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Aasmund Eilifsen, Erin L. Hamilton and William F. Messier, Jr.

Department of Accounting, Auditing and Law
Institutt for regnskap, revisjon og rettsvitenskap

NORWEGIAN SCHOOL OF ECONOMICS

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Aasmund Eilifsen^a, Erin L. Hamilton^b, William F. Messier, Jr.^{a, b, *}

^a *NHH Norwegian School of Economics, Helleveien 30, 5045 Bergen, Norway*

^b *University of Nevada, Las Vegas, 4505 S. Maryland Parkway, Las Vegas, NV 89154, USA*

* Corresponding author.

E-mail addresses: aasmund.eilifsen@nhh.no (A. Eilifsen), erin.hamilton@unlv.edu (E.L. Hamilton), bill.messier@unlv.edu (W.F. Messier, Jr.)

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The Importance of Quantifying Uncertainty: Examining the Effects of Sensitivity Analysis and Audit Materiality Disclosures on Investors' Judgments and Decisions

ABSTRACT: The amount of estimation uncertainty contained in financial statement items may be obscured from investors, given that all estimates, regardless of their imprecision, are reported as precise figures on the face of the financial statements. Our study examines two disclosures expected to help investors evaluate the reliability of subjective fair value estimates: a quantitative sensitivity analysis (QSA) and the auditor's quantitative materiality threshold. Using an experiment, we predict and find that when *both* a QSA and a materiality threshold are disclosed, investors judge the reliability of a reported estimate to be significantly higher when it is relatively precise (i.e., low sensitivity) compared to imprecise (i.e., high sensitivity). However, when materiality is not disclosed, investors fail to recognize differences in reliability between the two levels of sensitivity, even though the amount of imprecision in the low sensitivity condition represents a fraction of materiality, while in the high sensitivity condition, this amount exceeds materiality multiple times over. Furthermore, when both disclosures are absent and only a *qualitative* description of sensitivity is provided, investors appear to assume the worst and judge the estimate's reliability to be lower than when a QSA is disclosed. The results of our study should be informative to accounting and auditing standard setters as they continue to consider the types of disclosures that may help investors understand the most complex and subjective aspects of financial reporting.

Keywords: audit reporting; disclosures; estimation uncertainty; fair value estimates; materiality; sensitivity analysis.

Data Availability: The data are available from the authors.

1. Introduction

The extreme estimation uncertainty inherent in certain financial statement accounts has become a substantial concern in recent years for auditors and standard setters alike (Christensen, Glover, & Wood, 2012; Glover, Taylor, & Wu, 2017; PCAOB, 2012).¹ This estimation uncertainty (or imprecision) in reported numbers has resulted from the increasing complexity of business transactions and use of fair value measurements that often rely on management-derived models that are extremely sensitive to small changes in subjectively-chosen inputs (e.g., Level 3 fair value inputs) (Christensen et al., 2012; PCAOB, 2012). In fact, some numbers recognized on the face of the financial statements contain a level of estimation uncertainty that exceeds the auditor's overall planning materiality – sometimes by multiples of materiality (Christensen et al., 2012; Glover et al., 2017).²

At present, it is unclear whether investors recognize when financial statements contain extreme levels of estimation uncertainty, given that all estimates, regardless of their imprecision, appear as precise point estimates on the face of the financial statements. Understanding the amount of uncertainty inherent in reported estimates is important since prior archival research finds that less reliable estimates lead to lower earnings persistence, and a failure on the part of investors to anticipate this effect results in security mispricing (Richardson, Sloan, Soliman, & Tuna, 2005). Accordingly, the primary purpose of our study is to examine whether investors are

¹ We use the term *extreme estimation uncertainty* to describe an estimate "for which it is reasonably possible that the level of inherent (i.e., irreducible) measurement uncertainty could be closely approaching or exceed the financial statement (and auditor's) materiality threshold" (Bell & Griffin, 2012, p. 148). Estimation uncertainty results from multiple sources, including the inability to precisely measure one or more of the inputs into an estimation model at the date of the financial statements (i.e., unobservable inputs) and historical volatility in model inputs (Christensen et al., 2012).

² Overall (planning) materiality is an amount that the auditor establishes for the overall financial statements and is used to plan the nature, timing, and extent of audit procedures. Auditors apply the concept of materiality to meet the information needs of financial statements users. That is, materiality indicates the imprecision (i.e., the level of misstatement) in the financial statements the auditors expect users to tolerate.

better able to evaluate the reliability of reported estimates when (1) a quantitative sensitivity analysis (QSA) is included within a footnote disclosure related to the estimate, and (2) the quantitative materiality threshold used for the audit is disclosed in the auditor's report. We expect a materiality threshold to provide investors with a useful benchmark for evaluating the degree of imprecision communicated within a QSA since planning materiality indicates the company-specific imprecision the auditor expects investors to tolerate.

Over the past few years, regulators and standard setters worldwide have proposed or adopted various accounting and auditing standards intended to enhance financial statement users' understanding of complex and subjective aspects of financial reporting (e.g., EU, 2014; FASB, 2010, 2011; FRC, 2013; IAASB, 2015; IASB, 2010, 2011; PCAOB, 2013, 2016, 2017). The intent of such increased disclosure is to improve users' ability to make well-informed decisions based on inherently uncertain financial statement information. One such disclosure is a sensitivity analysis, which provides information about how a given estimate would vary if one or more of its subjectively-chosen inputs were to change (IASB, 2010). Sensitivity analyses can be either quantitative or qualitative in nature. A QSA explicitly quantifies the amount by which the estimate and/or net income would change if the company had used different assumptions in its estimation process. In contrast, a narrative sensitivity analysis (NSA) simply states that changes in the assumptions used in the estimation process could have a significant impact on the estimate, but does not explicitly quantify what this impact might be (FASB, 2011).

In 2010, the Financial Accounting Standards Board (FASB, 2010) and International Accounting Standards Board (IASB, 2010) considered requiring a QSA for all Level 3 fair value measurements. However, both the FASB and IASB decided to defer the decision on whether to require a *quantitative* disclosure (i.e., a QSA), and instead put into place a requirement that

management provide a narrative description of sensitivity (i.e., a NSA) that is purely *qualitative* in nature (FASB, 2011). The potential issue with disclosing only a NSA (without a QSA to supplement it) is that the NSA alerts investors to the high level of uncertainty contained in a reported estimate and its potential to significantly impact net income, but does not provide enough information to help investors understand the extent of this uncertainty. As a result, we expect the ambiguity inherent in a NSA disclosure will cause investors to assume the worst and view the estimate as extremely unreliable. In contrast, a QSA is expected to alleviate some of this ambiguity by explicitly quantifying the amount of uncertainty contained within a fair value estimate, resulting in reliability perceptions that are higher than when only a NSA is disclosed.

If investors understand the information disclosed in a QSA, they should perceive an estimate as more reliable when it is less sensitive to changes in underlying inputs compared to when it is extremely sensitive. However, the FASB has noted that one of the concerns with requiring QSA disclosures is that financial statement users may find “the range of reasonably possible Level 3 fair values...[to] be meaningless and possibly confusing” (FASB, 2010, p. 45). To address this concern, we examine whether the disclosure of a quantitative materiality threshold within the auditor’s report helps investors interpret a QSA. Since a materiality threshold indicates the amount of imprecision (i.e., the level of misstatement) auditors believe investors are willing to tolerate within the financial statements, we expect it to serve as a useful benchmark for evaluating the severity of imprecision communicated within a QSA. Accordingly, when the range of sensitivity indicated by the QSA is lower than the auditor’s materiality threshold, we expect investors will judge the reliability of the estimate to be higher than when the range exceeds the auditor’s materiality threshold. In contrast, when materiality is not disclosed, the absence of a benchmark against which the range of sensitivity can be compared

will result in more similar reliability judgments, regardless of the level of sensitivity indicated by the QSA. We also predict that investors will display a greater (lesser) willingness to invest when the QSA indicates a range of potential values that falls below (exceeds) the auditor's disclosed materiality threshold.

We test our predictions experimentally using a $2 \times 2 + 1$ between-subjects design in which we manipulate the range of uncertainty indicated by a QSA (low sensitivity or high sensitivity) and the presence or absence of a materiality threshold disclosure. We also include a control condition in which a QSA is absent from the footnote disclosure (i.e., participants only receive a NSA) and a materiality threshold is not disclosed.³ Consistent with our expectations, we find that when only a NSA is disclosed (i.e., the control condition), investors perceive the reliability of the fair value estimate to be lower than when a QSA is also provided. Most importantly, we find that when investors are presented with both a QSA and a materiality disclosure, they are better able to recognize when an estimate is relatively reliable (i.e., low sensitivity) compared to unreliable (i.e., high sensitivity). However, without the disclosure of materiality to help investors interpret the QSA, investors fail to recognize differences in reliability between the two levels of sensitivity, even though the amount of imprecision in the high sensitivity condition is approximately 15 times the amount indicated by the QSA in the low sensitivity condition.

Unexpectedly, we find that while investors perceive the estimate to be relatively unreliable in the presence of a high sensitivity QSA and a materiality disclosure, their willingness to invest in the company is not reduced relative to the low sensitivity condition. Additional experimentation reveals that this finding is unconscious (i.e., unintentional) on the

³ Note that all conditions in our design contain a NSA that informs participants that the fair value estimate was calculated based on subjectively chosen inputs and that a slight variation in one of these inputs may result in significant changes in operating profit reported for the period.

part of our investor participants. When differences in estimation uncertainty are made more salient to participants using a within-subjects design, we find that investors greatly prefer to invest in a company whose financial statements contain a lower level of estimation uncertainty.

Our study makes two important contributions to the accounting literature as well as to accounting practice and policy. First, while several studies have examined how investors respond to sensitivity analyses (e.g., Koonce, Lipe, & McAnally, 2005a; Koonce, McAnally, & Mercer, 2005b; Nelson & Rupar, 2015), very little evidence exists regarding factors that enhance the usefulness of the information contained within a sensitivity analysis disclosure. Our results suggest that sensitivity analyses may have limited effectiveness in helping investors understand the amount of uncertainty contained in Level 3 fair value estimates, unless they are quantitative in nature and supplemented with a disclosure of the auditor's overall materiality. Specifically, we find that without a QSA, investors respond to a NSA disclosure by assuming the estimate is highly unreliable. This finding suggests that NSA disclosures may be too ambiguous to be of value to investors and that the FASB and IASB should reconsider their decision to only require a narrative description of sensitivity, but not a QSA, for Level 3 fair value estimates.

Second, standard setters in most of the world, including the Public Company Accounting Oversight Board (PCAOB) and the International Auditing and Assurance Standards Board (IAASB), have decided auditors should *not* be required to disclose materiality. Our study suggests materiality provides investors with a useful, company-specific benchmark for evaluating the significance of financial statement items and the amount of uncertainty underlying these items. Thus, the results of our study should be informative to accounting and auditing standard setters as they continue to consider the types of disclosures that may help financial statement users understand the most complex and subjective aspects of financial reporting.

The remainder of the paper proceeds as follows. In section 2, we review related literature and develop our hypotheses. The methodology and results are discussed in sections 3 and 4, respectively. Finally, we conclude with a discussion in section 5.

2. Background and Hypotheses

2.1. Extreme Estimation Uncertainty

Many financial statement accounts require estimation due to uncertainty surrounding the measurement and valuation of items that are contingent on the outcome of future events (e.g., allowance for doubtful accounts, fair value measurement) (PCAOB, 2003). Some estimates require complex valuation models that use uncertain and unobservable inputs (e.g., Level 3 fair value inputs), which are highly subjective. As a result, the level of uncertainty inherent in some estimates creates a range of reasonably possible values that exceeds auditors' materiality thresholds, sometimes by multiples of materiality (Cannon & Bedard, 2017; Christensen et al., 2012; Glover et al., 2017). Christensen et al. (2012) use publicly available data to demonstrate that a relatively small change to a fair value input (e.g., interest rates) has the potential to change an estimate's reported value by as much as 50 times audit materiality. Because changes in fair value estimates often impact earnings, the net income figure reported by some companies may also include extreme estimation uncertainty (Christensen et al., 2012).

Highly subjective estimates can be problematic because they are inherently unreliable due to their dependence on management's judgment, which may be inaccurate due to bias or due to the difficulty of predicting future conditions and events (Lev, Li, & Sougiannis, 2010). Estimates that are less reliable are also less useful for decision-making purposes (Lev et al., 2010; Richardson et al., 2005).⁴ Richardson et al. (2005) provide empirical evidence that more

⁴ In our experiment, we define reliability as "the extent to which information is measured with little uncertainty, is verifiable, and reflects a company's business activities in an unbiased manner."

subjective and, therefore, less reliable accrual estimates result in lower earnings persistence, and investors often fail to anticipate this effect, leading to security mispricing. Unfortunately, it is not always possible to reduce estimation uncertainty to an immaterial amount (Bell & Griffin, 2012).

In the presence of extreme and irreducible estimation uncertainty, the question becomes, how can management and auditors effectively communicate the uncertainty contained within financial statement items, so that users can incorporate this information into their decisions in a meaningful way? Answering this question may be especially important in today's environment, given that estimation uncertainty is being made more salient to financial statement users through the disclosure of critical (or key) audit matters (CAMs) in the auditor's report.⁵ The IAASB (2015) and PCAOB (2017) anticipate that CAMs will focus on financial statement areas involving significant management judgment and high estimation uncertainty. By drawing attention to difficult and subjective audit areas, CAMs may enable financial statement users to "analyze more closely any related financial statement accounts and disclosures" (PCAOB, 2013, p. A5-23). We focus on two disclosures that are especially relevant for communicating the risk and uncertainty inherent in estimates containing extreme estimation uncertainty: (1) quantitative sensitivity analyses (QSAs) and (2) quantitative auditor materiality thresholds.

2.2. Quantitative Sensitivity Analyses

One type of supplemental footnote disclosure that may help financial statement users understand the amount of uncertainty contained within an account is the disclosure of a QSA. A QSA quantifies the potential increase or decrease in a reported estimate (and the resulting effect

⁵ A CAM, which is also referred to as a Key Audit Matter (KAM), is "any matter arising from the audit of the financial statements that...involved especially challenging, subjective, or complex auditor judgment" (PCAOB, 2017, para 0.11). CAM disclosures are now a standard component of the auditor's report and are now required by the PCAOB (2017), the IAASB (2015), the European Union (EU, 2014), and the U.K.'s Financial Reporting Council (FRC, 2013). Although CAM disclosures are unlikely to provide investors with enough information to fully understand a CAM item, they have an attention-directing effect, prompting investors to consider more carefully other disclosures that provide additional information about the item (e.g., related footnote disclosures) (PCAOB, 2016; Sirois, Bédard, & Bera, 2016).

on earnings) that would result from a change in one or more of the inputs used to determine the estimate (Linsmeier & Pearson, 1997). For example, an estimate may be calculated using various assumptions, such as future interest rates, commodity prices, etc. A QSA would indicate the effect on earnings if one or more of these inputs were to change by a certain amount (e.g., a one percent change in commodity prices would result in a \$5 million change in reported earnings). While a QSA is required for certain financial statement items (e.g., financial instruments measured at fair value per IFRS 7),⁶ other items may only require a narrative sensitivity analysis (NSA) or no sensitivity analysis at all. In 2010, the FASB (2010) and IASB (2010) considered requiring a QSA for all Level 3 fair value estimates. Although financial statement users were supportive of a quantitative disclosure and believe it provides “useful information that helps them to assess the subjectivity of an entity’s fair value measurements categorized [as] Level 3” (IASB, 2010, p. 16), both standard setting bodies ultimately decided that a NSA would suffice (FASB, 2011). An example of a NSA and a QSA is provided in Exhibit 1.

[Insert Exhibit 1 here]

Prior research finds that investors’ judgments and decisions are influenced by the information contained within a QSA. For example, the format in which a QSA is presented (e.g., stating the impact on earnings in dollar versus percentage terms) appears to influence investors’ judgments regarding an item’s risk and reliability (Koonce et al., 2005a; Nelson & Rupar, 2015). The amount of loss communicated within a QSA also appears to influence investors’ risk perceptions (Koonce et al., 2005b). Our study extends the literature on sensitivity analyses in two distinct ways. First, our study examines the effect of adding a QSA to a narrative description of sensitivity (NSA). This is an important comparison, given that standard setters have debated

⁶ Another example of a required QSA disclosure relates to the sensitivity of accumulated postretirement benefit obligations to a one percent change in assumed health care cost trend rates (FASB, 1990, 2003).

whether a QSA provides meaningful information to investors beyond that contained within a qualitative disclosure (FASB, 2010, 2011; IASB, 2010). Second, we examine whether the usefulness and understandability of a QSA can be enhanced by the additional disclosure of the auditor's materiality threshold.

When investors are made aware that an estimate reported on the face of the financial statements contains uncertainty and subjectivity (e.g., because this uncertainty has been highlighted within a CAM disclosure), they are likely to view the item as unreliable and desire additional information to understand this uncertainty better. A NSA is unlikely to do much to satisfy investors' desire for additional information. NSA disclosures simply state that if an assumption used in the estimation process were to change, the reported estimate would be significantly affected, but this effect is not explicitly quantified (FASB, 2011). This lack of information regarding the amount of uncertainty contained in a subjective estimate is likely to lead to feelings of ambiguity. Ambiguity is uncertainty that is created when relevant information, which could be known, is missing and salient (Camerer & Weber, 1992; Frisch & Baron, 1988). Individuals generally dislike ambiguity (Heath & Tversky, 1991) and often assume a worst-case scenario when faced with ambiguous information (Epstein & Schneider, 2008; Pflug, Pichler, & Wozabal, 2012). Accordingly, we expect that when investors are provided with only a NSA disclosure, which highlights the uncertainty of the estimate without quantifying it, they will assume the worst and believe the estimate is highly unreliable.

A QSA, on the other hand, explicitly quantifies the amount of uncertainty in a reported estimate and, therefore, should satisfy investors' desires for additional information regarding the subjective estimate and its potential impact on the financial statements. Investors prefer for highly subjective financial items, such as management estimates and earnings forecasts, to be

reported as range estimates rather than precise point estimates (Christensen, Glover, Omer, & Shelley, 2014; Du, Budescu, Shelly, & Omer, 2011). Unlike a point estimate, a range communicates the parameters of the uncertainty underlying the financial item and, therefore, is viewed as more informative and credible compared to a point estimate. While in our study, the Level 3 fair value estimate is always reported as a point estimate on the face of the financial statements, we expect the additional disclosure of a QSA to satisfy investors' desires for additional information about the item's imprecision. Furthermore, prior research suggests disclosures that are quantitative in nature are generally perceived as being more informative and credible compared to disclosures that are purely qualitative (e.g., Allen & Preiss, 1997; Botosan, 1997; Kadous, Koonce, & Towry, 2010). Accordingly, we predict that when only a NSA is disclosed, investors will assume the reported estimate is highly unreliable. The additional disclosure of a QSA, however, is expected to reduce ambiguity regarding the amount of uncertainty in the subjective estimate and lead to reliability perceptions that are higher compared to when only a NSA is provided. Stated formally, our first hypothesis is as follows:

H1. Investors will perceive an uncertain estimate as more reliable when a NSA disclosure is supplemented with a QSA compared to when it is not.

2.3. Interaction of a Quantitative Sensitivity Analysis and Materiality Threshold Disclosure

Although we expect investors to perceive an estimate as more reliable when a QSA is disclosed, the amount of sensitivity (i.e., imprecision) communicated by the QSA should also affect investors' reliability perceptions. Consider an example in which a company reports a QSA indicating that a one percentage point increase in an interest rate used to calculate a fair value estimate will result in a \$50 million decrease in earnings. Compare this to an identical disclosure that only indicates a potential earnings effect of \$2 million. Obviously, the latter example should cause investors to perceive the estimate as more reliable than the former example because it

communicates a lesser amount of imprecision (\$2 million as opposed to \$50 million). However, one of the concerns expressed regarding QSA disclosures is that financial statement users may not understand them (PCAOB, 2010). Therefore, we examine whether a disclosure of the auditor's quantitative materiality threshold assists investors in interpreting the information communicated in a QSA by serving as a relevant benchmark.

Financial statement information is material if its omission or misstatement is likely to influence the judgments of a reasonable investor (PCAOB, 2010). In recent years, several standard setting bodies have considered requiring the disclosure of quantitative materiality thresholds within the auditor's report. While most standard setters, including the PCAOB and IAASB, have decided not to require materiality disclosures, the U.K.'s FRC (2013) and the Netherlands' NBA (2014) have issued standards that now require auditors to disclose the materiality threshold used for the financial statements as a whole.⁷ Furthermore, auditors are not precluded from voluntarily disclosing materiality (IAASB, 2015), and PwC has elected to do so for audits of financial statements in Finland and Sweden.⁸ While audit reports in most of the world continue to exclude information about materiality, investors generally support the inclusion of such information (PCAOB, 2011; Singh & Peters, 2015).⁹

Much of the prior literature on materiality has focused on the various determinants of materiality thresholds (e.g., Eilifsen & Messier, 2015; see also Holstrum & Messier, 1982 and Messier, Martinov-Bennie, & Eilifsen, 2005 for reviews of the materiality literature). Only a few

⁷ The European Union requires that the auditor "disclose the quantitative level of materiality applied to perform the statutory audit for the financial statements as a whole and where applicable the materiality level or levels for particular classes of transactions, account balances or disclosures, and disclose the qualitative factors which were considered when setting the level of materiality" (EU, 2014 Article 11, para 2. (h)) in an additional report provided to the audit committee.

⁸ For examples of audit reports containing voluntary disclosures of materiality, see the annual reports of Tieto, Ferratum Oyj, and Betsson AB.

⁹ The PCAOB's Investor Advisory Group (2011) reports that 56 percent of investors surveyed agree that auditors should be required to disclose materiality, while only 17 percent disagreed. Also, the CFA Institute reports that 82 percent of investors surveyed support increased disclosure about materiality (Singh & Peters, 2015).

studies have considered the potential impact of disclosing materiality levels to the public. These studies suggest that the disclosure of materiality may increase the accuracy of security prices (Fisher, 1990) and help to reduce the expectations gap that exists between auditors and the investing public (Coram, Mock, Turner, & Gray, 2011; Gray, Turner, Coram, & Mock, 2011; Houghton, Jubb, & Kend, 2011). Our study extends prior research on materiality by examining how a QSA disclosure coupled with the disclosure of a quantitative materiality threshold influences investors' perceptions regarding the reliability of an amount recognized within the financial statements that contains estimation uncertainty.

While we expect a QSA disclosure to help quantify the amount of uncertainty in a reported estimate, once this uncertainty has been quantified, investors still must assess how significant this imprecision (i.e., potential misstatement) is.¹⁰ The disclosure of a quantitative materiality threshold should provide investors with a useful benchmark for assessing the significance of a potential misstatement. Because materiality thresholds are company-specific (i.e., are determined based on the quantitative and qualitative characteristics of a given company), they make it possible to evaluate the importance of an item or severity of a misstatement in the context of a given company's financial statements. According to context theory, the way in which a cue is interpreted depends on the context in which it is presented (Medin, Goldstone, & Gentner, 1993; Medin & Schaffer, 1978). A single cue (e.g. a QSA) may be too ambiguous to allow for a clear interpretation; however, the addition of a second cue can provide needed context and allow the initial cue to be interpreted more easily. One way in which a second cue may provide context is by serving as a benchmark or reference point against which an initial cue can be evaluated (Boles & Messick, 1995; Kahneman & Tversky, 1979).

¹⁰ Imprecision in reported estimates creates potential for material misstatement, as it indicates that an amount reported in the financial statements may not be accurate. If this imprecision is large enough, it may suggest that the financial statements (including net income) are materially misstated.

Based on context theory, we expect the disclosure of the auditor's materiality threshold will serve as a useful benchmark to investors and help them interpret information disclosed within a QSA. When a QSA suggests that the imprecision in a reported estimate exceeds materiality (potentially by multiples of materiality), investors are likely to perceive the estimate as unreliable. In contrast, when a QSA suggests the level of imprecision falls below materiality, investors are likely to perceive the related estimate as more reliable as it falls within a range of uncertainty considered “acceptable” by the auditors. In the absence of a materiality disclosure, however, investors may find it more difficult to interpret the information communicated in a QSA, leading to reliability perceptions that are not as sensitive to different levels of estimation uncertainty. Our second hypothesis predicts an interaction (as shown in Panel A of Figure 1) and is formally stated as follows:

H2. Investors will perceive an uncertain estimate as more reliable when a QSA is indicative of low sensitivity compared to high sensitivity, and this effect will be stronger when materiality is disclosed compared to when it is not.

[Insert Figure 1 here]

Given that the concept of materiality describes information or amounts expected to influence the judgments and decisions of reasonable investors, we also examine how our variables of interest influence investors' ultimate willingness to invest. When estimation uncertainty is made more apparent through a QSA and a materiality threshold disclosure, we expect investors to recognize the risk that certain financial statement amounts (including net income) may be materially misstated. As a result, we predict that when the uncertainty indicated within a QSA falls below auditors' materiality threshold, investors will be more confident that the financial statements are not materially misstated and will be more willing to invest. In contrast, when uncertainty communicated within a QSA exceeds the materiality threshold,

investors will doubt the reliability of the financial statements, and in turn, will be relatively unwilling to invest. Stated formally, our third hypothesis is as follows:

H3. Investors will be more willing to invest in a company with a QSA indicative of low sensitivity compared to high sensitivity, and this effect will be stronger when materiality is disclosed compared to when it is not.

3. Method

3.1. Participants

Participants in the experiment consisted of 193 graduate students enrolled in either the Master's in Accounting and Auditing program or the Master's in Economics and Business Administration program at a large public business school in Bergen, Norway.¹¹ Like MBA students, our participants also have the requisite coursework necessary to qualify as proxies for nonprofessional investors (Elliott, Hodge, Kennedy, & Pronk, 2007). Participants had completed an average of 8.8 classes (during their bachelor's and master's programs) related to financial accounting, auditing, finance, and valuation and had an average of 1.4 years of professional work experience in the fields of accounting, finance, and/or business. Fifty percent of participants were 22-25 years old, 40 percent were 26-29, 8 percent were 30 or older, and 2 percent were under 22 years old. Forty-one percent of participants were female.¹²

3.2. Case Materials

Our experimental materials were based on an actual fish farming company in Norway. The financial statements of fish farming companies often contain a high degree of estimation uncertainty due to the inclusion of a fair value estimate central to the companies' operations: the

¹¹ Two participants were determined to be outliers and were removed from the sample. One of the participants completed the study in less than three minutes (median completion time was 20.4 minutes). The other participant's response to the dependent variable (perceived reliability) was more than three standard deviations below the mean. Including these participants does not change our study's inferences.

¹² None of the demographic variables differ significantly across conditions nor are they significant covariates in any of the models tested.

fair value of live fish. Live fish (i.e., immature farmed salmon in the sea, not yet ready for harvesting) are biological assets which are measured at fair value less cost to sell in accordance with IAS 41 “Agriculture” and IFRS 13 “Fair Value Measurement.” Active markets for the future sale of live fish do not exist, so the valuation of live fish under IAS 41 and IFRS 13 requires the establishment of an estimated fair value in a hypothetical market. Therefore, fair value measurement of live fish is categorized as Level 3 in the fair value hierarchy. The calculation of the fair value of live fish is based on the estimated future market prices for harvested fish and estimated costs to transform live fish to maturity.¹³ The adjustment of live fish to fair value causes a gain or loss to be recognized on the income statement, which can be substantial in size. As such, fish farming companies routinely disclose QSAs to show the potential effects on profit that would result if the company had used a different estimate of future fish prices in its fair value model.

Our experimental materials were reviewed by five partners from two Big 4 firms, one of whom previously served as the chief accountant for a publicly traded fish farming company. The instrument was pilot tested with 14 authorized financial analysts during a training seminar by the Norwegian Society of Financial Analysts and resulted in minor changes to the case materials.

3.3. Experimental Design and Procedures

To examine our research hypotheses, we conducted an experiment that utilized a $2 \times 2 + 1$ between-subjects design. We manipulated the amount of sensitivity indicated by a QSA disclosure (low sensitivity versus high sensitivity) and the presence or absence of a materiality threshold disclosure within the auditor’s report. We also included a control condition in which both disclosures (QSA and materiality) were absent. The experiment was conducted online using

¹³ Marine Harvest Group describes its estimate of future fish prices as follows: “The key element in the estimation of fair value is the assumed market price. The assumed market price is the price that we expect to receive on the future date when the live fish is harvested” (Marine Harvest ASA 2016 annual report, p. 171).

Qualtrics and was administrated in two graduate-level courses by two of the study's researchers.

Participants were instructed to assume the role of a nonprofessional investor who is considering an investment in a hypothetical fish farming company, King Fish Farming Group (KFFG). Participants received a brief description of KFFG, before being provided with select information from the company's current year annual report. Specifically, participants viewed excerpts from the auditor's report, which included a standard unqualified opinion as well as a CAM disclosure. In all conditions, the CAM disclosure described the high level of uncertainty associated with estimating KFFG's "adjustment of live fish inventory to fair value," which is an income statement account reflecting gains and losses associated with adjusting the company's live fish inventory to fair value. At the end of the CAM disclosure, participants were directed to, "See note 1 to the financial statements for the disclosure...related to the fair value of live fish." The audit report also included our manipulation of the auditor's materiality threshold disclosure (absent or present). Appendix A contains a copy of the audit report.

The audit report was followed by a simplified income statement that included the operating profit line item "adjustment of live fish inventory to fair value." For each of the two years presented, the magnitude of the adjustment was substantial relative to earnings but with opposite effects (i.e., the adjustment reflected a gain in the current year and a loss in the prior year). Therefore, even though the company's earnings increased by nearly 30 percent in the current year, this increase is largely attributable to the substantial increase in the adjustment account, which represents a highly subjective management estimate.

After viewing the auditor's report and income statement, participants received a footnote disclosure related to "live fish inventory." In all conditions, the footnote included a narrative description of sensitivity (a NSA), which explained how the estimate critically depends on

estimated future market prices of live fish, and how even minor changes in these estimated prices may result in significant changes in operating profit. Participants who were not assigned to the control condition also received a QSA disclosure, described in detail in the next section. (See Appendix B for the full text of the footnote.) Participants completed the experiment by responding to the dependent variables, post-experimental questions, manipulation checks, and demographic questions. Access to the case materials was available to participants throughout the experiment, except when manipulation checks and demographic questions were being answered.

3.4. Independent Variables

The first independent variable, *QSA*, relates to the disclosure of a QSA within the "live fish inventory" footnote (*Low Sensitivity* versus *High Sensitivity*). The QSA appeared as a table, which quantified the amount by which operating profit for the current year (20X2) would change if a critical input used in the fair value estimate (i.e., estimated future market prices) had been higher or lower by 4% and by 20%. In the *Low Sensitivity* condition, both amounts (associated with a 4% and 20% change in market prices) fall below the auditor's materiality threshold (i.e., are less than 5% of pretax profit). In the *High Sensitivity* condition, however, both amounts exceed the auditor's materiality threshold. Specifically, a 4% change in market prices would cause operating profit to change by more than 1.5 times materiality, and a 20% change in market prices would cause operating profit to change by nearly 7.5 times materiality. (See Appendix B for the QSA disclosures.)

The second independent variable, *Materiality Threshold*, relates to a disclosure within the auditor's report of the quantitative materiality threshold used during the audit of KFFG (*Present* versus *Absent*). In all conditions, the audit report contained a brief definition of materiality, but only participants in the *Materiality Threshold–Present* condition received the following

sentence: “We determined materiality for the Group to be **NOK 44 million**, which is approximately **5%** of profit before tax.”¹⁴ (See Appendix A for the full audit report.)

In the *Control* condition, participants did not receive a materiality threshold disclosure or the table containing a QSA. However, all participants, including those in the *Control* condition, received a footnote disclosure that contained a NSA, which described the sensitivity of operating profit to changes in the estimated future market price of fish without quantifying the effect. Holding the NSA description constant across all conditions allows us to examine how the additional disclosure of a QSA (in the *Low* and *High Sensitivity* conditions) affects investors' judgments and decisions relative to a *Control* condition in which *only* a NSA is provided.

3.5. *Dependent Variables*

There are two primary dependent variables used in the study: (1) change in perceived reliability and (2) willingness to invest. To measure change in perceived reliability, participants indicated the reliability of the income statement account, "adjustment of live fish inventory to fair value" both before and after viewing the footnote disclosure related to live fish inventory, which contained the *QSA* manipulation.¹⁵ Reliability perceptions were collected on an 11-point scale with endpoints labeled “1 – Not at all Reliable” and “11 – Very Reliable.” We then calculated a change score by subtracting participants' initial reliability perceptions (before viewing the footnote) from those collected after participants viewed the footnote disclosure. This approach allows us to more precisely measure the effect of a QSA disclosure while taking into account *ex ante* differences in reliability perceptions across participants.

¹⁴ The Norwegian krone (NOK) is the currency of Norway. One U.S. dollar was equal to approximately 8.29 NOK at the time the experiment was conducted.

¹⁵ We provided the following definition of reliability to the participants: “Reliability is the extent to which information is measured with little uncertainty, is verifiable, and reflects a company’s business activities in an unbiased manner.” This definition of reliability is consistent with the one used by Frederickson, Hodge, & Pratt (2006) and Clor-Proell (2009).

Our second dependent variable, willingness to invest, was measured by averaging participants' responses to the following two questions: (1) “In your opinion, how attractive is KFFG as an investment?” and (2) “Assuming you had NOK 50,000 to invest in the common stock of one or more companies, how likely are you to invest a portion of this amount in the common stock of KFFG?” Responses to these questions were collected on 11-point scales with endpoints labeled “1 – Very Unattractive (Unlikely)” and “11 – Very Attractive (Likely).”¹⁶

4. Results

4.1. Manipulation Checks

We asked two questions to ensure participants attended to our manipulations. First, participants were asked whether or not the footnote disclosure had indicated “the exact NOK amount” by which operating profit would change if the estimated future market price of fish had been higher or lower by 4% and by 20%. Out of 193 participants, 150 (77.7 percent) answered this question correctly. Second, participants were asked whether the auditors had disclosed the NOK amount considered to be material during their audit of KFFG. One hundred seventy-seven participants (91.7 percent) answered this question correctly. Analyses below are based on the 140 participants who correctly answered both manipulation check questions.¹⁷

4.2. Test of H1

Panel A of Table 1 provides descriptive statistics for the perceived reliability dependent variable across conditions. In addition to the change score used to test H1 and H2, Panel A of

¹⁶ We also asked participants to indicate the amount they would be willing to invest (from NOK 0 to NOK 50,000); however, we do not find significant differences between experimental conditions on this measure.

¹⁷ Nearly all participants (87 percent) who failed a manipulation check question were in a condition in which the disclosure was present, but the participant failed to recall seeing it. By only including in our analyses those participants who correctly answered our manipulation check questions, we can rule out the possibility that our results are due to differences between conditions in information acquisition (Frederickson et al., 2006). Overall, results are similar (although weaker) when manipulation check failures are included in the analyses. Specifically, tests associated with H1 are no longer significant, while results for H2 and H3 are unchanged.

Table 1 also presents participants' initial reliability perceptions prior to viewing the footnote disclosure (i.e., pre-treatment perceptions) as well as participants' post-treatment perceptions. While random assignment should preclude any differences between conditions on participants' initial (i.e., pre-treatment) reliability perceptions, we find pre-treatment perceptions are significantly lower in the *Materiality Threshold-Present/Low Sensitivity* condition compared to the *Materiality Threshold-Present/High Sensitivity* condition ($t_{135} = 2.04$, $p = 0.044$, untabulated) and compared to the *Control* condition ($t_{135} = 2.12$, $p = 0.036$, untabulated).^{18,19} Our use of a change score removes the effect of these initial differences in perceived reliability.

H1 predicts investors will perceive the reliability of an uncertain estimate to be higher when a QSA is disclosed compared to when only a NSA is present. Panel C of Table 1 provides the specific contrast used to test H1. Because the *Control* condition excludes a materiality threshold disclosure, we initially limit our analysis to the *Materiality Threshold-Absent* condition. Consistent with H1, we find that in the absence of a materiality disclosure, investors perceive the reliability of the fair value estimate to be higher when a QSA is disclosed (i.e., the *Low* and *High Sensitivity* conditions) compared to when it is not (i.e., the *Control* condition) ($t_{135} = 1.55$, $p = 0.061$, one-tailed). Results are slightly stronger ($t_{135} = 1.70$, $p = 0.046$, one-tailed, untabulated) when this analysis is expanded to include the *Materiality Threshold-Present* condition as well (i.e., *Control* condition vs. all other conditions). These results support H1.

To provide support for our theory that the disclosure of a QSA reduces ambiguity compared to when only a NSA is provided, we asked participants how informative the footnote

¹⁸ All p-values in the paper are two-tailed unless otherwise noted.

¹⁹ Although participants viewed our *Materiality Threshold* manipulation prior to making their initial reliability judgments, we do not find differences in pre-treatment reliability perceptions between the *Materiality Threshold* conditions ($t_{138} = 0.84$, $p = 0.401$). Furthermore, our computerized experiment prevented participants from looking ahead in the instrument, so differences between conditions on the pre-treatment measure cannot be attributed to participants viewing the *QSA* manipulation prematurely.

disclosure was in helping them understand the amount of uncertainty contained in the fair value estimate (on a scale ranging from "1 – Not at all Informative" to "11 – Very Informative"). We find that participants view the footnote disclosure as being significantly more informative when a QSA is disclosed compared to when it is not ($t_{135} = 2.58$, $p = 0.011$, untabulated).²⁰ Furthermore, we note that participants' perceptions of the estimate's reliability do not differ between the *Control* condition and the *High Sensitivity* condition ($t_{135} = 1.05$, $p = 0.296$). This finding further supports our contention that when only a narrative description of sensitivity is provided (i.e., the *Control* condition), investors assume the worst and view the estimate in a manner similar to when extreme estimation uncertainty is present.

[Insert Table 1 here]

4.3. Test of H2

H2 predicts investors will perceive an uncertain estimate as more reliable when a QSA is indicative of low sensitivity compared to high sensitivity and that this difference will be greater when materiality is disclosed compared to when it is not (see Panel A of Figure 1 for the form of the predicted interaction). Panel B of Table 1 presents an ANOVA model that includes our two independent variables, *QSA* (*Low Sensitivity*, *High Sensitivity*) and *Materiality Threshold* (*Absent*, *Present*), and Panel B of Figure 1 graphs the results associated with H2. The ANOVA model includes a significant *QSA* x *Materiality Threshold* interaction ($F_1 = 4.82$, $p = 0.030$). Simple effects tests indicate that the form of this interaction is in line with our expectations. Specifically, the difference between the *Low* and *High Sensitivity* conditions is significant in the

²⁰ We also asked participants how difficult it was to evaluate the reliability of the estimate using information disclosed by management and the auditors (on a scale ranging from "1 – Very Difficult" to "11 – Very Easy"). Participants indicated it was significantly easier to evaluate reliability when both a QSA and materiality threshold were disclosed compared to when they were not ($t_{135} = 2.97$, $p = 0.004$, untabulated).

Materiality Threshold–Present condition ($t_{108} = 2.40$, $p = 0.009$, one-tailed), but not in the *Materiality Threshold–Absent* condition ($t_{108} = 0.71$, $p = 0.482$). Therefore, H2 is supported.²¹

Results obtained for H2 suggest that for investors to recognize the difference in reliability between an estimate that contains a relatively low level of sensitivity and one containing a relatively high level of sensitivity, a QSA alone is insufficient. Rather, the QSA must be supplemented with a disclosure of the auditor's materiality threshold. Furthermore, we note that even when we explicitly ask participants how sensitive they perceived operating profit to be in response to changes in future market prices (on a scale from "1 – Not at all Sensitivity" to "11 – Extremely Sensitive"), we find a similar pattern of results. When materiality is disclosed, participants judge the amount of sensitivity to be significantly lower in the *Low Sensitivity* condition compared to the *High Sensitivity* condition ($t_{108} = 2.71$, $p = 0.004$, one-tailed), but do not differentiate between *Low* and *High Sensitivity* when materiality is not disclosed ($t_{108} = 0.48$, $p = 0.631$, untabulated).

4.4. Test of H3

H3 predicts that investors' willingness to invest will be higher when a QSA is indicative of low sensitivity compared to high sensitivity and that this difference will be greater when materiality is disclosed compared to when it is not. Panel A of Table 2 provides descriptive statistics for investors' willingness to invest, and Panel B presents the associated ANOVA model. Although the *QSA x Materiality Threshold* interaction term is significant in the ANOVA model ($F_1 = 5.43$, $p = 0.022$), the form of the interaction is not consistent with our expectations.

²¹ Because H2 makes the prediction that one simple effect (*Low* vs. *High Sensitivity* when a *Materiality Threshold* is *Present*) will be larger than another simple effect (*Low* vs. *High Sensitivity* when a *Materiality Threshold* is *Absent*), we follow guidance from Guggenmos, Piercey, and Agoglia (2017), who indicate that such an interaction should be tested using the ANOVA interaction term.

Specifically, the *QSA* means in the *Materiality Threshold-Present* condition are not in the direction we predicted. Therefore, H3 is not supported.

[Insert Table 2 here]

4.5. *Supplemental Experimentation*

Results related to H2 suggest that when a *QSA* and materiality threshold are disclosed, investors perceive an estimate as significantly less reliable when the *QSA* is indicative of high sensitivity compared to low sensitivity. However, these reduced reliability perceptions in the *High Sensitivity* condition do not appear to deter investors' willingness to invest in the company (i.e., H3 is not supported). Although it is not clear precisely why investors' perceptions of reliability fail to "flow through" to their investment decisions in a predictable manner, this finding can be attributed to either a *conscious* preference on the part of some investors to invest in a company with greater estimation uncertainty (e.g., a higher risk/reward tradeoff) or an *unconscious* error in reasoning that prevents investors from translating their reliability perceptions into their investment decisions. As such, we conduct an additional experiment to examine whether participants' investment-related judgments are intentional. That is, we examine whether our finding that investors do *not* prefer to invest in a company with lower, compared to higher, estimation uncertainty is conscious (intentional) or results from unintentional bias.

Data for the primary study reported in this paper was collected in two rounds. Our additional experiment was administered in conjunction with the second round of data collection.²² Seventy-four participants completed the additional experiment, which immediately followed our primary experiment. Whereas our primary study manipulated *QSA* (*Low Sensitivity* or *High Sensitivity*) between-subjects, the additional experiment utilized a within-subjects

²² Round of data collection is not a significant covariate in any of the analyses reported previously.

manipulation. According to Kahneman and Tversky (1996), a between-subjects manipulation tests a participant's natural reasoning process, whereas a within-subjects manipulation makes the independent variables more salient to participants, allowing them to identify and correct any judgment biases or errors in reasoning that may exist. If we obtain different results related to H3 when sensitivity is manipulated within-subjects, compared to between-subjects, this would suggest that the between-subjects results are unintentional (Kahneman & Tversky, 1996; Libby, Bloomfield, & Nelson, 2002).

During the additional experiment, participants were told to consider two firms (Firm A and Firm B) that are identical, except for the sensitivity of a fair value estimate that appears on each firm's income statement. Participants were then presented with a QSA disclosure for each firm, where Firm A's QSA was identical to the *Low Sensitivity* manipulation from our original experiment, and Firm B's QSA was identical to the *High Sensitivity* manipulation. Thus, participants viewed both levels of our QSA manipulation simultaneously, and could decide which company they preferred.²³ Appendix C provides the full within-subjects manipulation. We then asked participants the following two questions regarding their willingness to invest in Firm A (*Low Sensitivity* disclosure) or Firm B (*High Sensitivity* disclosure): (1) "In your opinion, which firm is a more attractive investment?" and (2) "Assuming you had NOK 50,000 to invest in the common stock of Firm A or Firm B, which firm are you more likely to invest in?" We find that for both questions, a significantly greater proportion of participants prefer the firm with the low sensitivity disclosure (75.7 percent) compared to the firm with the high sensitivity disclosure (13.5 percent) ($\chi^2_1 = 56.57$; $p < 0.001$, untabulated), with 10.8 percent indicating no preference.

²³ We also provided participants with the auditor's quantitative materiality threshold for both companies, which was the same amount provided in the *Materiality Threshold-Present* condition in our main experiment. We chose to provide a materiality threshold because H3 predicts that differences in investors' willingness to invest between the *Low* and *High Sensitivity* conditions will be more pronounced when materiality is disclosed.

The results obtained on a within-subjects basis (i.e., a greater willingness to invest in a company with a QSA indicative of low sensitivity compared to high sensitivity) are inconsistent with results obtained on a between-subjects basis. This suggests that the between-subjects results obtained in our original experiment were unintentional. Specifically, participants are aware that companies with financial statements containing a lower level of estimation uncertainty are preferable for investment purposes; however, they are not able to access this information in their natural reasoning process (i.e., when evaluating only one company in isolation) (Kahneman & Tversky, 1996; Libby et al., 2002).²⁴ Given that most investment decisions are *not* made in isolation and often involve comparisons between companies, we believe our within-subjects experiment provides important insights regarding how QSA and materiality disclosures influence investment decisions by allowing investors to more easily compare the level of estimation uncertainty contained in different companies' financial statements.

5. *Discussion and Conclusion*

Over time, financial statements have begun to incorporate a greater amount of estimation uncertainty. As a result, investors often face the difficult task of making judgments and decisions based on inherently imprecise information. Although standard setters and regulators worldwide have considered mandating a number of disclosures to help users understand the uncertainty in audited financial statements, one concern is that individuals may still fail to understand and/or use this information once it is disclosed (Clor-Proell, Proell, & Warfield, 2014). To address this concern, we conducted a study that examined whether nonprofessional investors recognize

²⁴ As part of our within-subjects experiment, we also asked participants, “Which firm has a more reliable fair value estimate?” We find a significantly greater proportion of participants ($\chi^2_1 = 110.42$; $p < 0.001$, untabulated) believe the firm with the low sensitivity QSA has a more reliable estimate compared to the firm with the high sensitivity QSA (67.6 percent and 2.7 percent, respectively), which is consistent with our findings on a between-subjects basis and suggests the between-subjects results related to perceived reliability are consistent with participants’ intentions.

differences in estimation uncertainty more easily when a quantitative sensitivity analysis (QSA) and the auditor's materiality threshold are disclosed.

We found that investors generally perceive an estimate as more reliable when it is supplemented with a sensitivity analysis that is quantitative in nature, as opposed to being purely qualitative (as was the case in our *Control* condition). This finding suggests that QSAs provide an informative supplement to footnotes that otherwise would provide only a vague description of an estimate's sensitivity. Most importantly, we found that when *both* a QSA and a materiality threshold were disclosed, investors assessed the reliability of a reported fair value estimate to be significantly higher when the estimate was relatively precise (i.e., low sensitivity) compared to imprecise (i.e., high sensitivity). In the absence of a materiality disclosure, however, investors' reliability perceptions did not differ regardless of the level of uncertainty indicated within the QSA. These findings are particularly relevant given that financial statements frequently include uncertain estimates, but typically *exclude* QSA and materiality threshold disclosures, because such disclosures currently are not mandated by most standard setting bodies. Nonetheless, our results suggest that for nonprofessional investors to recognize differences in estimation uncertainty disclosed in sensitivity analyses, not only must this disclosure be quantitative in nature, but also supplemented with a disclosure of materiality.

Counter to our expectations, investors' willingness to invest was not deterred when the presence of extreme estimation uncertainty was disclosed most transparently (i.e., in the presence of a materiality threshold disclosure and a QSA indicative of high, as opposed to low, sensitivity). Even though investors perceived reliability to be significantly lower in the *High Sensitivity* condition, relative to the *Low Sensitivity* condition, when materiality was disclosed, these perceptions did not appear to “flow through” and influence investment decisions. However,

when differences in estimation uncertainty were made more salient with a within-subjects manipulation, we found results that were more consistent with our expectations, in that participants indicated a greater preference to invest in a company with a QSA indicative of low, compared to high, sensitivity.

Our finding that investment decisions were not responsive to the level of estimation uncertainty contained within financial statements is consistent with findings in the archival literature. Specifically, Richardson et al. (2005) find that security prices are not sufficiently reduced when financial statements contain highly uncertain estimates, even though such estimates are associated with lower earnings persistence. Our results suggest that this finding is likely driven in part by investors' failure to *recognize* the presence of low reliability estimates when additional quantitative disclosures (i.e., QSAs and materiality thresholds) are not provided. However, even when we provided participants with additional disclosures that helped them recognize the presence of a low reliability estimate, their willingness to invest still was not deterred. It was not until differences in estimation uncertainty were made more salient using a within-subjects design that participants' investment decisions reflected a strong preference for financial statements containing lower levels of estimation uncertainty.

Although our study provides important insights, it is also subject to certain limitations. First, participants in our study were provided with much less information than they might normally consider when making investment decisions. Although this approach may limit the generalizability of our results, it helps to ensure that participants acquire the pieces of information that are most important to our study, thus allowing us to examine how this information is used once it has been acquired (Clor-Proell et al., 2014). Second, we examined only two disclosures in our study. It is possible that other disclosures may also help investors

recognize differences in estimation uncertainty. These are questions for future research to explore. Finally, our study documented a potential advantage to disclosing materiality thresholds in the auditor's report; however, many other advantages as well as disadvantages likely exist. We believe that much more research is needed to fully understand the effects of materiality disclosures on the judgments and decisions of investors, auditors, regulators, and jurors.

Appendix A. Auditor's report containing the *Materiality Threshold* manipulation

Audit Opinion

We have audited the financial statements of King Fish Farming Group (the Group). In our opinion, the accompanying financial statements present fairly, in all material respects, the financial position of the Group at December 31, 20X2, and its financial performance and its cash flows for the year then ended in accordance with International Financial Reporting Standards (IFRSs) as adopted by the EU.

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the consolidated financial statements of the current period. One of the key audit matters in our audit of the Group relates to the estimation of the fair value of live fish inventory, as described below.

Adjustment of Live Fish Inventory to Fair Value

The Group values its inventory of live fish at fair value less costs to sell. Active markets for the future sale of live fish do not exist. Therefore, the Group estimates the fair value of live fish using a model that reflects the Group's own assumptions and projections.

The valuation of live fish and measurement of profitability critically depend on the current estimate of salmon and trout prices at the expected time of sale. Historically, salmon and trout prices have been subject to large fluctuations. The uncertain nature of market prices does not allow future sales prices to be estimated with certainty.

The fair value estimate of live fish is considered to be one of the most judgmental audit risks, as small changes in the assumptions used in the valuation (e.g., future sales prices) could have a significant impact on the Group's profitability. See note 1 to the financial statements for the disclosure of the accounting policies and management's estimation process related to the fair value of live fish.

Our Application of Materiality

We define materiality as the magnitude of misstatement in the financial statements that makes it probable that the economic decisions of a reasonably knowledgeable person would be changed or influenced. We use materiality both in planning the scope of our audit work and in evaluating the results of our work.

Materiality Threshold Manipulation

(viewed by participants in the Materiality Threshold–Present condition only)

We determined materiality for the Group to be **NOK 44 million**, which is approximately **5%** of profit before tax.

Bergen, 20 March 20X3

Big 4 accounting firm

Knut Johansen

State Authorized Public Accountant (Norway)

Appendix B. Footnote disclosure containing the QSA manipulation

NOTE 1. Live fish inventory (Extract)

The following table provides a reconciliation of the beginning and ending balances for live fish inventory.

(All figures in NOK 1 000)	
Beginning balance of live fish inventory at 01.01.20X2	3 082 219
Increase due to inventory costs added during the year	4 860 324
Reduction due to sale of fish inventory	-4 783 276
Adjustment of live fish inventory to fair value (profit impact)	383 156
Ending balance of live fish inventory at 31.12.20X2	3 542 423

The Company recognizes live fish inventory at fair value less costs to sell. Active markets for the future sale of live fish do not exist, so the calculation of fair value is carried out using a valuation model (level 3 in the valuation hierarchy) where the relevant inputs (e.g., future market prices) are primarily unobservable and uncertain.

NSA Disclosure

(viewed by all participants)

In 20X2, the Company recorded a gain of NOK 383 million to adjust live fish inventory to fair value, which directly impacts operating profit reported for the period. The amount of this adjustment critically depends on the estimate of future salmon and trout prices at the expected time of sale. Because salmon and trout prices are subject to reasonably large fluctuations, even minor changes in the estimated market price of fish used in our valuation model may result in significant changes in operating profit reported for the period.

QSA Manipulation

(participants not assigned to the Control condition viewed either the Low or High Sensitivity QSA)

The sensitivity of operating profit to changes in estimated future fish prices

The table below shows the amount by which operating profit for 20X2 would change if the estimated future market price of fish used in our valuation model had been higher or lower by 4% and by 20%.

Low Sensitivity

	4% price change	20% price change
Change in operating profit (in NOK 1 000)	+/- 4 380	+/- 21 900

High Sensitivity

	4% price change	20% price change
Change in operating profit (in NOK 1 000)	+/- 71 936	+/- 328 549

Appendix C. Within-subjects manipulation of *QSA* (*Low Sensitivity* versus *High Sensitivity*)

Consider two firms (Firm A and Firm B) that are identical, except for the sensitivity of a fair value estimate that appears on each firm's income statement. Below is a sensitivity analysis for each firm that shows the amount by which operating profit would change if an important input used in the company's fair value model had been higher or lower by 4% and by 20%.

Firm A's Sensitivity Analysis (in NOK 1 000):

	4% change in a fair value model input	20% change in a fair value model input
Change in operating profit (in NOK 1 000)	+/- 4 380	+/- 21 900

Firm B's Sensitivity Analysis (in NOK 1 000):

	4% change in a fair value model input	20% change in a fair value model input
Change in operating profit (in NOK 1 000)	+/- 71 936	+/- 328 549

Assuming that the auditors for both Firm A and Firm B determined materiality to be **NOK 44 million** (reflecting 5% of profit before tax), please answer the following questions:

In your opinion, which firm is a more attractive investment?

- ☐ Firm A is more attractive.
- ☐ Firm B is more attractive.
- ☐ Firm A and Firm B are equally attractive.

Assuming you had NOK 50,000 to invest in the common stock of Firm A or Firm B, which firm are you more likely to invest in?

- ☐ I am more likely to invest in Firm A.
- ☐ I am more likely to invest in Firm B.
- ☐ I am equally likely to invest in Firm A or in Firm B.

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Exhibit 1

Narrative (qualitative) versus quantitative sensitivity analyses.

Panel A: Example of a narrative sensitivity analysis (NSA)

“The significant unobservable inputs used in the fair value measurement of the reporting entity’s residential mortgage-backed securities are prepayment rates, probability of default, and loss severity in the event of default. Significant increases (decreases) in any of those inputs in isolation would result in a significantly lower (higher) fair value measurement.”

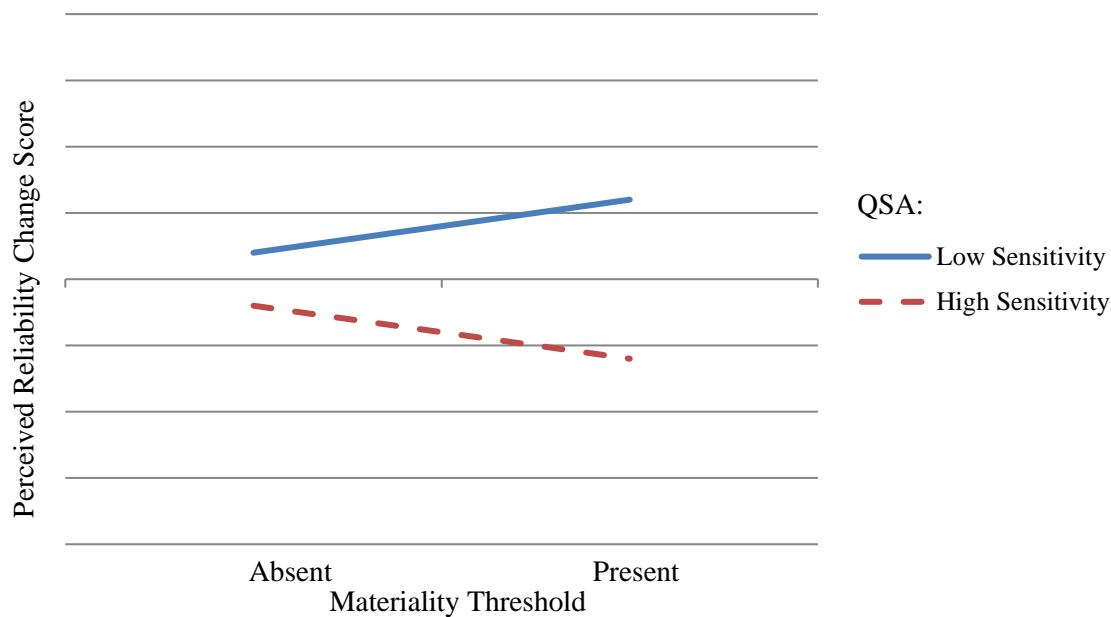
Panel B: Example of a quantitative sensitivity analysis (QSA)

The following table summarizes the potential impact as of October 2, 2016 to Starbucks future net earnings...from changes in commodity prices. The information provided below relates only to the hedging instruments and does not represent the corresponding changes in the underlying hedged items (*in millions*):

	Increase/(Decrease) to Net Earnings	
	10% Increase in Underlying Rate	10% Decrease in Underlying Rate
Commodity hedges	\$ 12	\$ (12)

Exhibit 1 provides examples of a narrative sensitivity analysis (NSA) and a quantitative sensitivity analysis (QSA). The NSA disclosure in Panel A is an illustrative example provided by the FASB (2011, p. 128) within ASU No. 2011-04. The QSA disclosure in Panel B is an excerpt from Starbucks’s 10-K for the year ended October 2, 2016.

Panel A: H2 interaction prediction



Panel B: H2 interaction results

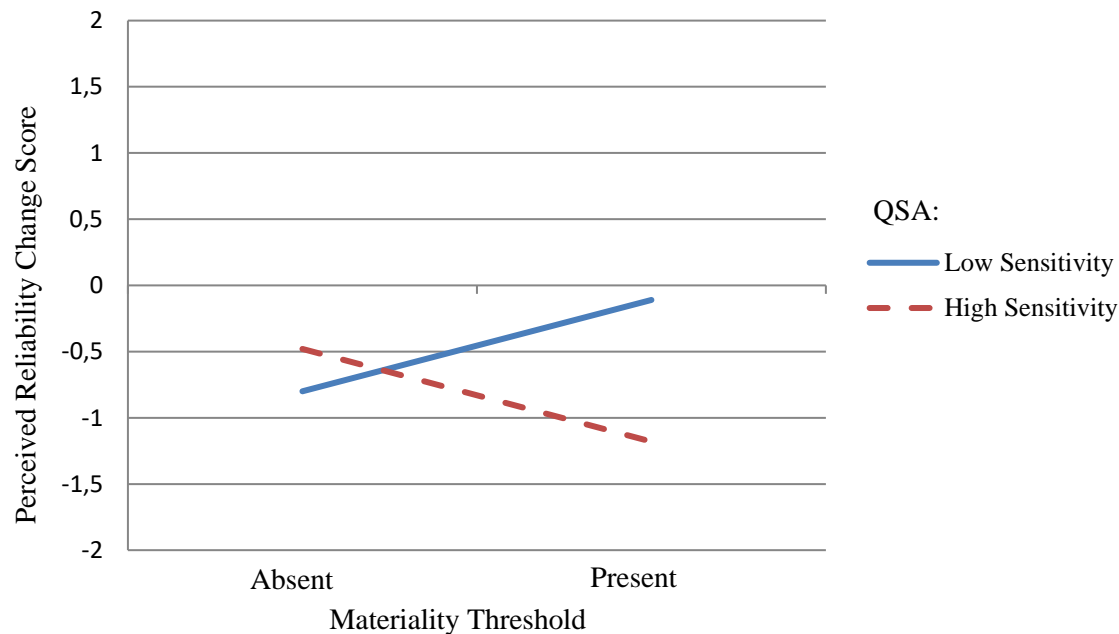


Fig. 1. H2 prediction and results: Interaction of *QSA* and *Materiality Threshold*.

QSA – The quantitative sensitivity analysis disclosure was manipulated at two levels: *Low Sensitivity* vs. *High Sensitivity* by varying the sensitivity of operating profit to changes in an underlying fair value input. *Materiality Threshold* – Manipulated at two levels: *Absent* vs. *Present* by varying whether the audit report contained a disclosure of the materiality threshold used for the audit.

Perceived Reliability – Change in reliability perceptions from before to after participants viewed a sensitivity analysis (using an 11-point scale where 1 = "Not at all Reliable" and 11 = "Very Reliable").

Table 1

Effect of *QSA* and *Materiality Threshold* disclosures on the perceived reliability of an uncertain estimate.

Panel A: Mean (Standard Deviation) of Perceived Reliability^a

	Materiality Threshold - Absent			Materiality Threshold – Present	
	No QSA ("Control") (n = 28)	Low Sensitivity (n = 25)	High Sensitivity (n = 31)	Low Sensitivity (n = 28)	High Sensitivity (n = 28)
Pre-treatment	5.07 (1.78)	4.84 (1.86)	4.58 (1.77)	4.11 (1.55)	5.04 (1.55)
Post-treatment	3.86 (1.58)	4.04 (2.01)	4.10 (1.51)	4.00 (1.66)	3.86 (1.63)
Change score	-1.21 (1.23)	-0.80 (1.85)	-0.48 (1.84)	-0.11 (1.42)	-1.18 (1.52)

Panel B: ANOVA Table – Perceived Reliability Change Score^a

Source	df	SS	F	p-value
QSA	1	3.97	1.43	0.235
Materiality	1	0.00	0.00	0.998
QSA x Materiality	1	13.40	4.82	0.030
Error	108	300.53		

Panel C: Planned Contrast and Simple Effects

Comparison	df	t	p-value
Materiality-Absent: Control < Low & High Sensitivity (H1)	135	1.55	0.061*
Materiality-Present: Low > High Sensitivity (H2)	108	2.40	0.009*
Materiality-Absent: Low = High Sensitivity (H2)	108	0.71	0.482

QSA – The quantitative sensitivity analysis (QSA) disclosure was manipulated at two levels: *Low Sensitivity* vs. *High Sensitivity* by varying the amount by which operating profit would change as the result of changing the value of an underlying input used to calculate the fair value estimate.

Materiality Threshold ("Materiality") – The materiality threshold was manipulated at two levels: *Absent* vs. *Present* by varying whether or not the audit report contained a disclosure of the quantitative materiality threshold used for the audit.

Perceived Reliability – The perceived reliability change score was measured by asking participants their perceptions regarding the reliability of an uncertain estimate using an 11-point scale where 1 = "Not at all Reliable" and 11 = "Very Reliable." This measure was elicited before (i.e., pre-treatment) and after (i.e., post-treatment) participants viewed a sensitivity analysis disclosure, and a change score was calculated.

^a The "Control" condition was dropped for purposes of the 2 × 2 ANOVA model.

*Consistent with our directional predictions, p-values presented are one-tailed.

Table 2Effect of *QSA* and *Materiality Threshold* disclosures on willingness to invest.Panel A: Mean (Standard Deviation) of Investors' Willingness to Invest^a

Materiality Threshold - Absent			Materiality Threshold – Present	
No QSA ("Control") (n = 28)	Low Sensitivity (n = 25)	High Sensitivity (n = 31)	Low Sensitivity (n = 28)	High Sensitivity (n = 28)
6.45 (1.94)	6.24 (1.04)	5.82 (1.64)	5.73 (2.03)	6.73 (1.49)

Panel B: ANOVA Table – Willingness to Invest^a

Source	df	SS	F	p-value
QSA	1	2.36	0.92	0.341
Materiality	1	1.12	0.44	0.511
QSA x Materiality	1	13.98	5.43	0.022
Error	108	278.32		

QSA – The quantitative sensitivity analysis (QSA) disclosure was manipulated at two levels: *Low Sensitivity* vs. *High Sensitivity* by varying the amount by which operating profit would change as the result of changing the value of an underlying input used to calculate the fair value estimate.

Materiality Threshold ("Materiality") – The materiality threshold was manipulated at two levels: *Absent* vs. *Present* by varying whether or not the audit report contained a disclosure of the quantitative materiality threshold used for the audit.

Willingness to Invest was measured based on participants' average response to the following two questions: (1) "In your opinion, how attractive is KFFG as an investment?" and (2) "Assuming you had NOK 50,000 to invest in the common stock of one or more companies, how likely are you to invest a portion of this amount in the common stock of KFFG?" Responses to these questions were collected on 11-point scales with endpoints labeled "1 – Very Unattractive (Unlikely)" and "11 – Very Attractive (Likely).

^a The "Control" condition was dropped for purposes of the 2 × 2 ANOVA model.

All p-values presented are two-tailed.

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