reporters view the imprecise signals is held constant, but the order in which reporters are incentivized to exhibit bias is counterbalanced across experimental sessions.\textsuperscript{17} Table 6, Panel A shows the results of a paired $t$-test confirming that reporters exhibit significantly more upward bias when their compensation increases with their estimate relative to when their compensation is not linked to their estimate ($t_{21} = 5.86$, two-tailed $p < 0.01$). As shown in Table 6, Panel B, for reporters incentivized to be unbiased, the average difference between estimates and the imprecise signal, although modest, is significantly greater than zero ($t_{21} = 2.97$, two-tailed $p < 0.01$).

[INSERT FIGURE 4 AND TABLE 6 ABOUT HERE]

Thus, consistent with Hales (2007) but in a context analogous to the financial reporting of complex accounting estimates, even reporters in the low risk of bias condition exhibit some degree of upward bias. Despite incentives to make accurate judgments, reporters’ preferences for a favorable uncertain outcome appear to add upward bias to estimates. This result contributes to the financial reporting literature by providing some initial evidence that, even if strong internal controls perfectly control managers’ economic incentives to exhibit bias, unintentional bias can still be present when managers possess directional preferences. With respect to implications for auditing, observing modest upward bias even when reporters are incentivized to be impartial underscores the importance of mitigating the potential for under-auditing when the risk of bias appears to be low.

\textsuperscript{17} $n = 10$ reporters were incentivized to be biased (unbiased) in the first (second) five rounds, and $n = 12$ reporters were unbiased (biased) in the first (second) five rounds.
V. CONCLUSIONS

Complex accounting estimates are a significant component of financial reporting and present auditors with unique challenges. Due to their subjective and uncertain nature, complex estimates are particularly susceptible to the influence of management bias. Accordingly, a number of environmental factors emphasize the impact bias has on the risk that estimates are misstated. Auditing standards place a spotlight on the risk of bias and trends suggest this emphasis is likely to increase as the PCAOB and IAASB develop new standards related to the audit of complex estimates. Evaluating audit procedures directed toward mitigating management bias in estimates is a point of emphasis for PCAOB inspectors. Audit firms prescribe methodology that focuses auditor attention on the risk of management bias.

Independent of potential effects of management bias, the measurement imprecision surrounding complex estimates is significant in its own right. Estimates’ reasonable ranges often exceed several multiples of audit materiality (Christensen et al. 2012; Cannon and Bedard 2016) and audit failures surrounding estimates are not caused exclusively by management bias (e.g., the Santander Consumer USA restatement). Although a significant source of risk, measurement imprecision is not emphasized in the same way as management bias. Auditing Standard 2810 (PCAOB 2010) and fraud brainstorming sessions required by SAS 99 (AICPA 2002) provide illustrative examples in that they elevate auditors’ focus on intentional bias, but not risks arising solely from measurement imprecision.

I predict and find that environmental factors emphasizing risks related to management bias cause auditors to be less sensitive to residual risks arising from measurement imprecision when the risk of bias is relatively low. Specifically, my study indicates that auditors generally respond to a high risk of bias with a high level of audit effort. However, emphasizing bias, versus
bias and imprecision, causes auditors to “lower their guard” to a greater extent when management bias is less threatening. Although mitigating the possible effects of management bias is essential for successful audits, efforts to increase auditors’ awareness of bias appear to be accompanied by diminished auditor sensitivity to measurement imprecision. Consistent with theory, supplemental analysis suggests that this weakness in auditor judgment stems from auditors relying heuristically on the relative risk of bias when making decisions regarding how much costly effort to exert. A more balanced emphasis on both bias and imprecision, however, results in a more optimal allocation of audit effort, as well as evidence that auditors employ a more systematic decision making approach.

Beyond implications for auditing, my findings also speak to how managers’ preferences impact their estimates of subjective amounts. Applying a framework similar to Hales (2007) to a financial reporting setting, I find that, even when reporters have financial incentives to make as accurate an estimate as possible, reporters’ preferences for a high realized value results in estimates that exhibit a modest degree of upward bias. Future research could consider possible methods to mitigate bias that occurs in settings where reporters do not possess incentives to exhibit bias, but nevertheless benefit from positive realizations of the estimated amount.

To fully evaluate regulators’ and practitioners’ efforts to increase audit quality by emphasizing the importance of management bias, it is necessary to consider the impact of such efforts on auditors’ sensitivity to other important sources of risk. Although my study does not test specific interventions auditors might employ when considering complex estimates (e.g., Griffith et al. 2015b; Austin et al. 2016), my study nevertheless contributes evidence of, and a potential solution for, an undesirable consequence of institutional factors that direct auditors’ attention toward risks related to management bias. Giving the consequences of measurement
imprecision “equal billing” with management bias in professional standards, inspections, and methodologies prescribed by audit firms related to complex estimates would likely mitigate auditors’ behavioral tendency to under-audit when the risk of bias is low, without compromising auditors’ response in situations where the risk of bias is high. As a practical example, fraud brainstorming sessions could easily be augmented to include a discussion of other significant sources of risk. Thus, my findings are relevant to regulators, inspectors, and auditors in roles that influence how factors present in the audit environment shape auditors’ attention toward risk.

I encourage future research that investigates ways to elevate auditors’ awareness of potentially overlooked sources of risk. Regarding complex accounting estimates, I find that directing auditors’ attention toward management bias can come at the expense of an adequate response to risks arising from measurement imprecision. To conduct effective audits, auditors must be attuned to all significant sources of risk, not just the risk of intentional bias.
References


Bell, T. B., Peecher, M. E., & Solomon, I. 2005. The 21st century public company audit: Conceptual elements of KPMG’s global audit methodology. KPMG LLP.


APPENDIX A
Parameters and Equilibrium for Audit Game

\( V = \) true asset value (unknown)
\( S = \) reporter’s private signal = \( V + e, \; e \in U[-15, 15] \)
\( G = \) reporter’s estimate, \( G \in \{ S - 15, S - 14, \ldots, S + 14, S + 15 \} \)

**Reported Penalty** = \( f(|G - V|): \)
- if \(|G - V| \leq 5\), **Reported Penalty** = $0
- if \(5 < |G - V| < 10\), **Reported Penalty** = $|5 - (|G - V|)|
- if \(|G - V| \geq 10\), **Reported Penalty** = $5

\( P(\text{Reporter Penalty}) = \) see Table 1 Panel B

**Auditor Penalty** = \( f(|G - V|): \)
- if \(|G - V| \leq 5\), **Auditor Penalty** = $0
- if \(5 < |G - V| < 15\), **Auditor Penalty** = $|G - V|
- if \(|G - V| \geq 15\), **Auditor Penalty** = $15

\( P(\text{Auditor Penalty}) = \) see Table 1 Panel A

**Audit Effort** \( \in \{1, 2, \ldots, 9, 10\} \)
\( c(\text{Audit Effort}) = \) Audit Effort \( \times $0.50 \)

**Reporter’s payoff** (high risk of bias condition)
\[ = $5 + 0.5(G + 15 - S) - [P(\text{Reporter Penalty}) \times \text{Reporter Penalty}] \]

**Reporter’s payoff** (low risk of bias condition)
\[ = $5 + 0.5(S + 15 - V) - [P(\text{Reporter Penalty}) \times \text{Reporter Penalty}] \]

**Auditor’s payoff** (in all conditions)
\[ = $20 - c(\text{Audit Effort}) - [P(\text{Auditor Penalty}) \times \text{Auditor Penalty}] \]

In the high risk of bias condition, the **reporter** faces a trade-off between the benefit of increasing the second term in his/her payoff function (by choosing a high \( G \)) and the cost of increasing the expected penalty (which increases in expectation as \( G \) deviates from \( S \)). The marginal benefit of choosing a high \( G \) is greater than the marginal cost imposed by a larger expected penalty (regardless of the likelihood of penalty as determined by audit effort), thus a wealth maximizing reporter will choose \( G^* = S + 15 \) (the highest possible \( G \)).

In the low risk of bias condition, the **reporter** maximizes expected utility by minimizing the expected amount of the **Reporter Penalty**. Because \( S \) is equal to \( V \), in expectation, the expected amount of the **Reporter Penalty** is $0 when the reporter chooses \( G^* = S \).
The auditor faces a trade-off between the cost of Audit Effort and the corresponding benefit provided by a lower probability of incurring the Auditor Penalty.

In the high risk of bias condition, the expected amount of the Auditor Penalty is:

\[ f(G^* - V) = f(S + 15 - V) = f(V + e + 15 - V) = f(e + 15) \]

\[ \Rightarrow \begin{align*}
  & \text{if } |e + 15| \leq 5, \text{ Auditor Penalty } = 0 \\
  & \text{if } 5 < |e + 15| < 15, \text{ Auditor Penalty } = |e + 15| \\
  & \text{if } |e + 15| \geq 15, \text{ Auditor Penalty } = 15
\end{align*} \]

\[ E[\text{Auditor Penalty}] \\
= [P(-15 \leq e \leq -10) \times 0] + [P(-9 \leq e \leq 0) \times \mathbb{E}[|e + 15|, \text{ given } -9 \leq e \leq 0]] \\
  + [P(1 \leq e \leq 15) \times 15] \\
= [(6/31) \times 0] + [(10/31) \times |e - 15|] + [(15/31) \times 15] \\
= $0 + $3.39 + $7.26 \\
= $10.65
\]

Evaluating the auditor’s payoff function using an expected Auditor Penalty of $10.65 shows that, given the possible levels of Audit Effort and associated \( c(Audit Effort) \) and \( P(Auditor Penalty) \), the auditor maximizes expected payoff by choosing \( Audit Effort^* = 10 \).

In the low risk of bias condition, the expected amount of the Auditor Penalty is:

\[ f(G^* - V) = f(S - V) = f(V + e - V) = f(|e|) \]

\[ \Rightarrow \begin{align*}
  & \text{if } |e| \leq 5, \text{ Auditor Penalty } = 0 \\
  & \text{if } 5 < |e| \leq 15, \text{ Auditor Penalty } = |e| \\
  & \text{if } |e| \geq 15, \text{ Auditor Penalty } = 15
\end{align*} \]

\[ E[\text{Auditor Penalty}] \\
= [P(-5 \leq e \leq 5) \times 0] + [P(-15 \leq e < -5) \times \mathbb{E}[|e|, \text{ given } -15 \leq e < -5]] \\
  + [P(5 < e \leq 15) \times \mathbb{E}[|e|, \text{ given } 5 < e \leq 15]] \\
= [(11/31) \times 0] + [(10/31) \times |e - 10.5|] + [(10/31) \times 10.5] \\
= $0 + $3.39 + $3.39 \\
= $6.78
\]

Evaluating the auditor’s payoff function using an expected Auditor Penalty of $6.78 shows that, given the possible levels of Audit Effort and associated \( c(Audit Effort) \) and \( P(Auditor Penalty) \), the auditor maximizes expected payoff by choosing \( Audit Effort^* = 8 \).
FIGURE 1
Manipulation of the Risk of Management Bias

Panel A: Reporters’ additional compensation in the **high** risk of bias condition

<table>
<thead>
<tr>
<th>Reporter’s Additional Compensation:</th>
<th>Lowest Possible Estimate (Signal – 15)</th>
<th>Highest Possible Estimate (Signal + 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0 increases by $0.50 per marble guessed</td>
<td>$0</td>
<td>$15</td>
</tr>
</tbody>
</table>

Panel B: Reporters’ additional compensation in the **low** risk of bias condition

<table>
<thead>
<tr>
<th>Reporter’s Additional Compensation:</th>
<th>Fewest Possible Marbles in the Container (Signal – 15)</th>
<th>Most Possible Marbles (Signal + 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0 increases by $0.50 per marble in the container</td>
<td>$0</td>
<td>$15</td>
</tr>
</tbody>
</table>
Panel A: Experimental timeline

1. Participants learn whether they have been randomly assigned to the role of *Reporter* ("Player A") or *Auditor* ("Player B").

2. Participants work through common set of instructions with embedded comprehension checks.

3. Participants are reminded of how the *Reporter* will be compensated in the first set of five rounds.
   *Auditor* makes risk assessment.


5. and 8. *Auditor* views estimate and selects level of costly audit effort.

6. *Auditor/Reporter* pairings rotate and participants are reminded of how the *Reporter* will be compensated in the second set of five rounds.
   *Auditor* makes risk assessment.


10. Outcomes are determined and revealed.

Sequence is repeated over two sets of five rounds.
**Panel B: Wording used to convey to auditors an emphasis on management bias**

At 1. (refer to Panel A):

You are about to learn that in some rounds of the task, you will be paired with a Player A who has incentives to ignore the information that is available to him or her and, as a result, make choices that are likely to increase the chances that you get a low payoff. During other rounds, you will be paired with a Player A who does not have such incentives.

At 3.*

In this first set of five rounds the additional payment to Player A increases as the actual number of marbles in the container increases.

*Player A’s Incentives*

Because Player A can get a higher payment by guessing more marbles (and the amount of this additional payment is more than Player A’s possible Loss), Player A has an incentive to always guess more marbles than indicated by the measurement provided by the scale.

At 6.*

In this second set of five rounds the additional payment to Player A increases as the number of marbles Player A guesses increases.

*Player A’s Incentives*

Because Player A’s guess does not impact Player A’s additional payment, but Player A’s Loss is based on the number of marbles by which his or her guess is “off”, Player A’s incentives are best served when he or she guesses a number that is close to the measurement provided by the scale.

*The order in which participants view the wording conveyed in 3. and 6. is counterbalanced between experimental sessions to match the counterbalanced order of the within-participant manipulation of management bias.
**Panel C:** Wording used to convey to auditors an emphasis on management bias and measurement imprecision

At 1. (refer to Panel A)

<table>
<thead>
<tr>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are about to learn that in some rounds of the task, you will be paired with a Player A who</td>
</tr>
<tr>
<td>has incentives to ignore the information that is available to him or her and, as a result,</td>
</tr>
<tr>
<td>make choices that are likely to increase the chances that you get a low payoff. During other</td>
</tr>
<tr>
<td>rounds, you will be paired with a Player A who does not have such incentives.</td>
</tr>
<tr>
<td>You will also learn that the information available to Player A is not very precise. Thus,</td>
</tr>
<tr>
<td>regardless of Player A’s incentives, the result of Player A’s decisions in the experimental</td>
</tr>
<tr>
<td>task might contribute to the possibility that you get a low payoff.</td>
</tr>
</tbody>
</table>

At 3.*

<table>
<thead>
<tr>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this first set of five rounds the additional payment to Player A increases as the actual</td>
</tr>
<tr>
<td>number of marbles in the container increases.</td>
</tr>
<tr>
<td><strong>Player A’s Incentives</strong></td>
</tr>
<tr>
<td>Because Player A can get a higher payment by guessing more marbles (and the amount of this</td>
</tr>
<tr>
<td>additional payment is more than Player A’s possible Loss), Player A has an incentive to</td>
</tr>
<tr>
<td>always guess more marbles than indicated by the measurement provided by the scale.</td>
</tr>
<tr>
<td><strong>Imprecision of the Scale</strong></td>
</tr>
<tr>
<td>The fact that the scale used to weigh the marbles is imprecise contributes to the possibility</td>
</tr>
<tr>
<td>that the measurement viewed by Player A, and ultimately his or her guess, might not be very</td>
</tr>
<tr>
<td>close to the actual number of marbles in the container.</td>
</tr>
</tbody>
</table>

At 6.*

<table>
<thead>
<tr>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this second set of five rounds the additional payment to Player A increases as the number</td>
</tr>
<tr>
<td>of marbles Player A guesses increases.</td>
</tr>
<tr>
<td><strong>Player A’s Incentives</strong></td>
</tr>
<tr>
<td>Because Player A’s guess does not impact Player A’s additional payment, but Player A’s Loss</td>
</tr>
<tr>
<td>is based on the number of marbles by which his or her guess is “off”, Player A’s incentives</td>
</tr>
<tr>
<td>are best served when he or she guesses a number that is close to the measurement provided by</td>
</tr>
<tr>
<td>the scale.</td>
</tr>
<tr>
<td><strong>Imprecision of the Scale</strong></td>
</tr>
<tr>
<td>The fact that the scale used to weigh the marbles is imprecise contributes to the possibility</td>
</tr>
<tr>
<td>that the measurement viewed by Player A, and ultimately his or her guess, might not be very</td>
</tr>
<tr>
<td>close to the actual number of marbles in the container.</td>
</tr>
</tbody>
</table>

*The order in which participants view the wording conveyed in 3. and 6. is counterbalanced between experimental sessions to match the counterbalanced order of the within-participant manipulation of management bias.
FIGURE 3
Average Level of Costly Effort Selected by Auditors

FIGURE 4
Reporter Estimates
TABLE 1
Probabilities Associated with Chosen Level of Audit Effort

Panel A: The impact of audit effort on the probability the **auditor** incurs a penalty

<table>
<thead>
<tr>
<th>Audit Effort</th>
<th>P(Auditor Penalty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>2</td>
<td>0.80</td>
</tr>
<tr>
<td>3</td>
<td>0.65</td>
</tr>
<tr>
<td>4</td>
<td>0.55</td>
</tr>
<tr>
<td>5</td>
<td>0.45</td>
</tr>
<tr>
<td>6</td>
<td>0.35</td>
</tr>
<tr>
<td>7</td>
<td>0.25</td>
</tr>
<tr>
<td>8</td>
<td>0.15</td>
</tr>
<tr>
<td>9</td>
<td>0.10</td>
</tr>
<tr>
<td>10</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Panel B: The impact of audit effort on the probability the **reporter** incurs a penalty

<table>
<thead>
<tr>
<th>Audit Effort</th>
<th>P(Reporter Penalty)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td>0.10</td>
</tr>
<tr>
<td>3</td>
<td>0.15</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
</tr>
<tr>
<td>5</td>
<td>0.35</td>
</tr>
<tr>
<td>6</td>
<td>0.45</td>
</tr>
<tr>
<td>7</td>
<td>0.55</td>
</tr>
<tr>
<td>8</td>
<td>0.65</td>
</tr>
<tr>
<td>9</td>
<td>0.80</td>
</tr>
<tr>
<td>10</td>
<td>0.95</td>
</tr>
</tbody>
</table>
### TABLE 2
**Manipulation Check: Emphasis on Bias versus Emphasis on Bias and Imprecision**

**Panel A:** Auditors’ mean (std. dev.) response to the post-experimental question, “In general, how much emphasis did the experimental materials place on the fact that Player A’s guess contributed to the amount of your potential loss?”

<table>
<thead>
<tr>
<th></th>
<th>Bias Emphasis</th>
<th>Dual Emphasis</th>
<th>df</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.69 (1.09)</td>
<td>5.94 (1.00)</td>
<td>65</td>
<td>0.94</td>
<td>0.35</td>
</tr>
</tbody>
</table>

**Panel B:** Auditors’ mean (std. dev.) response to the post-experimental question, “In general, how much emphasis did the experimental materials place on the fact that the imprecision of the scale contributed to the amount of your potential loss?”

<table>
<thead>
<tr>
<th></th>
<th>Bias Emphasis</th>
<th>Dual Emphasis</th>
<th>df</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.47 (1.75)</td>
<td>5.32 (1.42)</td>
<td>65</td>
<td>2.16</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Responses measured on a seven-point scale ranging from 1 = “not emphasized” to 7 = “heavily emphasized.” Reported p-values are two-tailed.
### Table 3
Average Level of Costly Effort Selected by Auditors

**Panel A: Descriptive statistics**

<table>
<thead>
<tr>
<th></th>
<th>High Risk of Bias</th>
<th>Low Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Emphasis</td>
<td>5.59 (1.96)</td>
<td>4.50 (2.34)</td>
</tr>
<tr>
<td>n = 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias Emphasis</td>
<td>5.82 (1.86)</td>
<td>3.71 (1.64)</td>
</tr>
<tr>
<td>n = 37</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Panel B: Repeated measures analysis of variance**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>M.S.</th>
<th>F-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between-Participants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emphasis</td>
<td>1</td>
<td>2.64</td>
<td>0.48</td>
<td>0.49</td>
</tr>
<tr>
<td>Error</td>
<td>66</td>
<td>5.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within-Participants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of Bias</td>
<td>1</td>
<td>86.28</td>
<td>41.02</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Risk of Bias × Emphasis</td>
<td>1</td>
<td>8.74</td>
<td>4.15</td>
<td>0.05</td>
</tr>
<tr>
<td>Error</td>
<td>66</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Panel C: Simple effect of emphasis given the risk of reporter**

<table>
<thead>
<tr>
<th>Effect of emphasis given:</th>
<th>F-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk of Bias</td>
<td>0.24</td>
<td>0.62</td>
</tr>
<tr>
<td>Low Risk of Bias</td>
<td>2.65</td>
<td><strong>0.05</strong></td>
</tr>
</tbody>
</table>

The within-participants dependent variables used in the analysis are auditors’ average chosen protection level, ranging from 1 to 10, over the five rounds comprising the high risk of bias condition and auditors’ average chosen protection level over the five comprising the low risk of bias condition. Reported p-values are two-tailed with the exception of directional predictions which are one-tailed, as indicated by **boldface.**
TABLE 4  
Auditors’ Risk Assessments

Panel A: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>High Risk of Bias</th>
<th>Low Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dual Emphasis</strong></td>
<td>6.90 (2.27)</td>
<td>5.10 (2.39)</td>
</tr>
<tr>
<td>n = 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bias Emphasis</strong></td>
<td>7.43 (2.79)</td>
<td>4.84 (2.50)</td>
</tr>
<tr>
<td>n = 37</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B: Repeated measures analysis of variance

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>M.S.</th>
<th>F-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between-Participants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emphasis</td>
<td>1</td>
<td>0.62</td>
<td>0.07</td>
<td>0.80</td>
</tr>
<tr>
<td>Error</td>
<td>66</td>
<td>9.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within-Participants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of Bias</td>
<td>1</td>
<td>163.36</td>
<td>46.30</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Risk of Bias × Emphasis</td>
<td>1</td>
<td>5.24</td>
<td>1.49</td>
<td>0.23</td>
</tr>
<tr>
<td>Error</td>
<td>66</td>
<td>2.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The within-participants dependent variables used in the analysis are auditors’ responses to the question “How concerned are you about the possibility that you will incur the Loss of up to $15 and, as a result, get a low payment for this set of five rounds?” Responses were measured prior to start of each set of five rounds, using an 11-point Likert scale anchored at 0 = “Not at all concerned” and 10 = “Very concerned.” Reported p-values are two-tailed.
TABLE 5
Supplemental Analysis: Evidence of Systematic and Heuristic Processing

Pearson correlations between auditors’ *perceived* impact of measurement imprecision on audit effort decisions and auditors’ *actual* level of audit effort.

<table>
<thead>
<tr>
<th>Perceived Impact of Imprecision on Audit Effort, Emphasis</th>
<th>Actual Audit Effort, High Risk of Bias</th>
<th>Actual Audit Effort, Low Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p = 0.74</td>
<td>p = 0.62</td>
</tr>
<tr>
<td>Bias-Emphasis</td>
<td>0.06</td>
<td>0.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perceived Impact of Imprecision on Audit Effort, Emphasis</th>
<th>0.48</th>
<th>0.49</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual-Emphasis</td>
<td>p &lt; 0.01</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

The variable “Actual Audit Effort” is auditors’ average chosen protection level, ranging from 1 to 10, over the five rounds comprising the high risk of bias condition and auditors’ average chosen protection level over the five rounds comprising the low risk of bias condition.

The variable “Perceived Impact of Imprecision on Audit Effort” represents auditors’ responses, measured on a seven-point scale anchored at 1 = “Strongly disagree” and 7 = “Strongly agree,” to the following statement: “The fact that the scale Player A used to estimate the number of marbles in the container was not very precise had a big impact on the Protection Level I chose.”

Reported *p*-values are two-tailed.
### TABLE 6
**Reporter Estimates**

**Panel A:** Mean (std. dev.) difference between reporter estimates and the imprecise signal

<table>
<thead>
<tr>
<th></th>
<th>High Risk of Bias</th>
<th>Low Risk of Bias</th>
<th>df</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upward bias</td>
<td>8.55 (5.39)</td>
<td>1.84 (2.90)</td>
<td>21</td>
<td>5.86</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

**Panel B:** One-sample *t*-test of the null hypothesis that the mean upward bias exhibited by reporters in the low risk of bias condition is equal to zero

<table>
<thead>
<tr>
<th></th>
<th>Low Risk of Bias</th>
<th>df</th>
<th>t-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upward bias</td>
<td>1.84 (2.90)</td>
<td>21</td>
<td>2.97</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

Reported *p*-values are two-tailed.